As high performance computing (HPC) becomes a ubiquitous part of the scientific computing landscape, the science of visualizing HPC data sets has become a critical field of its own. One of the hottest solutions can be found in commoditized high performance visualization clusters (HPVC), which are just starting to pop up in data rich environments around the world.

What Is HPVC?

An HPVC is a cluster specifically built for the purpose of visualization. Rather then being primarily based on MPI (Message Passing Interface) which is used to develop parallel applications, an HPVC has a unique software layer that enables it to drive multiple displays – these displays are mounted in a tile formation, and are often referred to as a “Viz Wall”. Each node (computer) in the HPVC is responsible for driving 1 (or 2) displays in the Viz Wall.

This paper discusses building a high performance visualization cluster with a tiled wall display using Rocks+ (a cluster distribution from Clustercorp and the Rocks™ Cluster Group, University of California, San Diego).

Selecting the Right Hardware

The design specification of an HPVC is often for general visualization of science, as opposed to a narrow, specific problem set, so it is important to put together a hardware configuration designed to meet many disparate needs. The main issues to consider for the compute nodes are physical form factor and the ability to host a high-end NVIDIA graphics card, which is required.

Here’s an example configuration:

**Master Node – Small Desktop Tower (Qty = 1)**
- Dual Core 2.6 GHz Processor
- 4GB 667MHz Memory
- NVIDIA® graphics card

**Visualization Nodes – Small Desktop Tower (Qty = 20)**
- Dual Core 2.6 GHz Processors
- 4GB 667MHz Memory
- NVIDIA® graphics card

**Display Panels – (Qty = 20)**
- 20-inch Wide-Screen LCD
- 5x4 Display Wall Frame

**Ethernet Fabric – (Qty = 1)**
- Gigabit Ethernet Switch, 24 Port
- Gigabit Ethernet Cat6 Cables (Qty = 22)

**Other Components**
- “Cluster Kickstart” system setup from Clustercorp (Includes deployment and 3 months support)
- “Rocks+Support” from Clustercorp (3-year support contract)

Rocks+ Makes It Work

Without a software stack that ties each of these systems together, your HPVC is simply a bunch of networked workstations with long display cables. The core component to manage this visualization cluster is the Rocks+ cluster distribution. Rocks is a complete open-source Linux distribution developed specifically for cluster computing – Rocks+ is a commercial version with enterprise class support and additions to the software stack that can be used to deploy specialized turnkey solutions.

The distribution is based on Red Hat Enterprise Linux or CentOS – an install-time choice. By using Rocks “Rolls”, the cluster distribution can be transformed into a fine-tuned HPVC stack that automates the deployment (and much of the configuration) of an HPVC; Clustercorp’s solution is called Rocks+Viz.
In this case, the key addition is the Viz Roll. The Viz Roll includes common packages used in visualization clusters such as SAGE, DMX, VTK and Chromium. It automates the installation and management process for visualization clusters in the same fashion that the Rocks+ core simplifies the basic compute cluster paradigm.

Clustercorp’s (http://www.clustercorp.com) Rocks+Viz package is sold as a subscription license that includes software and support.

**Impact on a Real World Problem**

Let’s talk about how users can get the most out of their HPVC... A new rear wing design for a Formula 1 Race Car? No problem, Stanford’s Flow Physics and Computational Engineering Group has used a Viz Cluster for this purpose. What about visualizing the seismic forces associated with an undersea earthquake and subsequent tsunami? Scripps Institution of Oceanography uses a Viz Cluster for this and many other earth science applications. How about analyzing the computational results of an integrated, multi-physics simulation of a jet engine? Clustercorp’s Scientific Computing group has worked on just such a project...

A jet engine is a complex engineering system consisting of a fan, compressor, combustor, turbine and exit nozzle. Using single displays for analysis proves inadequate, because component interaction requires the entire ensemble to be visualized at once, with a sufficiently large image. For example, the fan blade wakes propagate through multiple stages of the low pressure compressor, which can only be analyzed in detail by leveraging the resolution and size of a Viz Wall. Users are able to visualize the details of flow in each component, such as boundary layers on turbomachinery blades, tip-gap vortices, and unsteady wakes in the blade passages.

In addition, fully understanding the flow in a jet engine requires a collaboration of many research scientists, each with differing areas of expertise. The visualization of the flow features on a large screen proves to be an excellent vehicle for a fruitful scientific interaction. Visualization walls lead to collaborative efforts by scientists by bringing the display and analysis process into a conference-type setting.

**Make It Happen**

The process laid out in this paper is a mature, repeatable solution that should give new users the confidence to deploy similar solutions in research and production environments. HPVC is quickly becoming the method of choice for the analysis of massive data sets generated during large-scale scientific computing – a high-end visualization solution has become a must-have tool for scientists looking for clear views of complex data.

This product includes software developed by the Rocks Cluster Group at the San Diego Supercomputer Center at the University of California, San Diego and its contributors.