KES

Kajganic Energy Systems

EMS/DMS Applications

Software Development and Engineering the Future

October 2015

Why Distribution/Energy Management System?

- Distribution management system enables
  - Real-time network monitoring and control
  - Improve Network efficiency and reliability
    - Loss reduction
    - Safety network operation
    - Minimization of outage time
    - Reduction of energy costs
  - Operation optimization
  - Dynamic and automatic decision making
  - Act as decision support system to assist the dispatcher

Our Company and Philosophy

- Experts in the field of EMS and DMS with more than 20 years of experience
- We design and implement innovative applications for energy systems, to help our customers to breadth in their engineering discipline, understanding the critical role of the environment in energy systems, including economic factors.

KES - Objective, products and services

- We aim to improve the network operation and data management by implementing low-cost high technological solutions
  - Single-user SCADA
  - Main applications for EMS/DMS
    (state estimation, optimal feeder reconfiguration, loss minimization, OPF, etc.)
  - Expert advice
    (Technical and economical network assessment, Network modelling, data cleaning and collecting, operator training)

- Main features
  - Applications are independent from operating system (Windows, Linux, etc.)
  - Supports wide possibilities of database (Firebird, Oracle, SQL, MySQL, etc.)
  - Applications are modular and scalable according to the economic budget
    (improvements of existing applications and addition to new ones easy to implement)
  - All applications supports open source as well as commercial solvers
    - Third part software can be license free (no hidden costs)

→ Low implementation cost that are also compatible with existing equipment and data

SCADA System

- Single-user SCADA for substation use incorporating latest technology

Main features

- Supports main communication protocols including the latest one (IEC 61850)
- Independent from operating system (works under Windows, Linux, Raspberry PI, etc.)
- Supports a wide possibilities of database (Firebird, Oracle, SQL, MySQL, Postgres, etc.)
  - Flexible choice depending on specific requirements
- Interface to real-time database → easy incorporation of external applications

Applications and advantages

- Primary SCADA: Online-system supervision and control
- Secondary SCADA: Online-system for supervision working parallel with primary SCADA
- Tertiary SCADA: System for historical data and report development

→ Automatization of information intake, reducing personnel burden

→ Possibility of retrieving much more information enabling historical trends and reports

→ First step to achieve a distributed architecture, which enables to take autonomous and independent decisions without involving the main SCADA (Smart Grid)

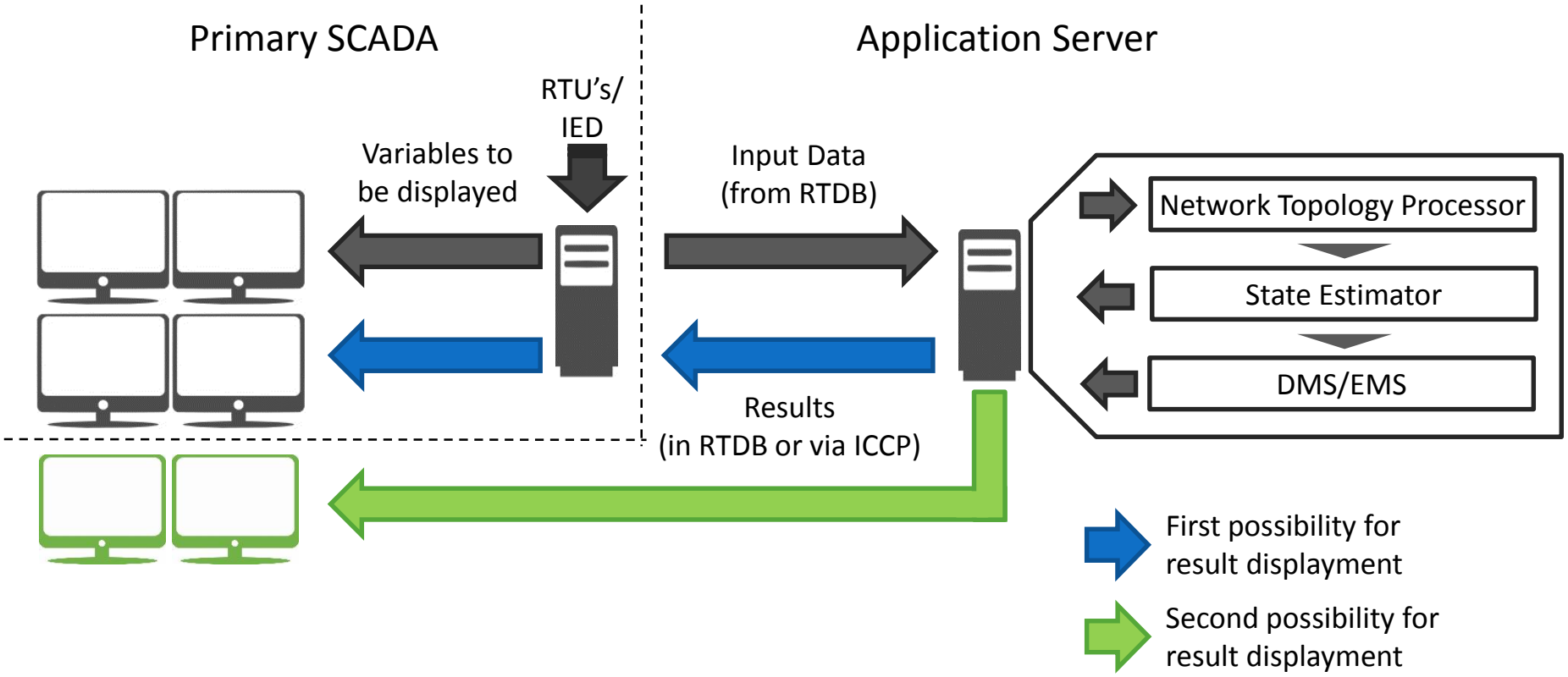
Basic DMS application - State Estimation

- Real time State Estimation is the essential tools for monitoring, analysis, controlling and optimizing the power system operation
- Input data
  - Topology and network parameters (PI models of lines, transformers, reactive power resources)
  - Signalizations for Network Topology Processor (disconnectors and circuit breakers)
  - RTU measurements (P, Q, I, tap position) and injections and load in each branch
- Results (in real time, every 5 minutes)
  - Voltage (magnitude and angle) at each node
  - Reliability results of input parameters
- Presentation of results (3 possibilities):
  - In main screen (results are saved directly in the real time database as new measurements, which are included in the GUI)
  - Sending the data via ICCP to the main SCADA System and showing the results as an adjacent network
  - Presentation of the results in an independent system (first in HTML and latter in GUI)

→ Implementation of the SE is first stage for implementing further DMS applications

Implementation of State Estimation and further DMS/EMS Tools

- Basic schema of proposed solution



- Minimum interference with main SCADA System
  - Access to real-time database
  - Saving results in real-time database (if desired)

Implementation phases - State Estimator (1/2)

Feasibility study

- Verify access to real time database
- Data gathering (measurements, topology, network parameters)
- Test of Unix system
  - Compile database and solvers for the optimization tool
  - Verify the quality of the solutions (comparison with proven Linux system)
- Check technical feasibility of possible solutions to present the results
  - In main SCADA System (through virtual measurements or via ICCP)
  - In separate screen (first HTML, then GUI)
- Definition of procedure and tests for data cleaning, and of minimum criteria to define a solution as acceptable
  - Disconnection of lines, increase of generation/load
- Results of the feasibility study
  - Technical viability of implementing DMS tool in current system (if not possible → technical reasons and alternative solutions)
  - Hardware requirement to implement the solution
  - Concrete example of how interface would look like

Implementation phases - State Estimator (2/2)

State estimator implementation (~ 6 months depending on scope)

- Data conversion to internal format (topology, network parameters, measures)
- Development of tool for obtaining snapshot of the network (dimensions, load, injections and signaling)
- Adjustment of State estimator to topology and network measures
  - Development and compare results
- Development of tool for presentation of results (GUI or interface to external system)
- Data cleaning and adjustment of parameters
  - Iterative test according to previously determined procedures, to meet the defined criteria
- For implemented state estimator, incorporation with other EMS/DMS tools is easy and fast
  - GUI to present results regardless of SCADA master (if required)
  - Load Flow Calculation, Contingency Analysis
  - Voltage Var Control, etc.

Advanced applications - Power Flow and Contingency Analysis

- Real time Power Flow and Contingency Analysis (running every 5 to 10 minutes) enables to detect hazard situations that may compromise the safety of the network

Main features

- Verification of (n-1) security criteria
  (failure simulation of lines, cables, transformers, generating units, etc.
- Analysis of cascading contingency
- Not only three-phase load flow possible, but also single-phase (optional)
- Dynamic response of the network to disturbances/events

Requirements

- Access to real-time database (for online application)
- Accurate network model, suitable for dynamic analysis
  - Positive, negative and zero sequence impedance models of network elements
  - Frequency response tests for generators to determine transfer functions
  - Dynamic simulations: Electromagnetic transient, stator transient and damper are neglected

Advanced applications - Feeder Reconfiguration

- Large industrial networks have many possibilities for the load supply, depending on the feeder configuration
- Feeder configuration also affects the single-phase loading of network elements
- Suboptimal feeder configuration can cause
  - Unbalanced loading of network elements (three-phase and single-phase)
  - High asymmetrical network operation

→ Risk of overloading network elements and high network losses

Main features

- Real time optimal feeder reconfiguration package (running every 5 to 10 minutes) gives proposals for feeder reconfiguration in order to
  - Achieve balanced loading of the network elements (three-phase model)
  - Reduce asymmetrical network operation (single-phase model)
- Benefits
  - Reduce risk of single and three-phase overload of any equipment
  - Prevent excessive heating of underground cables
  - Reduce energy losses (side effect)
  - Reduce electromagnetic interference

Advanced applications - Loss Minimization

- Large amounts of energy transfer over long distances produce significant network losses, resulting in higher energy consumption

→ Loss reduction can significantly decrease costs of energy consumption

Main features

- Loss minimization package gives proposals for operating decisions in order to reduce the network losses, through
  - Topology changes (switches and feeders)
  - Optimal tap configuration of transformers
  - Optimal operation of reactive power resources (condensers, reactors)

- Based on the availability/hardware, automatic decisions also can be taken in a close loop

- Loss Minimization package is similar to feeder reconfiguration, but especially designed to minimize the losses of lines and transformers

Advanced applications – Short circuit/Earth fault localization

- Short circuit and earth faults in compensated network require large time to localize the fault
- Depending on the position of the circuit breakers and operational topology configuration, short circuits may cause loss of supply for complete radial feeder and the loads connected to it
- → Faster localization, isolation and restoration of the faultless section of the network can reduce the outage time and the loss of load significantly

Main features

- In case of non-telemetered fault indicator relays, interactive localization is possible
- Keeps the history of fault cases and localize the fault progressively
- Gives switching proposal to isolate and restore the healthy section of the network

Requirement

- Earth fault and short circuit indicator in field (telemetered or non-telemetered)

Voltage VAR Control (VVC)

- One of the quality aspects of the power supply task is to maintain the desired voltage profile up to the consumer
- → With certain combination of capacitor bank switching and transformer taps, to achieve the desired voltage profile may be possible

Main features

- Optimization of transformer taps and switching of capacitor bank together to achieve desired voltage profile
- Desired voltage profile can be configured by operator on run time

Side Advantage

- Based on available generation in the grid, the overall load in the system can be reduced by configuring the desired voltage profile to the minimum without violating protection limits

Advanced applications - Optimal Power Flow

- Large freedom of degree to influence the network operation
  - Operating voltage (through tap of transformers)
  - Network topology (through network switches and feeder configuration)
  - Operation of reactive power resources (condenser, reactors)
  - Operation of available generating units
  - Load shedding

→ Optimal network operation can significantly reduce overall energy costs

Main features

- Optimal Power Flow Package determines the optimal network operation in order to
  - minimize costs,
  - maintaining the security and reliability of the network operation
- Much more powerful than Loss Minimization package, since it determines the optimal operation of own generating units as well as optimal load shedding
- Requirements
  - Hourly based generation and power price
  - Technical and economical parameters of available generating units
  - Proper model of water basin if hydraulic generating units available

Expert Advice - Data cleaning and collecting and operator trainee

- Most electrical network operators face the problem of not having accurate data of the network parameters
- Sound network model is the basis for the use of advanced EMS/DMS applications

- Offered solutions
- Expert advice in network modelling, data cleaning and collecting
- Operator training to maintain a sound database, as well as analysis of the network operation

Thank you for your attention

Contact us

Kajganic Energy Systems GmbH

Graudenzer Linie 43
68307 Mannheim, Germany
Phone: +49 621 4309631
Fax: +49 621 30787808
E-mail: info@kajganic.com
Web: www.kajganic.com