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Impact of Smart Grid Initiatives on SCADA/EMS

11th International Workshop on

Electric Power Control Centres

23-25 May, 2011 Altea, Spain

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What is SCADA/EMS?

- SCADA/EMS is hardware & software system to monitor and control the power system:

- Purposes of SCADA are:
  - Data acquisition
  - System Monitoring
  - System Controling

- Purposes of EMS are:
  - To balance between load and generation
  - To look after power system security

How Smart Grid Initiatives Impacts SCADA/EMS ?

- Broadly, Smart Grid may be defined as, improvement of efficiency in generation, transmission and distribution systems, leveraging the latest technological developments
- In this presentation we are focusing mainly on the areas of improvement for SCADA/EMS system in respect of:
  - Accomodating maximum amount of renewable energy in power system for reducing carbon foot print in the climate

How Smart Grid Initiatives Impact SCADA/EMS ?

  - Having dynamic state of the system (enhancing the data sampling resolution) for situational awareness
  - Making data acquisition simple and standarised by way of Sub-station Automation (SA)

- First two developments are related to transmission system operation – improvement in EMS contro system applications
  - SA is related to recent developments standarised through IEC 61850
- Overview of mentioned three Smart Grid developments for SCADA/EMS are discussed in following slides

EMS application related issue - wind energy dispatch

- Generation dispatch is a function of EMS is used for balancing load and generation in real time, by way generation dispatch scheduling
- For generation scheduling, EMS uses Unit Commitment (UC) application
- Same way, load forecasting application used in EMS for load predictions
- For load forecasting there are established, time tested algorithms are available for long terms as well as short term load predictions

Issues related to wind energy dispatch

- Wind energy commitment can not be done in the same way of conventional generation resource commitment; as availability of wind energy is full of uncertainity
- Same time smart grid objective is, to maximize the utilisation of wind and other renewable energy at any time for reducing the Carbon in the climate
- Therefore, modern EMS should have wind energy forecasting, rather wind energy commitment
- Wind energy forecasting essentally will be based on the parameters of weather forecasting

Issues related to wind energy dispatch

- Wind energy forecasting will determine the speed of the wind; when, how much for a plant site?
- A plant output look up table required to be developed for each specific plant depending wind speed
- From dispatching point of view, operator has to keep ready his plan for accomodating maximum wind energy in the grid
- This plan may include topological change in grid, regulation of conventional resources, market systems for providing ramping down the conventional plants, reactive power regulations etc.

SCADA developments by PMU

- Power system security assessment starts with the determination of the state of the system by state estimator
- Estimator determines the state of the system, based on the real time measurements
- Traditional SCADA measurements resolution or sampling interval spans from 4 -10 seconds or more depending on data communication configuation and infrastructures

Impact of PMU on SCADA/EMS applications

- Therefore, inconsistencies are common phenomena due to the time skewness in the SCADA measurements
- Consequence of time skewed measuremet is; solution inaccuracy in state estimator due to low resolution SCADA measurements
- This phenomena of inconsistency is more dominanat; especially in the situation of generating units ramp up and ramp down condition.

Impact of PMU on SCADA/EMS applications

- To avoid the mentioned inconsistent situation, state estimator may uitilize the time synchronised PMU measurements which are accurate, also high resolution in nature
- In addition to the traditional SCADA voltage and power flow measurements, state estimator can utilize the bus angle (phasor) measurements of PMU for improving solution accuracy and enhancing the solution robustness

Impact of PMU on SCADA/EMS applications

- Traditional Weighted Least Square (WLS) algorithms of state estimator need to be modified to take into account of bus angle measurements available from synchro-phasors
- Integration of PMU measurements with traditional SCADA/EMS measurements will enhance the state estimator solution quality
- Trending of PMU located sub-stations measurements offer near dynamic view of system behaviour, during the disturbance
- Network data model of EMS can be validated by PMU measurements
- In addition to the above, PMU measurement can be utilised for grid network protection
- Relative angle diffrence of two buses; offer an indication of security margin available in the grid network

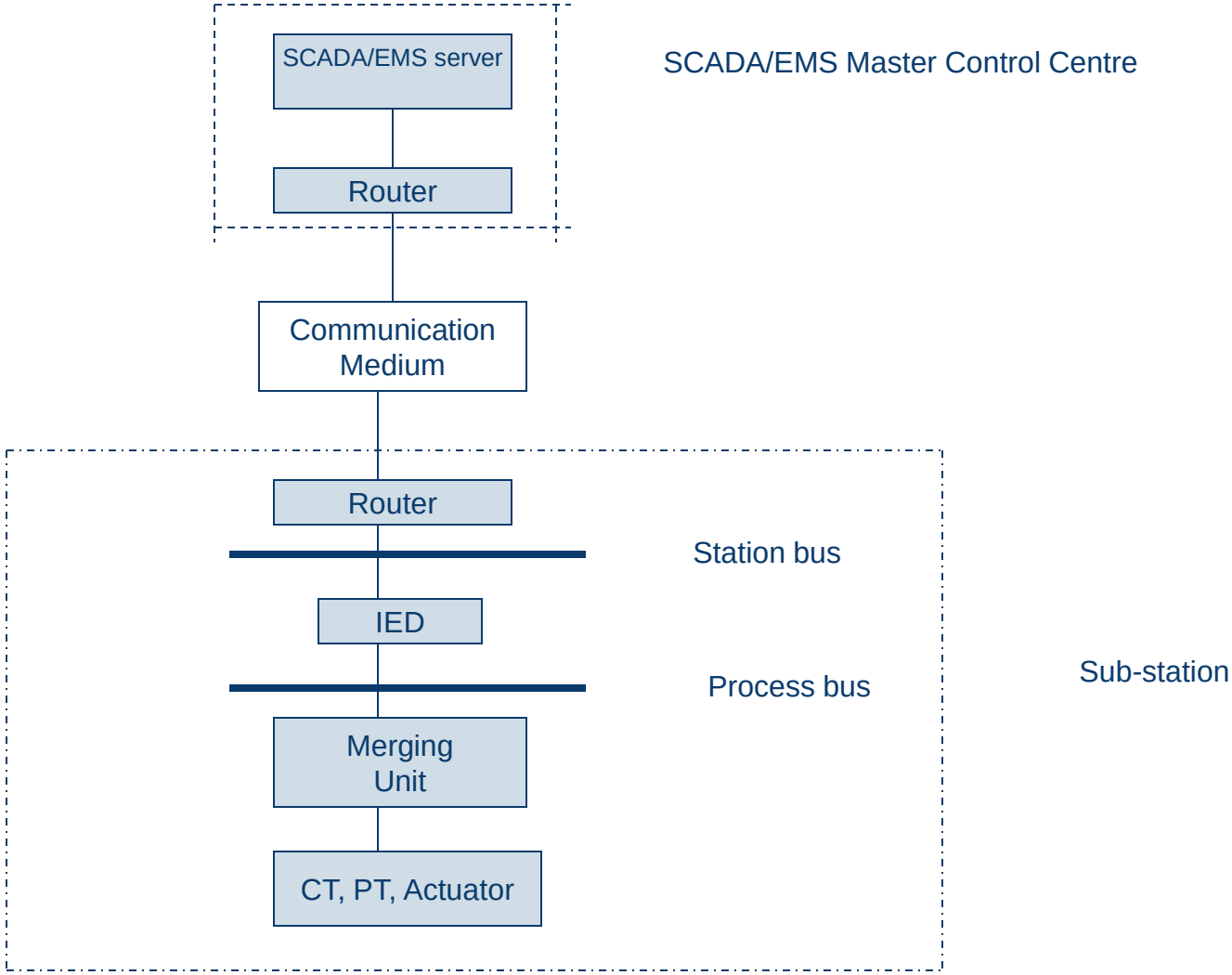
Data acquisition developments by Sub-station Automation (SA)

- SA is hardware & software system enabling electric utility to remotely monitor control & co-oridinate the equipments installed in the sub-station

- High speed microprocessor based Intelligent Electronic Devices (IED) are used for protection & control of sub-station feeders
- Merging Units (MU) are used for collecting measurements (analog & staus) values

- Data acqusition path can be described by the following block diagram

Sub-station Automation Block Diagrams



Data acquisition developments by Sub-station Automation (SA)

- There are three levels defined in IEC 61850 depending on secondary equipments and functions for SA
  - Process level – interfaced with primary equipment (CB, Trafo, lines etc) through sensors & actuators are called Merging Units (MU)
  - Bay level – comprised of protection & bay controllers – these are basically called IED
  - Top level – sub-station Master Control Center (MCC). This level comprised of HMI (operators console), Data server, data gateway to SCADA/EMS control center, engineering console

Data acquisition developments by Sub-station Automation (SA)

- SA logical and physical configuartions, project implementation strategy, database modeling, logical device and nodes naming conventions, communication protocols and other related issues are standarised through IEC 61850
- Different parts of 61850 standards deals with different aspects, described as follows:
- System Aspects
  - Part 1: Introduction and Overview
  - Part 2: Glossary
  - Part 3: General Requirements
  - Part 4: System and Project Management
  - Part 5: Comm. Requirement for Functions and Device Models

Data acquisition developments by Sub-station Automation (SA)

- Configuration
  - Part 6: Configuration Language for electrical Substation IEDs
- Abstract Communication Services
  - Part 7-1 Principles & Models
  - Part 7-2: Abstract Communication Services (ACSI)
- Data Models
  - Part 7-3 Common data classes
  - Part 7-4: Compatible Logical Node

Data acquisition developments by Sub-station Automation (SA)

- Mapping to real Comm. Networks (SCSM)
  - Part 8-1: Mapping to MMS
  - Part 9-1: Sampled Values over Serial Uni-directional Multi-drop Point-to-Point link
  - Part 9-2: Sampled values
- Testing
  - Conformance testing

Standarisation of Sub-station Automation

- Benifits of sub-station automation are listed as follows:
  - Sub-station automation has been realised through low cost hardwares like, LAN switches, Merging Units (MU), IED (digital relays, bay controllers)
  - LAN based sub-station automation is very easy to install, configure, and maintain
  - Interoperability of different devices are possible in SA
  - Standard namming conventions of equipments reduces the time and cost of database building
  - Extension or augmentation of SA can be done very easily
  - These benifits of 61850 are least but not last

Conclusions

- Three major Smart Grid developments; wind energy, Phase Measurements Units (PMU) and SA are discussed in brief
- These developments have considerable impact on SCADA/EMS design
- Modern SCADA/EMS has to address the these Smart Grid aspects while designing the system.

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Thank you for your attention

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