Application Brief

SGI at TransÉnergie Technologies: Real-Time Digital Power System Simulation

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Converter power station

Origin 2000 server

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When Hydro-Québec first decided to develop a fully digital, real-time power simulator for the energy industry, company researchers believed the only way to support the demands of such a complex computing environment was to build a custom reduced instruction set computing (RISC) hardware architecture. But when representatives from SGI Canada paid the company a visit in 1997 to introduce the Origin™ 2000 server, researchers soon realized they could tap into the expertise of a world leader in parallel computing and continue to offer a best-of-breed product to utilities.

"We had invested a lot of money to build and maintain our own hardware architecture," says Alain Vallee, general manager, sales and marketing, Asia/Africa/Europe for Montreal based TransÉnergie Technologies. "Until we viewed the demonstration of the Origin 2000 server, we felt this was the only way we could offer a system with sufficient power to run our complex and comprehensive simulations."

TransÉnergie Technologies, a subsidiary of the transmission division of Hydro-Québec based in Montreal, develops, sells, and supports a range of state-of-the-art products for the power industry. A leader in providing real-time power system simulators, its latest developments on the digital front are attracting worldwide attention in the form of an innovative simulation product called HYPERSIM.

HYPERSIM is the next stage in real-time digital simulation, offering users a precise replica of their energy transmission and distribution systems for testing or training purposes. Built on a robust parallel computing architecture, it incorporates 25 years of Hydro-Québec expertise in analog power system simulation with the added advantage of a powerful graphical user interface.

Origin 2000 Surpasses Expectations

Manufactured by Teqsim International, a TransÉnergie Technologies division, and tested on an ongoing basis by IREQ power system simulation laboratory, HYPERSIM was initially offered only on a RISC platform built by Teqsim engineers. Following the SGI visit to IREQ,

researchers decided to undertake a project to port HYPERSIM software to Origin 2000. At the end of 1998, an eight-processor machine arrived at IREQ. Just six months later, trials were completed with results so impressive that TransÉnergie Technologies decided to make HYPERSIM on Origin 2000 a commercial offering.

"For the actual equipment being tested, there is virtually no difference between the simulator and the real power system," says Yves Carmel, Chief Executive Officer, TransÉnergie Technologies. "The speed of the simulation is equivalent to the speed of the phenomena occurring in the real power system."

Already, HYPERSIM is being used by Mitsubishi Electric Corporation, Hitachi Ltd., Chubu Electric Corporation, and Osaka University of Japan. The benefits of the technology are numerous. Manufacturers can use the digital simulator to design, improve, and evaluate protection and control equipment; universities are using the technology for research activities and to train the next generation of power system engineers, operators, and technicians; and utilities are able to significantly reduce the risk of major service interruptions and predict problems by running predefined and/or random tests with the technology.

Cost savings are another advantage. Studies indicate that only three hours of outage per year can cost a utility upwards of U.S. $2 million, based on an average energy rate of 10 cents per kWh and a power system of 7,000 MW. Furthermore, blackouts cost more than just the loss of electricity sales, points out Vallee.

Open Architecture Eased Software Transfer

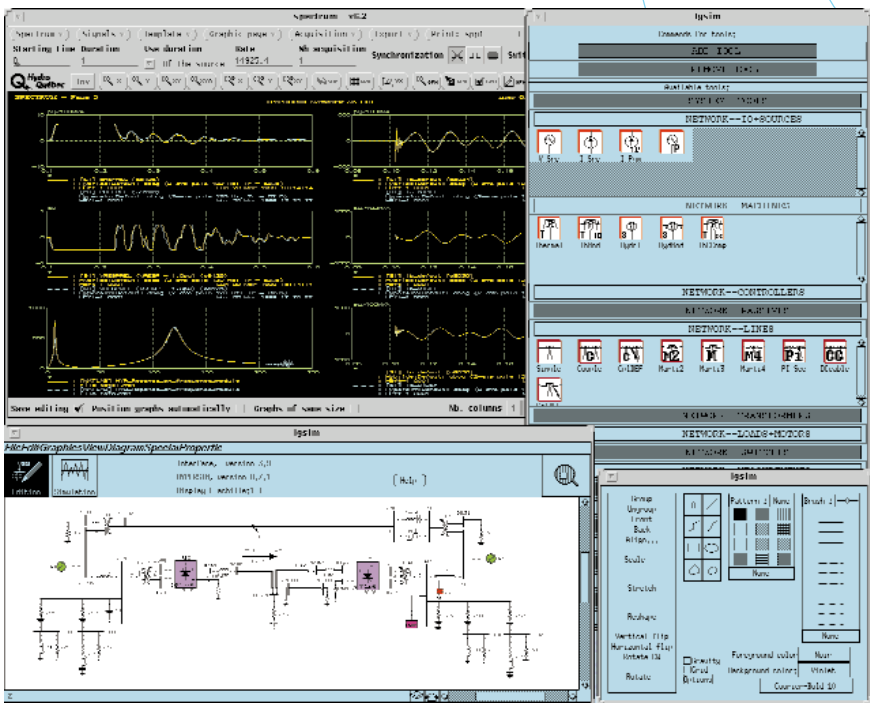
In order to achieve such valuable real-time simulation, the mathematical equations of a power system need to be computed in parallel. HYPERSIM does this using a partitioning method to divide a power system into several tasks that take into account delays introduced by transmission lines. The tasks are then assigned to the computer in real time.

The Origin 2000 server, based on a robust version of the ccNUMA architecture, is designed to provide the uninterrupted service and extremely high performance required by such an environment. Its CrayLink™ interconnect, which allows users to move from one to 256 and more processors in a single-system image by adding modules, is also critical since many of TransÉnergie Technologies' customers operate large-scale power systems and must therefore be able to scale the digital solution to suit their needs.

Another benefit of Origin 2000 is its open architecture, which enabled TransÉnergie Technologies to easily port its rich base of HYPERSIM software, written in the C programming language, to the new environment. The software performs HYPERSIM's visualization and simulation tasks, as well as online data processing, and provides an interface to other software packages like EMTP and MATLAB/Simulink from The MathWorks Inc. for further analysis.

"The effort to port our technology to the Origin server platform was a very successful project from both sides," says Yves Carmel, Chief Executive Officer, TransÉnergie Technologies. "We were able to make giant steps in a very short time because of the strong team approach established with SGI."

"We are expecting the Origin 2000 platform to be well-received by our customer base," he adds. "Not only is SGI the world leader in parallel systems, but people who buy HYPERSIM running on Origin 2000 will also be in a position to leverage the hardware technology to support other applications as well."



HYPERSIM powerful graphical user interface

Digital Solution Promises No More Compromise

HYPERSIM running on Origin 2000 is a cost-effective test system for companies that may have found traditional analog equipment too expensive to maintain and operate. It shortens the time cycle for testing from weeks to days, and it is able to simulate thousands of faults per day, analyzing them as tables or waveforms that can be displayed, printed, or saved in a text file.

"Using Origin 2000 and HYPERSIM we can easily create a new topology of a power system and be ready to perform a simulation from scratch inside one day," states Vallee. "Previously, using an analog simulator, you would need two to three weeks just to prepare the study."

TransÉnergie Technologies will continue to market analog and hybrid simulators (products that perform both digital and analog simulations), in addition to the fully digital HYPERSIM. Vallee is expecting the HYPERSIM solution to be of special interest to those companies currently using offline software to test their equipment.

"With offline software, you are only able to test an approximation of the real situation," he explains. "We're saying there's no need for such a compromise; it's now easy for people to justify having their own real-time digital simulator in-house."

In fact, TransÉnergie Technologies estimates that over a five-year period the average return on investment based on the purchase of a medium-size real-time digital simulator will exceed a ratio of 10 times the original investment. For those who prefer to turn to an external service for testing, IREQ's power system laboratory will continue to offer comprehensive real-time simulation facilities using its hybrid simulators and its own Origin 2000 platform.

The current graphical user interface (GUI) for HYPERSIM is running in a UNIX® environment, but TransÉnergie Technologies is planning to move to Microsoft® Windows NT® once the Origin 2000-based product gains market acceptance. In its future plans, the company may even consider virtual reality as a technology to enhance the GUI portion of the digital simulator. As Vallee mentions, Origin 2000 and SGI's expertise in the field will better position TransÉnergie Technologies to support such research if and when a prototype is developed.

The Manic-Outardes coffer dam

For now, the focus will be on marketing the innovative digital solution as a means to give players in the energy market a desired edge over their competition.

"For power system companies, investment in new equipment can cost hundreds of millions of dollars. They need to be sure that the new equipment will interact properly with their existing systems," says Vallee. "With our fully digital HYPERSIM on Origin 2000, we can give them that assurance and more knowledge about the behavior of their power systems."

sgi™

Corporate Office
1600 Amphitheatre Pkwy.
Mountain View, CA 94043
(650) 960-1980
www.sgi.com

North America 1(800) 800-7441
Latin America 1(650) 933-4637
Europe (44) 118.925.75.00
Japan (81) 3.5488.1811
Asia Pacific (65) 771.0290

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