



## Real Time Digital Simulator

The nation's electric power grid has been described by power system engineers as the greatest mechanical invention ever conceived. With massive transmission towers, multiple substations and millions of miles of power lines this expansive system of systems provides essential electric power to communities and citizens across the country and around the world.

However, as witnessed during the August 2003 blackout, this grid has vulnerabilities that could be exploited by acts of terrorism, aging or natural disasters. Since worst case power systems scenarios are rare and dangerous to induce in the real world, critical infrastructure protection specialists rely on advanced modeling and simulation programs

to predict, plan and prepare for catastrophic events.

In collaboration with the Department of Defense, cyber and electric grid reliability researchers at Idaho National Laboratory have acquired and are using a full-scale Real Time Digital Simulator for enhancing the security of the nation's electric power grid and related control systems including supervisory control and data acquisition systems.

The Real Time Digital Simulator, or RTDS provides power systems simulation technology for fast, reliable, accurate, and cost effective study of power systems with complex High Voltage Alternating Current (HVAC) and High Voltage Direct Current (HVDC) networks. The RTDS Simulator is a fully digital

electromagnetic transients power system simulator that operates in real time.

Since the simulator functions in real-time the power system algorithms are calculated quickly enough to continuously produce output conditions which realistically represent conditions in a real network. Real-time simulation is significant for two reasons - the user can test physical devices and the user is more productive by completing many studies quickly with real-time simulation.

Since the simulator is real-time, it can be connected directly to power system control and protection equipment. For example, it can be used to test HVDC (High Voltage Direct Current) controllers or protective relays. Testing on

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The RTDS system allows power systems engineers to visualize the effects of power grid failures.

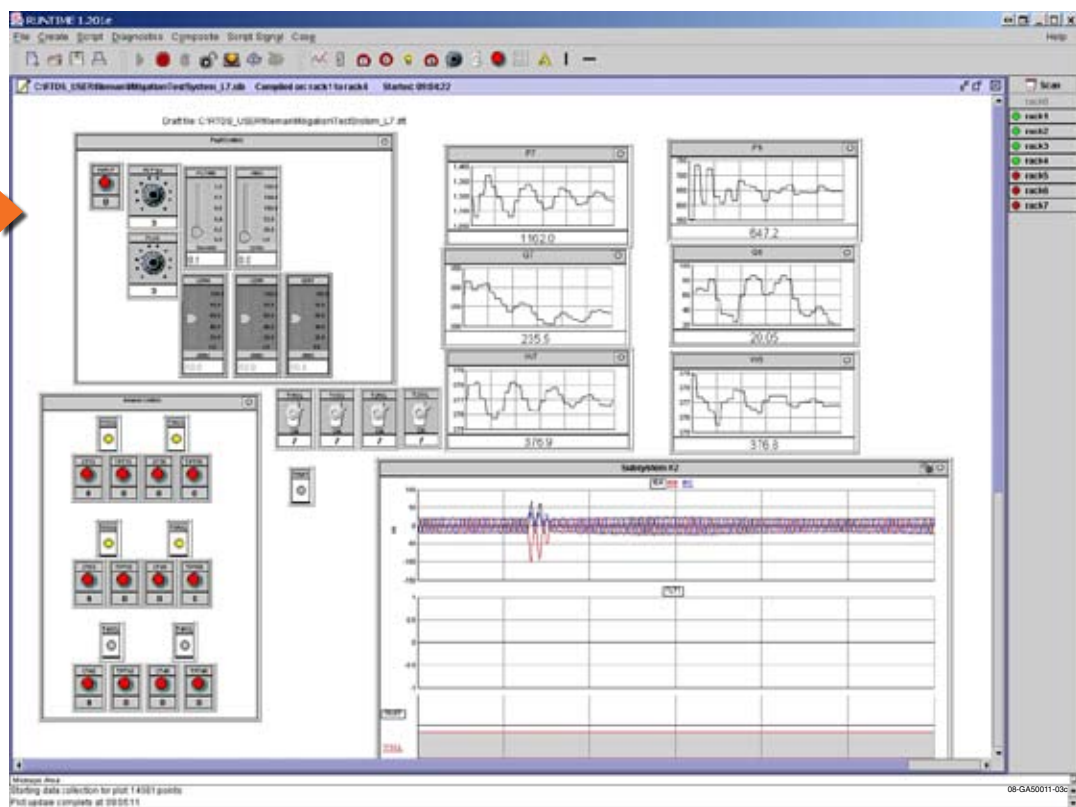
#### For more information

**Scott A. McBride, P.E.**  
(208) 526-5878  
Scott.McBride@inl.gov

**Warren Rees, P.E.**  
(208) 526-5376  
Warren.Rees@inl.gov

**Bobby Jeffers**  
(208) 526-9611  
Robert.Jeffers@inl.gov

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an RTDS Simulator is more thorough than other test methods because the user is able to subject the equipment to many severe but realistic conditions which could not possibly be achieved when it is installed on the physical system.

As well, the simulator can be operated with or without user interaction (interactive or batch mode operation). Therefore, the equipment can be subjected to thousands of tests in batch mode without requiring supervision. The RTDS Simulator will provide detailed reports on the equipment's response to each test. Whether the user is testing equipment or simply running simulation studies, the real-time capability significantly improves productivity.

The simulator provides power system researchers with a

supercomputer for electric grid reliably. Each modular system is fully digital and can be used for a range of studies including performing real-time closed-loop testing of protective relays and control systems, performing analytical power system simulations, testing protective relays and education and training.

The system's graphical user interface, proprietary software and mathematical algorithms can simulate any modern electric power grid configuration. As new equipment or components are added or subtracted from the simulator's configuration, the model instantly updates. For example, INL researchers can run simulated system-failure scenarios such as a control system cyber intrusion or a physical damage event such as a terrorist attack or natural disaster and instantly

detect the order and reasoning for why dedicated relays, breakers or substations failed.

The ability to simulate real-time power grid information is a key factor in detecting previously unknown vulnerabilities and providing emergency planners with a path forward for responding to grid failures. The RTDS Simulator enables power industry experts to define the network configuration and run real time tests for many aspects of service life allowing system problems to be discovered faster, and solutions to be designed and tested immediately.

The RTDS system at INL is the first U.S. government owned and managed simulator. The laboratory employs operators with extensive experience in dynamic power systems.