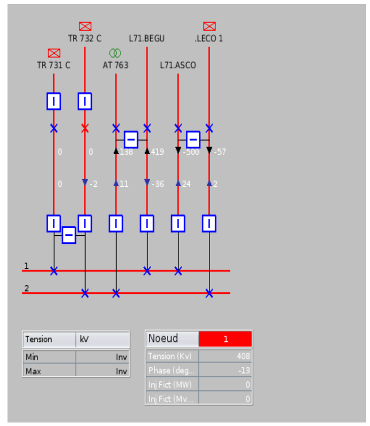


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        <switch id=".ESPL 7 .ASCO.1 SA.1" kind="DISCONNECTOR" retained="false" node1="9" node2="6" open="false"/>
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    <load id=".ESPL 7 TR 731 C" node="4" …/>
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</voltageLevel>
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Recent Developments in High-Fidelity Large-Scale Power System Datasets

IEEE PES GM 2017 – Chicago

Recent Developments in European AC Power Flow Datasets: iTesla, RTE Snapshots, and PEGASE

Patrick Panciatici – Senior Scientific Advisor

OUTLINE

- **Motivation**
- **What have we already done**
  ➔ *description of test cases provided by RTE in MatPower*
- **High fidelity?**
  ➔ For what
  ➔ What must be improved

Motivation: *CHALLENGING OPTIMIZATION PROBLEMS*

- **Problems: find "optimal" decisions for system operation, market operation, grid maintenance and grid expansion.**

- **Different types of very challenging optimization problems, not only "market clearing/unit commitment"**
  - ***Example: Risk based "optimal" preventive actions taking into account contingencies, uncertainties and "automatic" post fault corrective actions.***

- **Research teams propose advanced optimization methods to solve all these challenging problems.**

➔ we need to define relevant use cases with associated realistic modeling and realistic data in order to evaluate them.

What we have already done

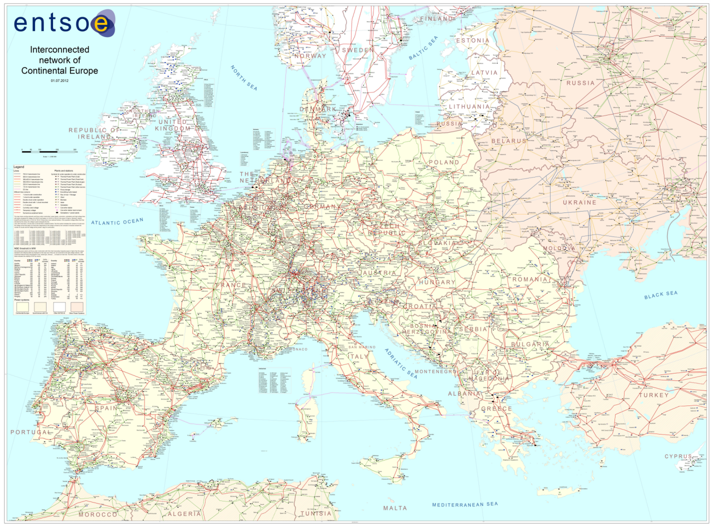
- RTE provided 13 test cases in Matpower. A paper in arxiv describes these test cases: https://arxiv.org/pdf/1603.01533.pdf

- Two sources of data:
  - Pegase project: Pan European Grid Advanced Simulation and State Estimation, co-funded by the EC 7th Framework Programme.
    - Fictitious European Transmission Grid: same size and complexity than the EHV actual grid but some electrical characteristics have been changed ….
  - iTesla project: Innovative Tools for Electrical System Security within Large Areas, co-funded by the EC 7th Framework Programme.
    - French Transmission Grid: past anonymized snapshots

Pegase test cases

Name	Bus.	Gen.	Branches	Transformers
case89pegase	89	12	210	32
case1354pegase	1354	260	1991	234
case2869pegase	2869	510	4582	496
case9241pegase	9241	1445	16049	1319
case13659pegase	13659	4092	20467	5713

- **Case9241Pegase** was converted from a dataset which was originally defined for CIM interoperability tests and publicly available. No geographical information except country and anonymization.
- Case89, Case1354, Case2869 are extractions of sub areas of case9241
- **Case13659Pegase** was created during the Pegase project in order to perform time domain simulations: mainly by disaggregating generators and adding step up transformers.



- **Case9241Pegase** described the EHV grid. Voltage levels: 750 400 380 330 220 154 150 120 110 kV
- Adaption to Matpower format

  Asymmetric shunt conductance and susceptance for some equivalent PI circuits ➔ bus shunts

  Same power flow solution but flows on these branches are different.

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RTE test cases *(iTesla)*

Name	Bus.	Gen.	Branches	Transformers
case1888rte	1888	297	2531	405
case1951rte	1951	391	2596	486
case2848rte	2848	547	3776	558
case2868rte	2868	599	3808	606
case6468rte	6468	1295	9000	1319
case6470rte	6470	1330	9005	1333
case6495rte	6495	1372	9019	1359
case6515rte	6515	1388	9037	1367

- **Case6468, Case 6470, Case6495, Case6515** are 4 full consistent EHV + HV (400 kV to 63 kV) snapshots of 2013 French transmission and sub-transmission Grid. State estimator solved cases.
- Case1888, Case1951, Case2848, Case2868 are extractions of sub areas from the full snapshots.
- No relevant id, no geographical information are given nor time stamp

- 380 225 150 90 63 kV voltage levels are present ion these test cases (for large cases 50% are 63 kV buses)
- Neighboring countries are approximately represented with Ward equivalents; so these parts are not real.
- Adaption to Matpower format
  - Node/Breaker ➔ Bus/Branch
  - A disconnected equipment is not described in the snapshot ➔ variability of the number of objects

High-fidelity?

- For what?

  ►Optimal preventive actions taking into account contingencies, uncertainties and "automatic" post fault corrective actions.

  ►Realistic modeling is a prerequisite
  - ACOPF needs a realistic modeling of **all voltage/reactive behaviors** of the components if not results could be worst than using a DC approximation!
  - Security Constrained Optimal Power Flow requires realistic simulations of **all protections/controls** embedded in the system, acting automatically after a contingency.

  ➔ **Node/breaker modeling is mandatory**

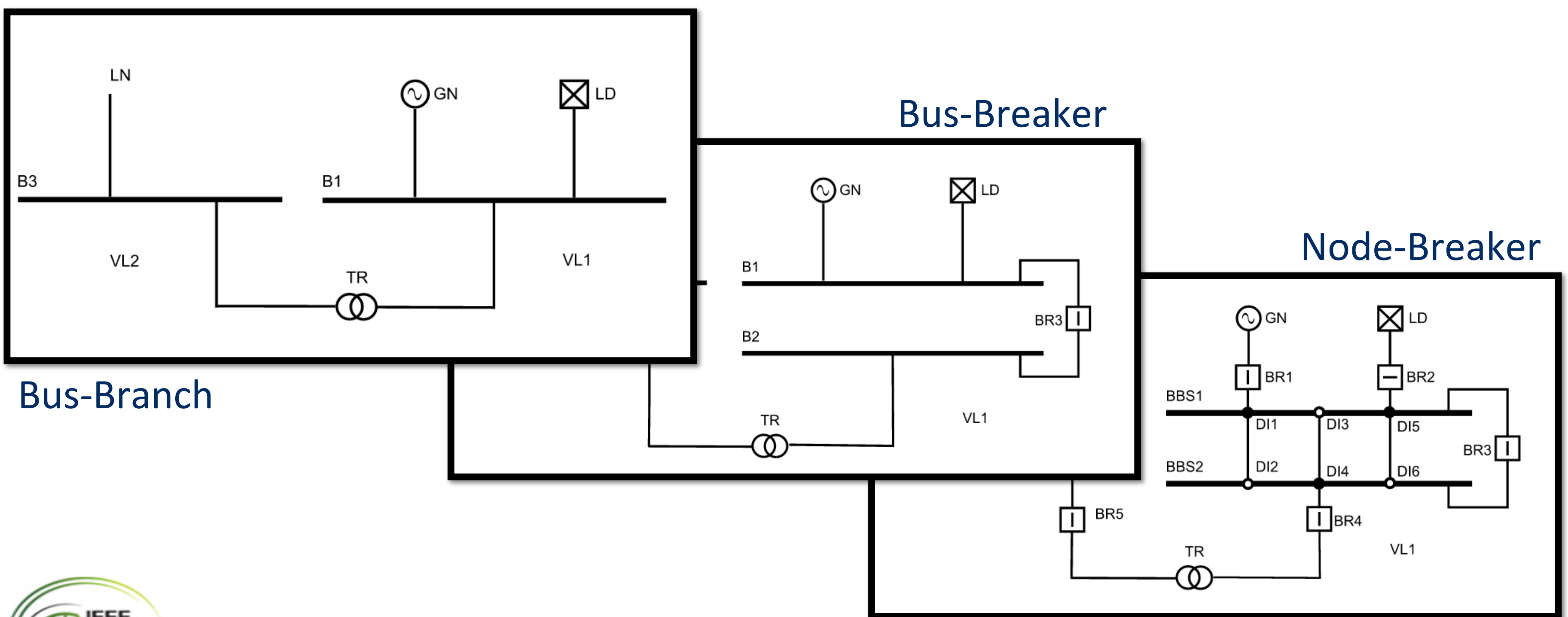
What must be improved?

- Node-Breaker modeling: *mainly for bus merging/splitting*
- Generator Capability Curve ("D curve") or (P,Q,V) 3D domain
- Phase Shifting Transformers: for some types reactance depends on tap position
- HVDC links: Reactive/voltage modeling (LCC ≠ VSC)
- Capacitors/Reactors banks (large banks)
- SVC, STATCOM, Series Compensation ….
- Automatic controls: AVR, Speed Governor, AGC, …
- Corrective actions: RAS, SPS, .. : If {some condition} then {action} …
- Open issues:
  - ✓ Dynamic Line Rating
  - ✓ Modeling of active Distribution grids for Transmission grid optimization

➔ **Simple and efficient format required!**

- CIM is not the right solution for a computational platform, parsing data should take a minimal time and some objects/concepts are not present or not clear in CIM format
- MATPOWER format seems too poor to be a good foundation

One important feature: Node/Breaker ➔ Bus/Branch



A new format (iidm) developed during the iTesla Project

open source: https://github.com/itesla

Package Hierarchies: eu.itesla_project.iidm.network, eu.itesla_project.iidm.network.util

- **Class Hierarchy**
- java.lang.Object
  - eu.itesla_project.iidm.network.AbstractTopologyVisitor (implements eu.itesla_project.iidm.network.TopologyVisitor)
    - eu.itesla_project.iidm.network.EquipmentTopologyVisitor
    - eu.itesla_project.iidm.network.TerminalTopologyVisitor
  - eu.itesla_project.iidm.network.util.ConnectedComponents
  - eu.itesla_project.iidm.network.Equipments
  - eu.itesla_project.iidm.network.Equipments.ConnectionInfo
  - eu.itesla_project.iidm.network.util.GraphvizConnectivity
  - eu.itesla_project.iidm.network.util.Identifiables
  - eu.itesla_project.iidm.network.NetworkFactory
  - eu.itesla_project.iidm.network.util.Networks
  - eu.itesla_project.iidm.network.util.ShortIdDictionary
  - eu.itesla_project.iidm.network.util.SV

► **Participation *in "High Fidelity, Year Long Power Network Data Sets for Replicable Power System Research"* one of GridData projects of DOE/ARPA-E.**

➔ **Improve and adapt the format and deliver realistic data in this format**

THANK YOU FOR YOUR ATTENTION

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