GA–A27474

SciDAC – CENTER FOR SIMULATION OF WAVE INTERACTIONS WITH MHD FINAL SCIENTIFIC/TECHNICAL REPORT

by
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NOVEMBER 2012

GENERAL ATOMICS

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Final Scientific/Technical Report

1. Introduction

The Center for Simulation of Wave Interactions with Magnetohydrodynamics (SWIM) project is dedicated to conduct research on integrated multi-physics simulations. The Integrated Plasma Simulator (IPS) is a framework that was created by the SWIM team. It provides an integration infrastructure for loosely coupled component-based simulations by facilitating services for code execution coordination, computational resource management, data management, and inter-component communication. The IPS framework features improving resource utilization, implementing application-level fault tolerance, and support of the concurrent "multi-tasking" execution model.

The General Atomics (GA) team worked closely with other team members on this contract, and conducted research in the areas of computational code monitoring, meta-data management, interactive visualization, and user interfaces. The original website to monitor SWIM activity was developed in the beginning of the project. Due to the amended requirements, the software was redesigned and a revision of the website was deployed into production in April of 2010. Throughout the duration of this project, the SWIM Monitoring Portal (http://swim.gat.com:8080/) has been a critical production tool for supporting the project's physics goals.

2. Monitoring

The IPS is a component-based framework, which provides an integration mechanism for a variety of simulation codes with a small amount of effort. However, the high degree of scalability and flexibility of the IPS design is not without cost. Components that run on different nodes can fail due to a variety of reasons, such as broken hardware, non-existent input data or non-valid intermediate results. Furthermore, SWIM team members are located in various geographical locations and execute IPS runs on multiple supercomputers, which makes it difficult to monitor code runs and detect errors.

Because the project team members are in various locations, monitoring the IPS runs is necessary in order to give the scientists the ability to track their simulations. The SWIM monitoring portal was designed for two purposes: 1) Real-time monitoring of ongoing simulations, and 2) Search and discovering of completed simulations to further scientific discovery.
Figure 1. displays the SWIM Monitoring portal main page.

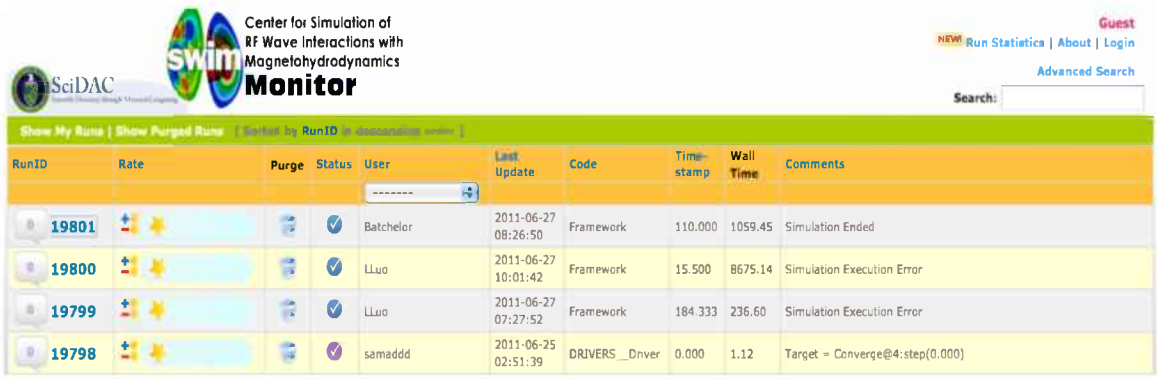

Figure 1. SWIM Monitoring Portal Main page

3. Metadata Management

The monitoring portal collects metadata information about simulations. It also provides a web-based interactive interface for logging user comments and rating the quality of the simulation. Both of these actions create further metadata. The portal supports a variety of user interaction options for searching, sorting, and visualizing metadata.

Some of the data created by the simulation and all of the related metadata are managed by two data servers associated with the web portal. The physics data sets are collected and stored by the MDSplus data management system that operates a standalone, independent of the full DIII-D MDSplus repository. The metadata and other relational aspects of the physics data are stored and managed by a MySQL relational databases system. The metadata collection process is automated, and transparent from users.

Figure 2 displays the data management servers in the portal context.

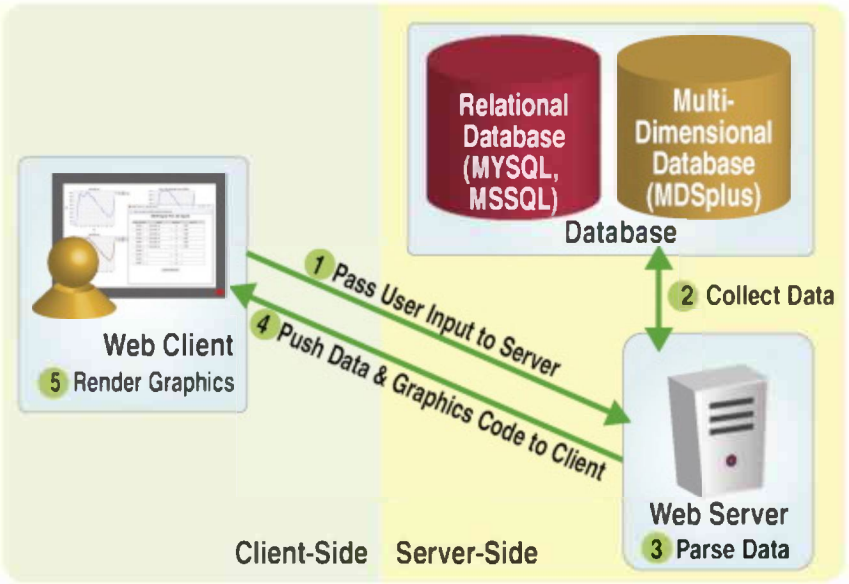

Figure 2. Data management servers in the SWIM portal context.

4. Web-based Visualization and User Interfaces

Due to the large volume of information collected from simulations, data visualization tools are critical for SWIM researchers. Interactive visualization using the web browser offers a way of monitoring and processing the complex simulation data quickly and effortlessly.

To be flexible enough to handle the evolving science of the SWIM project, this web implementation needs to be more general and modular so that while it can be applied to the simple overview pages, it can also be applied to the more complex web-portals. HTML5 is the 5th major revision of HTML and it introduced new features, such as SVG, to help the development of web applications. The SVG-based Protovis library was chosen for generating a web-based interactive visualization package for SWIM. Utilizing Javascript's event handlers, the dynamically created Protovis code provided highly interactive output to the users such as the multi-dimensional time slice bar as well as "pan, zoom and crosshair".

Figure 3 shows two variations of the web-based graphics that have been provided to the scientific team. First, is a lightweight overview page of all available plots without any interaction so the scientists can rapidly visualize their data. Clicking on each plot will lead to an interactive view of the selected plot – offering pan, zoom, crosshair, and the slider bar when necessary. Second, is a downloadable PDF file of all available plots that the scientists can quickly view and also send to teammates.

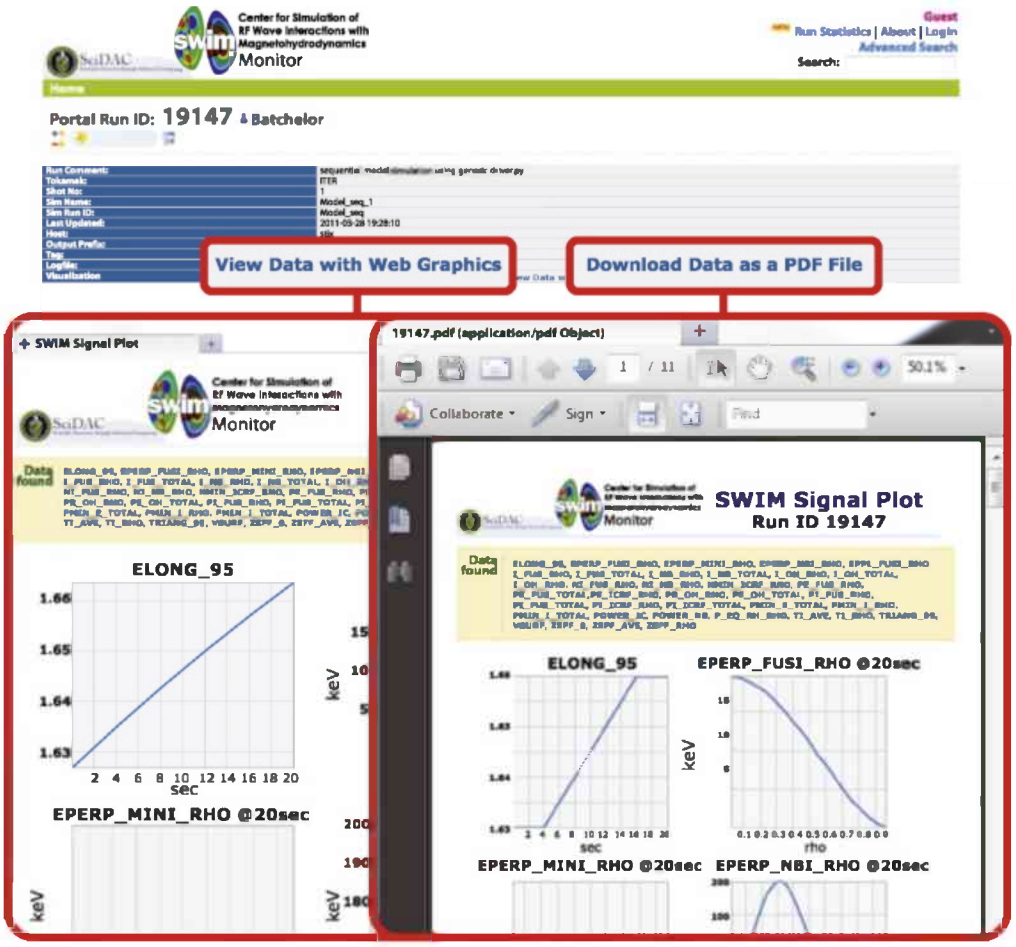

Figure -3 SWIM monitoring portal provides real-time, interactive signal plots.

5. Conclusion

The General Atomics Team performed research on monitoring, data management and visualization aspects of the project. They transformed the research results into unique software that was deployed for production usage. The deployment became an important production service for the SWIM research team and collaborators. The research results and deployment experiences were published in peer-reviewed technical journals and shared with larger scientific community.

Over the last two years of the project, the SWIM web portal service (http://SWIM.GAT.COM:8080) monitored and collected information from 8000 simulations which ran for a total of 360 CPU days. The computers included multiple super computers in US and clusters worldwide, including one located at ITER-France. The software and data management service have been proven stable and are still serving more than two-dozen fusion scientists worldwide.

6. Related Publications by General Atomics Team

E.N. Kim, D.P. Schissel, G. Abla, S. Flanagan, X. Lee, "Web-Based (HTML5) Interactive Graphics for Fusion Research & Collaboration," Fusion Eng. & Design, 2011

G. Abla, D.P. Schissel, L. Kim, S. Flanagan, and X. Lee, "Interactive Monitoring Portal for Fusion Simulations," Fusion Eng. & Design, 2011

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