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GridSuite and PowSyBl:

an Open Source approach to develop advanced tools for grid analysis and simulation of power systems

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1 Context

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RTE's missions

RTE is:

- The French TSO (transmission system operator): has the responsibility to operate safely the French electrical Grid (20kV – 400 kV) and provide electricity access 24/7
- Assets owner: responsible of its assets renewal policy (billions of euros of investments)
- Responsible to adapt the structure of the grid for the energy transition:
 - Increase interconnections capacities (ex: DC link between France and Ireland)
 - Adapt the grid to the new energy mix: (ex: Build a network to accommodate marine energy sources)



Many challenges in a fast-changing world

- The future holds numerous challenges:
 - helping to achieve the Green Deal's carbon-neutrality target by 2050 by continuing to integrate an increasing amount of renewable energy;
 - supporting the integration of electric vehicles into the power system;
 - supporting decentralised power generation.
- In order to successfully complete the energy transition in accordance with the EU's objectives, transmission systems must continuously come up with novel solutions.
 - RTE must adapt its tools to be compliant with evolving grid codes
 - RTE is actively involved in research programmes seeking to develop technological innovations.



Power system tools must adapt quickly

- Today's need is not to build a tool to answer present's needs but to build a tool that is flexible enough to integrate quickly and efficiently tomorrow's needs.
- Do we have a precise vision of functionalities that will be required in 5 years? **No**
- How do we get back control of our future? **Open source!**



2 PowSyBI



A software ecosystem dedicated to power grid transmission

- PowSyBl: a set a low-level software components used as a foundation for building power system applications
 - Power Grid Modeling
 - Convenient and rich API to build and update Grid models for study purposes
 - Visualization of grid network and grid substation
 - Grid data format conversion
 - Standard data format (CIM, UCTE)
 - Commercial tool (PSS/E, PowerFactory) for interoperability
 - Academic data format (IEEE, Matpower)
 - Analysis functions:
 - Power flow calculation
 - Security analysis
 - Sensitivity analysis
 - Short circuit calculation
 - Dynamic (time domain) simulation
 - Mostly Java (17) code, no complex framework, as light as possible.



3 GridSuite



GridSuite

A software ecosystem dedicated to power grid transmission

- GridSuite: an application built on top of PowSyBl and used for all power grid studies
 - From real time studies (security analysis) to long term grid planning (studies to connect new renewable generation).
 - In production environment at RTE since end of 2023 for a few early users.
 - Target: 400 users end of 2025 with 24/7 support
 - 20+ developers
 - 100% open-source technical stack with a modern and scalable architecture:
 - Around 40 Micro services, Java, Spring Boot, REST API, RabbitMQ based messaging, PostGreSQL, Elastic search
 - Orchestrated by a k8s cluster
 - Web frontend: ReactJS , DeckGL (WebGL) for high performance grid geographical view.

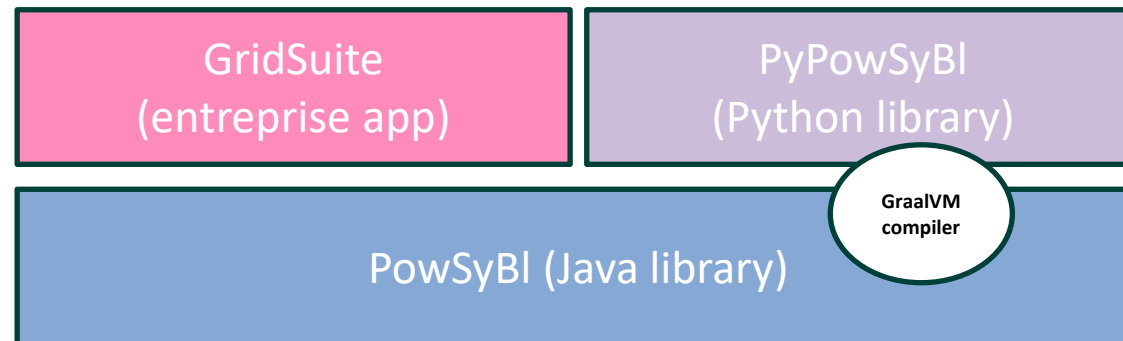


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Industrial use and experimental use:
is it PowSyBI?

An architecture to meet both enterprise and research needs

- Technical stack mismatch between
 - **Classical enterprise application:** technical stack based on Java ecosystem (Spring, Quarkus, etc)
 - **Research / data science community:** mainly on Python ecosystem.
- How to reconcile these 2 needs and continue to share same building blocks for all our users ?
 - Java to native code compilation using GraalVM (<https://www.graalvm.org/>) to build a C library from all PowSybl Jars
 - Python extension module based on PowSyBl C library



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**Vital minimum information
(because 15 min is way too short for this subject!)**

Where is it ?

- Useful links
 - <https://github.com/powsybl>
 - <https://github.com/gridsuite>
 - PowSyBI LFE: <https://lfenergy.org/projects/powsybl/>
 - PowSyBI documentation <https://www.powsybl.org/>
 - PyPowSyBI documentation <https://pypowsybl.readthedocs.io/en/stable/>
 - GridSuite architecture: <https://github.com/gridsuite/documentation>
 - Slacks for questions/support powsybl.slack.com and gridsuite.slack.com
 - GridSuite Online demo !! <https://demo.gridsuite.org> (GH account for login)
 - GridSuite demo Youtube Video: <https://www.youtube.com/watch?v=1AmiEldTtqw>

GridSuite demo?

The screenshot displays the GridStudy software interface. At the top, the navigation bar includes the GridStudy logo, the project name 'Grid modif 1', and tabs for 'Carte', 'Tableur', 'Résultats', 'Logs', and settings. A green button labeled 'Calcul de répartition' is visible in the top right.

On the left, a project overview diagram shows a hierarchy: a green icon at the top, followed by a blue box labeled 'Grid modif 1', which is connected to two grey boxes labeled 'Grid modif 2' and 'Grid modif 3'.

The central panel, titled 'Grid modif 1', lists '2 modifications':

- Ouverture de TAVELP6_TAVEL 6COUPL DJ
- Ouverture de TAVELP6_TAVEL 6VIRAD.1 DJ

Two detailed network diagrams are shown:

- TAVELP6 - FRANCE:** A schematic diagram showing a horizontal busbar with three vertical branches. The top branches are labeled VIRAD2 (228), VIRAD1 (-2), AT764 (-271), and AT763 (-338). The bottom branches are labeled ARDO13 (271), ARDO12 (55), and ARDO11 (55). A legend indicates 238,0 kV (-3,2") and 238,6 kV (-2,3").
- VLEJUP7:** A network diagram showing a central node connected to several peripheral nodes, with a depth of 'Profondeur : 1'.

The background features a map of France with a complex network of power lines overlaid in various colors. A legend in the bottom right corner allows filtering by voltage levels: 380 kV, 225 kV, 150 kV, 90 kV, 63 kV, 45 kV, 42 kV, and 20 kV.