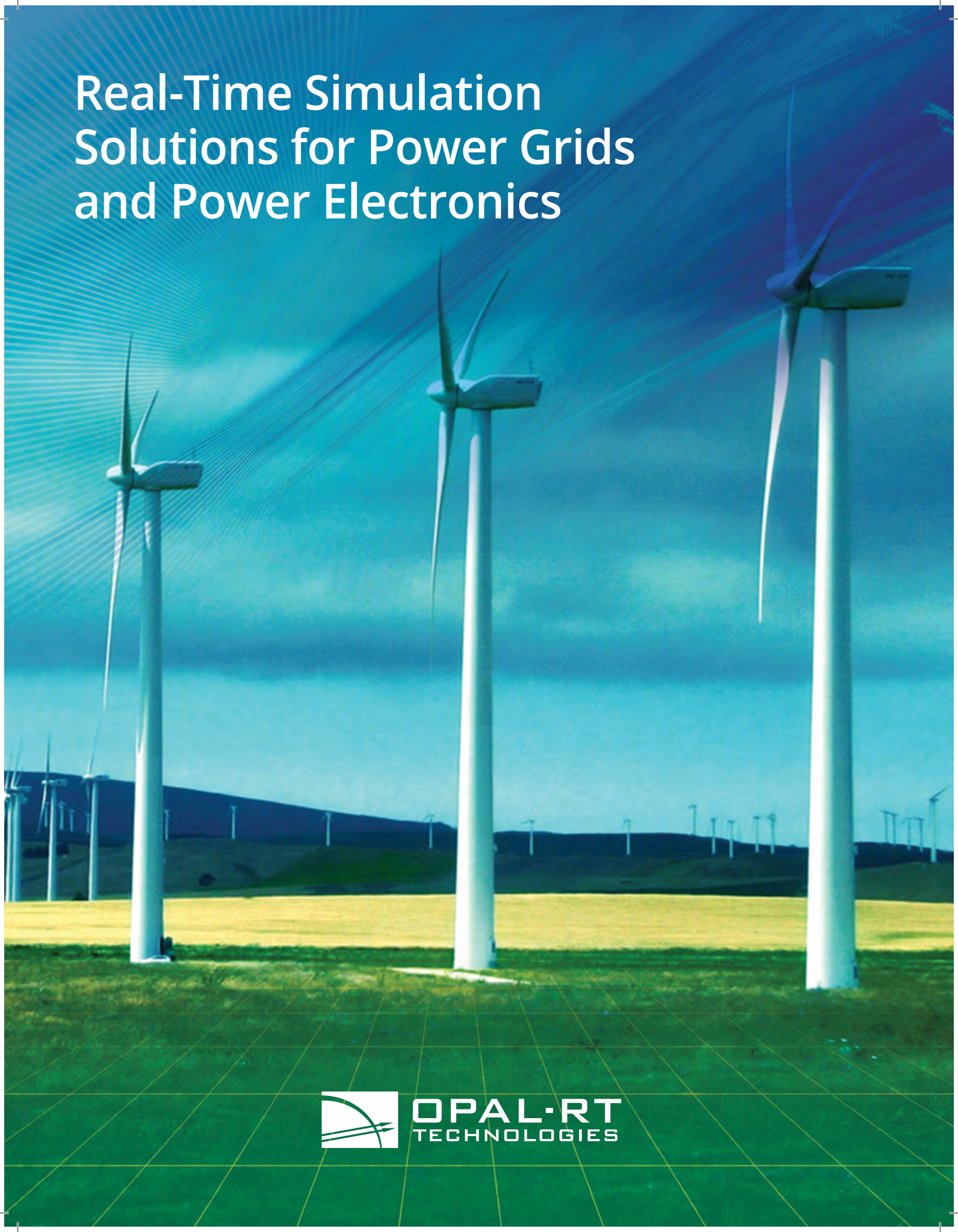
Real-Time Simulation Solutions for Power Grids and Power Electronics



OPAL-RT TECHNOLOGIES

The Most Advanced Real-Time Simulation Systems Available

The power system industry is changing considerably with the shift from centralized power generation to a grid featuring considerable distributed energy resources (DER). Along with the integration of smart technologies with the potential to provide advanced real-time monitoring, control, and protection capabilities, this paradigm shift has dramatically increased the complexity of bulk and localized power systems. While new technologies promise increased reliability and efficiency, they bring their own set of technological and integration challenges, which cannot be ignored.

OPAL-RT provides accessible, cutting-edge, real-time simulation technology in order to address these challenges and accelerate the availability of greater products and more reliable energy transmission.

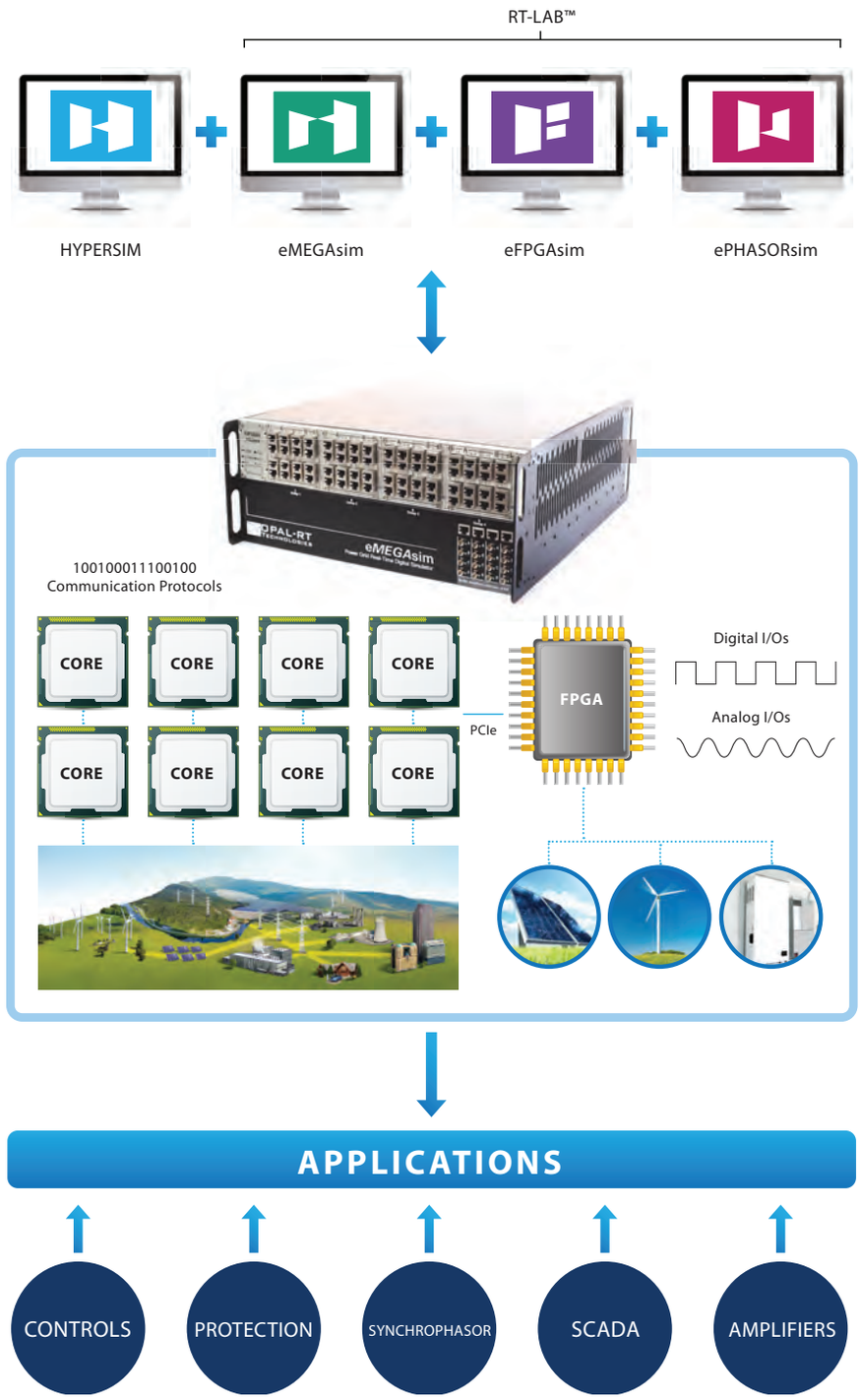
Since 1997, engineers and scientists are turning to OPAL-RT's powerful, versatile and cost-effective technologies to optimize the security, efficiency and performance of micro grid, renewable energy sources and large interconnected power grids while increasing return on investment.

Our Customers

OPAL-RT has gained the trust from over 800 customers, including many Fortune 500 companies, academic institutions and laboratories. More than 2000 people are currently using OPAI-RT in more than 40 countries around the world.

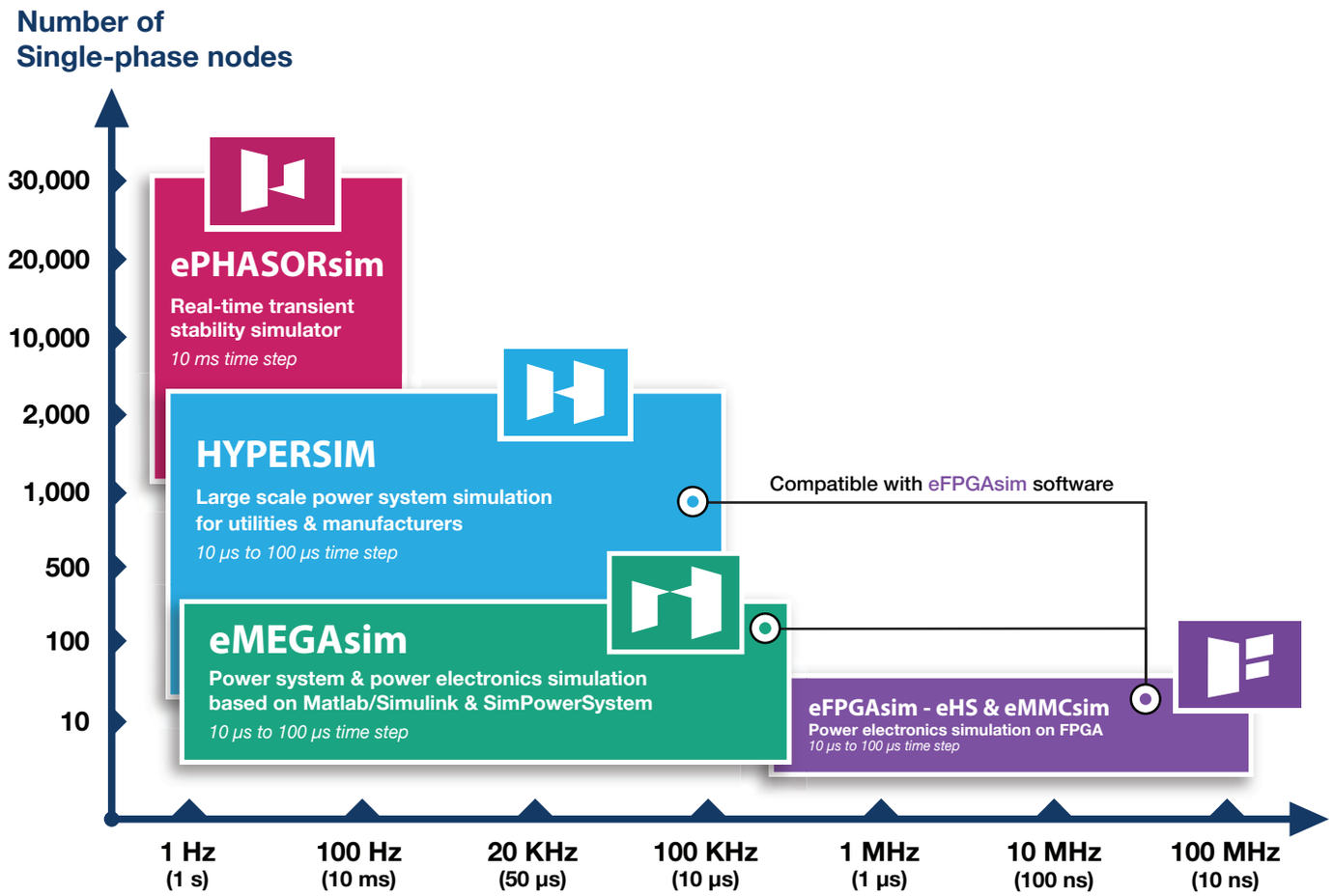
Find the Simulation System Perfect for Your Needs

OPAL-RT provides a complete range of real-time simulation and control prototyping systems for power grids, power electronics, motor drives and other mechatronic systems. These systems include cutting-edge software interface and hardware platform designed to help you perform feasibility studies, develop new concepts, design and test your controllers for a wide variety of applications including small power converters, hybrid electric drives, large power grids and renewable energy systems.



Electrical Systems Simulation Overview

OPAL-RT's solutions cover every requirement of power grid and power electronics real-time simulation, and offer an unsurpassed level of scalability required to design, simulate and test complex next-generation power systems. Using the chart below, see which OPAL-RT system works best for you based on the frequency of your transient phenomena and the number of nodes you require simulated.

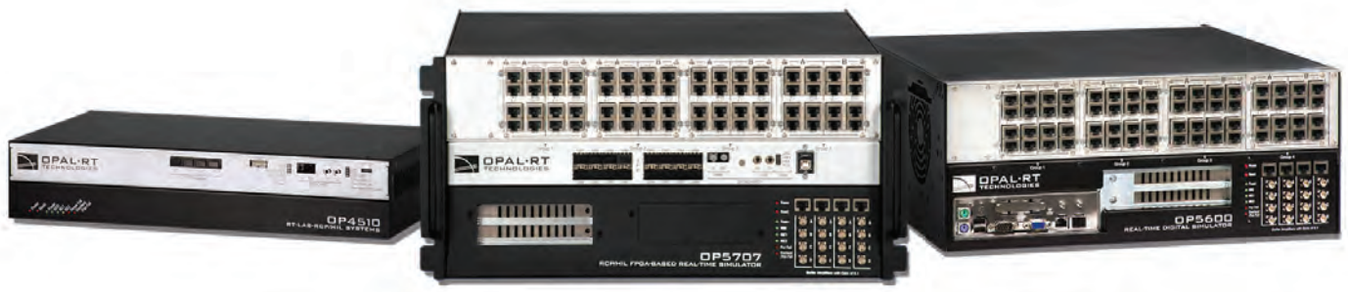


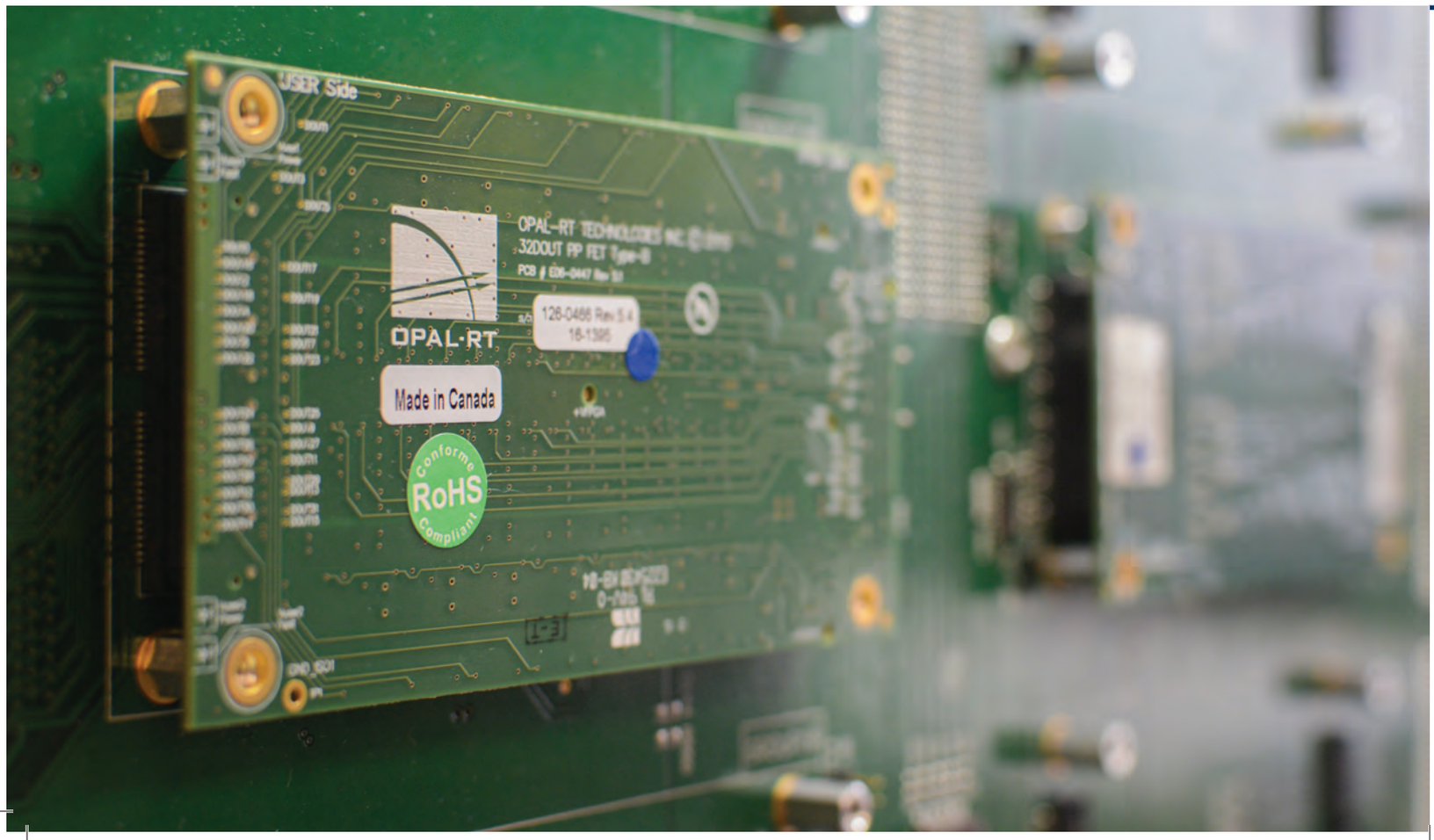
Multiple Hardware Platform

Backed by decades of expertise in the development of innovative hardware solutions, OPAL-RT's unique approach integrates parallel, distributed computing with commercial-off-the-shelf technologies, to offer an unmatched combination of performance, openness and affordability.

OPAL-RT's production and operations teams are ISO9001:2008 certified for the manufacturing of PC/FPGA-based real-time simulators, hardware-in-the-loop (HIL) testing and rapid control prototyping (RCP) equipment.

OPAL-RT's offers a wide range of simulator platforms to meet all needs and the industry new challenges ahead. All simulators are based on a modular and flexible design, can be fully customized for specific I/O requirements and can be easily expanded as needed.





RT-LAB™ Software Platform

RT-LAB is OPAL-RT's flagship integrated simulation environment for eMEGAsim, ePHASORsim and eFPGAsim simulation solutions. It enables engineers to conduct distributed parallel computing for real-time simulation of large and complex models for HIL and RCP applications. With its interactive interface, RT-LAB™ provides all the required functionalities to configure and manage simulator functions and interact with running simulations, making model development and test easier. RT-LAB™ also allows several commercial software to quickly interface with the simulators.

MATLAB
SIMULINK

HYPERSIM is an advanced real-time simulation system developed specifically for Hardware-in-the-Loop (HIL) testing. Whether you are developing, integrating or testing new components or systems and require HIL, HYPERSIM is made for you. HYPERSIM is the product of over 20 years of joint expert research by Hydro-Québec, Réseau de Transport d'Electricité (RTE) and China Electric Power Research Institute (CEPRI) and is now widely used internationally across industry, academia and research centers.

Applications

- MMC, HVDC, FACTS, SVC, STATCOM
- Micro grid: PV, wind turbine, generator, fuel cells, capacitor banks
- Smart grid
- PMU and SCADA (C37.118)
- Relay and protection systems (IEC61850, DNP3, and more)
- Energy storage
- Utilities
- Power utilities equipment manufacturers
- Research centers
- Electrical engineering department of universities
- Industries with large electric infrastructure

Features and Benefits

- **Extreme scalability using off-the-shelf computers**

  Power systems with thousands of three-phase buses integrated with several HVDC and FACTS systems can be simulated with hundreds of high-end INTEL™ processors sharing the same memory. Such capability, available with off-the-shelf technologies, is beyond the reach of competing solutions that use custom-made computer and communication boards

- **Ease-of-use with fully automated processor allocation**

  Large scale power grid simulation is made easy since available processor cores are automatically allocated to simulate each network subsystem without any manual intervention

- **Real-time parameter modifications**

  Users can easily modify and set the power system and control circuit parameters, even while the simulation is running in real-time orin offline mode. Most competing solutions do not allow to modify impedance RLC values on-the-fly

- **Accelarated simulation on the same hardware**

  HYPERSIM can be used on a standard laptop, workstation server, supercomputer, and even on the cloud to accelerate large simulation for offline optimization and MonteCarlo analysis

- **Validated power LCC and MMC converter models**

  HYPERSIM includes thyristor-based LCC HVDC and FACTS models validated against field tests, as well as MMC HVDC system models

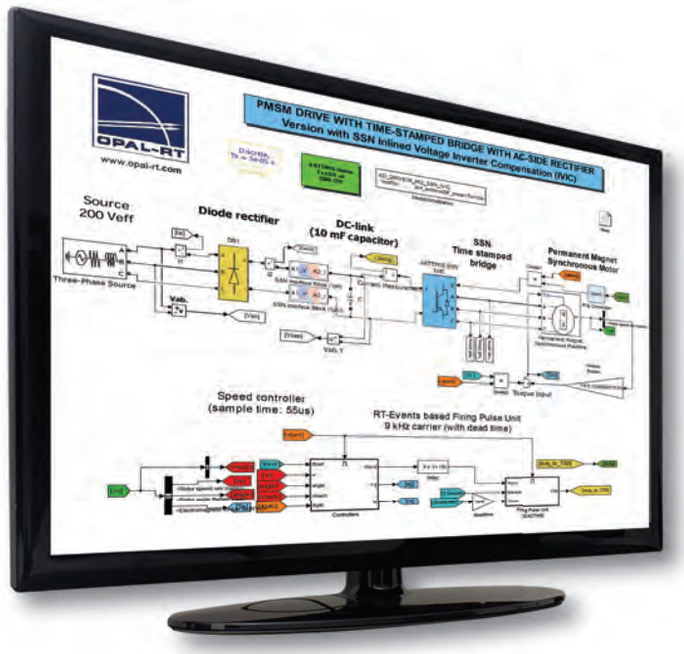
- **Rich library of transmission line, transformer, load and arrestor models and validated models**

- **FPGA-based I/O and simulation system with sub-micro second time step for the implementation of fast power electronics models and to reach maximum accuracy**

eMEGAsim is the only MATLAB™/Simulink™/SimPowerSystems™ based real-time digital simulator for the development and testing of protection and control systems using HIL simulation. Used for teaching, R&D and HIL, eMEGAsim accurately simulates the electromagnetic transients required by power grids and very complex and fast power electronic and converters systems.

Applications

- Development and testing of control and protection equipment
- Large-scale power systems simulation requiring up to 32 processors
- Line commutated HVDC transmission system – controller development and testing
- Modeling and rapid control prototyping of wind turbine controller
- Power HIL testing, Hardware-In-the-Loop and Controller-In-the-Loop (CHIL)
- IEC 61850 relay and protection equipment testing MMC, FACTS, STATCOM
- Complete power grid of electric ship
- Universities and research laboratories
- Power manufacturers including industrial and transportation systems
- All SimPowerSystems™ users who want to accelerate the simulation of complex systems or perform HIL simulation and tests



Features and Benefits

- **The highest accuracy and speed for simulation of grids and power electronics systems on FPGA**

  eMEGAsim uses the unique ARTEMiS and SSN solvers developed by OPAL-RT to increase speed, accuracy and numerical stability for the simulation of critical systems. The highest performance is achieved by taking advantage of parallel processing and advanced techniques to eliminate errors caused by artificial delays used with conventional solvers for parallel simulations

- **Rich library of power systems components including frequency-dependant line and cables, loads, machines and motors**

- **Validated MMC converter models**

  eMEGAsim includes thyristor-based LCC HVDC and FACTS models. HIL simulation of an MMC HVDC system with more than 1000 MMC cells per arm is also possible using standard processors or FPGA chips

- **Real-time parameter modifications**

  Users can easily modify and set the control system parameters and other mechanical models implemented with Simulink™ and Simscape™ even while the simulation is running in real-time or in offline mode

- **Automatic Test Control**

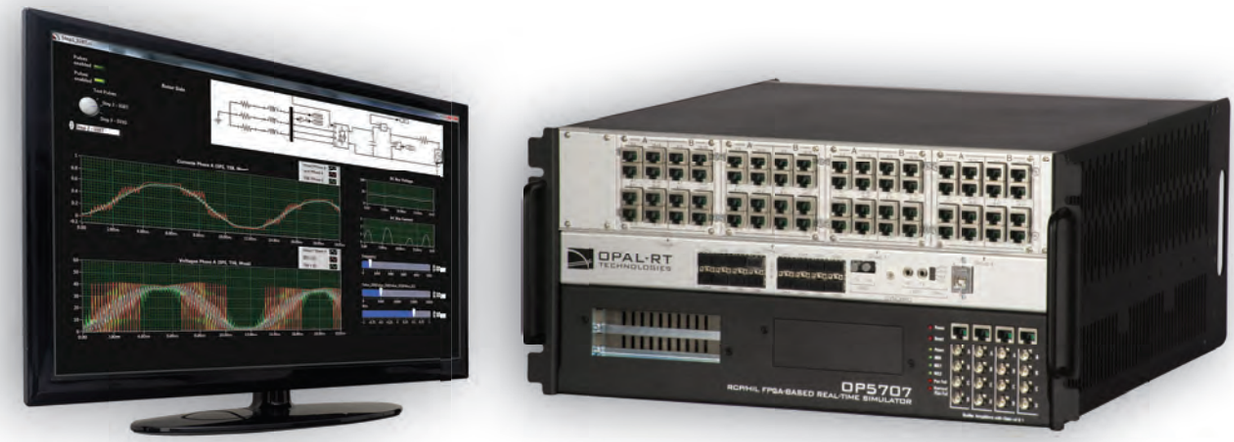
  Automatic tests and optimization studies can be implemented using NI TestStand™, LabVIEW, Java, C and Python™ scripts

- **Simulation of large distributed systems with up to 600 nodes or less than 100 micro seconds**

eFPGAsim combines the performance of high fidelity digital simulators with very low communication latency to provide power electronics engineers with an easy-to-use HIL platform for the development and testing of control and power electronics systems that require sub-microsecond time step capacity.

Applications

- Protection and control system development and testing
- HIL simulation and testing of industrial and traction motor drives, industrial power converters, solar power conditioners, multilevel converters and inverters
- More electrical aircraft, electrical trains and ships
- Research centers
- Electrical engineering department of universities
- Electric motor drive manufacturers
- PV converters system manufacturers
- Manufacturer of power transmission and distribution systems



Features and Benefits

- **Reliable HIL implementation of new generation of controllers for electrical drives**

  Users can test motor controllers simulating test fault conditions, as well as perform virtual fault injection on converters, bridges and electrical motors and Finite Element Analysis

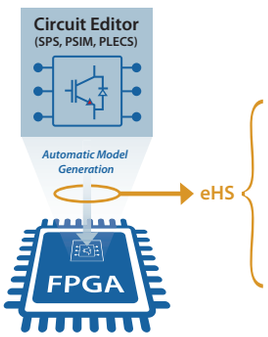
- **Generate custom, application specific models that can be implemented on an FPGA device with RT-XSG**

  RT-XSG is a Simulink™ toolbox that provides a convenient way to build models. It offers greater flexibility by allowing users to implement their own calculations and models on FPGA

- **MMC model implementation on FPGA including up to 6000 MMC submodules, and run at 250ns**

Automatic FPGA Model Generation from the Circuit with eHS

The innovative eHS technology, a generic electrical FPGA Hardware Solver, is at the heart of the eFPGAsim solution. It is intended to facilitate the design cycle of complex circuit simulation on the FPGA by allowing a gradual simulation integration set-up from off-line simulation to FPGA on-chip simulation



Automatic generation of electric circuit model:

- **No mathematical modeling**
- **No FPGA expertise**
- **No VHDL programming**
- **No need for Xilinx Blockset or other Xilinx FPGA tools**

ePHASORsim performs real-time and faster than real-time transient stability simulation for transmission and distribution grids with thousands of buses. Its Phasor domain solver with a typical time-step of few millisecond allows to compute the RMS and angle values of voltage and current, as well as active and reactive powers, machine frequency, and reference for every spot in a system. It is perfectly suited for interactive simulation in real-time and operation studies.

Applications

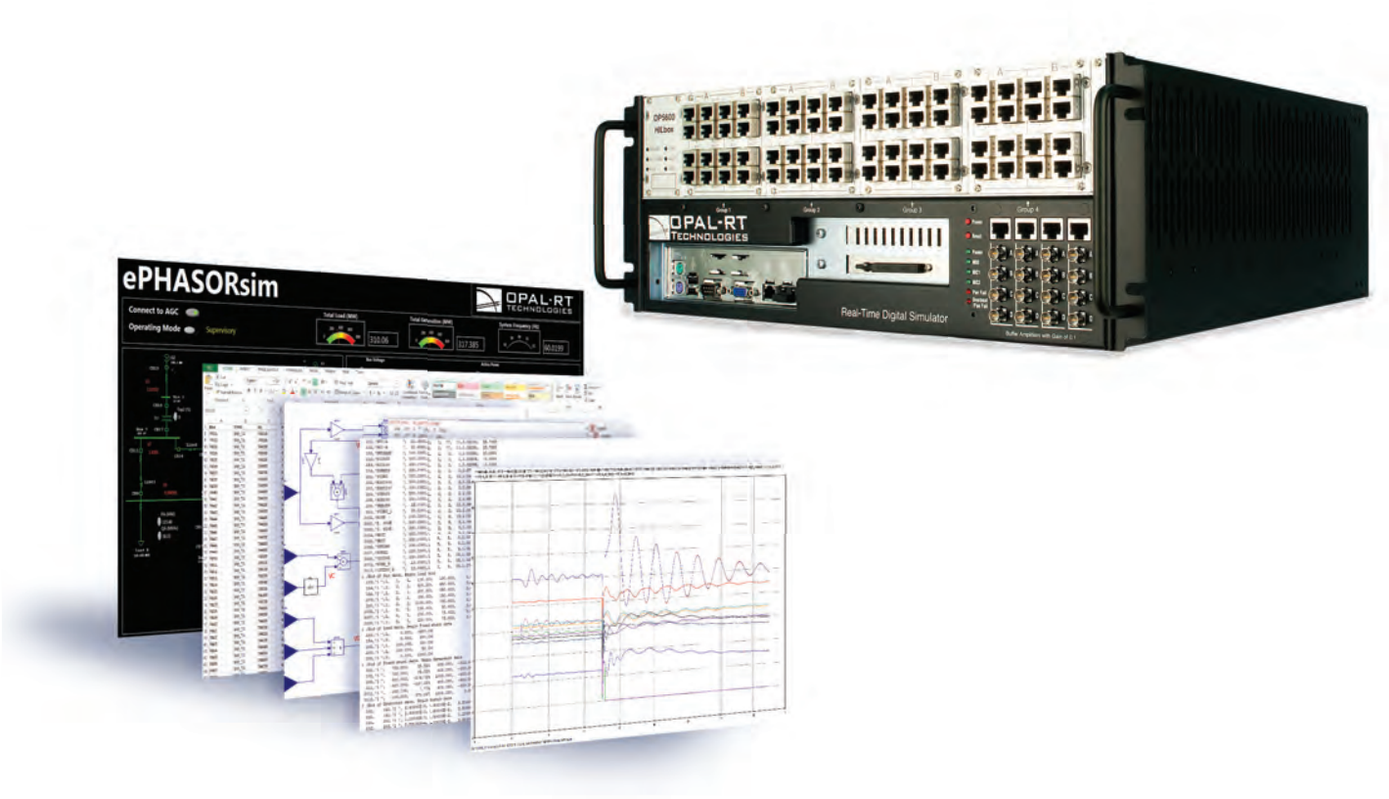
- Testing of interaction between FACTS and HVDC transmission systems on system stability of interconnected systems

Power utilities to:

- Train operators for transmission systems
- Test wide area conrtol and protection on SCADA systems
- Predict system responses faster than real-time

Research facilities with focus on:

- Transient stability simulations for systems in range of 30,000 nodes
- Wide area control/protection/state estimation algorithms
- EMS tools and algorithms such as AGC and load shedding
- PMU streams and PDC applications
- System studies with massive number of renewable penetration
- Design and test local controllers such as voltage regulators
- Advanced metering and information network
- Impact of load profiles in distribution networks



Features and Benefits

- **Large-scale power system simulation in real-time**

  Simulate power grids with up to 30,000 node distribution systems including more than 70,000 in-ports and out-ports, as well as thousands of generators, transmission lines, cables, loads and transformers. Simulate also synchronous generators with power system stabilizers, excitation systems, turbine governors and various voltage- and machine-speed regulators

- **Test automation platform**

  Perform test automation using Python™ scripts, use ScopeView to record, display and analyze the results and modify parameters while the simulation is running

- **Rich and expandable library of models**

  Built-in library through Modelica based interface (FMU) includes generator, voltage source, load, transmission line, power system stabilizer, reactor, external Simulink™ blocks, etc. Moreover, a modelica based library of models that includes various type of generators and controllers is available

- **Integration through Ethernet protocols**

  ePHASORsim is becoming an standard tool where user wants to interact with the simulation engine via various types of communication protocols including SCADA, EMS tools, and wide area control algorithms. Some of user stories includes integration with AGC toolbox of ETAP for load-frequency control, and RTDMS package from EPG for PMU-PDC streams and visualization applications

- **Flexible data input**

  The main input data interface is in Excel spreadsheet that user can automate and customize its creation.
  It can also import PTI's PSS/e data files (*.raw, CYME, and *.dyr)

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ABOUT OPAL-RT TECHNOLOGIES

OPAL-RT is the world leader in the development of PC/FPGA Based Real-Time Digital Simulator, Hardware-In-the-Loop (HIL) testing equipment and Rapid Control Prototyping (RCP) systems to design, test and optimize control and protection systems used in power grids, power electronics, motor drives, automotive industry, trains, aircraft and various industries, as well as R&D centers and universities.

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