VisIt: a Production Tool for Visualizing and Analyzing Large Data

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Summary

The Visualization and Analytics Center for Enabling Technologies (VACET) deploys much of its research to SciDAC stakeholders via the VisIt visualization and analysis tool. VisIt, an R&D 100 winner, has two main focii: processing massive data and providing an end-user production tool. VACET has worked to further both of these goals by preparing VisIt for the petascale and by adapting VisIt to meet the needs of SciDAC users spanning many scientific areas, such as fusion, astrophysics, climate, and turbulent flow. VACET's strategy of using VisIt as a delivery vehicle for its research has several benefits: quickly and easily delivering results to stakeholders, minimizing development and deployment costs, and addressing long-term software maintenance and support concerns.

Figure 1. VisIt-produced SciDAC review cover images. Left: the net ecosystem exchange. Middle: collapse of a type II supernova. Right: confinement and dispersion of small molecules within carbon nanostructures.

To gain scientific insight, SciDAC scientists need to investigate the massive data sets their simulations produce. Their investigations take many forms: traditional visualization, quantitative and comparative analyses, visual debugging, as well as communication of these results. Further, these scientists need easy-to-use and richly featured tools, as the types of investigation they want to perform change from moment to moment. Further, they need tools because the number of simulations being run far exceeds the number of visualization and analysis experts available to provide assistance. VACET researchers are ensuring that SciDAC scientists can use VisIt for their day-to-day needs, and also are using it to deliver VACET's research to them.

VisIt is an open source, end user visualization and analysis tool with a strong emphasis on large data. It has a unique contract-based system that allows it to adaptively apply optimizations and also scale on large number of processors to handle the biggest data sets. VisIt has been shown to scale up to 4096 processors, and has been used to visualize data sets as big as 64 billion cells (even with only 128 processors!). Further, VisIt is undergoing Joule code certification, which will further demonstrate its scalability. VisIt follows a client-server design, with the server being

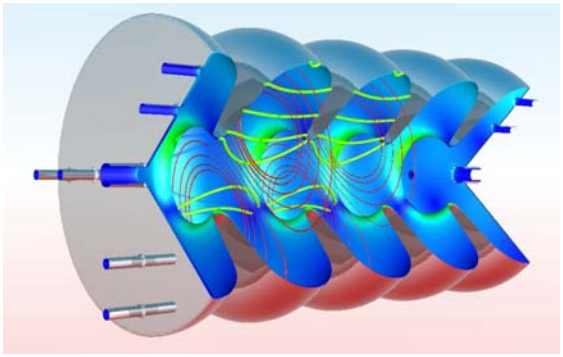

Figure 2. This image, created by John Cary of FACETS using VisIt, was part of a video animation that won a *People's Choice Award* at SciDAC 2008's Visualization Night.

parallelized. This architecture allows data to be visualized and analyzed where it was simulated, avoiding data movement. Further, the design allows for the client to run locally, enabling interactive graphics.

VACET has deployed VisIt to many stakeholders in the Office of Science community. Customers include many SciDAC Science Applications and Centers: Framework Application for Core-Edge Transport Simulations (FACETS); the Community Petascale Project for Accelerator Science and Simulation (COMPASS); the Computational Astrophysics Consortium (CAC); Simulation of Turbulent Flows with Strong Shocks and Density Variations (Shocks); the Global Cloud Resolving Model (GCRM); the Center for Extended Magnetohydrodynamic Modeling (CEMM); and the Applied Partial Differential Equations Center (APDEC). Further, VACET has collaborated with other SciDAC centers to deploy research in VisIt, namely the Scientific Data Management Center (SDM), and, to a lesser extent, the Interoperable Technologies for Advance Petascale Simulations Center (ITAPS), as well as with institutional visualization experts at Office of Science Laboratories, to ensure that VisIt is available and runs well on their platforms, and with SAPs for fusion and climate.

The research and software engineering performed by VACET has significantly improved VisIt. VACET transformed VisIt's streamline algorithm from one of the tool's weak spots into a strong point. VACET's integration of FastBit bitmap indexing enabled the interactive browsing of massive amounts of particles. VACET has greatly improved VisIt's volume renderer, including multi-variable support and improved shading. VACET improved VisIt's AMR infrastructure to the point that the APDEC retired their homegrown, AMR-specific visualization tool in favor of VisIt, saving them development costs. Further, VACET greatly improved the core infrastructure of VisIt. In addition to the standard bug fixes, porting changes, and small enhancements, VACET is responsible for making VisIt's software repository open to the public (instead of only available to Lawrence Livermore employees), and making a public, archived mailing list.

VisIt was originally developed by the NNSA's Advanced Simulation & Computing (ASC) program, which culminated in an R&D100 award in 2005. Its development continued and the project is now co-developed by ASCR, the NNSA, and the Office of Nuclear Energy, in addition to developers at universities, foreign laboratories, and support from private industry. The VisIt software repository has twenty-five developers from ten institutions. When VACET was originally funded, VisIt represented approximately fifty man-years of initial investment, and that investment has been further leveraged by ongoing activities outside of VACET. That said, VACET is a dominant force in VisIt development, accounting for approximately one third of all development work.

VisIt is extensively used for production visualization work around the world. It has been downloaded over one hundred thousand times and is used on supercomputers worldwide. The "visit-users" mailing list has almost three hundred subscribers, and receives approximately three hundred posts per month. SciDAC users can bypass this mailing list and directly access VisIt developers using the "visit-help-scidac" mailing list, which is supported by VACET.

For further information on this subject contact:

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