Power Grid Dynamic Monitoring and Disturbance Identification

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Outline

- Overview of PMU/WAMS
- Disturbance Detection by WAMS
- Oscillation Detection & Analysis by WAMS
- Conclusion and Future Work
Development of PMU/WAMS in China

First China PMU was developed in Tsinghua Univ.

Planned 500kV line phase to ground test was made to identify dynamic model parameter

Role of PMU&WAMS was emphasized after blackouts in North America and Europe in 2003

Operation of 1000kV UHVAC pilot project was monitored by WAMS

Operation of Three Gorges Hydro-plant was monitored by WAMS

Serious contingency event in Central China was recorded by WAMS

WAMS being integrated as a part of SG-OSS
PMU Coverage in China

Northwest: 272
Northeast: 291
Central: 341
North: 312
East: 147

500kv
1000kv
330kv

Fossil-fuelled power plant
Hydraulic Power plant
Nuclear power plant
Substation

China State Grid
China Southern Grid
WAMS Architecture in Control Center
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Disturbances Encountered by Dispatchers

- Short circuit faults
- Generator tripping
- HVDC blocking
- etc.
Short Circuit Fault Identification

- Fault line recognized by features of curves
  - Before faults, the voltage and current of each phase are kept within normal range;
  - When fault occurs, sudden change of certain phase current is larger than threshold;
  - During fault, current of certain phase decreases to zero due to action of protection relay, voltage of certain phase also decrease remarkably
Direct Detection of Line Fault

Line single phase to ground fault

Alarm offered by WAMS
Direct Detection of Line Fault

Phase A Voltage

Phase A Current
Fast Short Circuit Fault Positioning

- Visualizing node voltage variations by contour map, some fault information on lower voltage level without PMU can be obtained quickly.
Generator tripping & HVDC blocking detection recognized by features of curves

- Before event, output active power and positive sequence current both are larger than threshold;
- When event occurs, active power decreases to zero, and positive sequence current decreases to zero
Generator Tripping

Generator tripping event

Alarm offered by WAMS
Generator Tripping

Active Power

Pos. Seq. Current
HVDC Blocking

HVDC Blocking event

Alarm offered by WAMS
HVDC Blocking
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Low Frequency Oscillation in Power Grid

- Nature problem of modern interconnected power grid
- Endangers the power grid operation and restrict the power transfer capability
- Dispatcher should know what happens and take some measures if necessary
Low Frequency Oscillation Monitoring

- Detect occurrence of oscillation and involved buses/lines
- Coherent bus grouping and visualization
Enhancing WAMS Analysis Result by Online Simulation

- Match the WAMS result with online simulation result by detected oscillation frequency
- Detailed information about generator participation can be provided by online simulation
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Conclusion and Future Work

Through the history of PMU/WAMS deployment and application, dynamic monitoring function offered by PMU/WAMS plays an important role in power grid operation.

Further work such as model parameter identification, wide area real time coordinated control, power grid data mining among multiple data source, is being taken and outcome of some pilot projects has been proved to be fruitful.
Thank you!