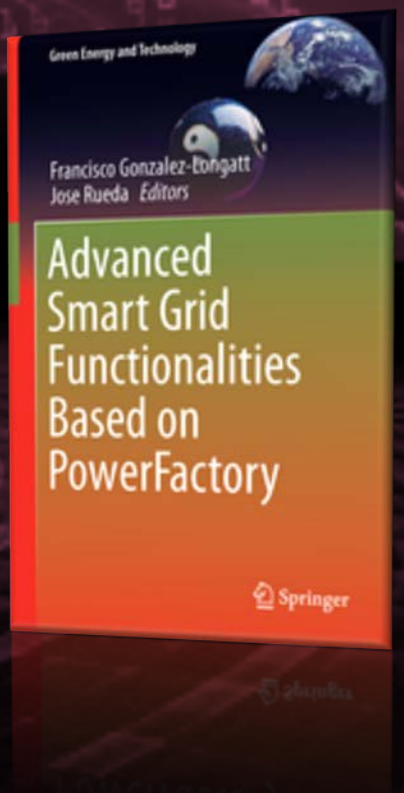
Advanced Smart Grid Functionalities Based on PowerFactory

Francisco Gonzalez-Longatt and

José Luis Rueda Torres



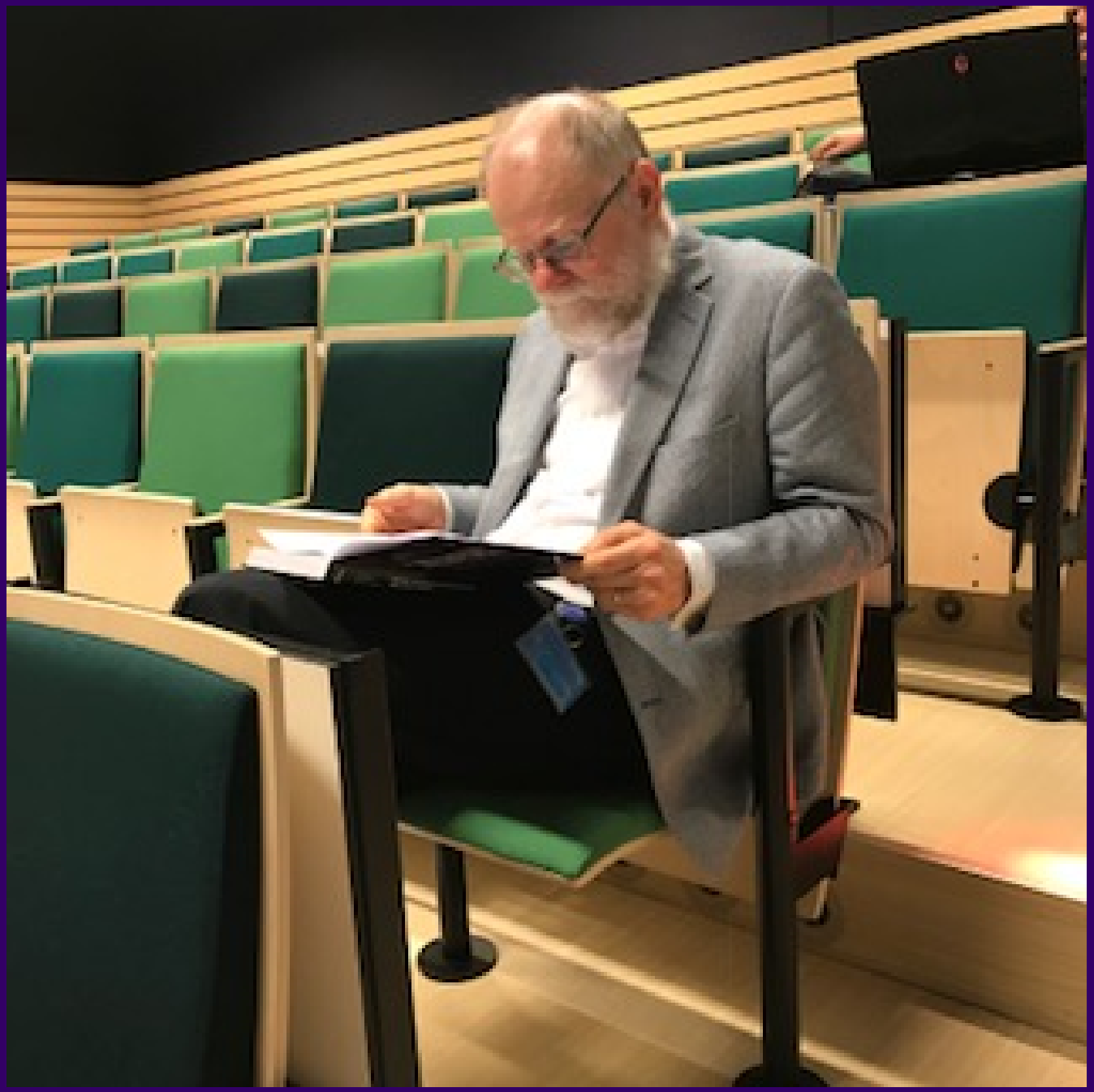
Symposium on Stability Assessment and Intelligent Control for Sustainable Electrical Power Systems

Friday, 20th April 2018
Delft University of Technology -TU Delft, Delft Netherlands

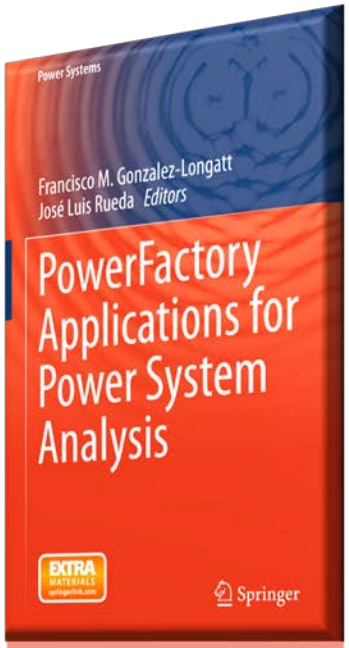
TU Delft

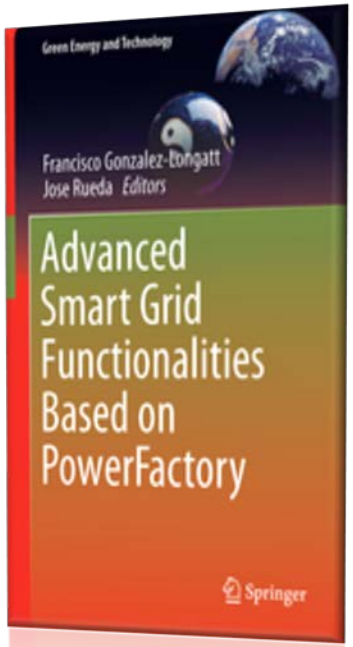
Loughborough University

IEEE SB Delft



Acknowledgment





More to come!!!

Dr.-Ing. Martin Schmieg
Managing Director bei
DIgSILENT GmbH Stuttgart Und Umgebung Deutschland

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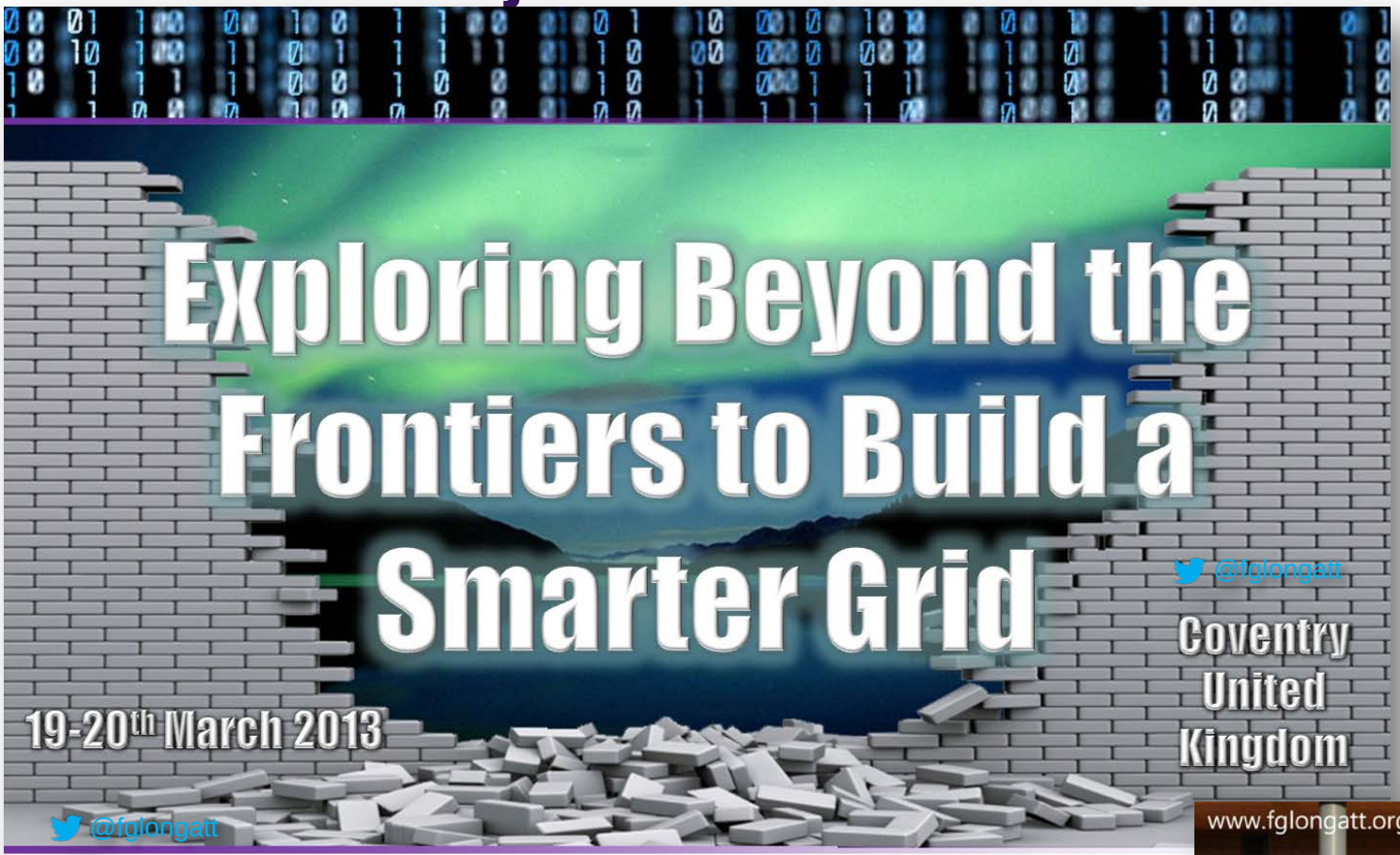
WARNING

The following slides contains graphic Images that some viewers may find disturbing

Research Project



http://www.fglongatt.org/Desechable/SEMINAR%20Exploring%20Beyond%20frontier.pdf

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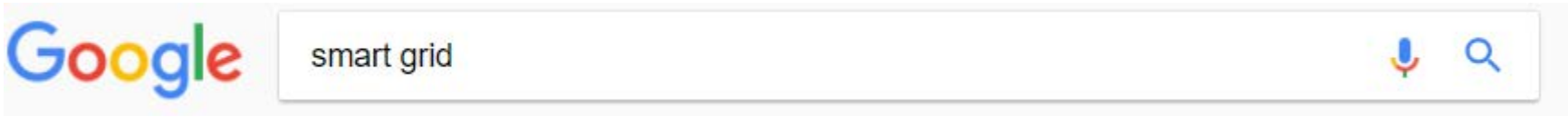
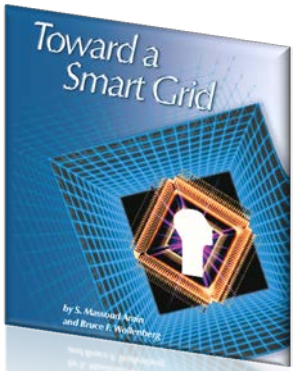
Introduction

- The phrase "**Smart Grid**" is, without any doubt, one of the most utilised expressions in the power utilities in recent years



About **5,280,000 results!!!** (0.41 seconds)



The term smart grid has been in use since at least 2005, when it appeared in the article "*Toward A Smart Grid*" by Amin and Wollenberg.

"Smart Grid / Department of Energy"

http://energy.gov/oe/technology-development/smart-grid

Smart Grids European Technology Platform

http://www.smartgrids.eu/

Department of Energy & Climate Change and Ofgem

https://www.gov.uk/government/policies/maintaining-uk-energy-security--2/supporting-pages/future-electricity-networks

A smart electricity grid that develops to support an efficient, timely transition to a low carbon economy to help the UK meet its carbon reduction targets, ensure energy security and wider energy goals while minimising costs to consumers

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/285417/Smart_Grid_Vision_and_RoutemapFINAL.pdf

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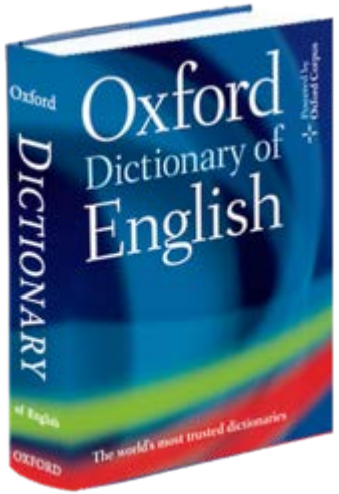
SMART versus SMART-ER



smart

ADJECTIVE

1. (of a person) clean, tidy, and well dressed
   '*you look very smart*'

2. *Informal* Having a quick-witted intelligence.
   'if he was the smart he would never been tricked'

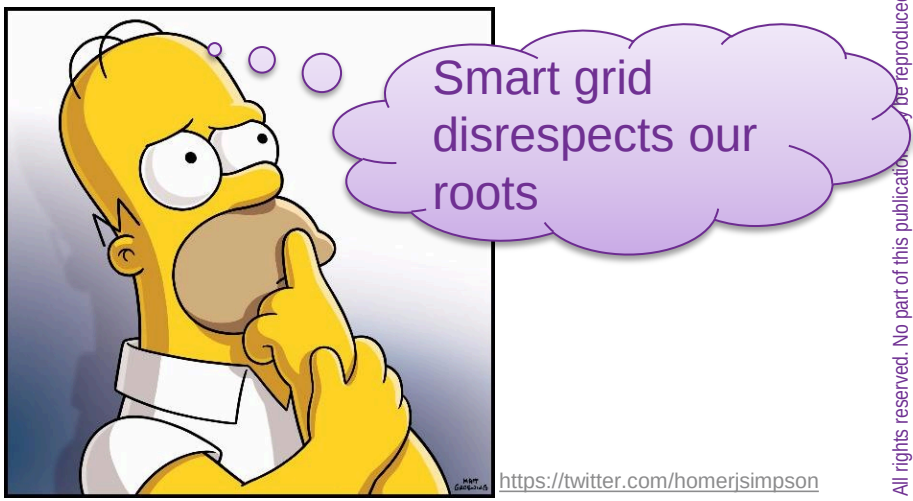
https://en.oxforddictionaries.com/thesaurus/smart

- The **attributive adjective** or adjective of quality "smart" in the phrase smart grid is used to indicate **the intelligence** as an attribute of the power systems.

ANTONYMS

1. dull,
2. stupid,
3. unintelligent,

…etc



https://twitter.com/homerjsimpson

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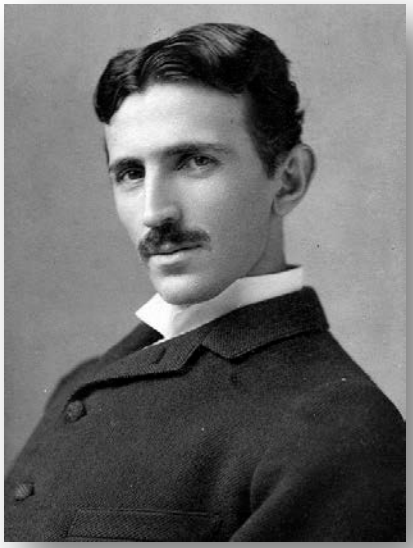
Smart grid disrespects our roots

- If you think about implications behind the **absence of the adjective smart in the classical power system**,
- it is clear the **negative effects and disrespects** on the roots and the past history of the electric power industry and its pioneers.



Nikola Tesla (10 July 1856 – 7 January 1943)

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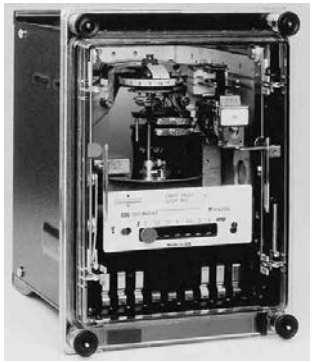
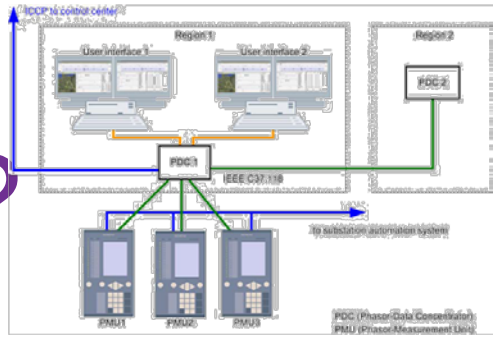
Natural Evolution

- The idea of a smart-er grid coincides with the original vision provided by Amin and Wollenberg [1]: "…*To add intelligence to an electric power transmission system*".



Natural Evolution?

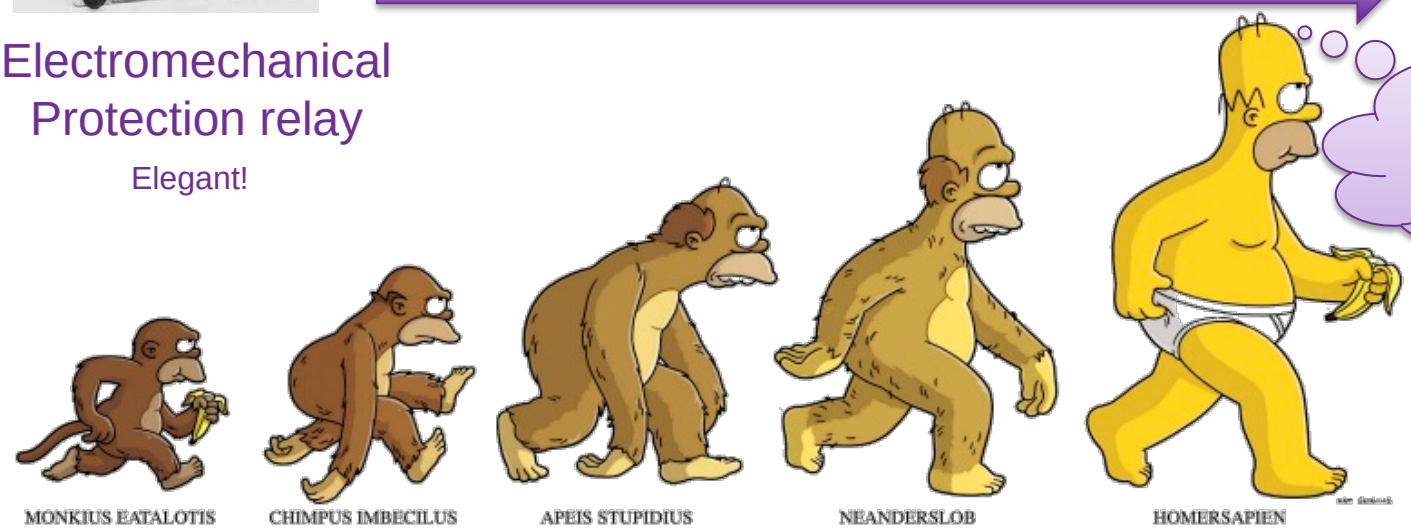
No disruptive!



Inter-net
Inter-connected
Inter-blah! blah!

Electromechanical
Protection relay

Elegant!



Intelligent or fancy?

HOMERSAPIEN

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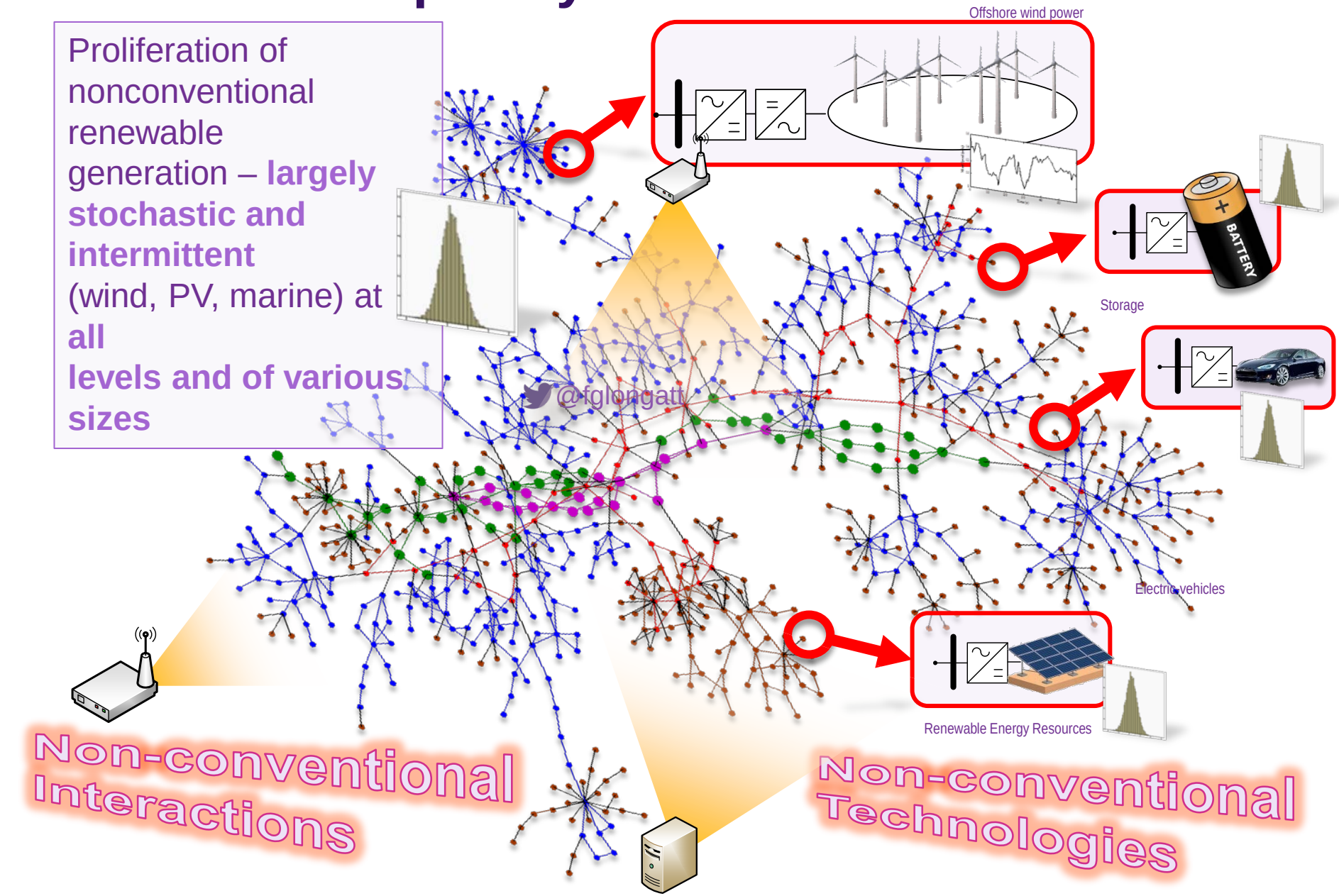
Increased complexity

Proliferation of nonconventional renewable generation – **largely stochastic and intermittent** (wind, PV, marine) at **all levels and of various sizes**



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Power System Analysis Tools

1. Free or open-source tools (Non-Commercial Software).

- Dome (Python based)
- GridCal,
- GRIDLAB-D,
- MatDyn,
- MATPOWER,
- OpenDSS (Distribution system simulator),
- Power Systems Analysis Toolbox (PSAT)

2. Commercial tools.

- APSEN,
- BCP Switzerland (NEPLAN),
- CYME,
- ETAP,
- IPSA Power,
- Power Analytics (EDSA),
- Siemens PTI (PSS/E and SINCAL),

DIgSILENT PowerFactory.

DIgSILENT is one of the most used power system analysis tools. DIgSILENT offers the most economical solution, as data handling, modelling capabilities and overall functionality replace a set of other power software systems analysis software.

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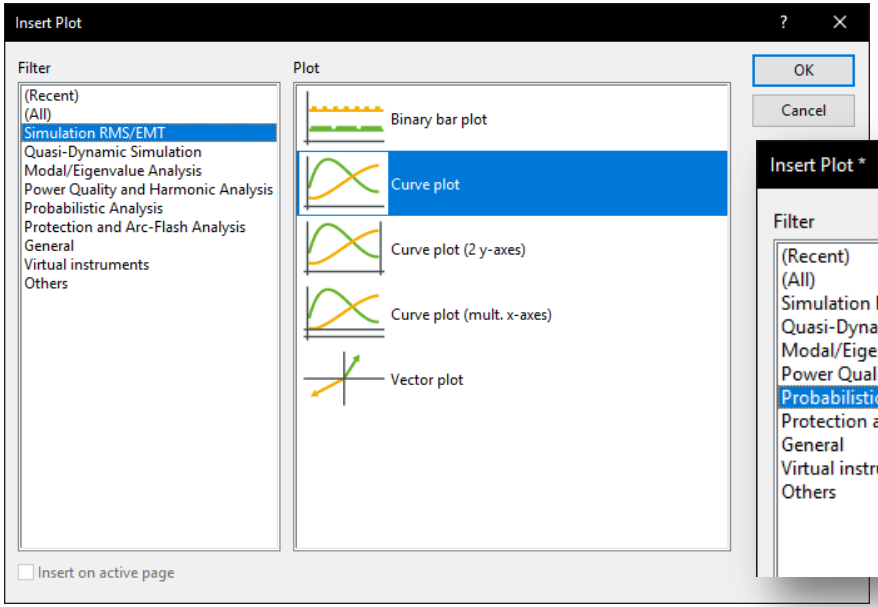
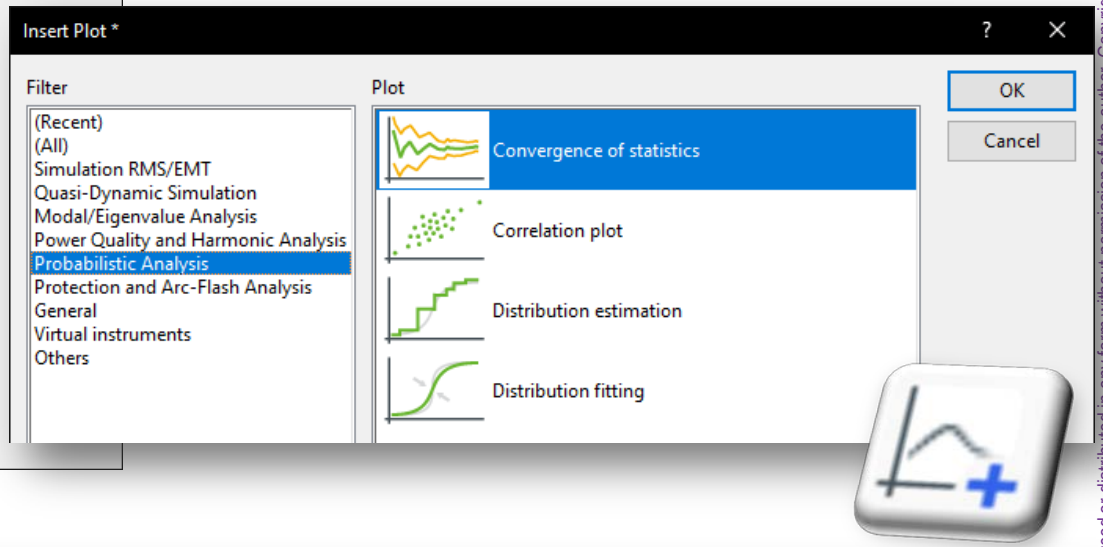
What's New

DIgSILENT
PowerFactory 2018

- Redesign of Plot Insert Dialog





DIgSILENT
PowerFactory 15.2.10 (x64)
Digital Simulation and Network Calculation

RIP

DIgSILENT
PowerFactory 2018 SP1 (x64)
Digital Simulation and Network Calculation
Build 18.0.3 (8031) / Rev. 50568

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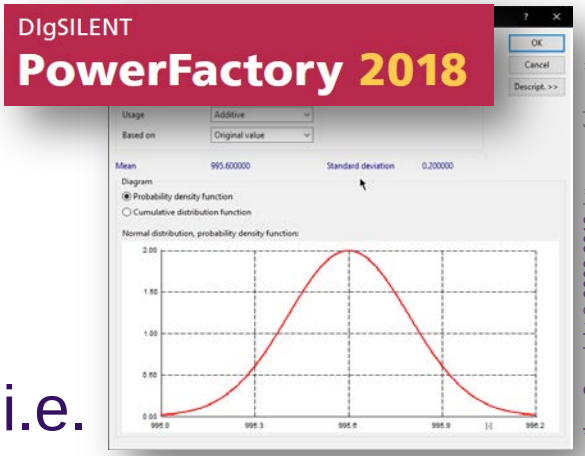
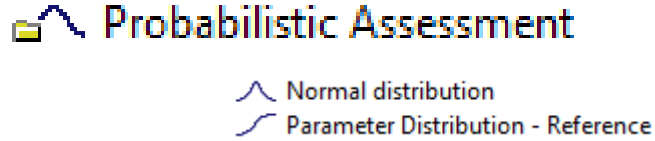
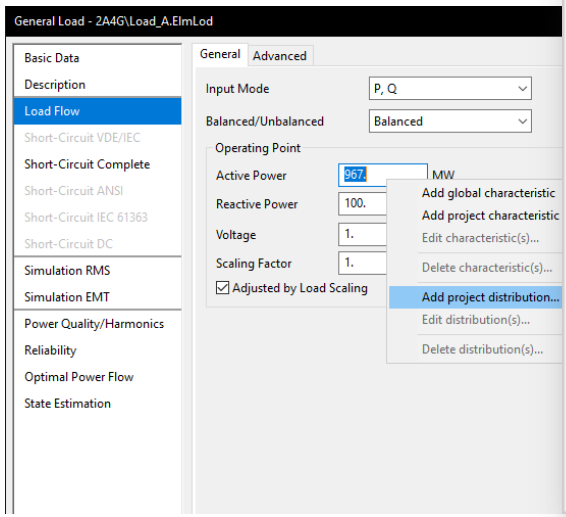
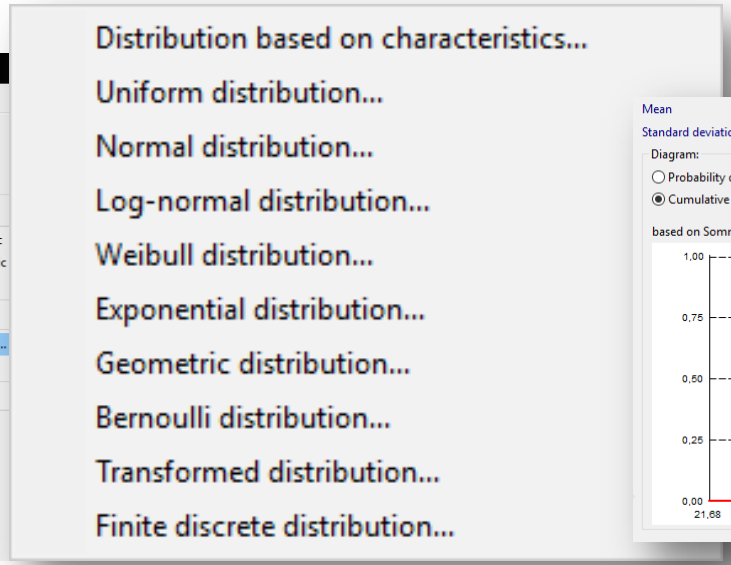
Probabilistic Analysis

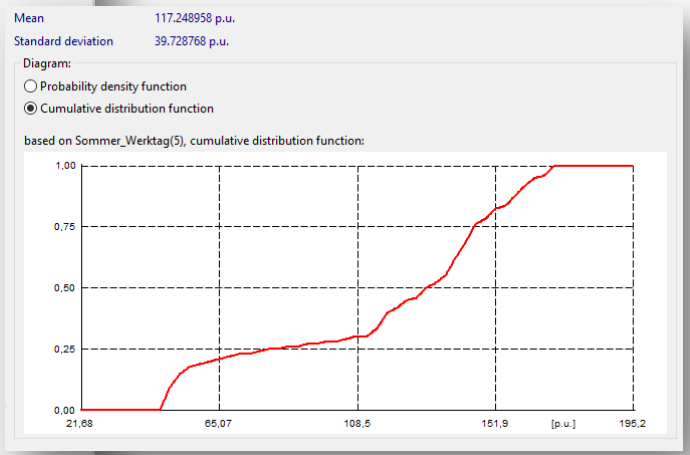
- Probabilistic Analysis is offered for:
  - Load Flow Analysis;
  - Optimal Power Flow.
- The fundamental functions of this module, i.e.
  - Processing of input data;
  - Executing a simulation;
  - Defining result variables for the analysis;
  - Detailed investigation of results including visualising via stochastic plots;











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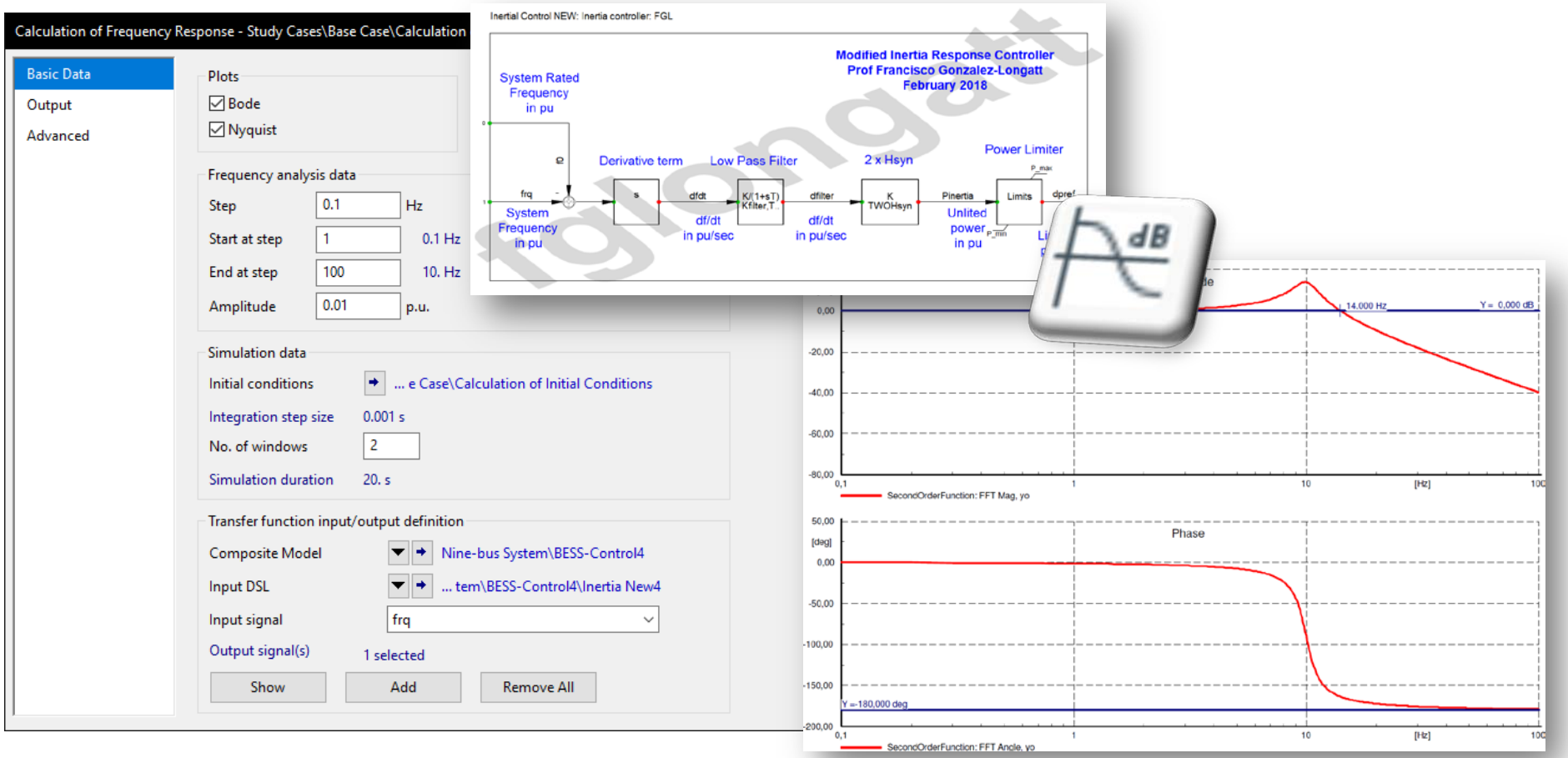
Frequency Response Analysis

DIgSILENT PowerFactory 2018

- Obtaining the transfer function of an already developed dynamic model can be a cumbersome task and usually means that the specific model must be extracted from its original setup and analysed separately.



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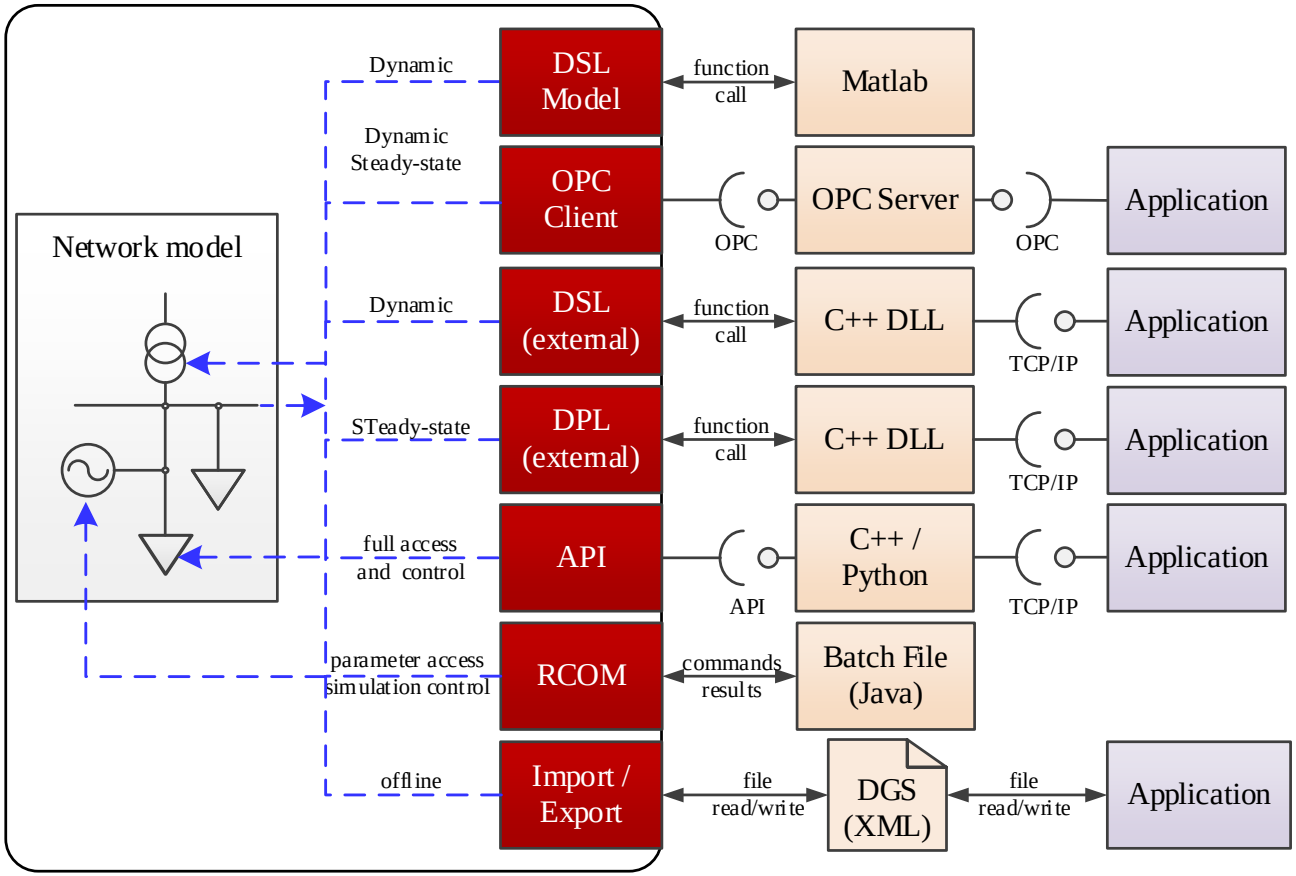
Interfaces for Co-Simulation

- DIgSILENT offers the most economical solution, as data handling, modelling capabilities and overall functionality replace a set of other power software systems analysis software.

General Overview of the Interfaces provided by DIgSILENT PowerFactory



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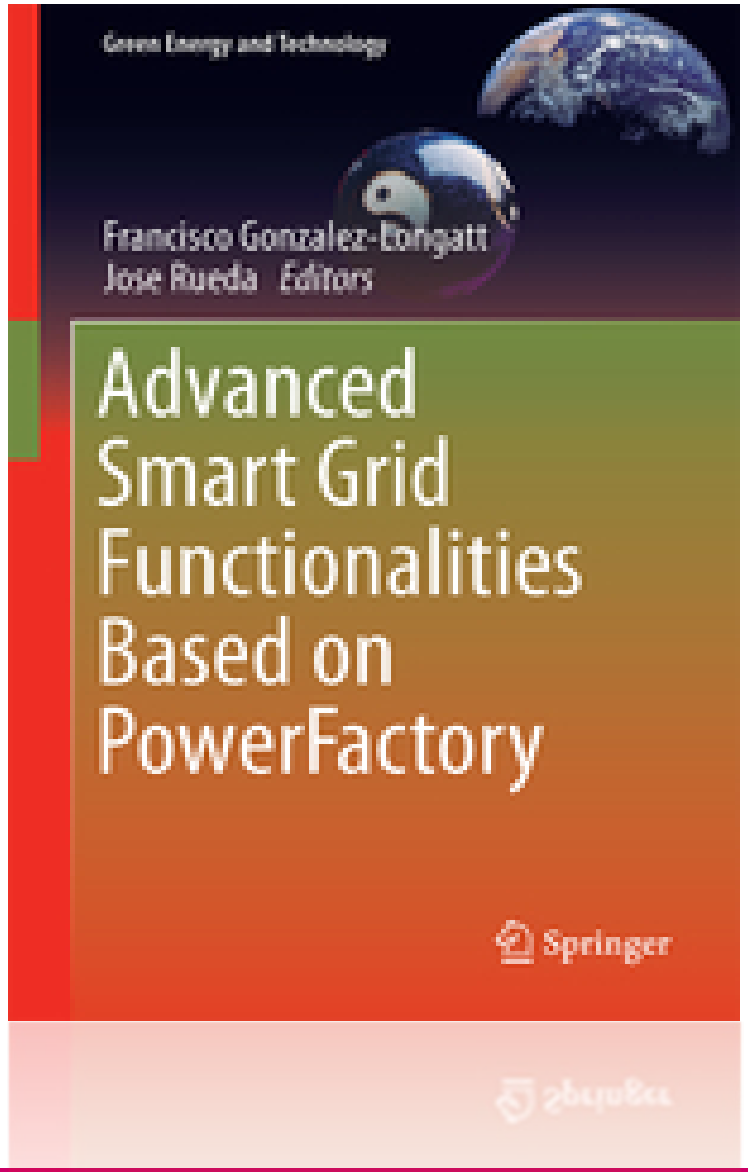
Key Indicators



14 Chapters

40 Authors

10 Countries

- DIgSILENT Programming Language (DPL)
- DIgSILENT Simulation Language
- Third party communication
  - Python
  - Matlab
  - C++, Dll

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ILUSTRATIVE CASES: SMART GRID APPLICATION USING POWERFACTORY

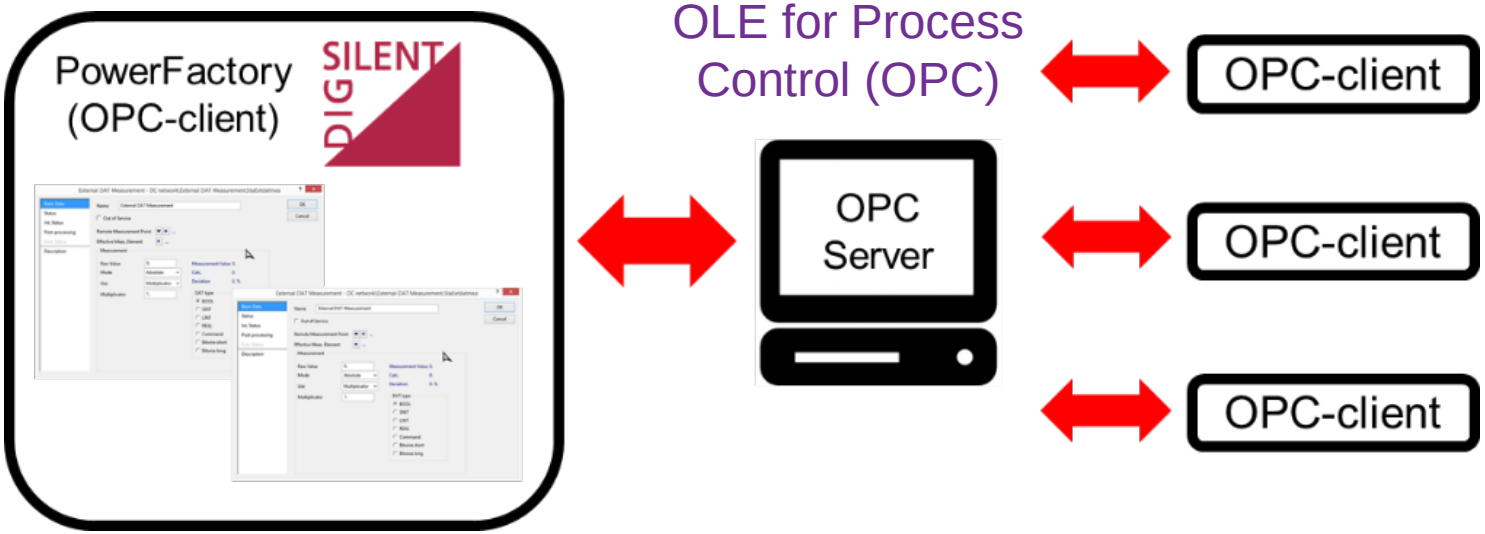
Extensive experience

DIgSILENT Ibérica

Power System Engineering and Software

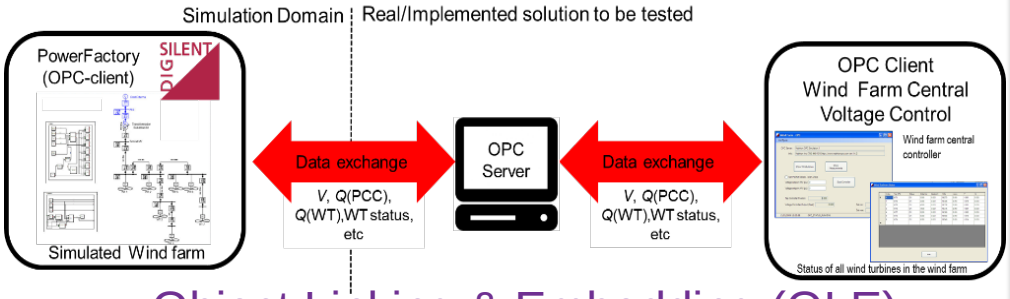
Virtual Control Commissioning

- Virtual Control Commissioning: Connection to SCADA system via OPC protocol



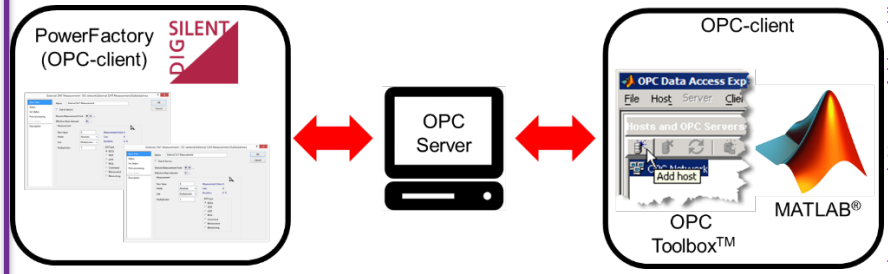
Overview of the OPC interface Server/Client using OPC

General overview of the OPC – Virtual Commissioning: Example used by Wind farm central voltage controller



Object Linking & Embedding (OLE)

Matlab and PowerFactory communicate as OPC client.



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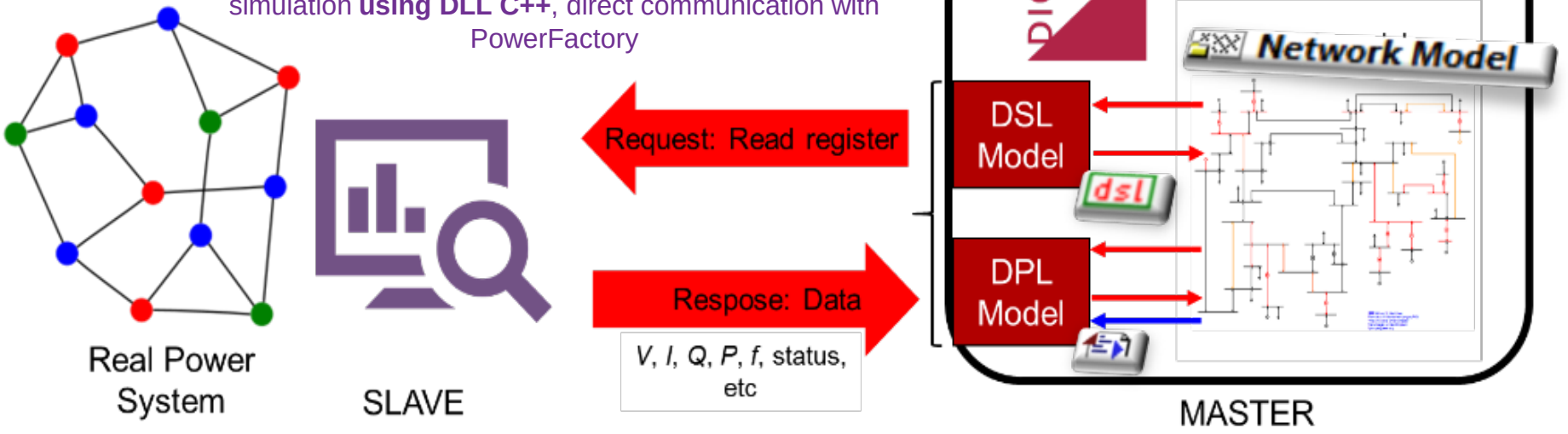
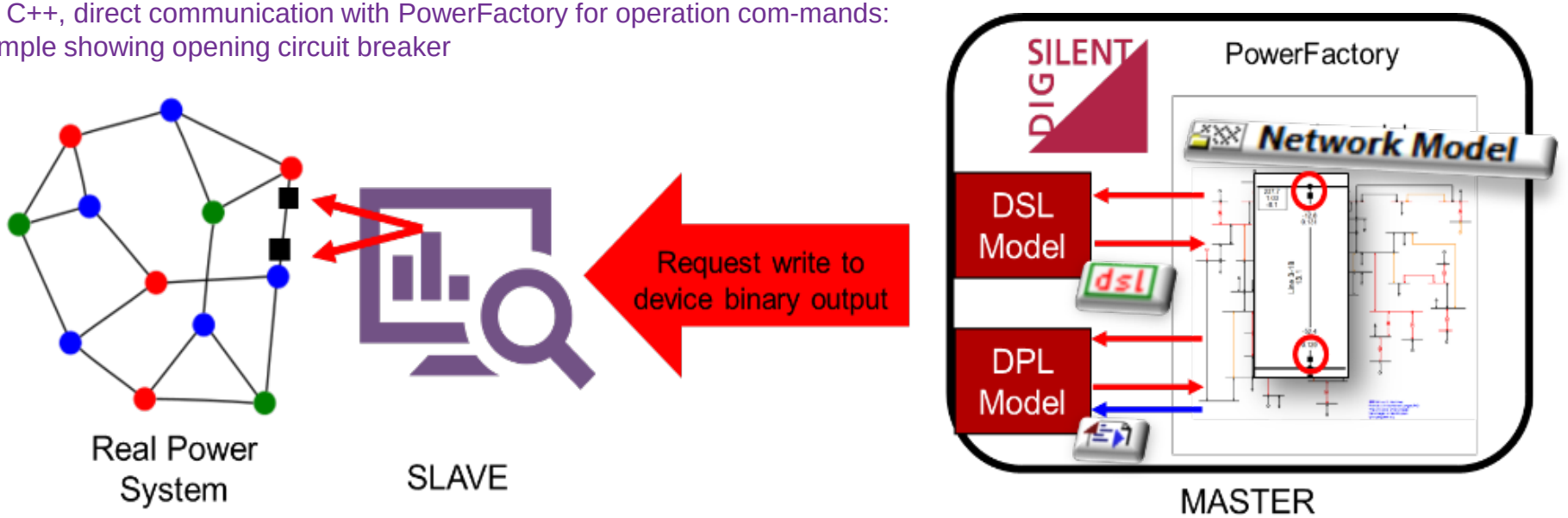
Direct Connection to MODBUS TCP Devices

Credits to: DIgSILENT Ibérica — Power System Engineering and Software

Implementation of Modbus communication protocol for in-loop simulation **using DLL C++**, direct communication with PowerFactory



Implementation of Modbus communication protocol for in-loop simulation using DLL C++, direct communication with PowerFactory for operation com-mands: Example showing opening circuit breaker



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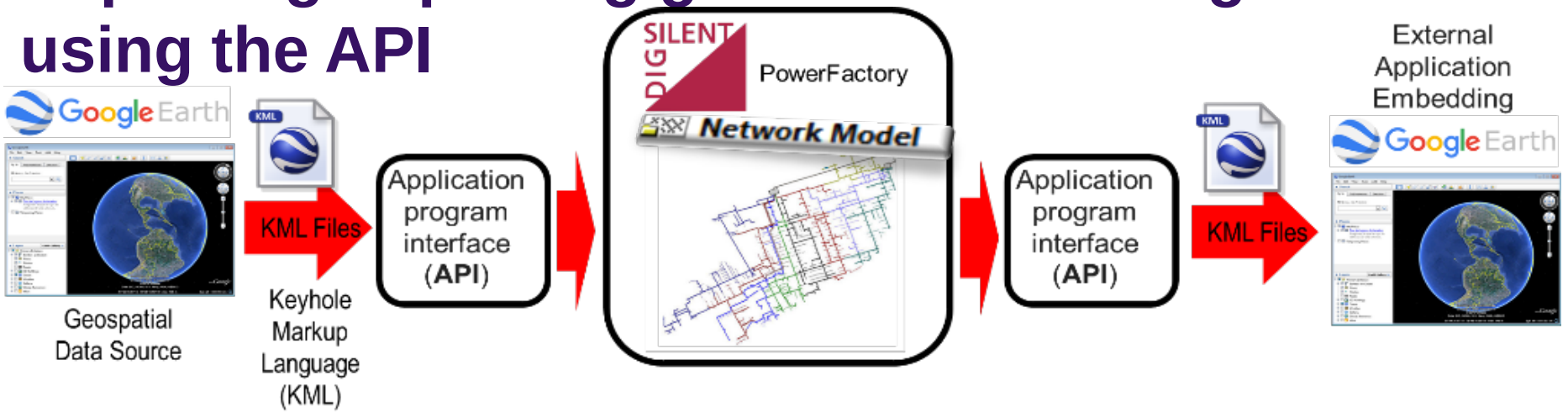
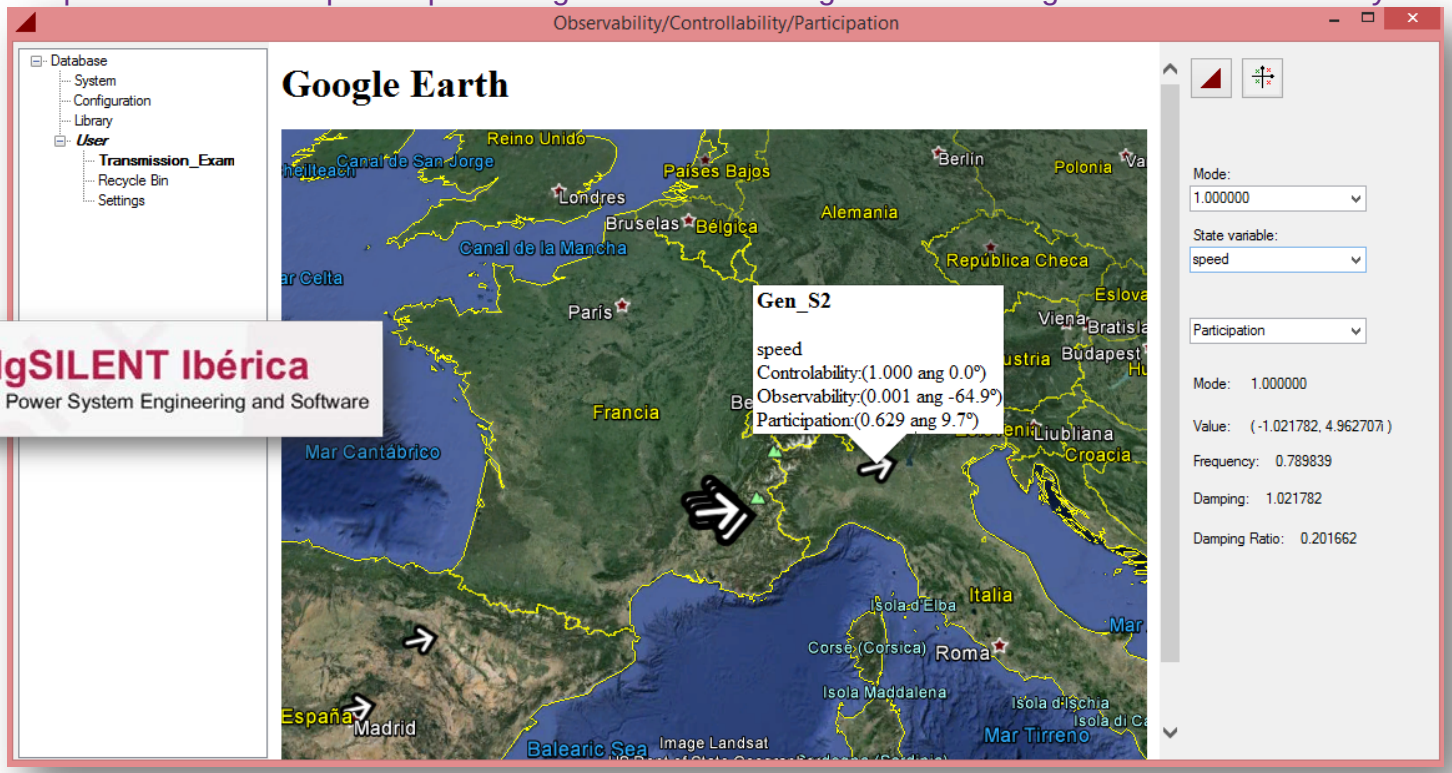
Exporting/Importing grids to/from Google Earth using the API



Implementation of Import/Export Google Earth data using an API and DIg-SILENT PowerFactory.



Credits to:

DIgSILENT Ibérica
Power System Engineering and Software

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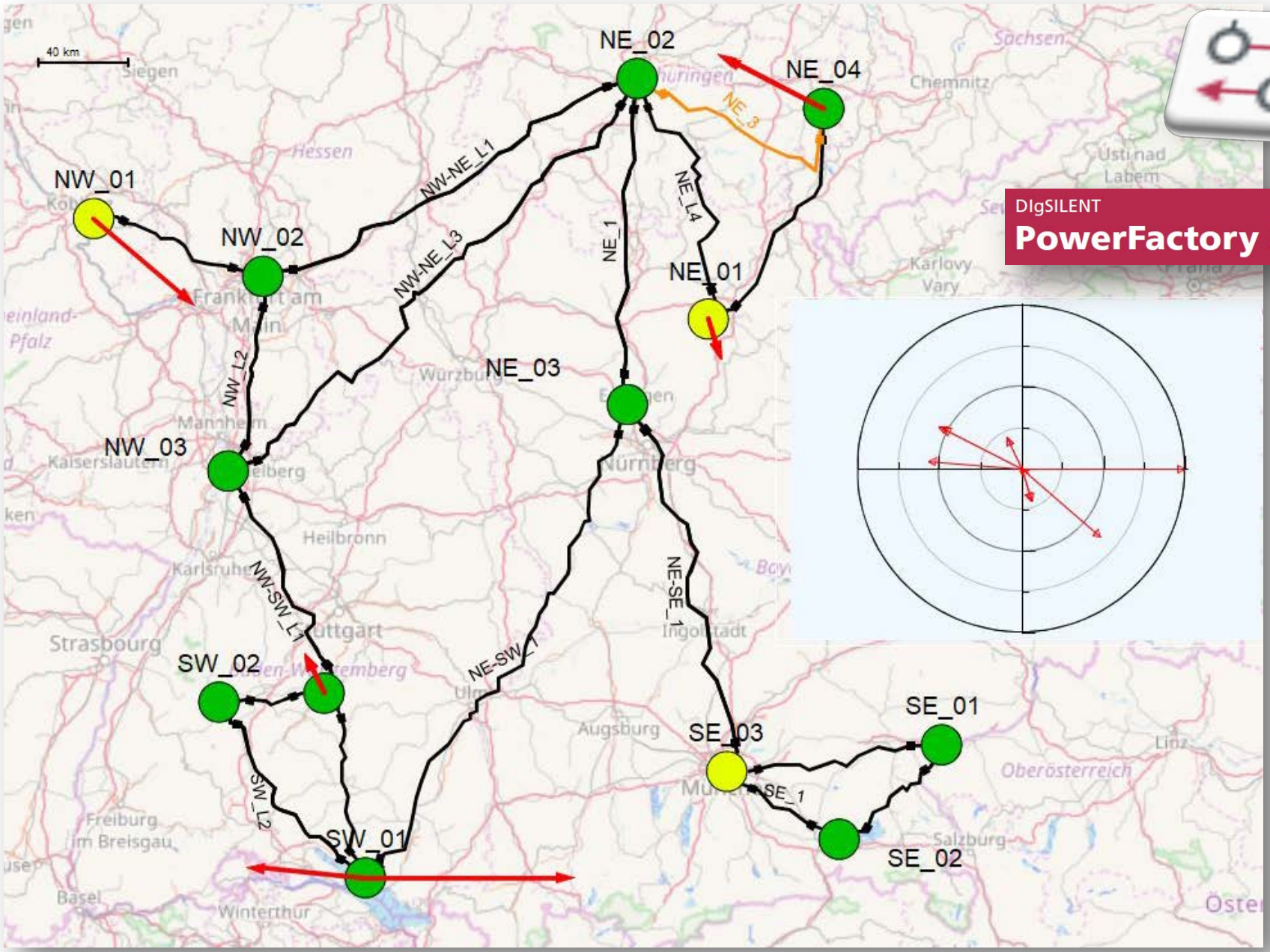
Visualisation of Eigenvectors in the Single Line Diagram



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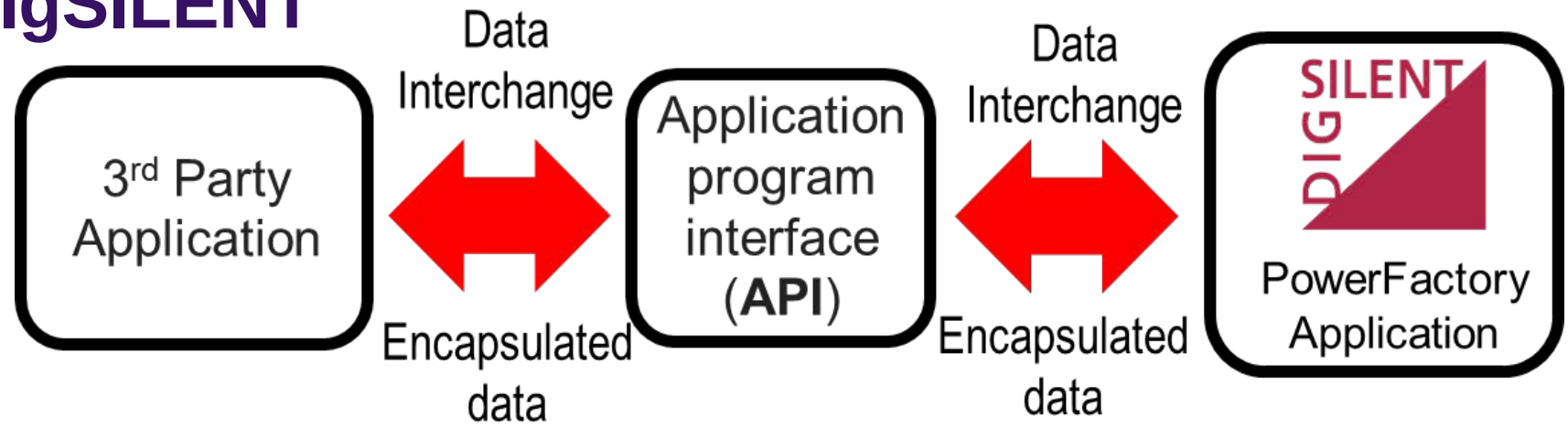
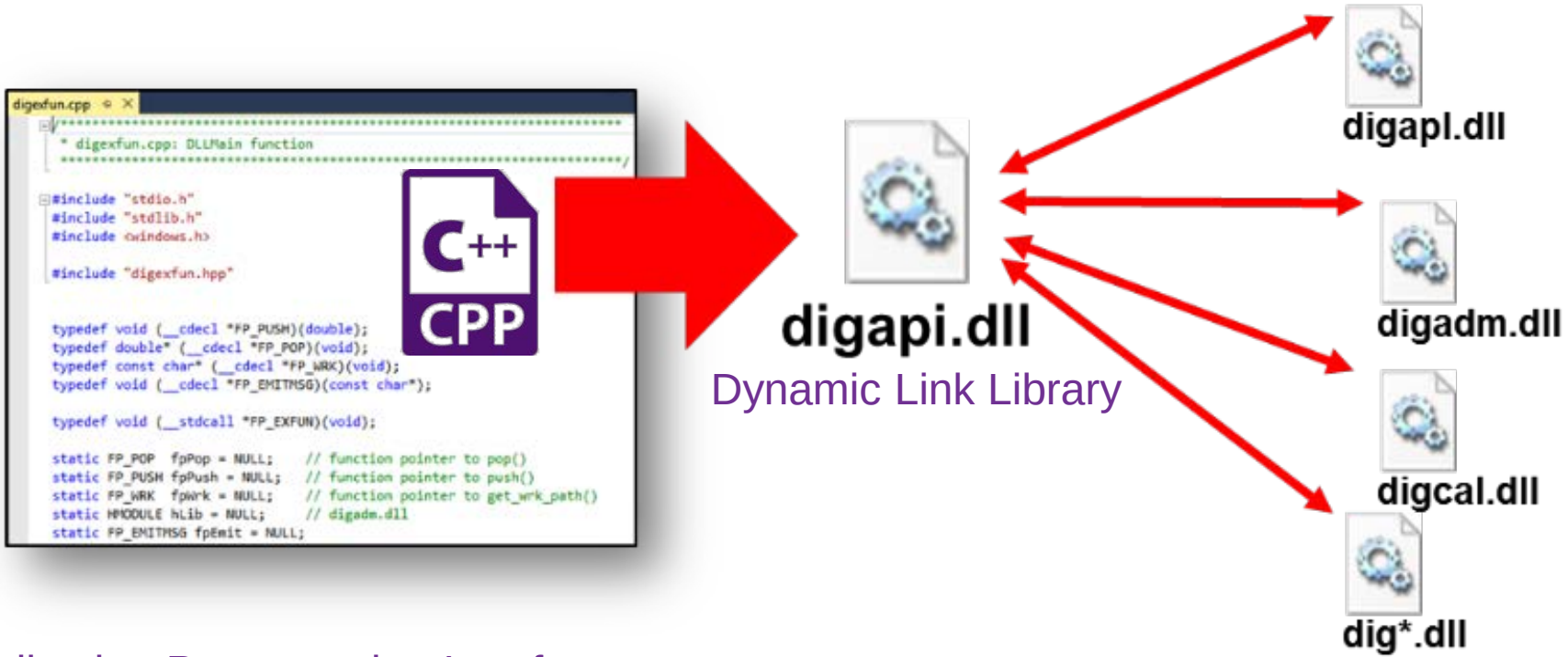
API interface data flow interaction with DIgSILENT





Application Programming Interface.

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Chapters (1/3)

Chapter 1
Introduction to Smart Grid Functionalities

Francisco Gonzalez-Longatt and José Luis Rueda Torres

Chapter 2
Python Scripting for DIgSILENT PowerFactory: Leveraging the Python API for Scenario Manipulation and Analysis of Large Datasets

Claudio David López and José Luis Rueda Torres

Chapter 3
Smart Network Planning—Pareto Optimal Phase Balancing for LV Networks via Monte-Carlo Simulations

Benoît Bletterie, Roman Bolgaryn and Serdar Kadam

Chapter 4
Co-simulation with DIgSILENT PowerFactory and MATLAB: Optimal Integration of Plug-in Electric Vehicles in Distribution Networks

J. Garcia-Villalobos, I. Zamora, M. Marinelli, P. Eguia and J. I. San Martin

Chapter 5
Probabilistic Load-Flow Using Analysis Using DPL Scripting Language

Francisco Gonzalez-Longatt, S. Alhejaj, A. Marano-Marcolini and José Luis Rueda Torres

Chapter 6
Dynamic Stability Improvement of Islanded Power Plant by Smart Power Management System: Implementation of PMS Logic

Hamid Khoshkhoo and Ali Parizad

Chapters (2/3)

Chapter 7
Determining Wide-Area Signals and Locations of Regulating Devices to Damp Inter-Area Oscillations Through Eigenvalue Sensitivity Analysis Using DIgSILENT Programming Language

Chapter 8
Dynamic Stability Improvement of Islanded Power Plant by Smart Power Management System—Principles, Descriptions and Scenarios

Ali Parizad and Hamid Khoshkhoo

Chapter 9
Wide-Area Measurement, Monitoring and Control: PMU-Based Distributed Wide-Area Damping Control Design Based on Heuristic Optimisation Using DIgSILENT PowerFactory

Amin Mohammadpour Shotorbani, Sajad Madadi and Behnam Mohammadi-Ivatloo

Chapter 10
Optimal PMU Placement Framework Under Observability Redundancy and Contingency—An Evolutionary Algorithm Using DIgSILENT Programming Language Module

Mohsen Zare, Rasoul Azizipanah-Abarghooee, Mostafa Malekpour and Vladimir Terzija

Chapter 11
Implementation of Slow Coherency Based Controlled Islanding Using DIgSILENT PowerFactory and MATLAB

I. Tyuryukanov, M. Naglič, M. Popov and M. A. M. M. van der Meijden

Chapter 12
Peer-to-Peer (P2P) MATLAB–PowerFactory Communication: Optimal Placement and Setting of Power System Stabilizer

Andrei Stativă and Francisco Gonzalez-Longatt

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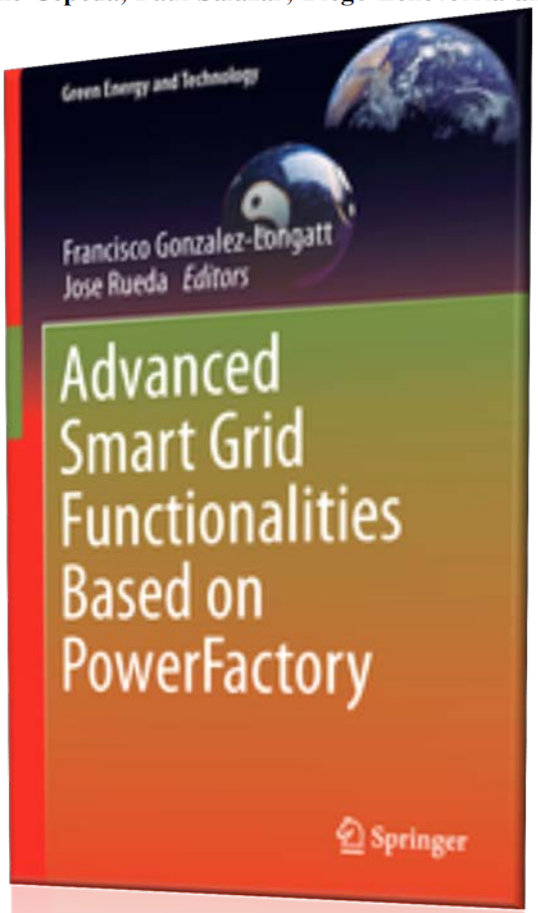
Chapters (3/3)

Chapter 13
Implementation of the Single Machine Equivalent (SIME) Method for Transient Stability Assessment in DIgSILENT PowerFactory

Jaime Cepeda, Paúl Salazar, Diego Echeverría and Hugo Arcos

Chapter 14
Generic DSL-Based Modeling and Control of Wind Turbine Type 4 for EMT Simulations in DIgSILENT PowerFactory

Abdul W. Korai, Elyas Rakhshani, José Luis Rueda Torres and István Erlich



There are so many things to do…

Next step…

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Closing…
or Opening?

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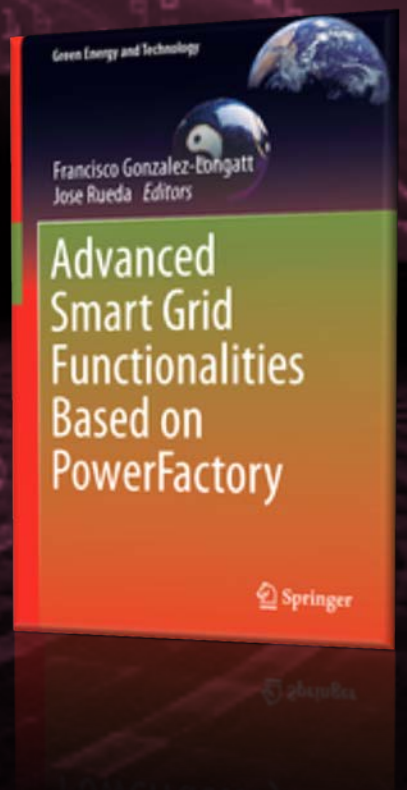
Advanced Smart Grid Functionalities Based on PowerFactory

Francisco Gonzalez-Longatt and
José Luis Rueda Torres



QUESTIONS

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