

Project Information

Company Name: RNET Technologies

Title: VnV: A Self Documenting Testing Framework for In-situ Verification and Validation in High Performance Computing Applications.

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Topic Number/subtopic letter: 30d (Modeling and Simulation)

Problem Statement

Verification and Validation (V&V) of numerical simulations is a discrete process that cannot realistically account for every possibility. This causes issues in general purpose simulation packages because, while it is the responsibility of the developers to ensure the product is mathematically correct, it is the responsibility of the end-user to ensure the solution is a suitable representation of the physical model. After all, the direct costs of a design failure, be it time, money or loss of life, fall squarely on the shoulders on the end-user, and any attempt to shift the blame to simulation library *X* will certainly fall on deaf ears.

General Statement

The VnV toolkit facilitates the development of *explainable* numerical simulations that, in addition to the final solution, provide the end-user with a detailed report on why the solution can be trusted.

Phase I Feasibility

The Phase I effort demonstrated the feasibility of developing a framework that facilitates end-user V&V in advanced numerical simulations. This included the development of a portable solution for declaring injection points in a code, an intuitive interface for writing tests and injecting them at runtime, and an automated documentation generation system with support for 2D and 3D visualization.

Phase II Plans

The Phase II effort will develop the complete VnV framework, including the development of custom preprocessor directives that allow injection points to be configured in more dynamic ways and efficient statistical metrics for asserting the state of data stored in distributed arrays. The value of the VnV framework will be demonstrated through integration into MOOSE, PETSc, and libMesh.

Commercial Applications and Other Benefits

Numerical modeling and simulation (M&S) is almost always more economical than live prototyping; a fact that has seen wide-scale uptake of M&S in industry (e.g., automotive, nuclear, aerospace, advanced manufacturing, etc.). In all cases, the explainable numerical simulations facilitated by the VnV toolkit provide end-users with the wealth of knowledge required to ensure dangerous errors do not propagate into final designs.

Key Words

Verification, Validation, Accreditation, In-situ testing, HPC, Documentation generation, ADIOS, NEAMS.

Summary for Members of Congress

The VnV framework provides scientists with the tools required to create explainable numerical simulations that, in addition to the final report, provide users with a detailed report on why the solution should be trusted. Such information will help end-users ensure uncaught simulation errors do not propagate into final designs.