

Study Committee B5-PS3

Integration of Intelligence on Substations (Joint PS with B3)

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Implementation of Protection Operation Analysis and Fault Management System Based on Fault Data Aggregation and Detailed Digital Simulation

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Motivation

The work is devoted to specifics of implementation of new protection operation analysis and fault management system (POA FMS),

deployed by the System Operator of the United Power Systems of the Russian Federation.

Prerequisites for the implementation of POA FMS:

- timely detection of incorrectly functioning relay protection considerably reduces the risks of power system blackouts
- availability of comprehensive information about fault events and means of their simulation, including simulation of relay protection actions
- updating the utilities standards in terms of the requirements for the fault events data collection and corresponding data exchange between the power industry entities and the System Operator
- availability of CIM-based power system model ready for detailed protection modelling

Objects of investigation

POA FMS is a part of an informational environment where various services are interconnected via CIM based on IEC 61970 and IEC 61968.

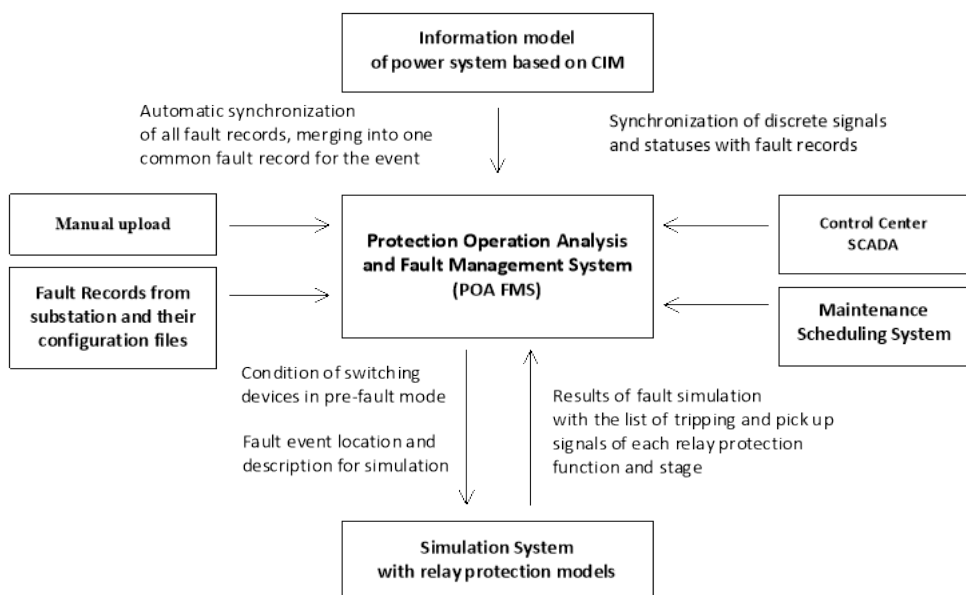
Positive effects:

- reducing time and costs of the initial data engineering
- synchronization and unification of information

Fault records are the main input data for the fault event analysis. POA FMS processes fault records in COMTRADE.

Control Center SCADA is the source of the following discrete signals needed for analysis:

- statuses (In service/Out of service) of power lines, primary equipment and breakers
- signals of primary equipment fault tripping
- statuses of relay protection devices (In service/ Out of service)



Method/Approach

Important part of the analysis is the verification of measured phasors. This is done to

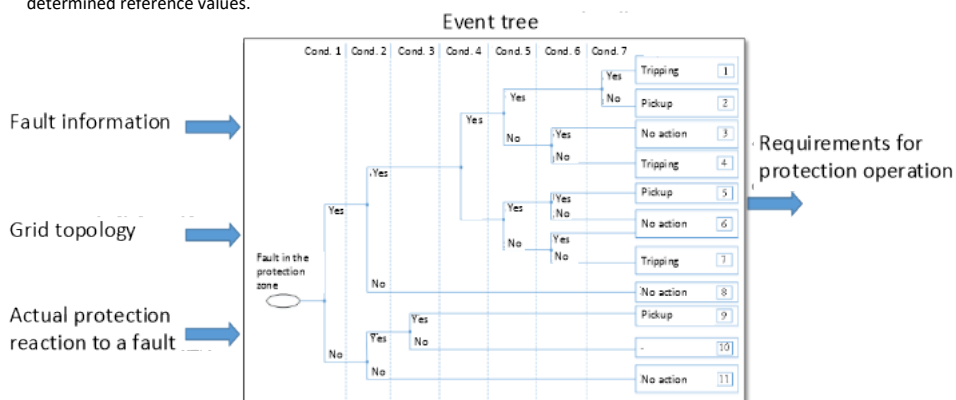
- detect a malfunction of the measurement circuits
- conduct subsequent analysis based on reliable data

Verification is made by comparing phasors with determined reference values.

POA FMS analyzes correctness of each relay protection function operation during event. It is performed by the two methods:

- Event Tree Analysis
- Detailed protection device simulation

Finally, the manual expert requirement on protection operation has priority over automatic requirements.



Experimental setup & test results

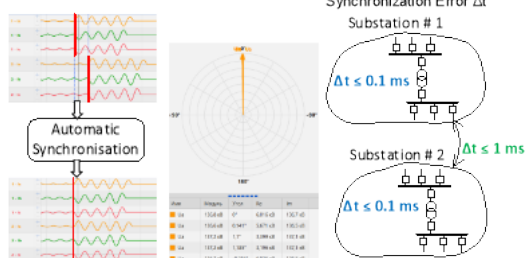


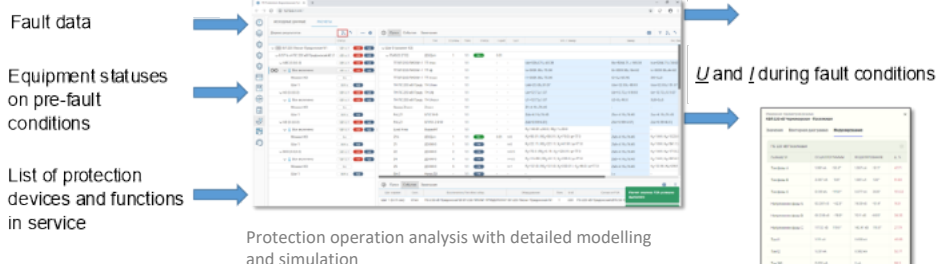
Illustration of automatic fault records synchronization

Discussion

The analysis using detailed modelling is predictive one and enables detection of hidden failures in relay protection functioning, such as:

- errors in settings and in relay protection design
 - incorrect settings group
 - non-conformance of actual settings in device with reference settings
 - errors in protection algorithms and logics
- malfunctions of secondary measurement circuits
- incorrect operation of protections in conditions of transients in the network (incorrect operation of protections in dynamics)

Power system Simulation with detailed protection models



Conclusion

Successful deployment of POA FMS was ensured by its integration into the CIM model based on IEC 61970 and IEC 61968.

Use of POA FMS enables achieving the following effects:

- automated collection and analysis of fault data that reduces time required for further follow-up actions and restoration planning in the grid
- detection of hidden failures and incorrect settings of protection devices that contributes into enhancement on overall power system reliability