Application

The Optimal Power Flow (OPF) package offers a versatile and powerful functions for optimization of actual and future operating situations, addressing both active and reactive problems. The OPF calculates the values of control variables that minimize a desired objective, concerning security and/or economy of the power system operation, while respecting system operating limits. In case a limit violation cannot be avoided (infeasibility), a "best" alternative solution is generated.

The Dispatcher Power Flow (DPF), a sub-function of the OPF, is a powerful planning tool for interactive analysis of the changes in the power system operating conditions. The DPF computes the system power flow taking loss of transmission capability, change of generation, load and area interchange into account. The Dispatcher Power Flow function or the State Estimator function provides a base solution for the OPF.

Benefits

- Evaluation of the current performance of the power system.
- Provides means for operating closer to the power system limits.
- Reduces the production cost and losses.
- Prioritisation of different control devices in enhancing the system security.
- Identification of transmission bottlenecks in the power system.
- Development of corrective strategies for both active and reactive power in the event of system operating constraint violation.
- The solutions is based on PCA's state-of-the-art algorithms.
Functions

Optimization objectives
- Minimum costs of generation, ensuring that no system active power operating constraints are violated.
- Real power loss minimization, ensuring that no system reactive power operating constraints are violated.
- Minimum generation cost plus minimum MW loss, ensuring that all system operating constraints are satisfied.
- Feasibility solution is derived such that the change between the solution point values of the control variables and their power flow solution values are minimum, ensuring that all system operating constraints are satisfied.
- Security optimization drives the control variables to the mid-points of their respective operating regions, ensuring that all system operating constraints are satisfied.
- Real-time tracking of the system state such that the changes between the solution point values of the control variables and their input values are minimum.

Power System Controls
The controls that can be scheduled to perform active-power optimization are:
- Generator MW outputs
- Phase shifter taps
- Non-controlled area MW interchange with the controlled area
- Load shedding
- Combustion turbine start-ups
- Reactive power generation (generator unit and synchronous condenser) and related bus volt-ages
- LTC transformer taps
- Regulating capacitors and reactors (controlled shunt banks)

Power System Constraints
The active-power subset of constraints is:
- Branch flow limits -- in Ampere, MVA or MW
- Controlled area MW export limits -- the total export of the controlled area can be subjected to MW limits
- Zone MW generation limits -- these constraints effectively reflect the MW reserve requirements for the zones

The reactive-power subset of constraints is:
- Branch flow limits -- in Ampere or MVA
- Bus voltage limits
- Generator and synchronous condenser reactive power limits
- Zone MVAR generation limits - these constraints effectively reflect the MVAR reserve requirements for the zones

Control variable limits:
- All control variables are constrained by their upper and lower limits

Methods
Two power flow methods are provided: The Fast Decoupled method and the full Newton-Raphson method. Efficient and flexible state-of-the-art logics are incorporated into both methods for handling of local control adjustments.

The well-established decoupling principle is used in the optimization, i.e. the active and reactive power optimization is solved separately. The active power optimization is performed by the successive linear programming (LP) method that iterates over solutions to the non-linear ac power flow problem. For each load flow solution point a linear incremental model is constructed and the corresponding linearly constrained problem is solved by the dual simplex LP algorithm.

The same successive LP method as in the active power optimisation is applied to the minimum control shift objective of reactive power optimisation.

Features
- Partial optimization objective
  In a multi-area system, any area or set of areas can be designated as a controlled area where controls are optimized. Controls in other areas remain unchanged.
- Control prioritisation
  All controls can be prioritized globally or individually to designate their relative importance in the optimization.
- Constraint relaxation
  All constraints can be designated as "Hard", "Soft" or "Ignored" globally or individually. The violations of soft constraints are permitted and are included as weighted components of the objective function.
- Suppression of ineffective reschedulings
  In the Linear Programming (LP) optimization any control rescheduling, which is of little value in alleviating the constraint violations, may be optionally suppressed.

Various available power flow and local control options:
- Flat start
- Distributed slack
- Area interchange control
- Phase shifter flow control
- MVAR limit control
- Generator remote voltage control
- Transformer tap voltage control