PowerFactory 15

PowerFactory User's Conference and Future Networks Technical Seminar

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Overview

- PowerFactory's history
- Highlights PowerFactory Version 15
  - Graphical User Interface & Network Diagrams
  - Data model enhancements
  - Database & License Server
  - New/enhanced analysis functions
  - New/enhanced models
- Outlook PowerFactory Version 15.1
- At last but not least….

PowerFactory History

1985: First commercial power system analysis software (Unix, M.Schmieg)

1995: Final release DIgSILENT 10.31

1998: DIgSILENT *PowerFactory* 11.0

2000: DIgSILENT *PowerFactory* 12.0

2003: DIgSILENT *PowerFactory* 13.0

2005: DIgSILENT *PowerFactory* 13.2

2008: DIgSILENT *PowerFactory* 14.0

2010: DIgSILENT *PowerFactory* 14.1

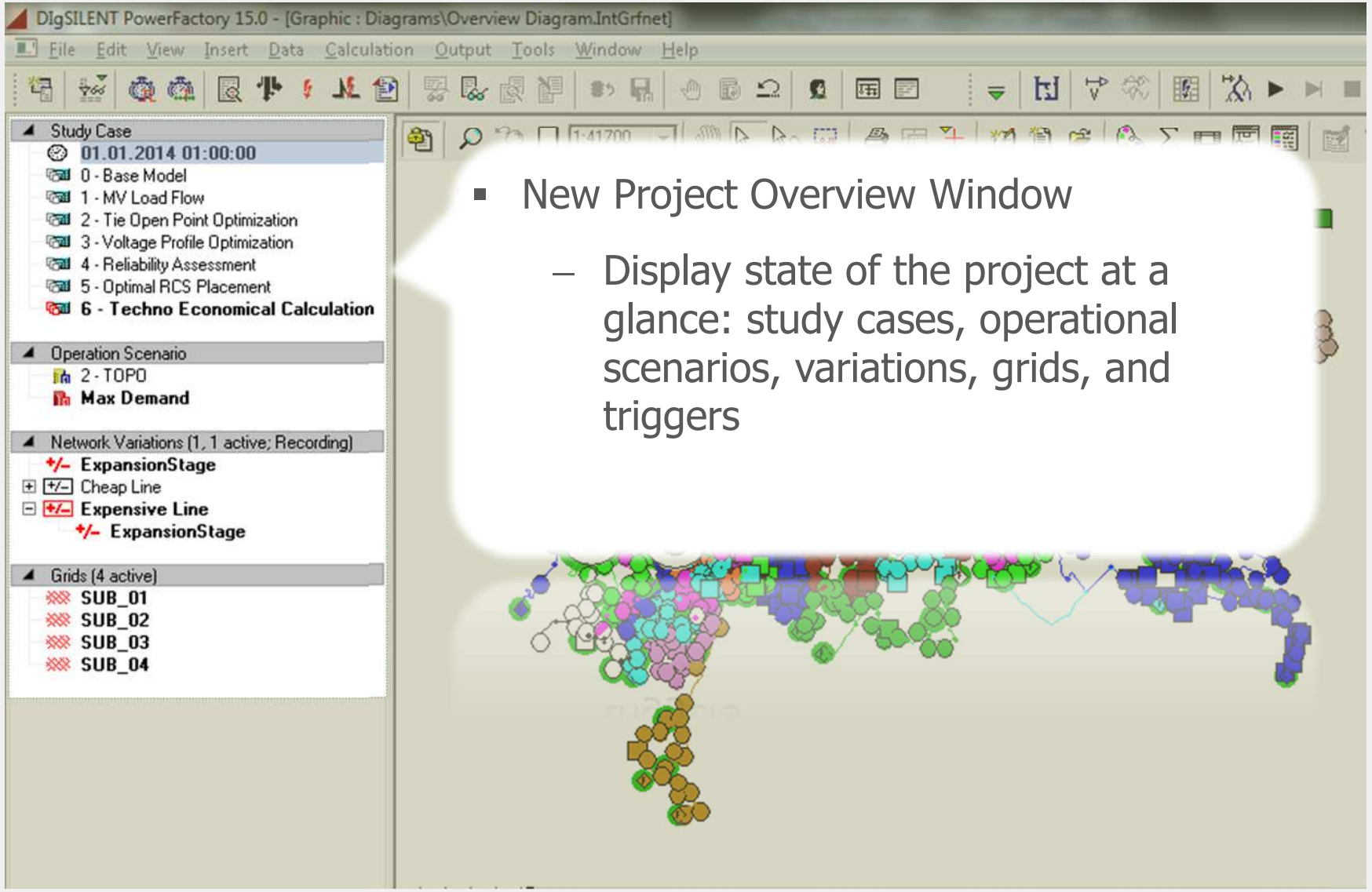
2013: DIgSILENT *PowerFactory* 15

Installations in more than 110 countries; > 10000 licenses

Graphical User Interface

- New Project Overview Window
  - Display state of the project at a glance: study cases, operational scenarios, variations, grids, and triggers
- Redesign of Main Menu
  - Main menu in close accordance with the toolbars
  - Additional Main Menu items:
    - View (functions from the Graphic Board)
    - Insert (new project objects such as study case, variation, etc.)

Graphical User Interface



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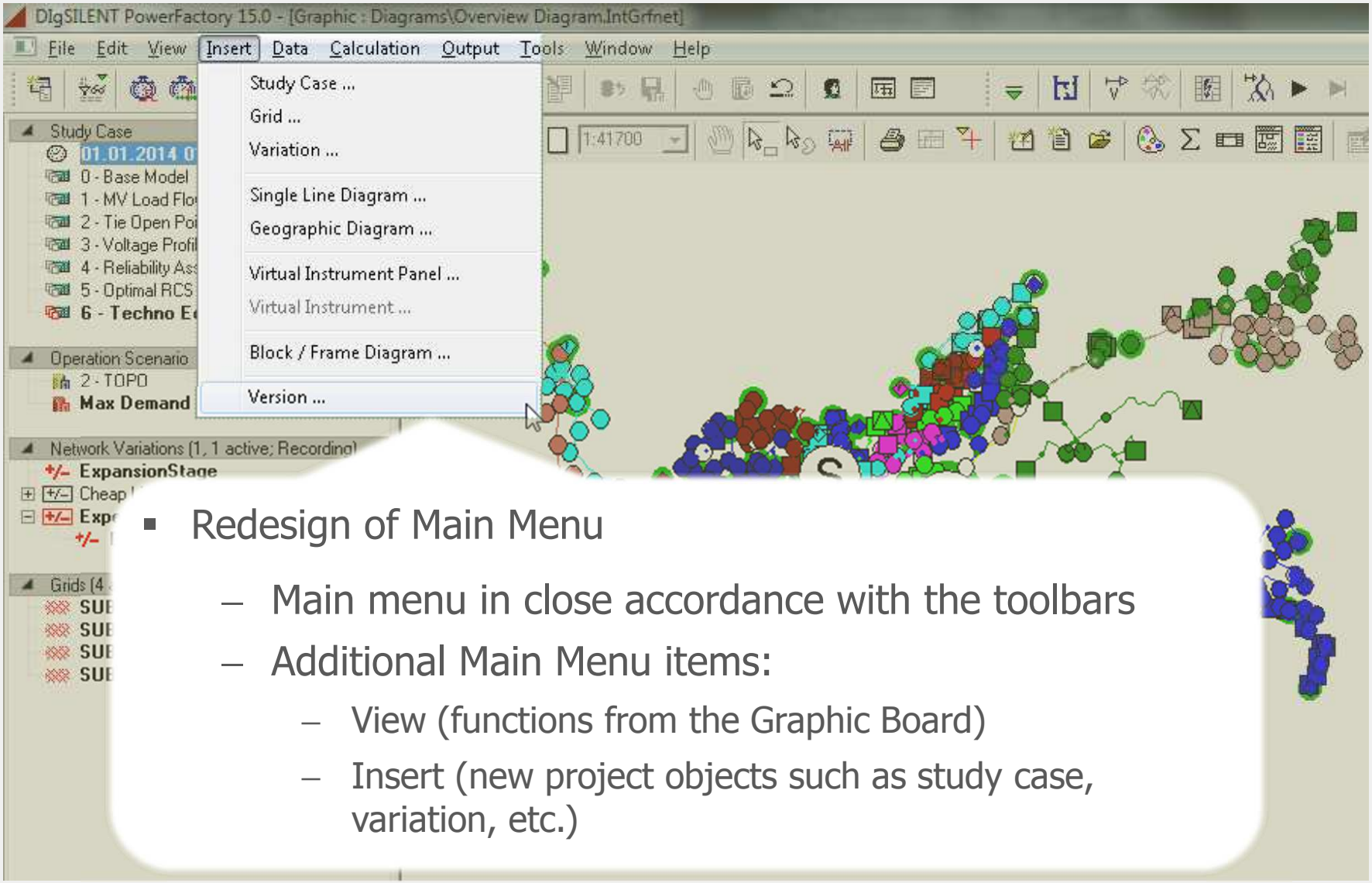
Graphical User Interface



- Redesign of Main Menu
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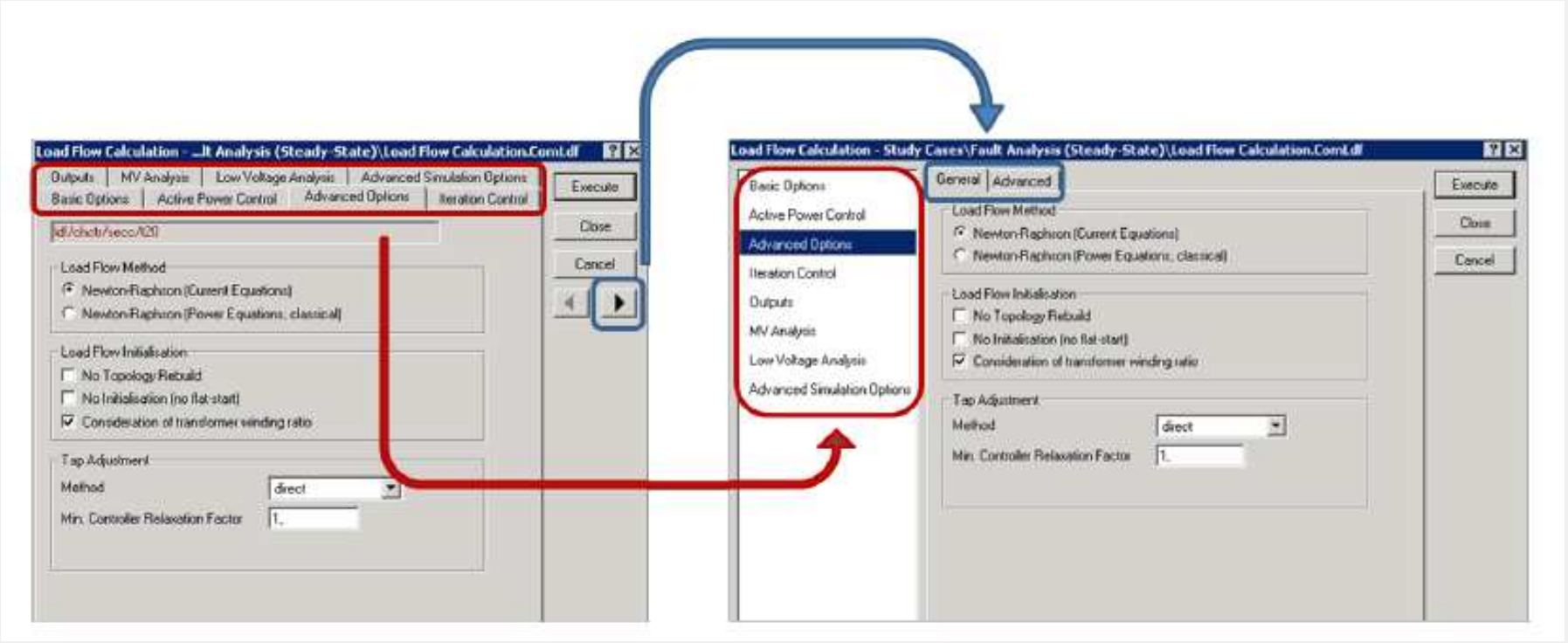
    - View (functions from the Graphic Board)
    - Insert (new project objects such as study case, variation, etc.)

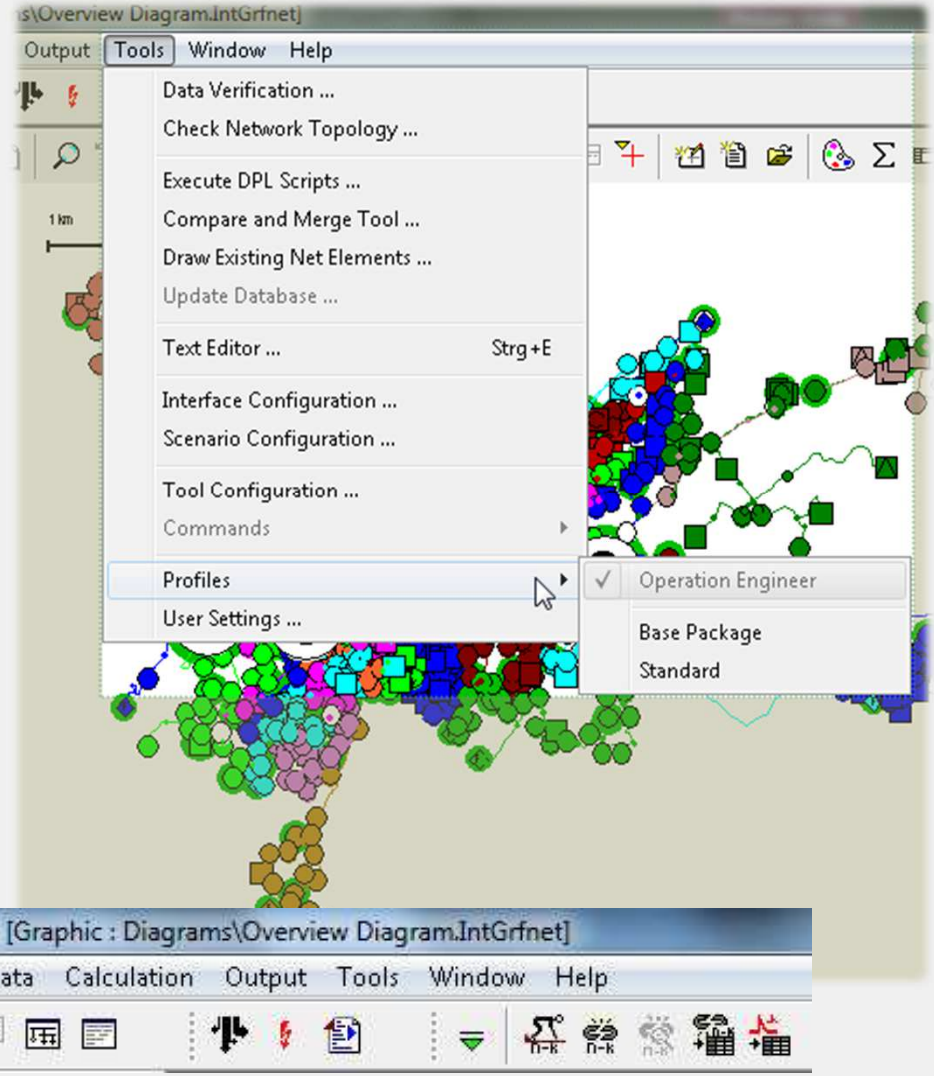
Graphical User Interface

- Redesign of Dialogue Tabs
  - Original tabs now presented as a menu and the original second page now presented as a tab



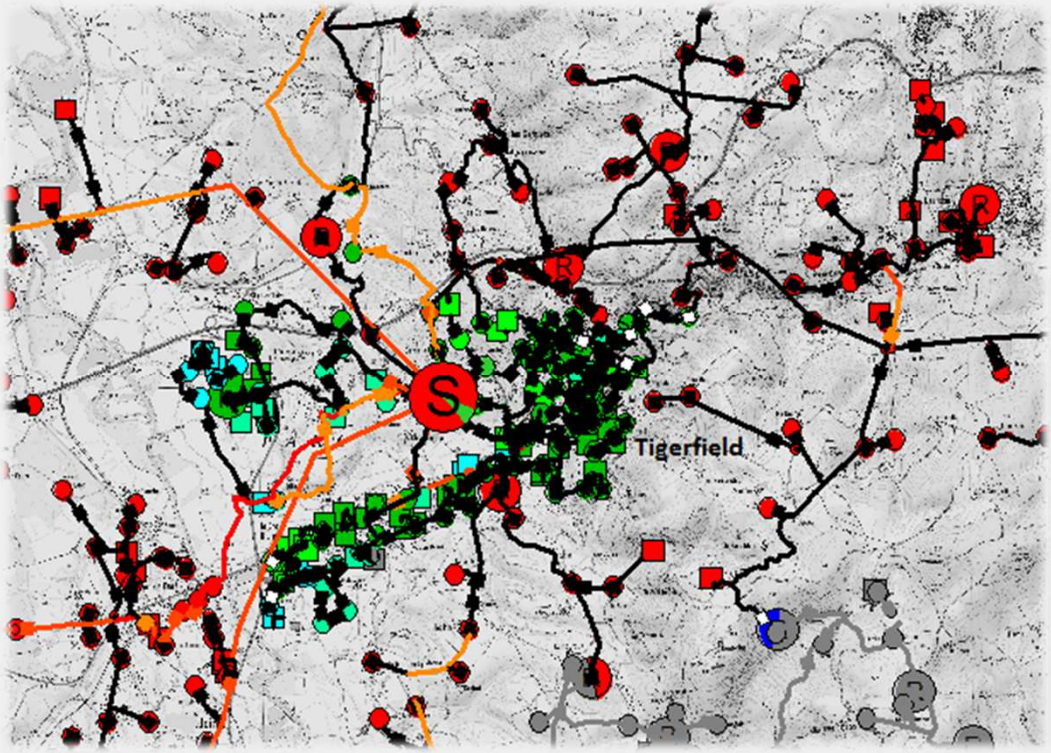
Graphical User Interface

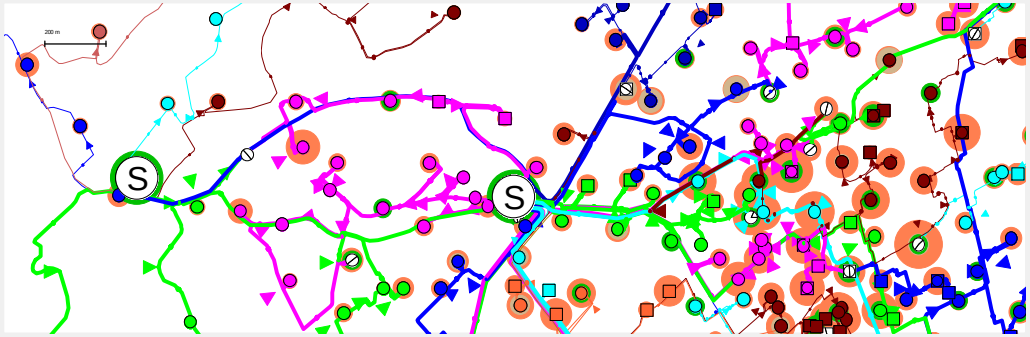
- User Profiles to customize the GUI, including the ability to customize:
  - Main, Graphic Board and Drawing Toolbars
  - Element dialog pages
  - Main Menu and context-sensitive menu commands
  - Add user-defined icons for custom DPL commands and templates
- Pre-configured Standard and Basic Package user profiles



Network Graphics

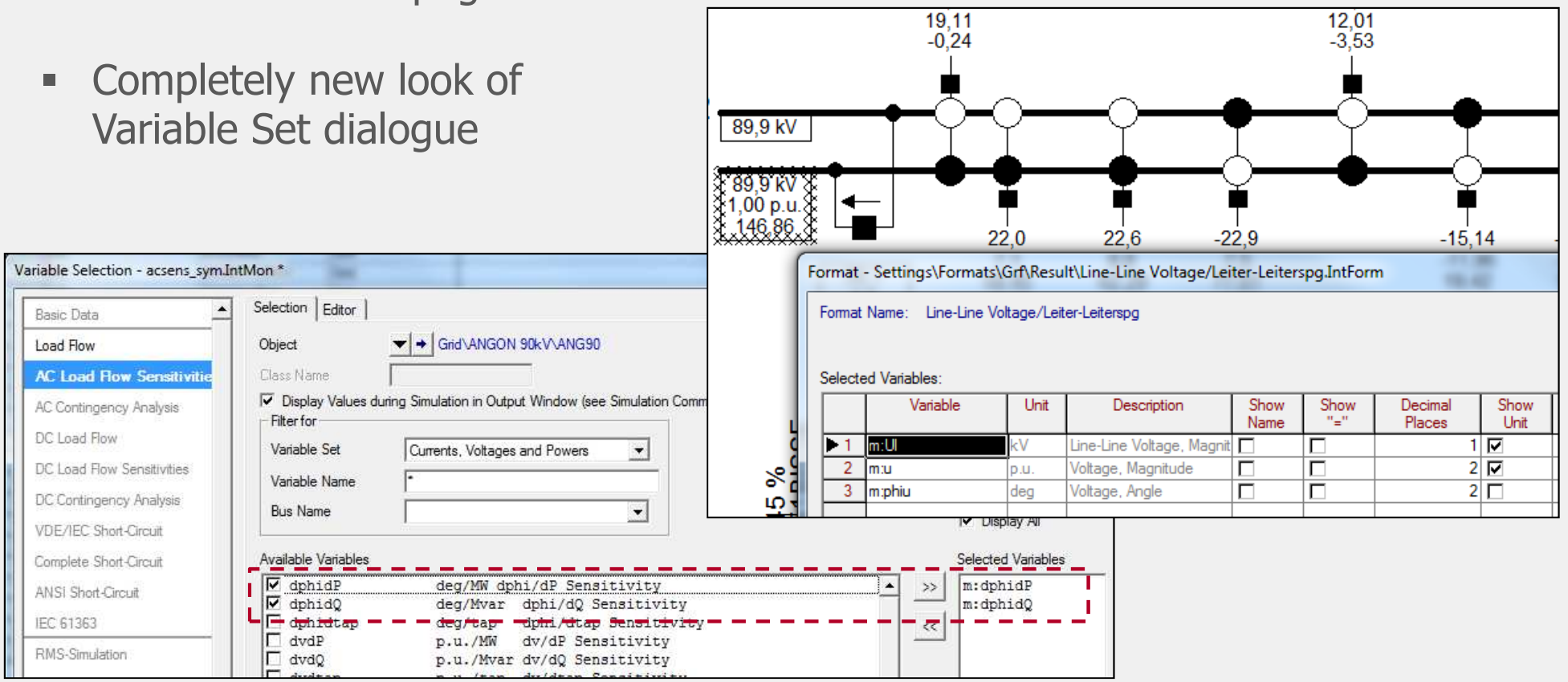
- Support of *Geographical Diagrams*
  - Automatic generation
  - Based on GPS coordinates (latitude and longitude)
  - Support background maps of various common projection types
  - Customize from which scale level text and result boxes become visible
  - Additional layer *Load/Generation Distribution* to illustrate the magnitude of network load and generation





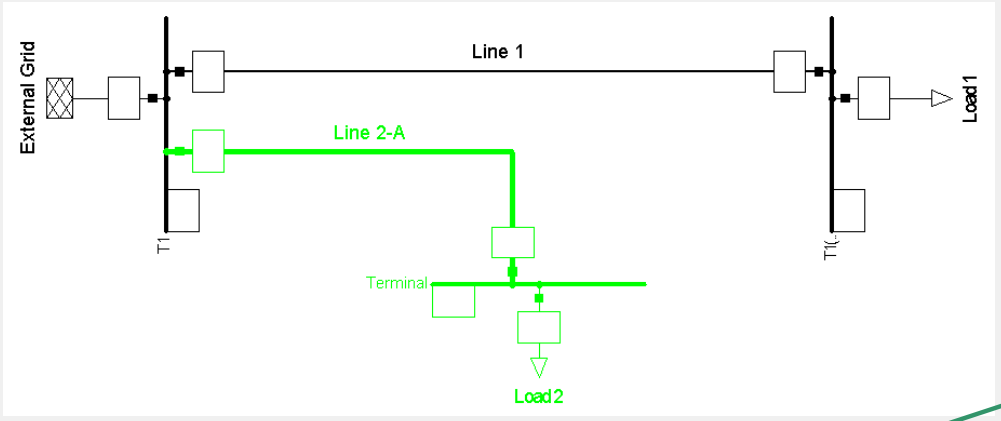
Handling & Data Management

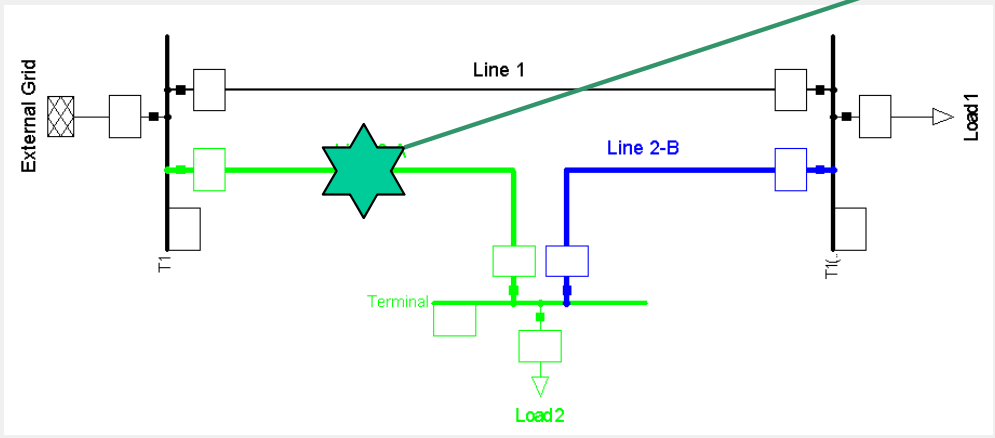
- Better support of distinct calculation models (such as Contingency analysis, sensitivity analysis, optimal power flow, etc.)
  - Improved predefined results in single line diagrams and flexible data pages
- Completely new look of Variable Set dialogue



Handling & Data Management

- Variation and Expansion Stages : **Error Correction Mode**





Base Network

Variation A
Stage 1: 01.01.2015

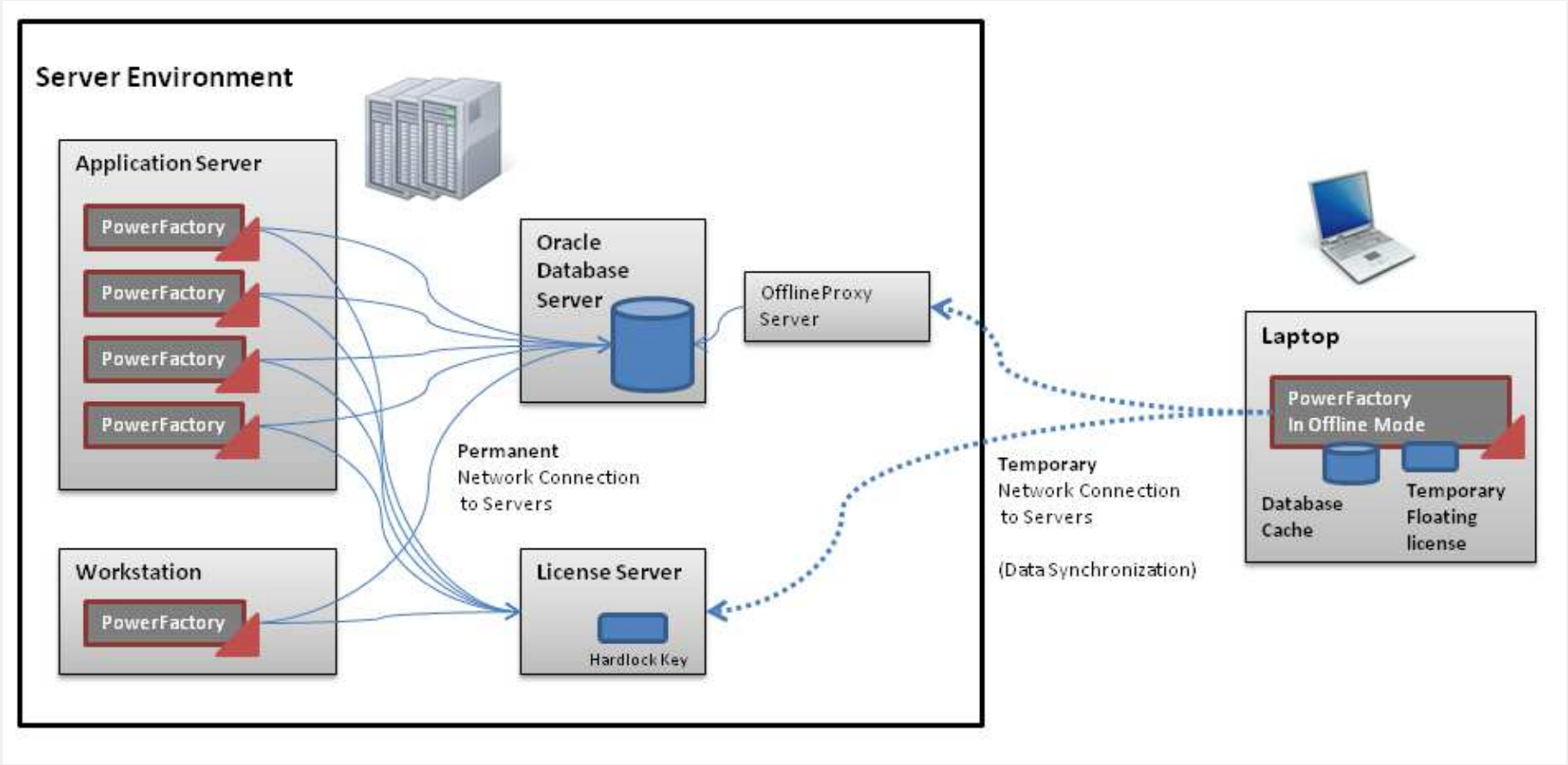
Variation B
Stage 1: 01.01.2020
(recording stage)

Handling & Data Management

- Pack external references
- Invalidation of calculation results (User Settings)
- Hot Keys
  - **F10** Load Flow calculation
  - **Ctrl+F10** Edit load flow options
  - **F11** Short-circuit calculation
  - **Ctrl+F11** Edit short-circuit options
  - **F12** Reset calculation

Database and License Server

- Offline Mode



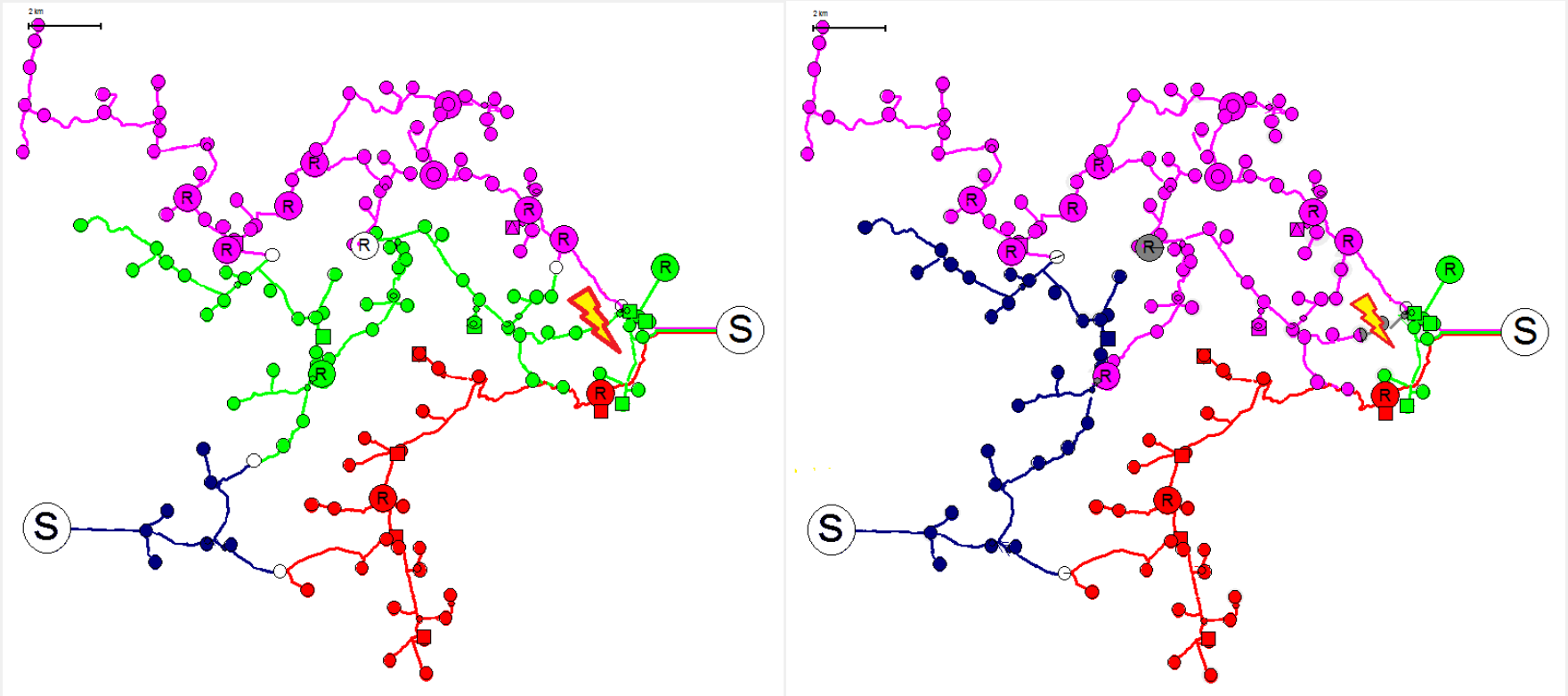
Database and License Server

- User authentication on license server
  - License server can be configured to grant licenses only to a list of named PowerFactory users
- Housekeeping & Archiving for multi-user databases
  - Automatic execution of scheduled housekeeping tasks such as project purging, emptying of users recycle bins, archiving and/or deletion of old projects
  - Housekeeping moves heavy data processing to off-peak periods
  - Benefit: quicker activation of projects, quitting PowerFactory.
- Selective DB migration for multi-user databases (Oracle, SQL-Server)

Analysis Functions

Tie Open Point Optimization

- Enhanced, fast TOPO algorithm
- Power restoration in distribution networks incorporates *Tie Open Point Optimization* methods to achieve an utmost level of resupply

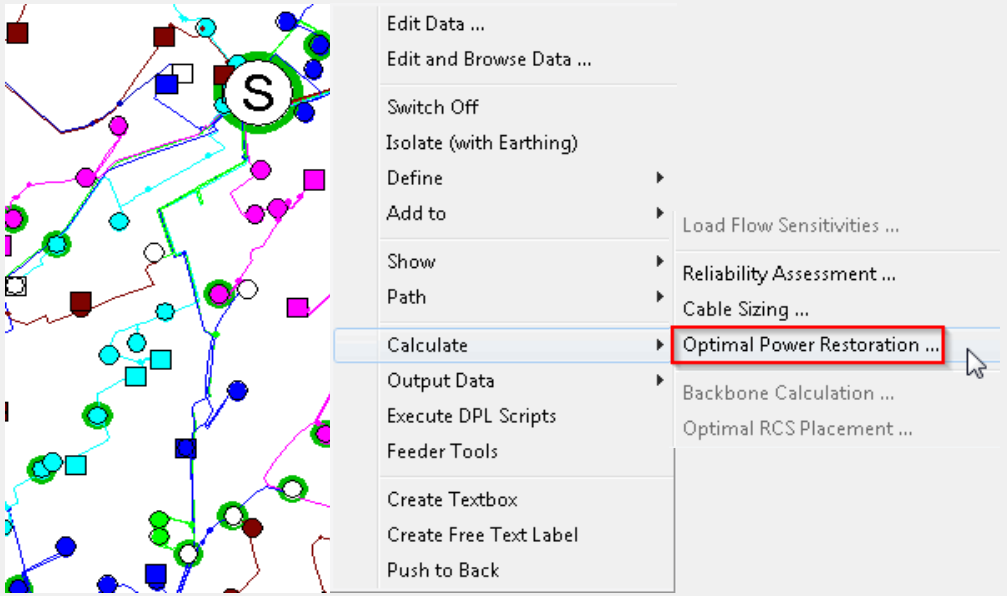


Reliability Analysis

- Support of both balanced and unbalanced network representations (reliability & tie open point optimization)
- Feeder constraints
  - Maximum allowed voltage drop/rise (global or feeder-wise)
  - Particularly important in network with high portions of distributed generation, where bidirectional power flows may occur
- Load states and load distribution states
- Incorporates optimal power restoration based on an automatic Tie Open Point Optimization (reduction of network losses)

Optimal Power Restoration

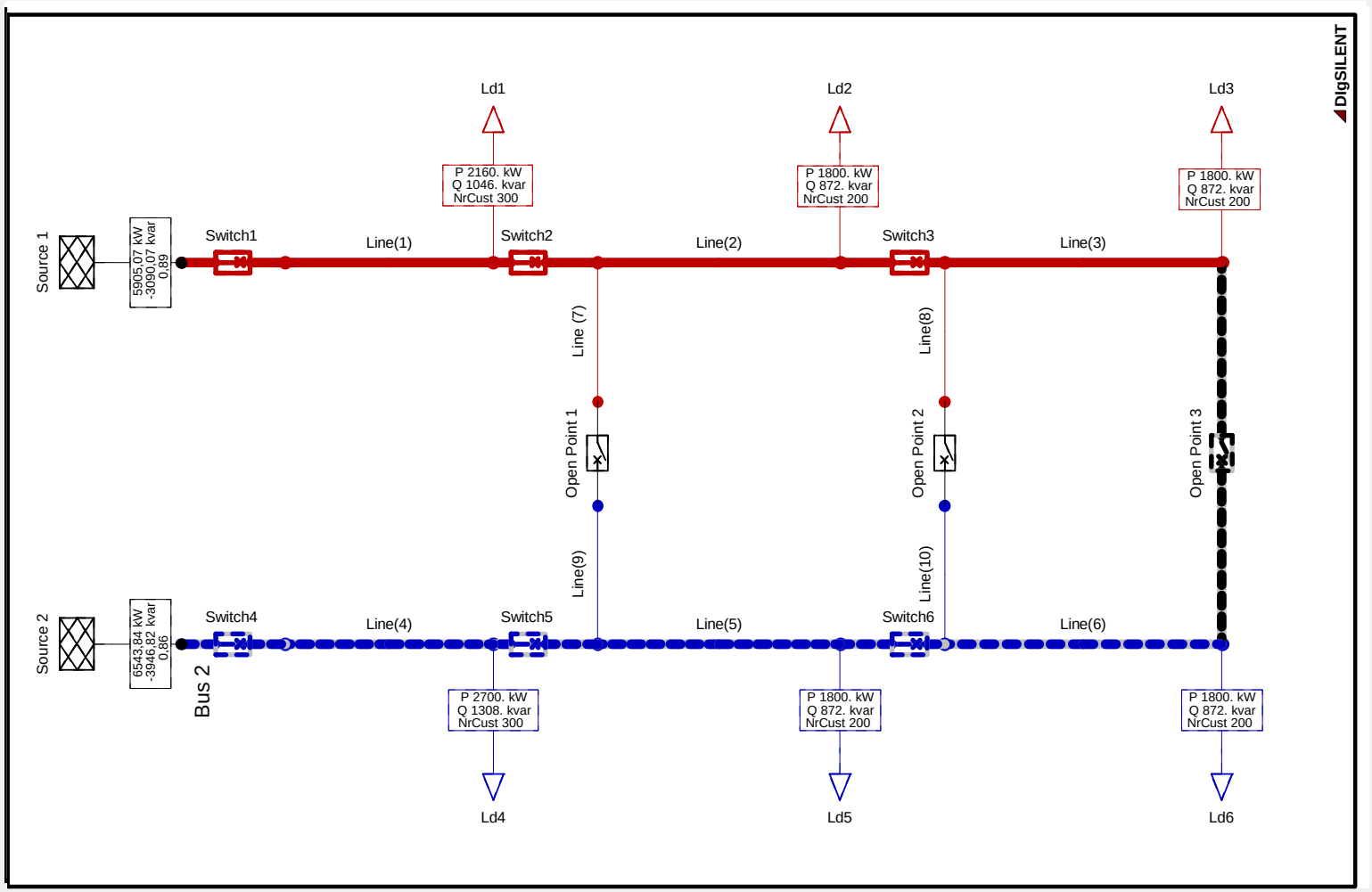
- Optimal power restoration
  - Conduct optimal restoration analysis for a single element, even in case that no failure data is available
  - Report recovery scheme



0:00	Protection	Open	SW_0998	SUB_3	Interrupted:	1142,0 kW	
1:00	Remote Controlled	Open	SW_1206	TRFSTAT_31	Interrupted:	1142,0 kW	
					Restored Power:	0,0 kW	(0,0 %)
					Restored Customers:	0	(0,0 %)
					Totally Restored Power:	0,0 kW	(0,0 %)
					Totally Restored Customers:	0	(0,0 %)
					ENS:(0:00 - 1:00)	19,0 kWh	
					Total ENS:	19,0 kWh	
30:00	Short Circuit Indicator	Open	SW_1353	TRFSTAT_47			
30:00		Close	SW_0998	SUB_3			
30:00	Manual	Open	SW_1527	TRFSTAT_61			

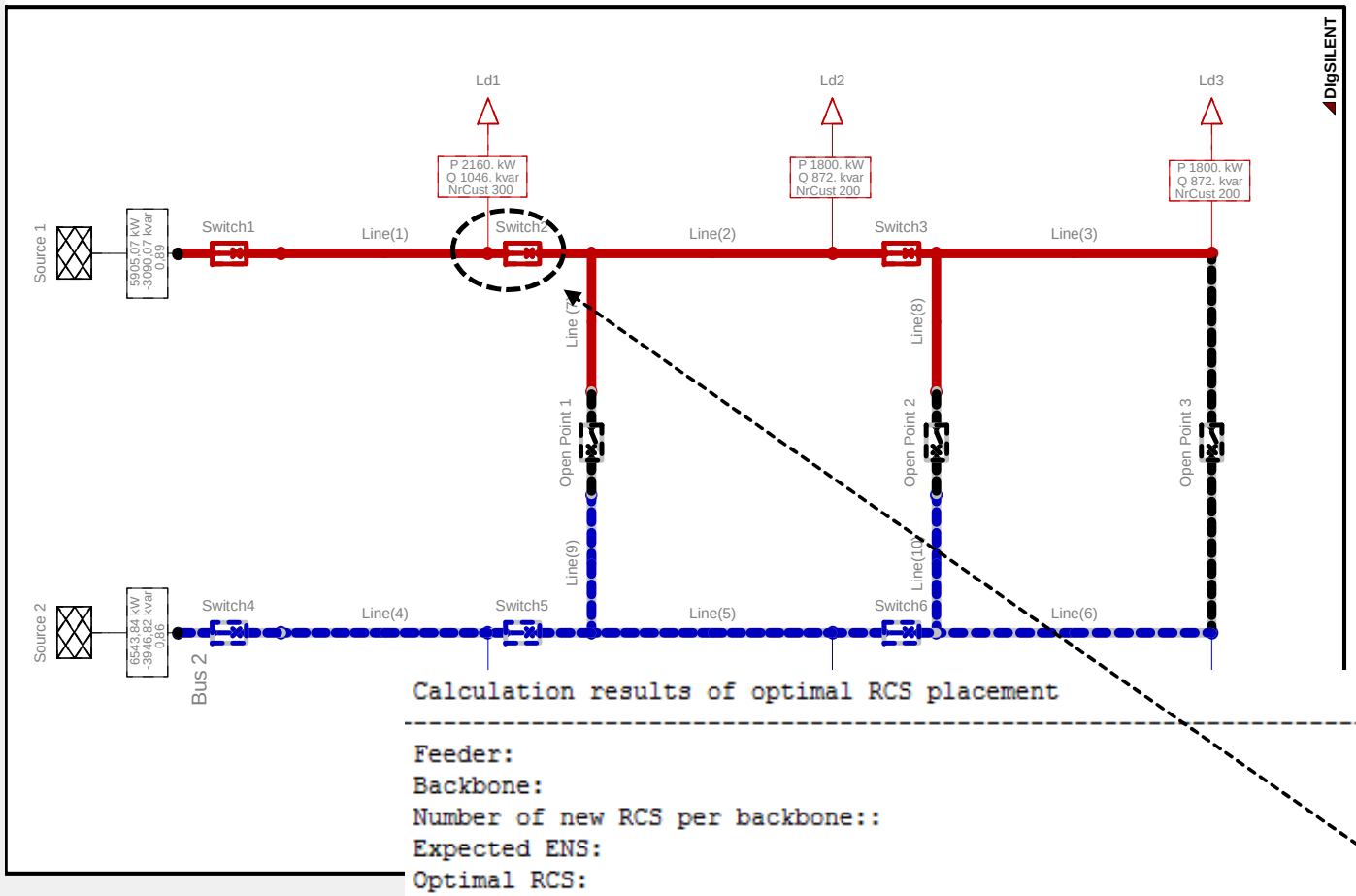
Backbone calculation

- Backbone: electrical path between two meshed feeders



Optimal Remote Control Switch (RCS) Placement

- Optimizes RCS locations within feeders to minimize Energy Not Served (ENS), Expected Interruption Costs (EIC) or balance ENS

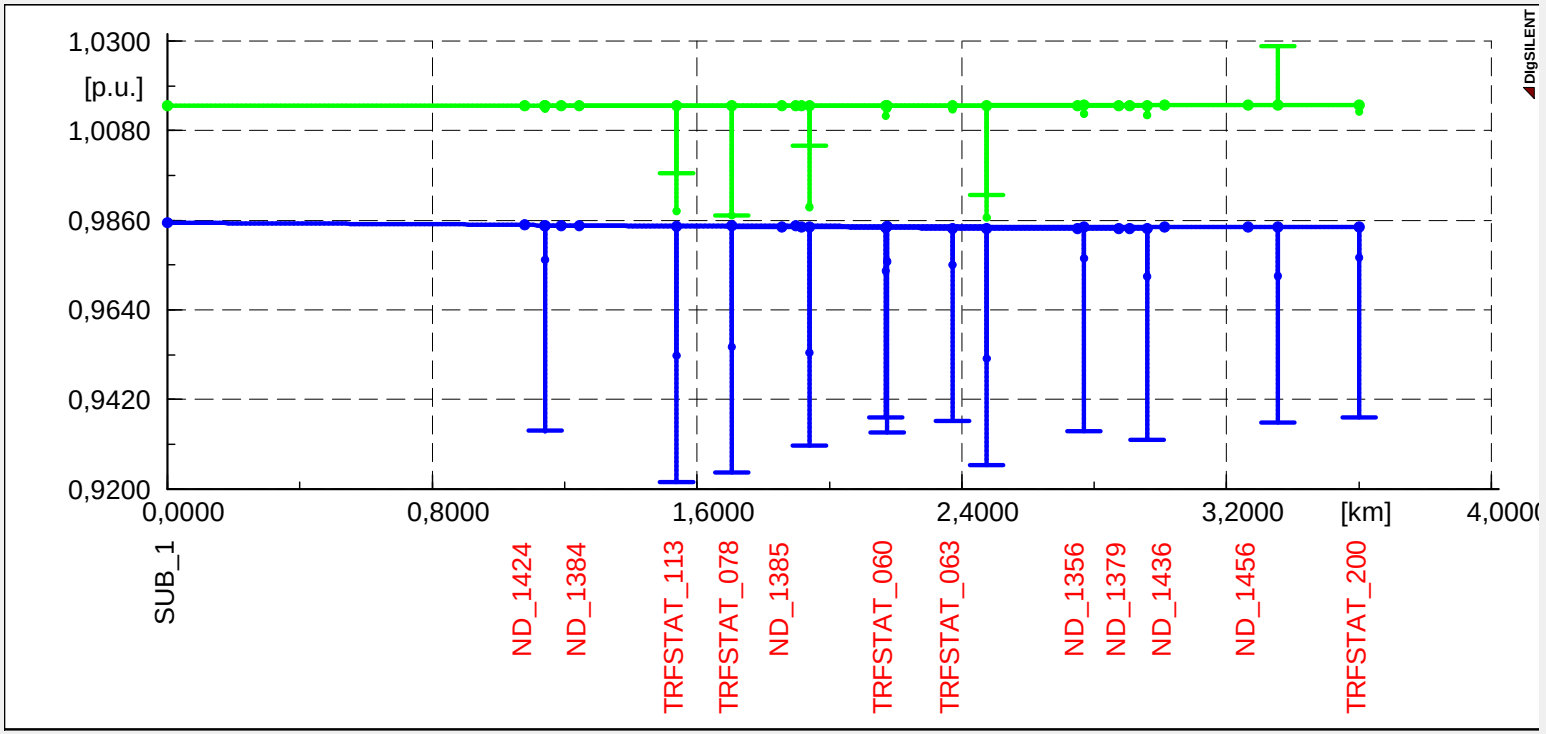



```
Calculation results of optimal RCS placement
-------------------------------------------------------------------------------
Feeder:                                          Feeder 1
Backbone:                                        Feeder 1_Feeder 2
Number of new RCS per backbone::                 1
Expected ENS:                                    1,240 MWh/a
Optimal RCS:                                     Switch2
Existing (calculation-relevant) RCS:             None
```

Voltage Profile Optimization

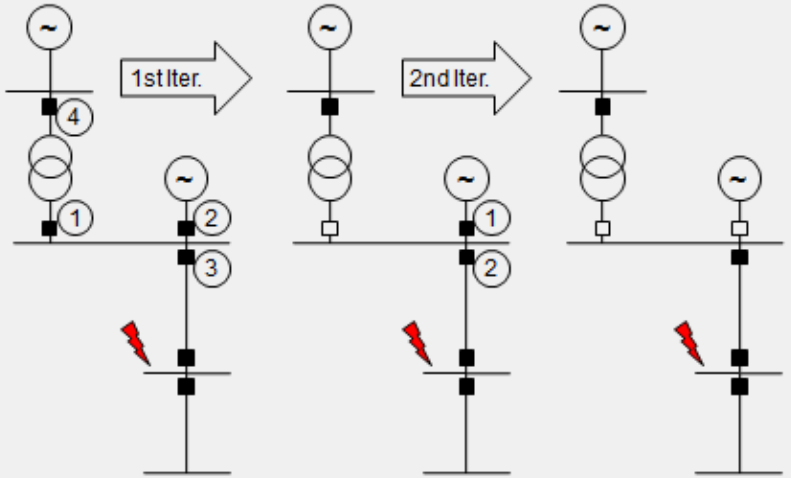
- Optimization of distribution transformer tap positions with consideration to the range of expected load and generation conditions (bidirectional power flow)

- Allows for a combined study of MV and LV networks



Protection

- Short-Circuit trace
  - Based on complete short-circuit method
  - Accounts for the effect of switching actions on the fault current



- Tabular relay settings reports

Protection Settings (Distance)

Project: Overcurrent & Distance Protection
Study Case: Distance Coordination

	Protection Device	Location	Branch	Manufacturer	Model	Stage (Phase)	Reactance [pri. Ohm]	Reactance [sec. Ohm]	Resistance [pri. Ohm]	Resistance [sec. Ohm]	Impedance [pri. Ohm]	Impedance [sec. Ohm]
▶ 1	R1	HV-Infeed	Infeed/SS-D1		Poly Z3	ZPHPH1 [21N]	26,880	2,688	20,000	2,000		
						ZPHPH2 [21N]	50,400	5,040	31,000	3,100		
						ZPHPH3 [21N]	65,000	6,500	50,000	5,000		
2	R2	SS-D1	Infeed/SS-D1		Poly Z3	ZPHPH1 [21N]	26,800	2,680	27,000	2,700		
						ZPHPH2 [21N]	50,400	5,040	50,000	5,000		
						ZPHPH3 [21N]	190,000	19,000	120,000	12,000		
3	R3	SS-D1	D1/D2		Relay - Mho	Ph-Ph 1 [21]					21,000	
						Ph-Ph 3 [21]					55,000	

- Reach settings for distance relays in Primary or Secondary ohms

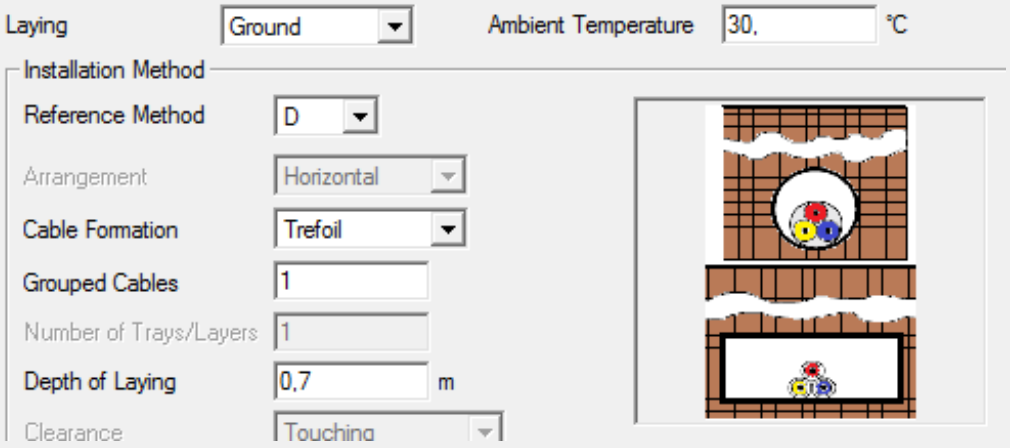
Arc-Flash Hazard Analysis

- Calculation acc. with IEEE-1584 (2002) and NFPA 70E (2008) standards
- Globally or individually specified circuit-breaker tripping times or fault clearing times based on actual protection settings
- Automated preparation of Arc-Flash labels

Cable Sizing

- Cable Reinforcement
  - Support of unbalanced networks
  - Constraints: loading, voltage per terminal and along feeder
  - When applied to a network without types, PF will automatically assign types from the library, with consideration of loading/voltage drops
  - Report on short-circuit loading of lines/cables

- Automatic Cable Sizing
  - Cable sizing optimization based on international standard:
    - IEC 60364-5-52
    - BS 7671
    - NF C15-100, C13-200

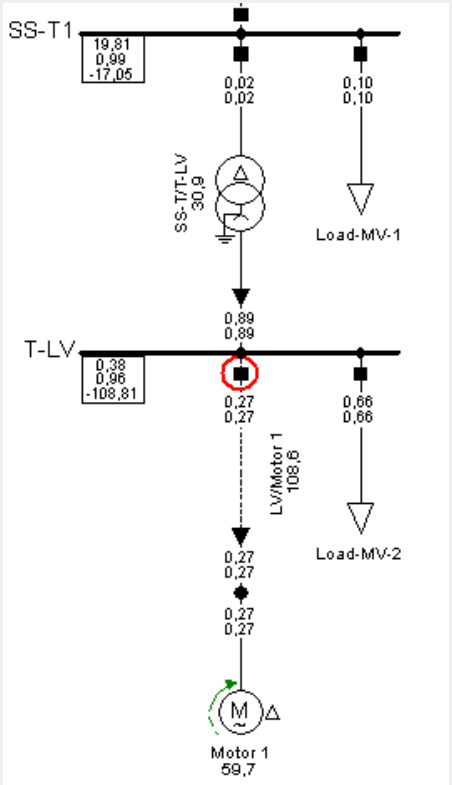


Techno-Economical Analysis

- Economic assessment of network reinforcement strategies (expansion stages) under consideration of:
  - Cost of electrical losses
  - Economic impact on the failure rates (reliability)
  - Costs for the expansion:
    - Investment costs, additional costs per year
    - Commercial equipment value: original value, scrap value, expected life span
  - User-defined costs
- Output: Net Present Value (NPV) of the expansion strategy over the selected period

Additional Tools: Motor Starting

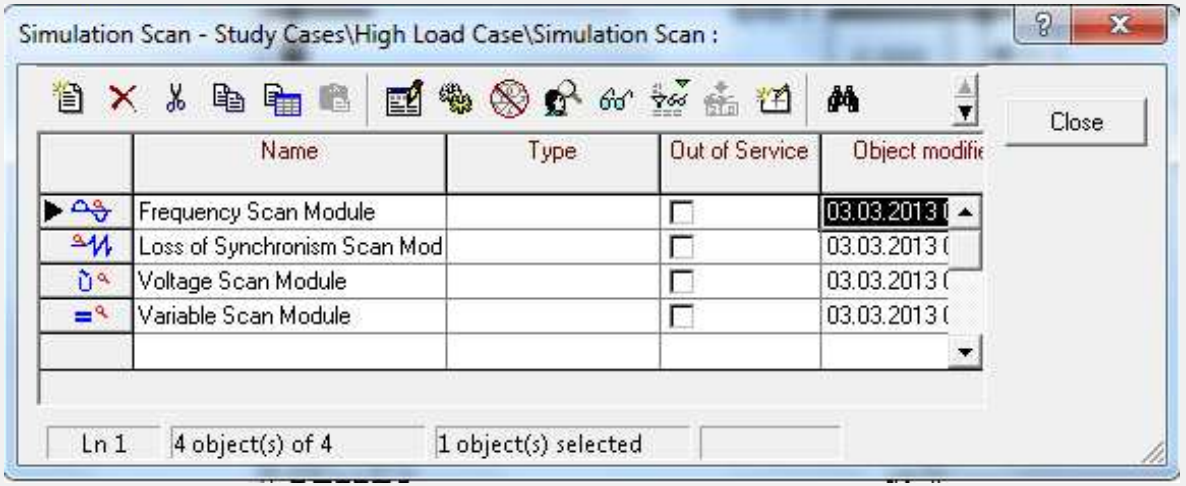
- Motor starting
  - Static motor starting (besides dynamic)
  - Assess voltages before, during and after starting
  - Assess whether starting is successful or not



Motor Name	Terminal Name	Terminal Voltage Before Starting (p.u.)	Motor Voltage Minimum on Starting (p.u.)	Motor Voltage After Starting (p.u.)	Starting Current (kA)	Starting Current (p.u.)	Starting P.F.	Successful Start?
Motor 1	Motor	0,000	0,761	0,948	1,978	4,568	0,814	Yes

Simulation Scan

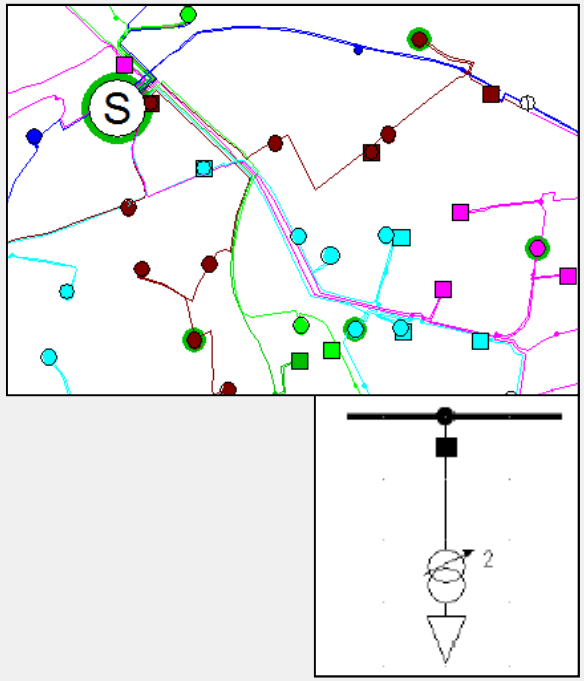
- Monitor network results and parameters during time-domain simulations
  - Frequency minimum and maximum limits
  - Loss of synchronism
  - Voltage max/min limits and limit violation time
  - Voltage recovery and voltage recovery time
  - User-selected parameters
- Action:
  - Display output message
  - Stop simulation

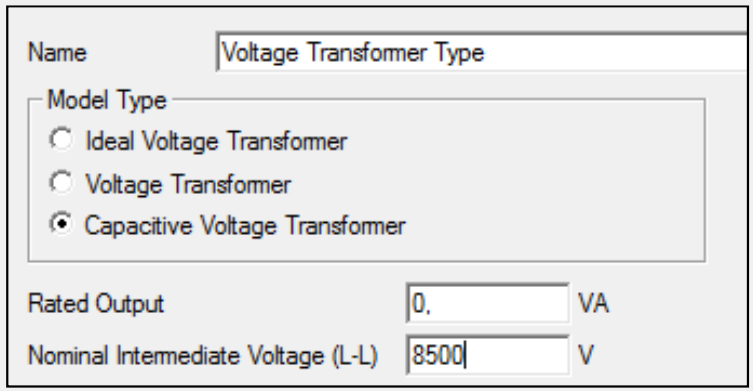


Models
(Selected)

New Models

- Secondary substation
  - Broad variety of predefined secondary substation configurations
- MV load
  - Representation of distribution transformer together with a reduced load/generation model
- Single-phase and single phase-neutral static generator
- Single-phase and single phase-neutral PLL
- Detailed CVT model

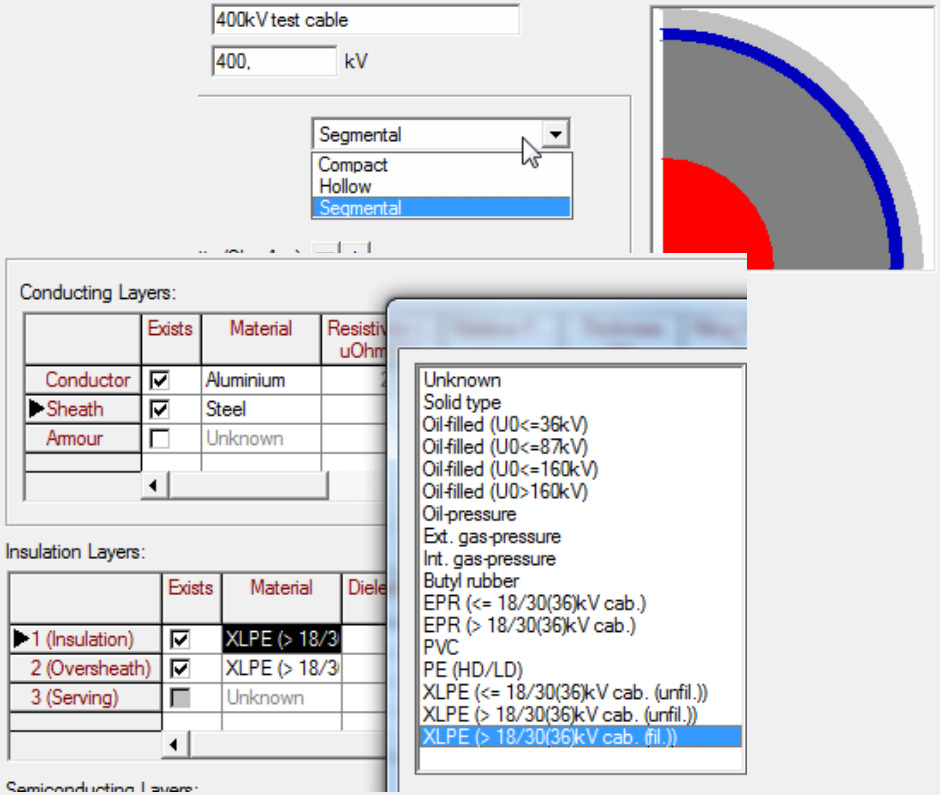




Models Enhancements

- Series capacitor:
  - Built-in tripping criteria for spark gap acc. to:
    - Current or voltage,
    - MOV energy/power

- Cable parameter calculation
  - Better support of cross-bonding and reduction options
  - Support of segmental conductors
  - Material selection in accordance with IEC60287



Models Enhancements

- Station controller : support of following control options
  - Support of PWM converters
  - Support of following control options:
    - *cosphi(P)*
    - Q(V)-characteristics
    - Reactive power distribution acc. to voltage setpoint
- Background harmonics (phase correct, IEC61000)
  - External Grid
  - AC voltage source

Outlook
PowerFactory v15.1

Short Circuit Calculation in DC Networks

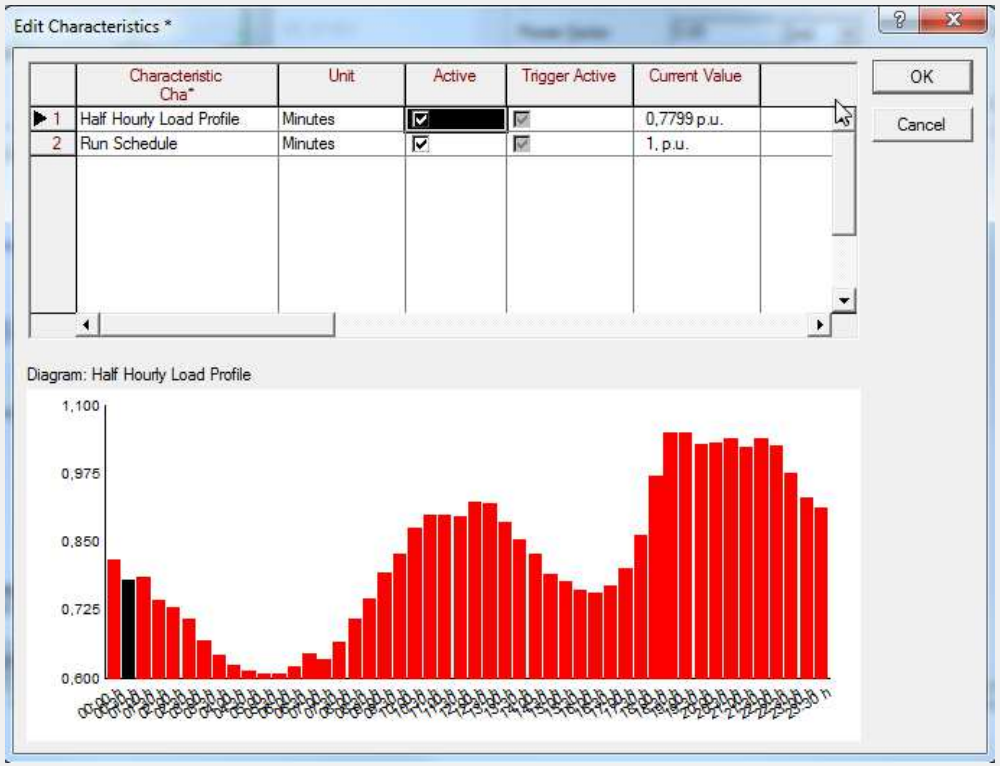
- DC short-circuit calculation acc. to IEC61660 and ANSI/IEEE 946
- Contribution to the short-circuit from:
  - AC/DC converters (recifier/inverter) in bridge connection
  - *Batteries (new)*
  - Smoothing capacitors (only IEC)
  - *DC motor/generator (new)*
- Pre-fault voltage calculation based on standard LDF calculation
- Calculation results
  - Peak short-circuit current
  - Quasi-steady-state short circuit current
  - Time to peak
  - Rise- & decay times, rate of rise
  - Equivalent system resistance and inductance, network time constant

Load Flow Sweep

- New „Time Characteristic“ in the operation library
  - Built-in time scale for easier handling
  - Recurrence (daily, weekly, monthly, yearly, none)
  - Resolution / Step size (minutes, hours)

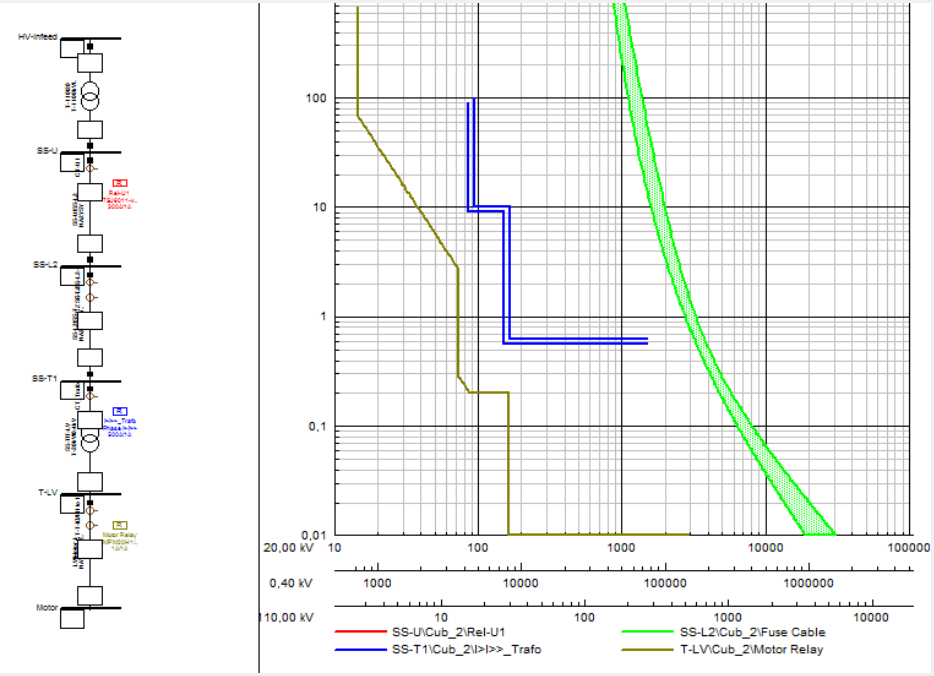
- New „Characteristics Viewer“
  - All characteristics at a glance
  - Characteristic diagrams
  - Out of service flag per characteristic

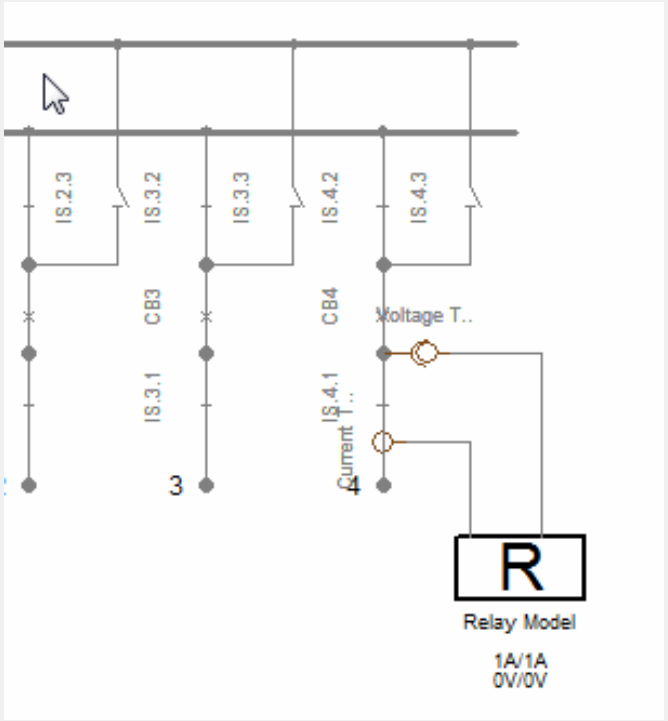
- Load flow time sweep



Protection Functions

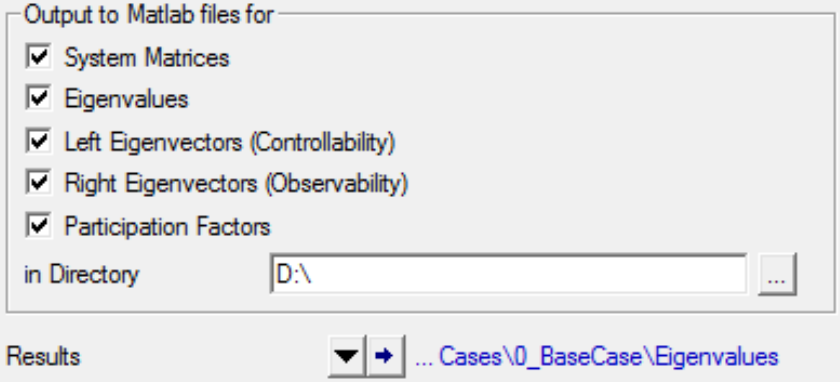
- Protection coordination assistant (distance)
- Visualization of protection devices
  - CTs, VTs in overview diagrams/substation diagrams
  - Detailed view for connecting





Eigenvalue Analysis

- Eigenvalue Analysis (Small Signal)
  - **QZ factorization method** to support models not previously supported by the QR-method
    - ElmAsm, ElmVscmono, ElmVsc, DDIG machine, DC-machine, CD-line, complex load, DC shut, surge arrester, DC valve, DC series reactor
  - Output results to Matlab:

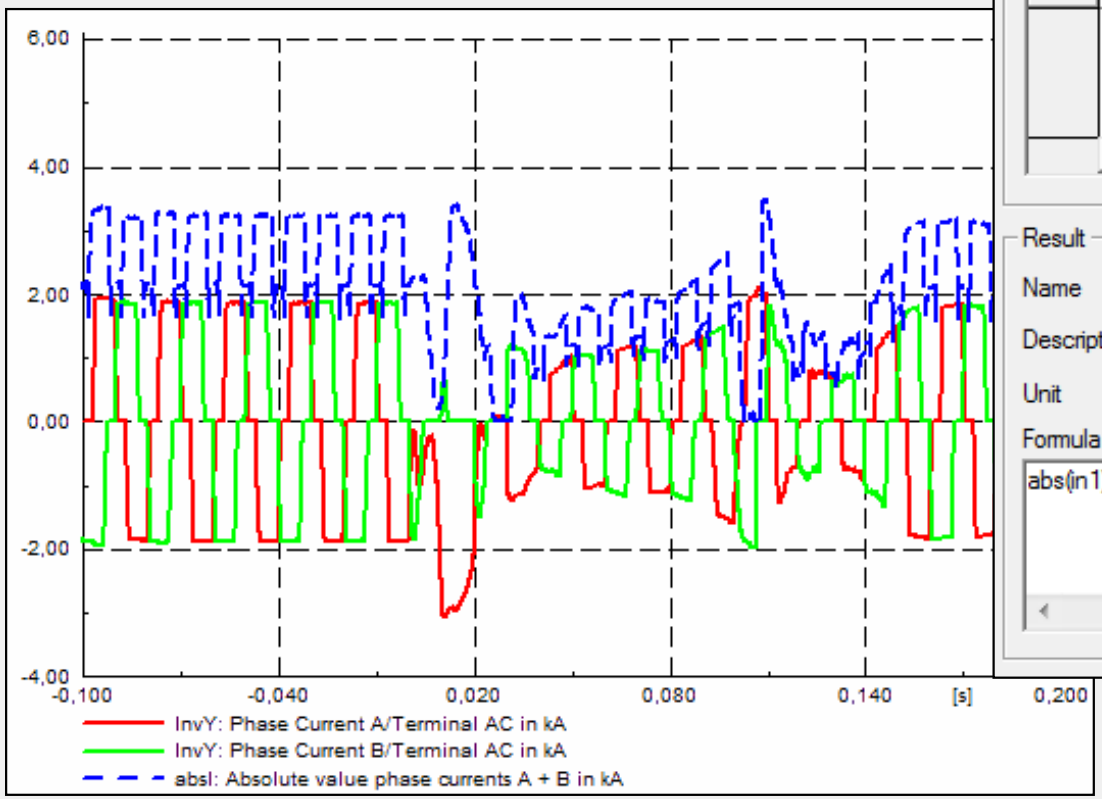


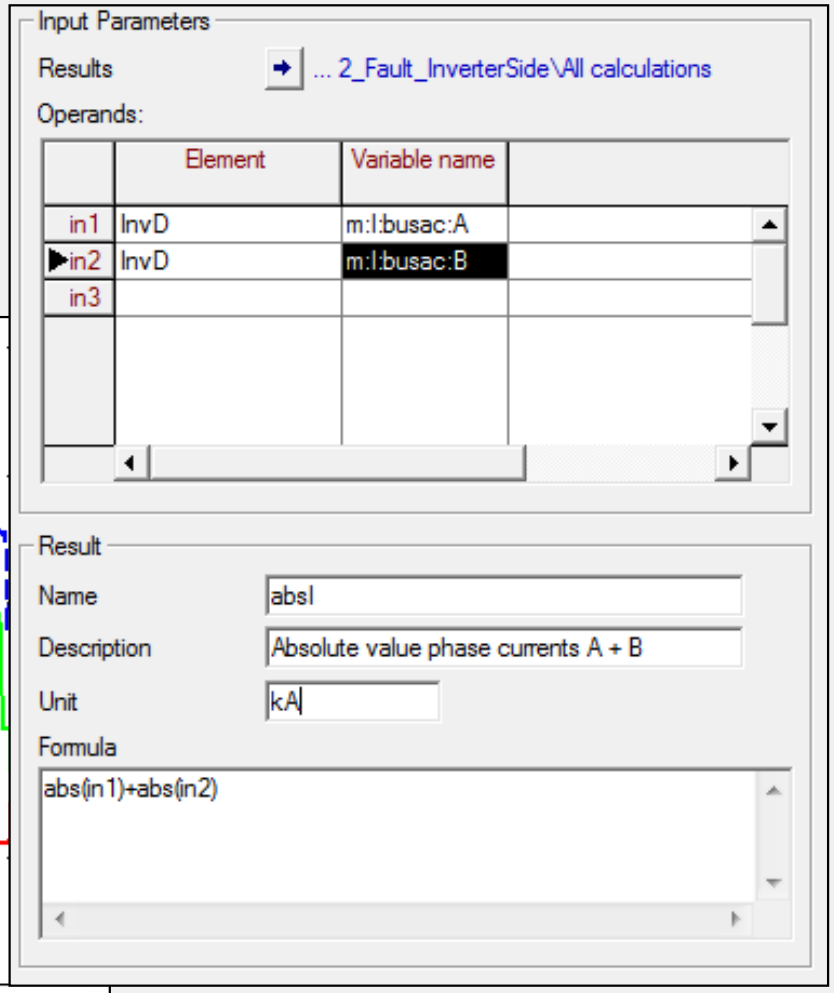
Calculation Functions

- D-A-CH guideline

Virtual Instruments

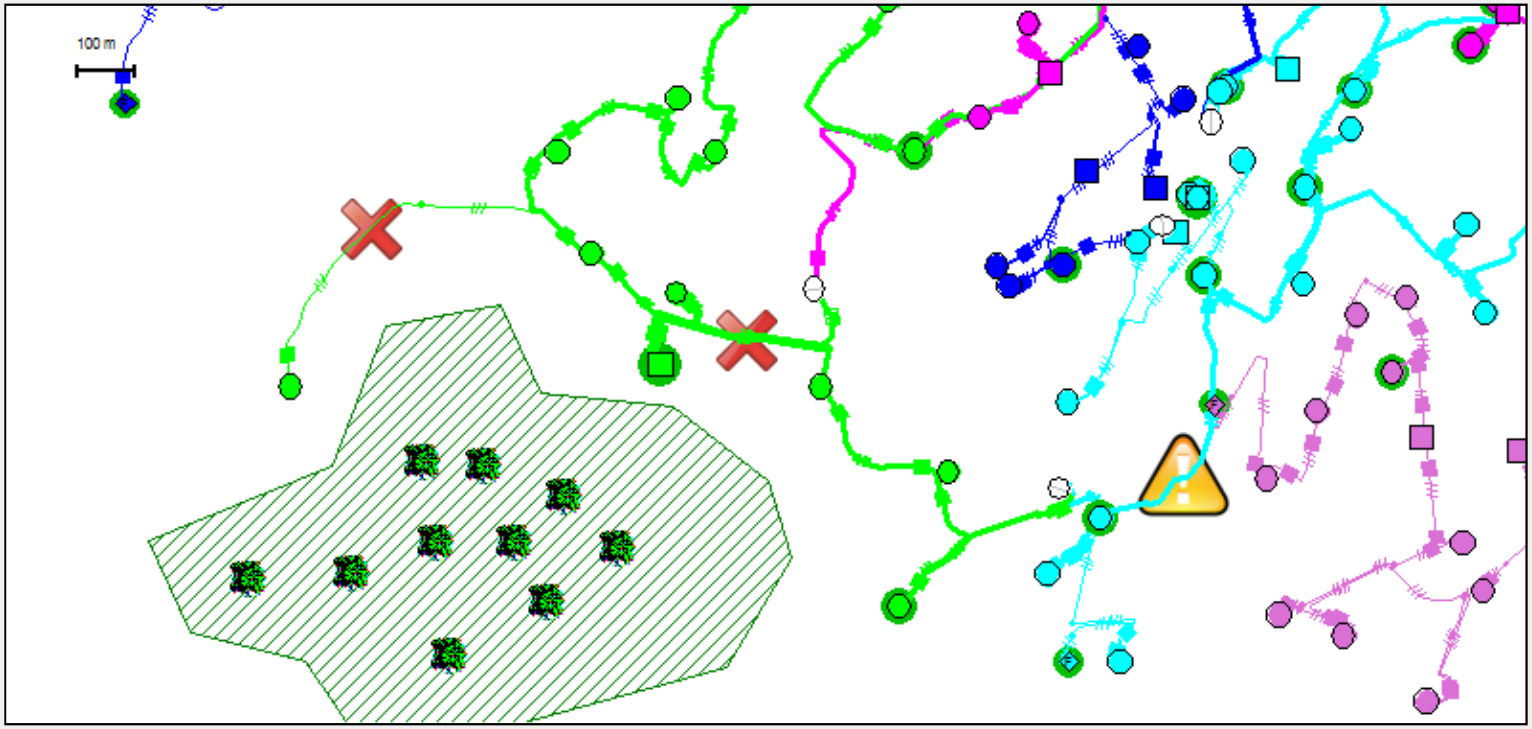
- Arithmetic post-processing of simulation variables
  - User defined result variables (DSL-syntax)





Graphics

- User-configurable annotation (transparent) layers
  - Support of SVG, SGI graphics
  - Dedicated freeze mode
  - Import/Export support of annotation layers (incl. GPS coordinates)



Scripting Language

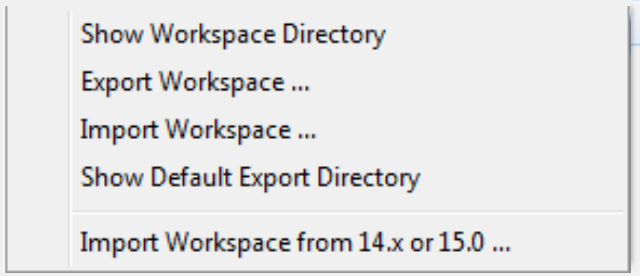
- Python Scripts
  - Non-proprietary programming language
    - Open source license
    - Extensive standard libraries and third party modules for virtually every task
    - Debugger
  - Quicker and more effective integration of external systems
    - Interfaces to external databases and MS-Office like applications
    - Web-services, etc.
  - Integration of compiled scripts in PF
    - Hence no further needs for script encryption
  - Scripts execution from outside PF also possible

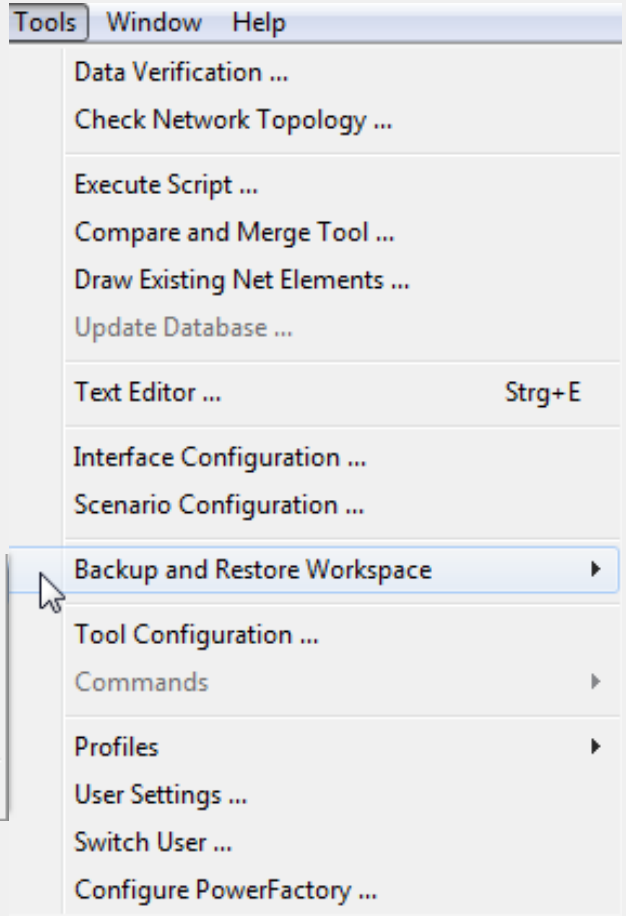
Enhanced Windows 8 Compatibility

- PF Installation folders
  - C:\Program Files\DIgSILENT (installation files)
  - C:\Users\Username (user's files, i.e. projects)

- User workspaces
  - Contains all user relevant information
  - Export/Import of workspaces as .zip file
  - Backup & Restore workspace

- Help option
  - Create „Support package“



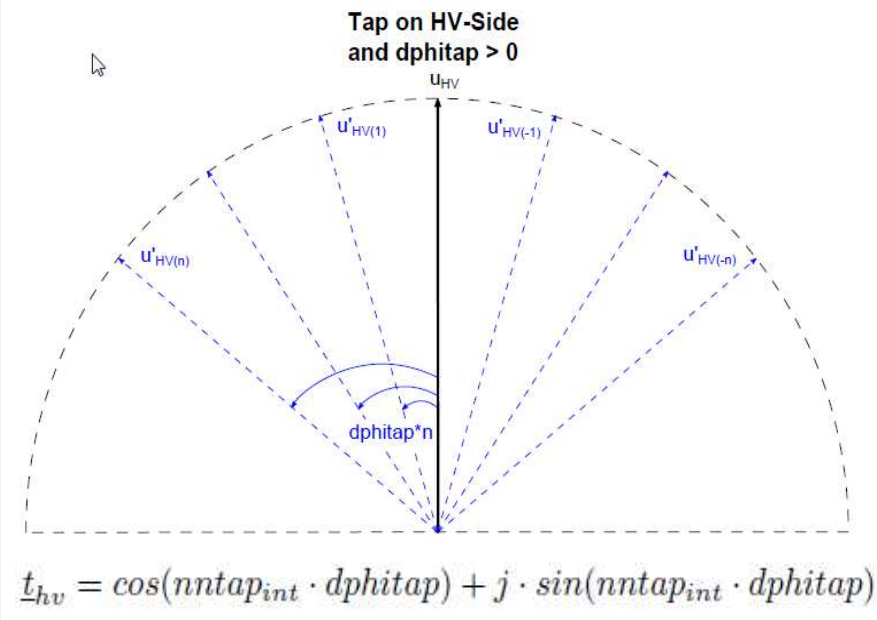


New Models

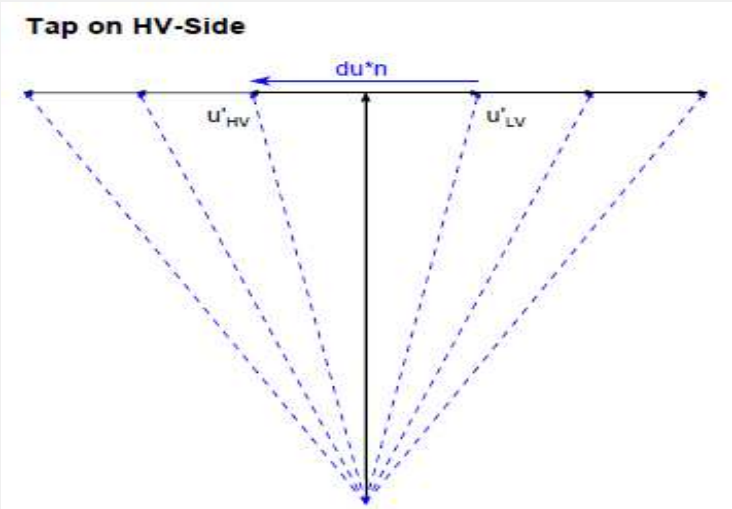
- PV systems (*ElmPVsys*)
  - System geographical location: latitude, longitude (GPS coordinates from the busbar) and time zone
  - Orientation angle and tilt angle
  - Mounting system: fixed/stationary, dual axis tracking system, etc.
  - Operating point: active power or acc. to irradiance
- Impulse souce (*ElmImpulse*)
  - Waveforms: two-exponential, Heidler, acc. to IEC62305-1 (time functions of the lightning current for analysis purposes: first positive, first negative and subsequent impulses)
- DC Battery (*ElmBattery*)
  - As DC element, for the calculation of DC short-circuit currents
- DC-machine (*ElmDcm*)
  - Motor/generator

Model Enhancements

- Two-windings transformer
  - Two tap changers now supported (in ElmTr2)
  - Extended phase shifter model
    - Ideal phase shifter (voltage magnitude does not change)
    - New symmetrical phase shifter (taps on HV and LV side)



$$\underline{t}_{hv} = cos(nntap_{int} \cdot dphitap) + j \cdot sin(nntap_{int} \cdot dphitap)$$



$$\underline{t}_{hv} = 1 + nntap_{int} \cdot du \cdot (cos(phitr) + j \cdot sin(phitr))$$

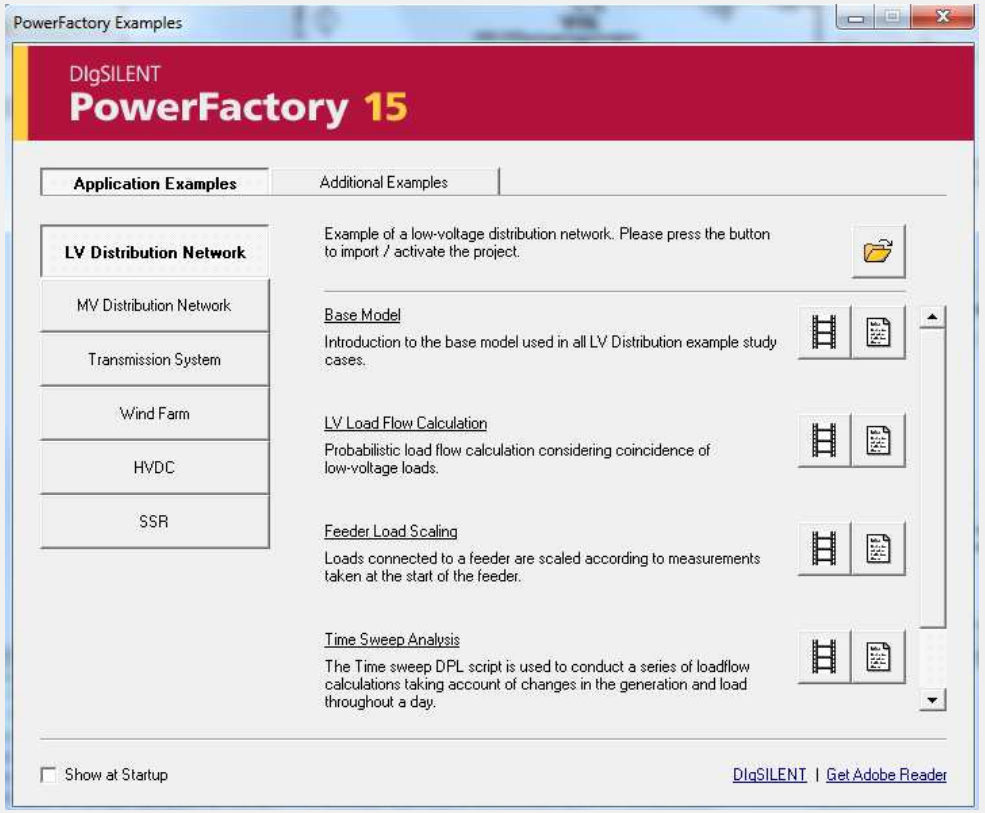
$$\underline{t}_{lv} = 1 - nntap_{int} \cdot du \cdot (cos(phitr) + j \cdot sin(phitr))$$

Model Enhancements

- Synchronous generators (*ElmSyn*)
  - Saturation curve: exponential and quadratic equations
  - New input signal “delta speed” (for instance required for SSR applications)
- Measurement tables for shunts (*ElmShnt*)
- Measurement devices (*StaPQmea, StaVmea, StaImea*)
  - Single phase models now supported
- Neutral connection (*ElmSyn, ElmShunt, ElmXnet, ElmGenstat*)
  - Explicit neutral connection now supported

At last but not least…

- Vastly revised User Manual now presented in PDF format
- Application examples, including demonstration videos



Thanks for your attention