



# Helping You Visualize Your World

## Visualizing the Road to Exascale

As the computing landscape evolves, high-performance computing (HPC) is transforming the way research communities tackle challenges, from investigating nuclear energy to modeling climate research. The potential to unlock answers and insight into these challenges, however, requires processing data of unprecedented size. Researchers face the difficulty of how to manage, analyze, and visualize data that is approaching the exascale.

Visualization is a key step in obtaining such in-depth insight, and Kitware develops tools designed to address these visualization needs. As one of the primary contributors to the open source Visualization Toolkit (VTK), ParaView, and CMake, Kitware is working closely with customers and collaborators to build the foundation for exascale visualization. These long-standing software toolkits and applications are part of the exascale ecosystem and offer critical benefits such as in situ analysis and revolutionary technology stacks to evolve with the next generation of computing.

### ParaView

Visit the ParaView website to see how ParaView is being leveraged in a variety of domains and offers different flavors to meet diverse computing needs.  
[paraview.org](http://paraview.org)



### Visualization Toolkit

Visit the VTK website to learn about upcoming releases and the newest features for VTK.  
[vtk.org](http://vtk.org)



### Computational Model Builder

Visit the CMB website to explore all the components of the CMB suite, from pre-processing tools to post-processing visualization options.  
[computationalmodelbuilder.org](http://computationalmodelbuilder.org)



### CMake

Visit the CMake website to find out more about how CMake has been used in a variety of projects.  
[cmake.org](http://cmake.org)



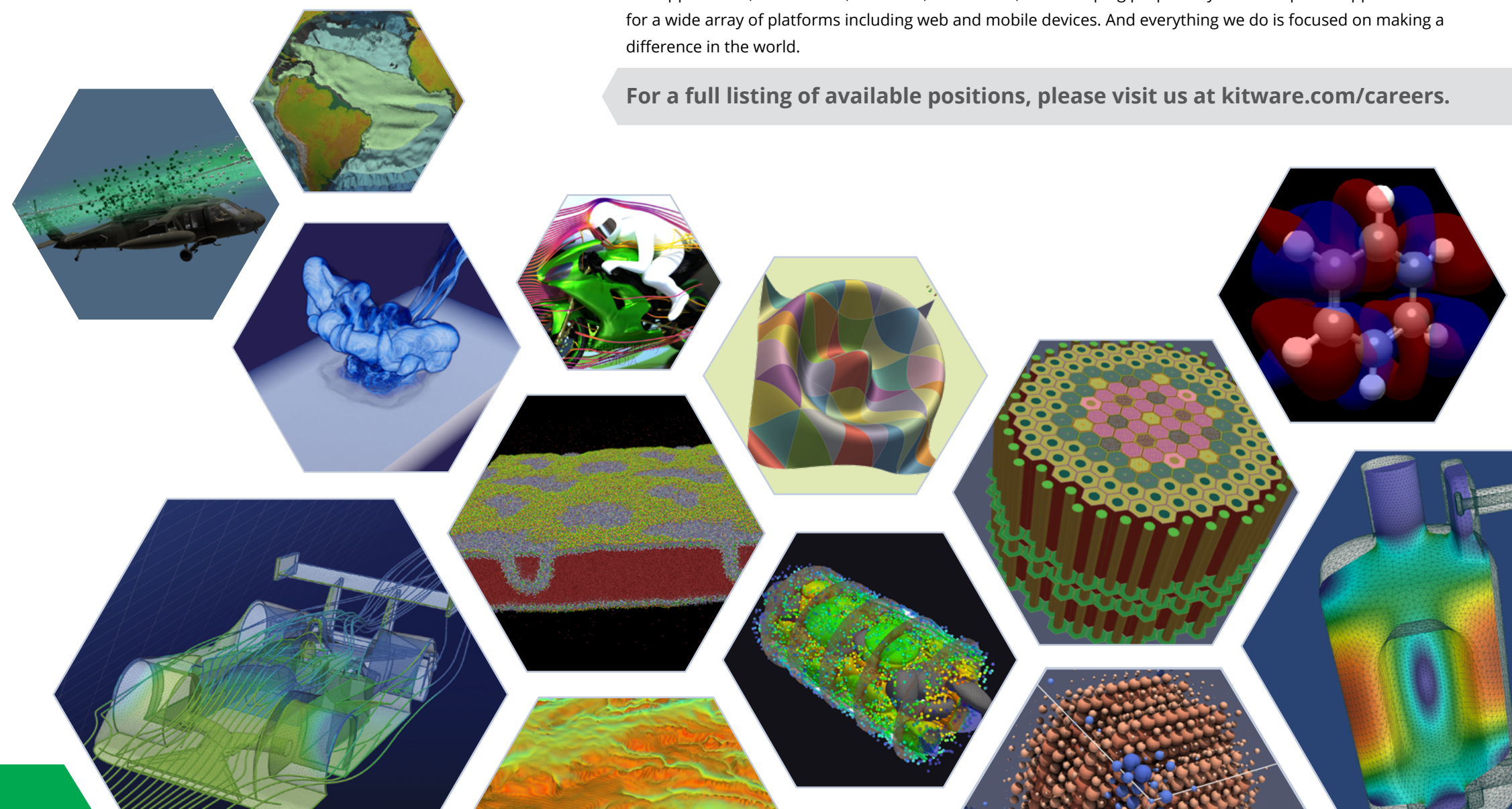
Want to see more of Kitware at SC21? Visit us virtually at [kitware.com/sc21](http://kitware.com/sc21)

## Kitware is Hiring

When you join Kitware, you create sophisticated software solutions that change the world, making it a better place. You utilize cutting-edge research methods, like deep learning and high-performance computing, to solve the world's biggest problems. You collaborate internally and externally to advance future discovery.

We collaborate with top universities from around the world, national labs, medical device manufacturers, car manufacturers, oil and gas companies, financial institutions, and many others on a multitude of basic and applied research and development projects. The projects range from extending our open source C++ libraries and applications, such as VTK, ParaView, and CMake, to developing proprietary domain-specific applications for a wide array of platforms including web and mobile devices. And everything we do is focused on making a difference in the world.

For a full listing of available positions, please visit us at [kitware.com/careers](http://kitware.com/careers).





# Kitware Tools in Action

## VTK and ParaView for Visualization of Large Data

Data analysis and visualization is often the most critical bottleneck in the scientific discovery process. The exponential growth of data in size, scale, and complexity makes it difficult for scientists and engineers to obtain insight by analyzing and visualizing their data. As data approaches exascale, this problem becomes even more constraining. Moreover, the data is becoming increasingly diverse through the integration of experimental observations and associated metadata within the data. Kitware is addressing these large data analysis issues by providing expertise in high-performance computing, distributed visualization, and data processing.

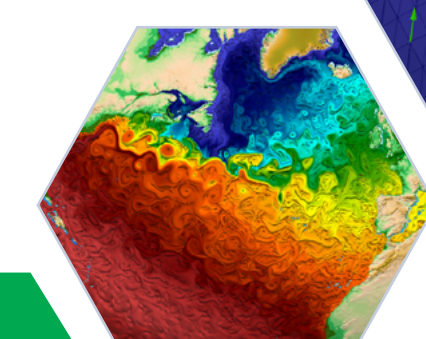
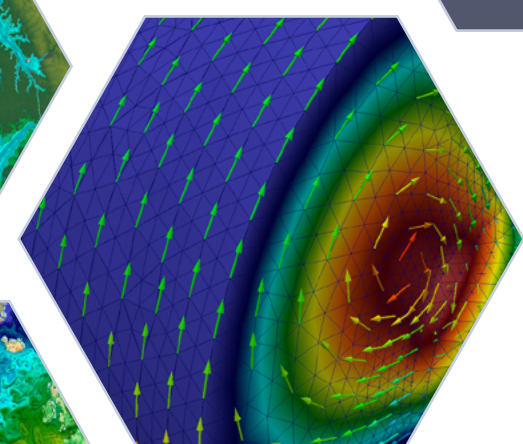
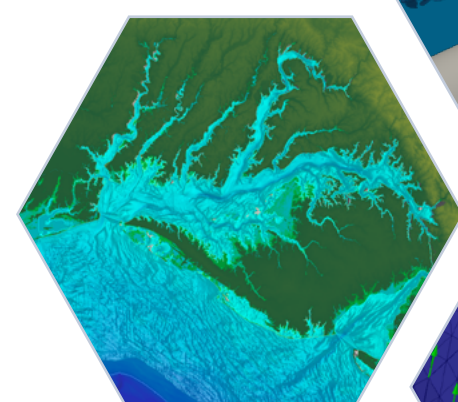
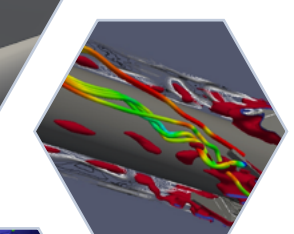
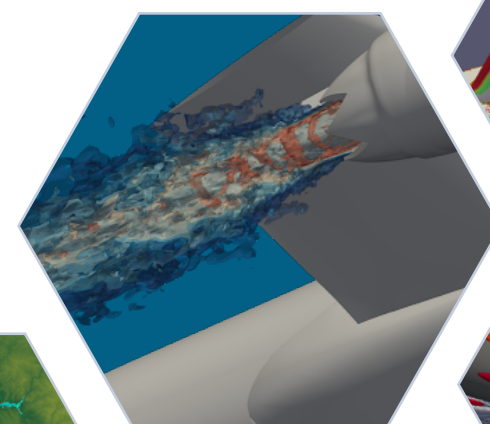
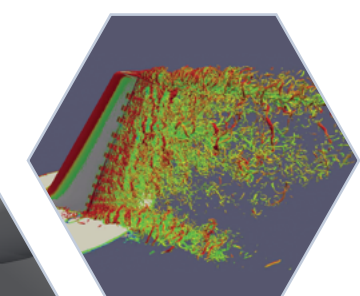
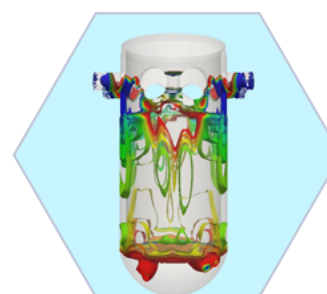
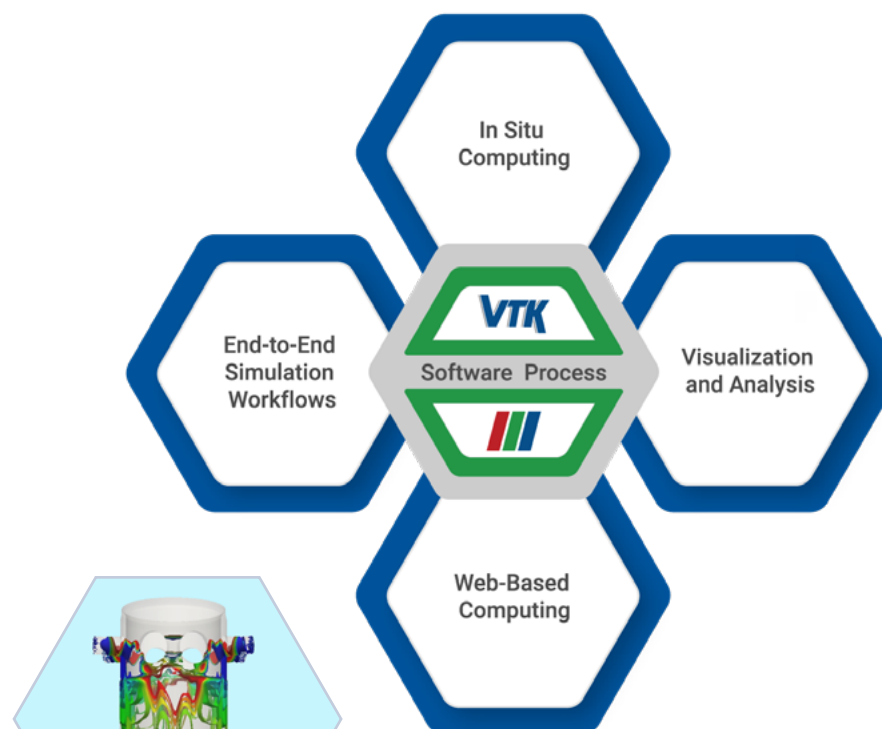
VTK is an open source, freely available software system for 3D computer graphics, modeling, image processing, volume rendering, scientific visualization, and information visualization. VTK is used worldwide in commercial applications and research and development, forming the foundation for many advanced visualization applications.

Designed to harness the power of parallel computing, ParaView is an open source, multi-platform data analysis and visualization application built on top of the VTK library. Research and commercial organizations in domains including structural analysis, fluid dynamics, astrophysics, and climate science use ParaView analysis and visualization for large data. Additionally, ParaView is incredibly flexible and can scale from a web-based application interacting in real time with a server, to a desktop application, to a parallel deployment run on leading edge supercomputers.

## Software Services

Kitware's expertise in HPC software, HPC platforms, build systems, and software process combined with a lifelong commitment of collaborating and developing open source communities has made Kitware a leader in providing software services to projects across a wide range of domains. As the creator of CMake, CDash, and CTest, Kitware has extensive experience in building high-quality software, upgrading infrastructure, and facilitating community outreach for a range of customers from national laboratories, government institutions, corporations, and universities.

The experience that Kitware has developed in a range of HPC domains allows it to provide bespoke services and solutions including: build and package development with expertise in cross platform needs, software deployment on enterprise and HPC systems, code and build improvements for new hardware platforms, and software process management with expertise in workflows for open source projects.



## ParaView Catalyst: In situ Analysis

Either because of I/O cost savings, increased temporal accuracy, or use of all available computational resources, in situ analysis and visualization is of considerable interest in the HPC community.

ParaView Catalyst provides these specific benefits for in situ analysis and visualization utilizing the ParaView platform. Catalyst has been integrated and used with a number of simulation codes, including ones from the Department of Energy (Albany, MPAS-O, and Sierra), the Department of Defense (AdH, GEMS, Helios, and SMURF), and others (BEC, LESLIE, PHASTA, Code Saturne, CAMV and UH3D). These simulation codes fuel a variety of research in fields such as rotorcraft analysis and design, ocean systems exploration, atmospheric changes, and thermal hydraulics processes inside nuclear reactor cores.

## Did You Know?

The largest-scale run that leveraged ParaView Catalyst was a simulation with the PHASTA CFD code run using 1M+ MPI processes.

## Computational Model Builder: End-to-End HPC Simulations

The Computational Model Builder (CMB) addresses the entire simulation high-performance computing (HPC) workflows. We can quickly employ the framework to specific problems for defining the proper geometric domain and mesh, setting simulation parameters, submitting the simulation job, and simulation result analysis and visualization. Our approach to simulation HPC workflow management contrasts with current monolithic programs and creates a modular environment that, when tailored, may leverage existing and future simulators, mesh generators, and HPC toolkits. By utilizing BSD licensing, we have created a variety of custom CMB applications from hydrological to nuclear reactor simulations.

CMB uses Cumulus, a platform for the dynamic provisioning and execution of HPC workflows. Cumulus provides the infrastructure needed to build applications that employ HPC resources in their workflows. Cumulus presents functionality in several key areas: cluster provisioning (traditional as well as dynamic cloud-based clusters), data management (using Girder, a scalable MongoDB based data management system), job submission (regardless of job scheduler), and workflow orchestration (from Celery-based Taskflow).