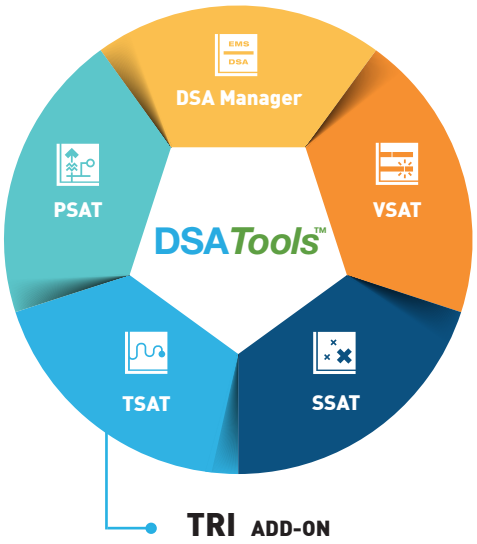
TRI TSAT-RTDS Interface

TRI is an advanced platform with the cutting-edge technological advancements in the area of power systems dynamic simulation to perform Co-Simulation studies using TSAT and RTDS™.



Co-Simulation studies aim at combining detailed modeling capability available in Electro-Magnetic Transient (EMT) packages with bulk power system simulation of Transient Stability Assessment (TSA) tools. This approach helps engineers to simulate a much larger system while reducing cost, effort, and time needed to set up and run the system. Additionally, the engineer can analyze aspects of system dynamic behavior that may not be captured in a pure EMT- or TSA-study.

The TSAT-RTDS Interface (TRI) module is an add-on module to TSAT that enables user to perform Co-Simulation studies using TSAT and RTDS™. The TRI performs a real-time simulation where both TSAT and RTDS™ simulate the system in real-time. Moreover, the Co-Simulation performed by TRI is synchronized, meaning that TSAT and RTDS™ exchange results at the end of every TSAT simulation time-step, which facilitates studying interactions between TSAT- and RTDS-side systems.

The TRI's Co-Simulation starts by dividing the power grid into an internal and external system. The internal system is typically small enough to be simulated on available RTDS™ racks at a typical EMT time-step ranging, e.g. 50µs, while external system is much larger and it is simulated in TSAT at a typical planning/operation study's time-step, i.e. 1/4 to 1/2 cycles. Using an interface board sitting on PCI/E slot of the PC, TSAT exchanges simulation results with RTDS™ and enables engineer to study the interactions between internal and external systems.

TRI module is a joint development with Korea Electric Power Corporation (KEPCO) and Yonsei University

PRODUCT FEATURES:

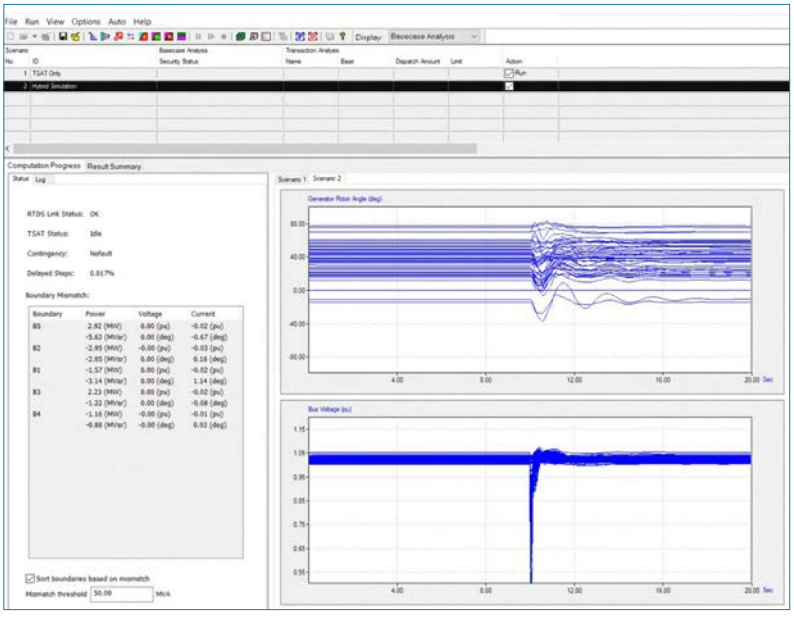
- *Performing synchronized and real-time Co-Simulation studies using TSAT and RTDS™*
- *Supporting multiple RTDS™ racks*
- *Handling real-time simulations for systems with more than 5000 buses*
- *Taking advantage of rich model libraries available in TSAT and RTDS™*
- *Synchronized simulation of multiple sub-systems in real-time*
- *Supporting RTDS™ GPC, PB5, and NovaCor architectures*

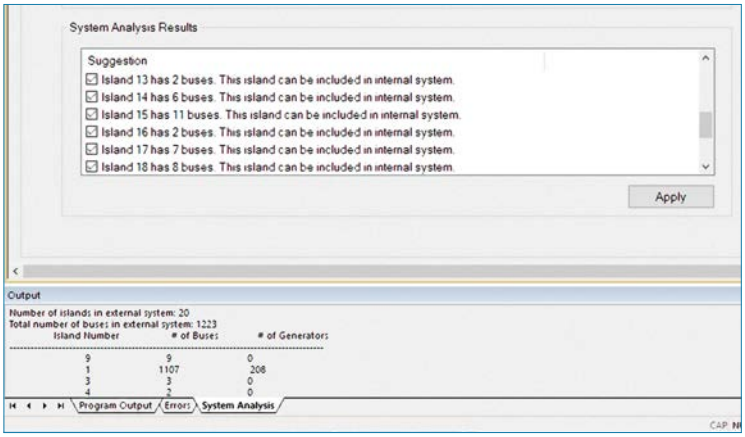
Powertech

TRI TSAT-RTDS Interface

ADVANTAGES

- Real-time, synchronized large power system simulations using TSAT and RTDS™
- Based on TSAT and RTDS™ - mature tools widely used in Power industry with significant embedded application knowledge that have been tested by numerous industrial experts over many years
- Reducing hardware requirement to meet computation capacity of available RTDS™ racks
- Rich model libraries in TSAT and RTDS™, including HVDC systems, distributed energy resources, FACTS devices, synchronous machines, etc.
- Capable of simulating power systems with over 5000 buses in real-time while maintaining the synchronism between TSAT and RTDS™
- Usability and user-friendliness – the tool's design minimizes the effort needed to set up a Co-Simulation study and simplifies result analysis
- Automatic identification of boundaries, including metrics to quantify the validity of boundaries between internal and external systems

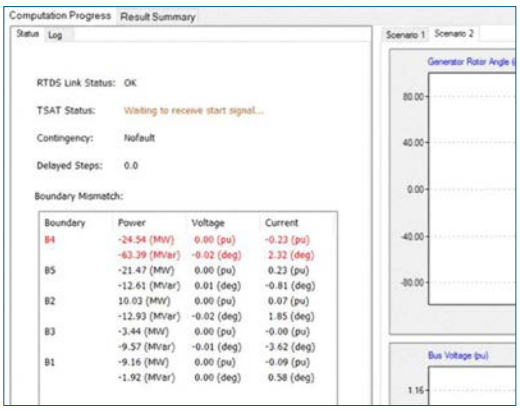




APPLICATION SCOPE

The Co-Simulation solution provided by TRI can be used in a variety of applications, including:

- Analyzing interactions between system-wide events and detailed devices such as fault analysis in HVDC systems or Sub-synchronous resonance studies
- Simulations requiring detailed models that may be available only in an EMT package such as HVDC systems, renewable generators, and FACTS devices
- Studying impact of distributed energy resources on transmission network
- Reducing the effort needed to create and maintain RTDS™ cases by modeling the major part of the system in TSAT
- Increasing size of the study system to evaluate impact of low frequency oscillations on the internal system simulated in RTDS™
- Performing hardware-in-loop tests while simulating a much larger portion of the system in TSAT
- Studying the impact of unbalanced faults on transmission network



The TRI has been designed with specific focus on usability and user-friendliness to minimize the effort needed for setting up a Co-Simulation study and simplify the process of results analysis. The followings highlight main TRI features:

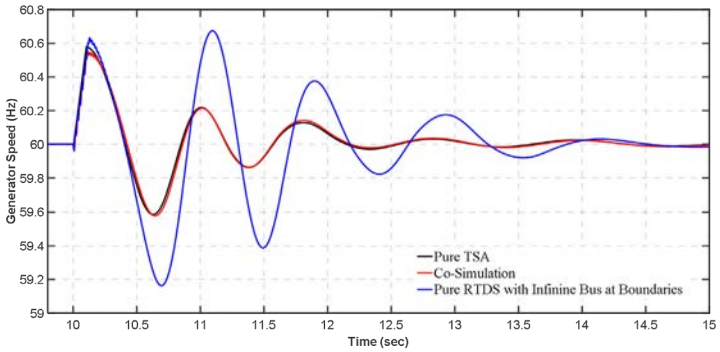
- By providing an easy-to-use interface, user can manually select boundaries between internal and external systems. Alternatively, the engineer may take advantage of logic embedded in TRI to automatically perform a system partitioning.
- The validity of selected boundaries can be analyzed by TRI and suggestions are made and/or applied to improve the system partitioning.
- A RTDS™ draft file with all components related to Co-Simulation study is generated by TRI and this file may be used to facilitate creation of RTDS™ case.
- A powerflow file representing internal system is generated by TRI, which helps creating the equivalent system in RTDS™.
- TSAT and RTDS™ simulation status as well as synchronization between TSAT and RTDS™ is continuously monitored and reported to user.
- Internal RTDS™ signals may be sent back to TSAT to simplify results analysis step.

CASE STUDY - ADVANTAGE OF USING CO-SIMULATION

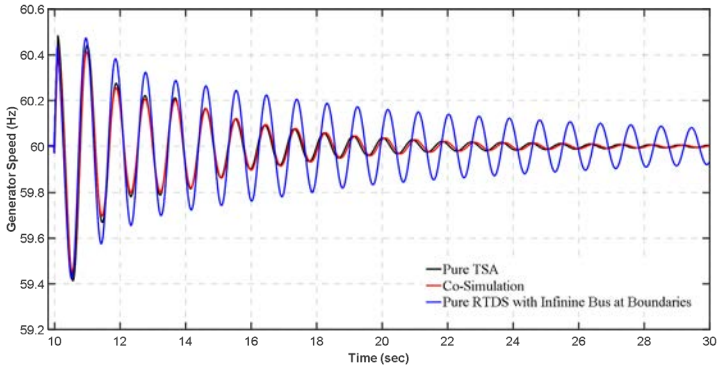
In a typical EMT study, system size needs to be reduced to meet the computational capacity of available RTDS™ racks, which is typically achieved by representing external system as equivalent machines or sources. While this approach helps reducing system size and meet hardware requirements, it can significantly affect both transient and steady-state behavior of the system. As an example, real power system data are used here to perform a comparison between pure-EMT study and Co-Simulation. The objective of study is to perform a fault impact analysis on a few generation plants with a total output of 9300MW. The power system under study has 1300 buses and following scenarios are considered:

1. Modelling the focus area in RTDS and representing rest of system as infinite bus with appropriate equivalent impedance.
2. Modelling the whole system in TSAT to perform a pure-TSA study.
3. Using Co-Simulation to model the focus area in RTDS while TSAT simulates rest of the system.

The fault is applied at terminals of one of unit in internal system and speed of this generation unit in different scenarios is shown below, where it is demonstrated that ignoring dynamics of external system in pure-EMT study results in unrealistically large swings after fault clearance. This emphasizes the importance of accurate modeling of external system in capturing generator transients following fault clearance.



The impact of system simplification is not limited to transients and it may also affect lower frequency oscillations which are observed in the time-frame of 10 to 30 seconds. To verify this point, the same power system is used to perform another fault analysis study on a different generation unit with 530MW output. The focused plant along with about 25 nearby buses is modeled in RTDS and Co-Simulation results are compared with pure-TSA and pure-EMT (with external system represented as infinite bus) simulations as shown below. As can be seen, the low frequency oscillations in the system show a much better damping in Co-Simulation study while oscillations in pure-EMT study demonstrate an unrealistically poor damping, which further emphasizes that accurate representation of external system is crucial in achieving accurate results.



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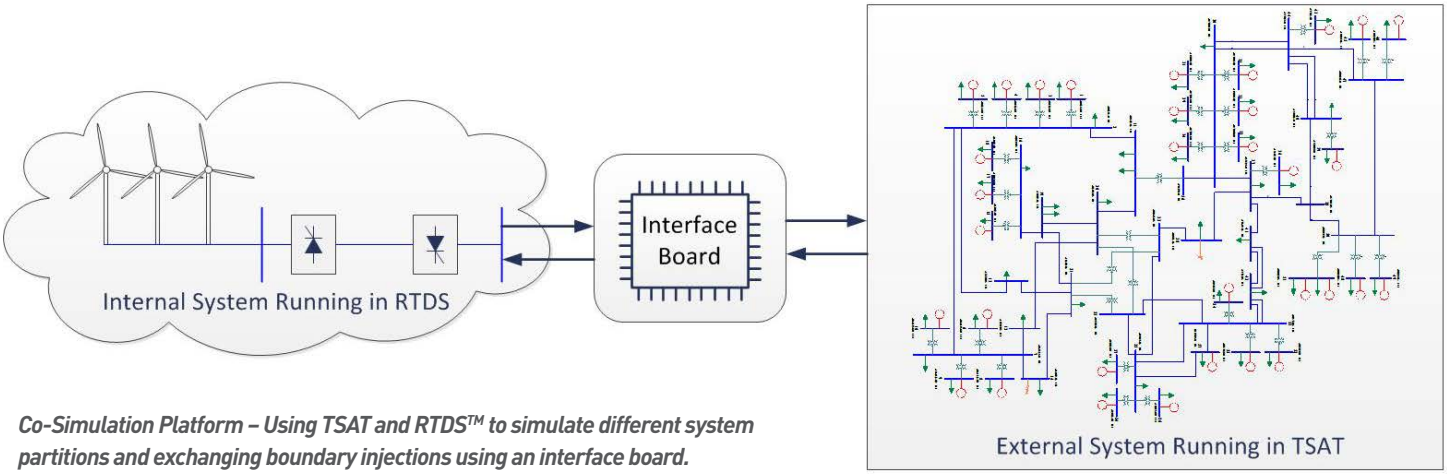

Co-Simulation Platform – Using TSAT and RTDS™ to simulate different system partitions and exchanging boundary injections using an interface board.

SPECIFICATIONS AND REQUIREMENTS

- Runs on MS Windows 7/10/Server 2012.
- Requires TSAT and RTDS™ to run.
- Requires Xilinx VC707 general-purpose FPGA board

OTHER POWERTECH SERVICES

- Licensing of the power system analysis software package DSA*Tools*™
- Licensing of other software products for utility applications
- Implementation of on-line dynamic security assessment (DSA) systems
- Development of custom software systems
- Development of models for use in power system analysis
- Generator field testing, model development and validation
- Training
- Technical consultancy studies including
  - Development of power system base cases
  - System planning and operation studies
  - Facility (including renewables) interconnection studies
  - Compliancy studies (such as NERC TPL, CIP, UFLS, etc.)
  - Post-mortem analysis of system disturbances

ABOUT POWERTECH LABS

Powertech Labs Inc. is one of the largest testing and research laboratories in North America, situated in beautiful British Columbia, Canada. Our 11-acre facility offers 15 different testing labs for a one-stop-shop approach to managing utility generation, transmission and distribution power systems.

Outside of the utilities industry, Powertech provides routine testing capabilities, product development, research and consulting services to support an array of industrial-type operations, electrical equipment manufacturers and automotive original equipment manufacturers.

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