



# NASA Meets Satellite Project Testing and Verification Goals with Wind River Simics

Powerful High-Fidelity Simulator Minimizes Target Hardware Dependencies and Brings Significant Long-Term Cost Savings

## NASA

### Industry

Space exploration

### Solutions

Wind River Simics

### Benefits

- Reduced risks and costs by eliminating hardware availability delays and finding bugs earlier in the development process
- Increased quality by introducing automation, catching show-stopper bugs, and improving consistency of hardware setups
- Increased engineering efficiency by finding and fixing bugs faster, and by enabling more hardware/software co-development
- Enabled tremendous longterm cost savings, since 80–90% of Simics simulation models can be reused for future missions

NASA's Independent Verification and Validation (IV&V) Program was founded as part of the agency's strategy to provide the highest achievable levels of safety and cost-effectiveness for mission-critical software.

NASA IV&V's primary business is software verification and validation. The program has more than 150 full-time employees and also leverages the expertise of in-house partners and contractors.

## The Challenge

Rising development and maintenance costs comprise the key business challenge of testing and verification for NASA IV&V. Because of their complexity and stringent safety requirements, most NASA projects take many years to come to fruition.

It wouldn't be practical to perform traditional hardware-based testing and verification because of the cost of supporting and maintaining the hardware. Too much time and effort would be expended trying to find old boards that are no longer available in order to run tests. Then there's the cost of storing inventory and the issues surrounding portability. It's difficult to replicate hardware for multiple uses.

For these reasons, software simulations have recently become essential to the NASA IV&V test and verification process.

In 2010, the NASA IV&V Independent Test Capability (ITC) team joined forces with NASA Goddard Space Flight Center (GSFC) to develop a software-only simulator for the Global Precipitation Measurement (GPM) Operational

Simulator (GO-SIM) project. The GPM mission is an international network of satellites providing next-generation global observations of rain and snow. GO-SIM includes the GPM ground system and database, flight software executables, and spacecraft simulators.

GO-SIM was designed as a high-fidelity simulator with no hardware dependencies. Its functions include loading and running unmodified flight software binaries, executing flight scripts, performing single-step debugging, injecting errors via the ground system, stressing the system under test, and validating findings from other analyses.

## The Approach

Wind River Simics, simulating a BAE RAD750 processor, enables target software to run on the virtual platform the same way it does on physical hardware. Along with Simics' capabilities of scripting, debugging, inspection and fault injection, it enables users to define, develop and integrate their systems without the constraints of physical target hardware.

Simics allowed NASA's ITC team to simulate their target hardware, ranging from a single processor to large, complex, and connected electronic systems, and build its GO-SIM product with all the desired features.

Using this virtual environment, the ITC team can adopt approaches and techniques not possible on physical hardware. For example, developers can freeze, save, email, and restore the whole system; they can view and modify every device, register, or memory location; and they can run the whole system in reverse to find the source of a bug. Simics equips the ITC team with a risk-reduction toolbox capable of injecting errors anywhere in the system and testing fault-management responses. This improves product quality and engineering efficiency.

With Wind River Simics, IV&V team members can identify flight software issues that they can't find using other IV&V analyses.

They can verify expected software behaviors and increase their confidence that flight software will work as expected and properly handle adverse conditions. By incorporating science instrument simulators, they can reduce risk for instrument-spacecraft interfaces and ensure internationally cooperative systems.

Simics is easily and quickly configurable. Setting up a particular target system is much faster than on hardware. Configurations of the virtual platform can be saved and accessed at a later point in time, ensuring consistent hardware setups within a development organization and customer support situations. Simics also supports rapid prototyping and the ability to quickly determine the impact of a potential hardware change on software performance.

*By using Wind River Simics, 80–90% of the simulation models can be reused for other missions, representing tremendous cost savings for NASA.*

## The Result

With Wind River Simics, NASA IV&V successfully met its goals to develop a complete simulator with no hardware dependencies in a reduced time frame and at lower cost than if it had been developed using traditional hardware simulations.

ITC team members now have test assets available when they need them. Government agencies like NASA typically buy assets for a five- to 10-year project upfront, and then by the time they need them the requirements have changed and they can't get the hardware.

Wind River Simics solved this problem. Engineers don't have to sit idle, waiting for the physical hardware to show up, before they can work.

Simics has enabled NASA IV&V to enhance quality in two ways. First, the ITC team can be confident in its ability to verify issues. Second, during development the software simulations enable the team to find bugs early in the process and fix them before they advance to the next phase.

By using Wind River Simics, NASA IV&V enables 80–90% of the simulation models to be reused for other missions, representing tremendous cost savings. It's far less expensive to use multiple copies of the simulator than to create new ones for each project.

The ITC team reduces costs by 93% and can replicate a complete instance of the simulator in a few hours. The development and time savings will add up quickly as they continue to pull simulators off the shelf to support future missions.

## Future Plans

GO-SIM and its Wind River Simics components provided a successful solution for the GPM mission, but the significance of this project is much larger and more long-term than this one project.

GO-SIM was developed with reuse in mind and will continue to be used to perform dynamic analysis of software running on multiple spacecraft.

For example, components of GO-SIM are now being used in the James Webb Space Telescope IV&V Simulation and Test (JIST) project. In addition, NASA is looking into the possibility of commercializing the solution beyond its own flight system applications.

The ITC team has also developed custom components for use within its simulation environments that will likely be widely reused. For example, the ITC Synchronous Bus (ITCSB) was created for GO-SIM, but is being reused in JIST. This reusable mechanism ensures consistent and correct data passing among distributed components of a simulation system.

The same methods, interfaces, and mechanisms apply to a vast majority of all embedded systems. NASA IV&V has many customers and potential customers that would benefit from many of the GO-SIM components and GO-SIM architecture, and is anxious to get out there and share how powerful it is.

For more information on GO-SIM, go to [www.nasa.gov/centers/iv/jstar/ITC.html](http://www.nasa.gov/centers/iv/jstar/ITC.html).

