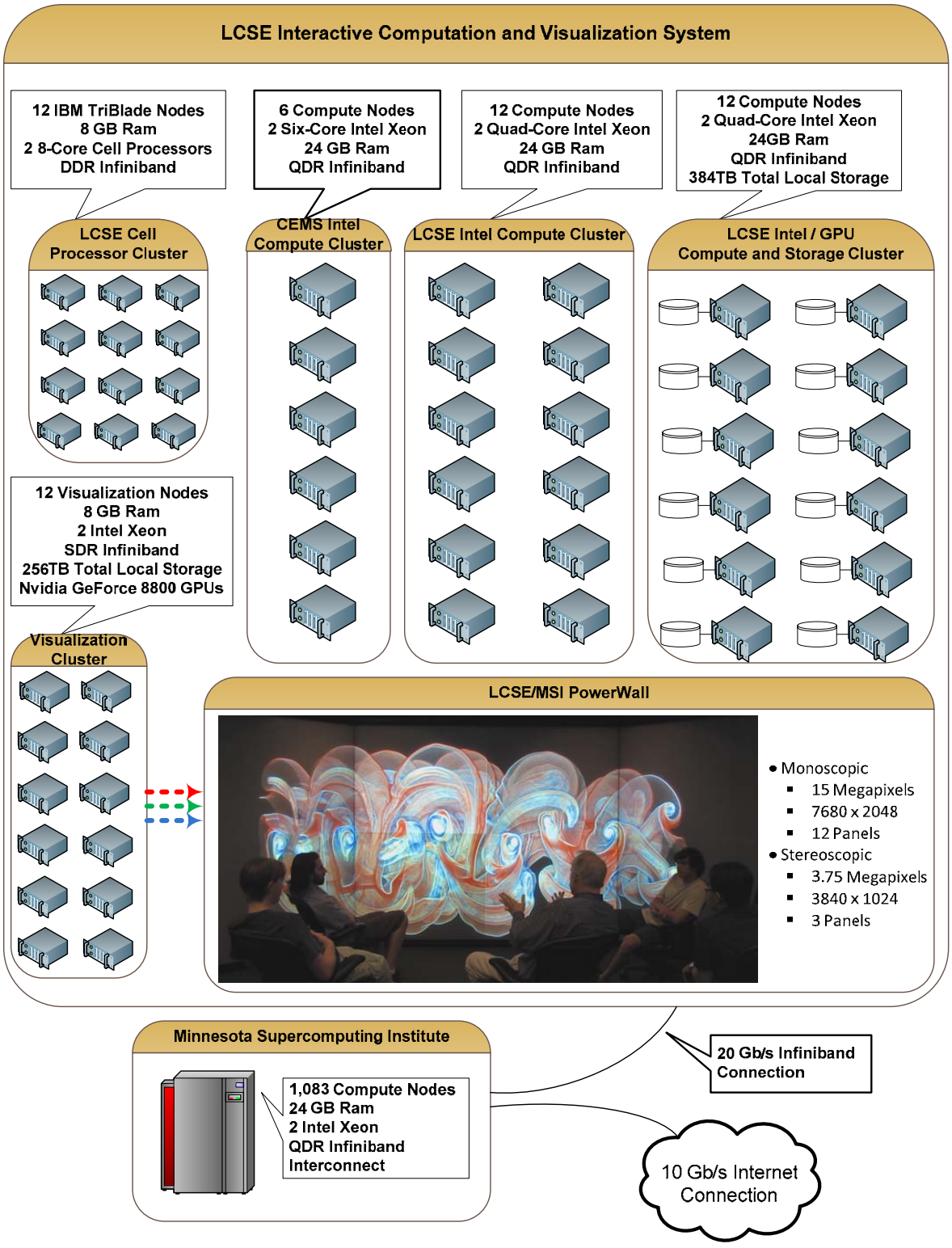
Facilities

The LCSE is part of the University of Minnesota's Digital Technology Center (DTC), located at the heart of the campus in the recently renovated Walter Library Building. The LCSE has roughly 3500 sq. ft. of prime space on the ground floor of this building for its PowerWall visualization room (see photo at the bottom of the next page) and its machine room. LCSE offices are located on the 4th floor of this building in the primary DTC space. The Minnesota Supercomputer Institute (MSI), of which Woodward is a Fellow, is located on the 5th floor of the building and has its batch-production-oriented machine room in the basement of the building serving the broad University community. MSI has co-invested in the PowerWall display in the last few years as part of its normal program and also as matching support to the NSF Computing Research Infrastructure grant to the LCSE. The LCSE system manager is jointly supported by this NSF grant and by MSI.

With NSF MRI (Major Research Instrumentation) funding, an interactive visualization capability for multi-terabyte datasets was added to the LCSE system in 2004-2005. This project put into place a 10-node Infiniband cluster, to which 4 nodes were added with DoE support. Each of these nodes now has 3 TB of locally attached disks capable of streaming data at 200 MB/sec, and half of this disk capacity is reserved as a scratch space where a data set of up to 1.5 TB can be replicated on every node. Each node has an 8 GB memory and dual Xeon 3.6 GHz CPUs plus an Nvidia GeForce 8800 GTX graphics engine. These nodes are shown at the right on the system diagram on the next page. The LCSE software enables these machines to cooperatively volume render images from 1 billion voxel snap shots of our flow simulations at full 16 Mpixel PowerWall resolution at interactive rates. These images can be rendered for a remote display at any desired resolution and sent to that screen over the Internet. The LCSE software also provides a capability to easily specify movie renderings, working with either the full data or, if remote, a coarsened version of it. The movie specification can then be submitted as an off-line movie rendering job, and it will automatically be generated and stored at any desired location for later convenient display.

The present active NSF CRI grant to the LCSE is supporting the development of an interactive supercomputing capability. This involves collaboration with IBM and the Los Alamos National Lab (LANL) to exploit IBM Cell processor and Intel Nehalem multicore technology to deliver interactive fluid flow simulation capability to the researcher. The Cell-based system follows the IBM Roadrunner design, with 6 triblades containing 24 Cell processors, each with 8 cores and 4 GB memory. These are shown at the left in the system diagram. Handling more general purpose tasks, including serving over half a petabyte of extremely fast disk storage and (soon) hosting the latest Nvidia GPUs (through a CDI grant to participating faculty in the geology department), are 25 Intel Nehalem based workstations on a QDR Infiniband switching fabric (40 Gbit/s). The Cell systems deliver roughly 0.8 Tflop/s sustained performance to the codes we will use in this project, and the Nehalem systems deliver roughly 1 Tflop/s to those same codes. Interactive runs with this stellar convection code are possible if the grid size is brought down to 192^3 cells. Interactive performance is also achieved on grids of 512^3 or even larger, if the low Mach numbers are above 0.2. We can perform exploratory runs of the proposed stellar convection problems interactively at either low resolution or by increasing the energy injection rate, so that the Mach numbers rise above 0.1. The LCSE has a direct 20 Gbit/s connection to the MSI supercomputers in the basement of the building, which offer 20 times the computing capability of the lab. This permits interactive runs of stellar convection. There is also 10 Gbit/s connectivity of the building to the Internet, which permits very effective use of the LCSE equipment in conjunction with the nation's largest computing facilities, such as the LANL Roadrunner machine, the Kraken machine at ORNL, and, soon, the Blue Waters machine at NCSA.LCSE researchers are shown here at the PowerWall display, viewing an interactive simulation.


LCSE Interactive Computation and Visualization System
12 IBM TriBlade Nodes
8 GB Ram
2 8-Core Cell Processors
DDR Infiniband
6 Compute Nodes
2 Six-Core Intel Xeon
24 GB Ram
QDR Infiniband
12 Compute Nodes
2 Quad-Core Intel Xeon
24 GB Ram
QDR Infiniband
12 Compute Nodes
2 Quad-Core Intel Xeon
24GB Ram
QDR Infiniband
384TB Total Local Storage
LCSE Cell Processor Cluster
CEMS Intel Compute Cluster
LCSE Intel Compute Cluster
LCSE Intel / GPU Compute and Storage Cluster
12 Visualization Nodes
8 GB Ram
2 Intel Xeon
SDR Infiniband
256TB Total Local Storage
Nvidia GeForce 8800 GPUs
Visualization Cluster
LCSE/MSI PowerWall
• Monoscopic
▪ 15 Megapixels
▪ 7680 x 2048
▪ 12 Panels
• Stereoscopic
▪ 3.75 Megapixels
▪ 3840 x 1024
▪ 3 Panels
Minnesota Supercomputing Institute
1,083 Compute Nodes
24 GB Ram
2 Intel Xeon
QDR Infiniband
Interconnect
20 Gb/s Infiniband Connection
10 Gb/s Internet Connection