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FINAL REPORT
PROTOTYPING A COMBUSTION CORRIDOR
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The Combustion Corridor is a concept in which researchers in combustion and thermal sciences have unimpeded access to large volumes of remote computational results. This will enable remote, collaborative analysis and visualization of start-of-the-art combustion science results. Achieving this capability requires collaboration of researchers in modeling of combustion and in networking technologies. Under this project the Engine Research Center (ERC) at the University of Wisconsin – Madison partnered with Lawrence Berkeley National Laboratory, Argonne National Laboratory, Sandia National Laboratory and several other universities to build and test the first stages of a combustion corridor.

The ERC served two important functions in this partnership. First, we work extensively with combustion simulations so we were able to provide real world research data sets for testing the Corridor concepts. Second, the ERC was part of an extension of the high bandwidth based DOE National Laboratory connections to universities.

The Combustion Corridor requires the development of new network aware visualization technologies. Current network communication provide generic services and do not take application specific requirements into account. Remote visualization is highly sensitive to issues such as latency and bandwidth, and has a unique set of communication

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requirements. In the long term, visualization applications will have to be modified to use direct access to flexible communication protocols and network status information to adapt to network behavior. Combustion requirements for visualization were analyzed to determine how to apply current and near-furture network aware techniques.

During this project the initial phase of a network testbed was developed in conjunction with the project partners. The ERC provided real combustion data for this testbed. The ERC used the MREN network to which the University of Wisconsin belongs. This was coordinated with the efforts at LBNL and ANL on the ESnet and NTON networks. The longer-term goal is to combine these various high bandwidth networks so that from the users perspective multi-point collaborative visualization and analysis can occur seamlessly. Specific tasks accomplished as part of the current project towards this longer-term goal are outlined further below.

On the network testbed advanced networking services provided by the GLOBUS toolkit were deployed. These were used to characterize and reserve the computational, network, and storage devices used in a collaborative session. Also, GLOBUS was used to manage the mapping of data to appropriate levels of network service. These services can be extended where needed to deal with the particular requirements of the high performance visualization application being used. In the future GLOBUS will also be able to provide security, data access, and communications services (e.g. shared control libraries) to the Combustion Corridor.

The specific tasks accomplished at the ERC under this program are listed below in chronological order:

- A Cisco 7507 router, on loan from UW-Madison's Division of Information Technology (DoIT), was installed at the DoIT network operations center to provide connectivity between the Engine Research Center (ERC) an the ESnet/MREN Regional Grid Experimental NGI Testbed (EMERGE) network. This installation was handled by Jeff Bartig of the UW Division of Information

Technology (DoIT). DoIT's Bill Jensen attended a meeting at ANL later in the month where details of the router configurations where determined.

- While router configuration issues were being resolved a route for the fiber optic connection between ERC and the router were determined and installed by DoIT's Paul Nazario and the Computer Aided Engineering Center's Ken Bartz.

- While the network logistics were being resolved we were learning about the GLOBUS toolkit. Copies of the proposal indicated that GLOBUS would be one of the foundational technologies that projects on the EMERGE network would be using. After reading though the materials available at the GLOBUS website (http://www.GLOBUS.org), we built and installed a copy of the GLOBUS toolkit on a SGI O2 at ERC. We requested and received the GLOBUS authentication certificates from the GLOBUS certificate authority.

- After GLOBUS was installed and some initial testing completed, we obtained a copy of MPIGH-G, an MPI implementation built on top of the GLOBUS toolkit. MPI was successfully built and setup to run. Example code with MPICH-G on the O2 at ERC was used as test cases.

- A permanent replacement for the loaner Cisco 7507 was obtained and installed at DoIT. The fiber connection arrived at ERC several months later, and the O2 was connected to the EMERGE Network. Later a second Ethernet interface was added to the O2 allowing it to access both the EMERGE and ERC networks.

- We started working with the IBRAVR, later renamed VISAPULT, code released by LBL. A copy was built on the O2 and some example data sets were tested with everything running on the O2. Next tests were done with data pulled from the distributed parallel storage server (DPSS) at LBL. Data was pulled from the DPSS at LBL then rendered and displayed on the O2. Next a copy of the VISAPULT rendering backend was built for the SGI Origin 2000 system at ERC

and a test was conducted pulling data from the DPSS at LBL. This data was rendered on the Origin 2000 and then finally displayed on the O2 system.

- After these successful tests of VISAPULT, a small DPSS server was setup at ERC using a spare PC that was installed with Linux. We ran in to a few difficulties if we tried to load data on to the DPSS from our Irix machines, but if the data was moved on to the Linux machine and DPSS tools used there, then we could load the data sets in to the DPSS. A test was then made substituting the ERC DPSS for the LBL DPSS. Then, the data was rendered on the ERC Origin 2000 and once again displayed on the O2.

- Initial efforts were made in writing a program to convert some of the common combustion simulation output formations in use at ERC to a format that would be useable by VISAPULT.

- Finally, a conversion utility was created to modify the simulation output formulations used for combustion simulations at the ERC into a format that would be useable by VISAPULT. Initial tests were successful so that ERC data can be viewed through the VISAPULT system.