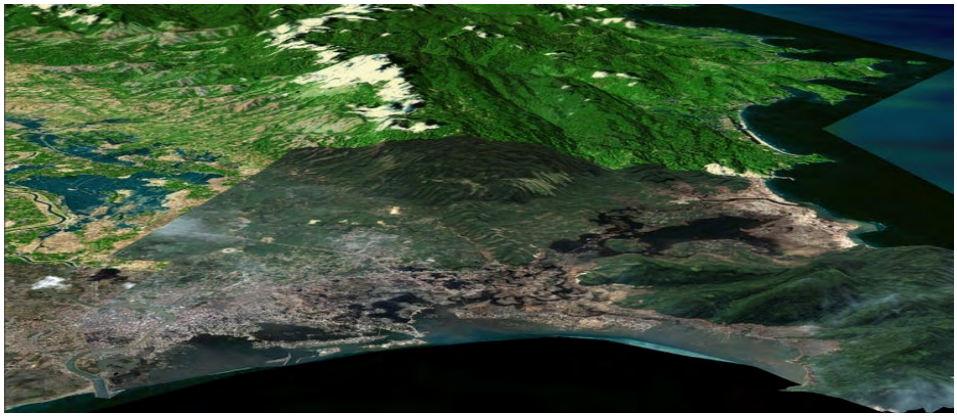
Success Story

Time-Critical GIS Visualization



Accelerating Tsunami Relief at San Diego State University

High Resolution GIS Visualization with Silicon Graphics Prism™ Systems

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– John Graham,
Senior Research Scientist,
SDSU Visualization Center

When the horrific tsunami arose from the Indian Ocean on December 26, 2004, the Immersive Visualization Center at San Diego State University (SDSU) sprang into action. Already involved with the processing and dissemination of large geophysical data sets for a variety of national and international training and disaster response efforts, SDSU's Visualization Center had a Silicon Graphics Prism visualization system up, running and ready for anything.

SDSU was one of the first of any organization to acquire high-resolution before and after satellite imagery of Banda Aceh, Indonesia, where the worst devastation occurred. Because of the high performance and speed of the Silicon Graphics Prism system, the Visualization Center was able to process the high-resolution satellite imagery and deliver high-fidelity 3D geospatial visualization and maps to relief workers and government officials so they could establish initial refugee camps and provide emergency medical care. In early January, the center also supported SDSU adjunct faculty medical doctors who work with the U.S. military, NGOs (non-government organizations) and the United Nations. Relief efforts continue today, with ongoing visualization improving the ability of the people on the ground to continue their work.

In the case of tsunami relief, time was of the essence. Delivering the compressed satellite imagery to relief workers in the field helped them to determine what roads were out, what land was now underwater, where they would need boats to bring in supplies, and what hills could be used to set up communication systems. By visualizing hundreds of gigabytes of geospatial data on a Silicon Graphics Prism system with eight Intel® Itanium® 2 CPUs, four graphics pipes, 24GB of memory, and running the Linux® operating system, the researchers at the Visualization Center are able to continuously create up-to-date 3D fly-throughs that depict the changes wrought by the tsunami.

"To put three 20GB files together as one, then write those out to the GeoFusion GeoMatrix format took 10 hours on the Silicon Graphics Prism, and if I wasn't running on a multi-processor-aware software system, again, it would have taken easily over 100 hours, just to process this image."

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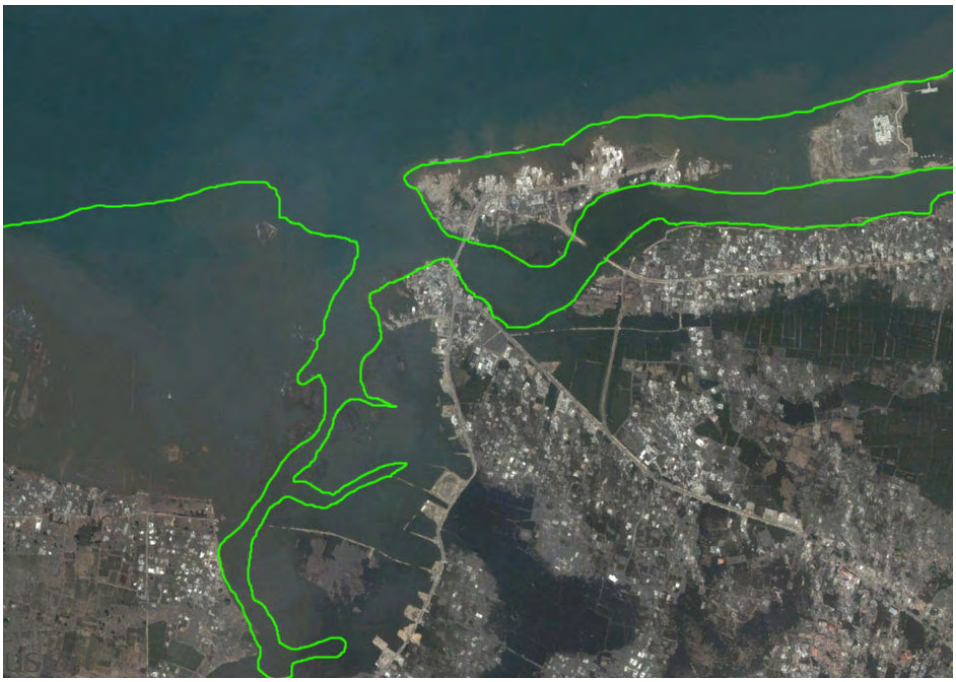
In addition to natural disaster mitigation and response, the SDSU Visualization Center is involved in many research projects including homeland security, global sharing of information and collaborative visualization, remote sensing and environmental monitoring, and grid computing. Rapidly becoming the nerve center for all of these efforts, the Silicon Graphics Prism system is an integral part of the geospatial imagery processing pipeline used to create new datasets and convert all data into GeoMatrix® Toolkit format; the data, just like the tsunami imagery, is then stored back out to SDSC online servers for public access.

"With 8 CPUs running our image processing software, we get 10 times the improvement of speed, so a project that would have taken 100 hours takes 10," said John Graham, senior research scientist at SDSU Visualization Center. "We chose the Silicon Graphics Prism system because it's hard to find a single machine with so many CPUs and so much RAM. I can throw very large images with very long process times at it, and the Prism just cranks it up and does it."



SDSU played a critical role in tsunami relief efforts by quickly processing and delivering high fidelity 3D geospatial visualization and maps to relief workers and government officials. In this satellite image of Banda Aceh, Indonesia, the green outline highlights the original coastline before the tsunami.

Homeland Security

The SDSU Visualization Center is also actively involved in increasing homeland security efforts through the use of advanced, high resolution 3D GIS and video surveillance. Visualization Center researchers have collaborated with local law enforcement and fire departments to create a 60 Gbyte 3D GIS model of all of San Diego country using their Silicon Graphics Prism system. This model features one-foot resolution imagery, and is used in collaborative practice exercises with local agencies and for a graduate studies course on the use of mapping technology and visualization techniques.

For example, SDSU recently worked with the San Diego Police Department to augment their beach area and fireworks surveillance with high-resolution technology. Networked cameras and geographic information system (GIS) situational awareness software were demonstrated. Also shown was one-foot aerial photography for the entire county, running on the Silicon Graphics Prism. Soon, SDSU will be processing imagery on the Prism that will extend their mapping and security possibilities to greater Los Angeles, followed by the entire state of California.

Besides sheer power and speed, one of the most important benefits of the Silicon Graphics Prism system is that its compute and visualization power can be used however needed. The Visualization Center system can be simultaneously used by local users to perform high-resolution 3D fly-throughs, by remote users to evaluate threat scenarios and for computational

tasks like processing the latest satellite imagery and real-time surveillance video. One current project, for the U.S. Border Patrol, uses open source programs based on GDAL that are translating and re-projecting 6-inch per pixel aerial photography of the California-Mexico border.

"Some of our images are 20GB files, so when you have to mosaic three of those 20GB files together, which is what I'm doing right now with the California-Mexico border, it really helps to have the multi-processor support in the program that's doing it," said Graham. "To put three 20GB files together as one, then write those out to the GeoFusion GeoMatrix format took 10 hours on the Silicon Graphics Prism, and if I wasn't running on a multi-processor-aware software system, again, it would have taken easily over 100 hours, just to process this image."

SDSU Visualization Center researchers are using their Silicon Graphics Prism system to quickly process and piece together 6-inch per pixel aerial photography of the California-Mexico border.

Global GIS Visualization

Maybe one 60GB image sounds like a lot of data to interact with in real time but what happens when you look at the entire Earth? "We're about to receive global Landsat7 mosaics that are 15-meter resolution, covering the entire planet," adds Graham. "That will be a big bucket of data!"

SDSU collaborates with Lucian Plesea at NASA's Jet Propulsion Laboratory, which is currently finishing the creation of the global datasets from the Landsat7 satellite, which will be transferred to SDSU's lab for further processing, and Web hosting via the SDSC. The Visualization Center will process the images in the Silicon Graphics Prism into the GeoMatrix format, which highly pre-compresses and optimizes visual data in tiles, making it ready for the GeoFusion engine to display in 3D interactively on local high-resolution displays or on a Web browser for remote access.

"The interactivity is phenomenal, and just like the live San Diego county images, the global mosaics will be available at our website to anyone. You will be able go anywhere on the planet and zoom right down, and see the latest results that were processed on the Silicon Graphics Prism," notes Graham. "We don't know the final size of all the rendered images that are creating the global mosaic as yet, but they will be very big. It will definitely be several terabytes."

As the SDSU Visualization Center takes on ever-expanding image processing projects, there is an insatiable demand for processing and visualization power. Because Silicon Graphics Prism visualization systems run the Linux operating system, applications and data can easily be moved between sites. "We're creating these tools and datasets in open source formats so we can distribute them globally and so we can have other people helping us process data," notes Graham. "If we could apply the power of the entire 10,240 CPU SGI® Altix® supercomputer at NASA Ames to this problem, processing that used to take a month could be completed in 4 minutes, revolutionizing how we look at global resources."

The open source GIS software Graham and his associates are writing will become available throughout the geospatial imaging community. The Silicon Graphics Prism system's open environment enables SDSU to tap into an open source library called GDAL, Geospatial Data Abstraction Library. "The data library is used in just about every piece of GIS software known to man," Graham explains. "We're collaborating with an open source developer, Mario Beauchamp, using the library to do pan sharpening and warping, and all kinds of different processes to the satellite imagery, and we're going to be giving that back as open source software, like everything we develop."

High-Performance 3D GIS

The GeoMatrix Toolkit from GeoFusion, Inc. provides the software backbone for the Visualization Center's high performance GIS environment. GeoMatrix based applications and standard data formats allow for the import of image and vector GIS information and it's display using geospecific terrain data and annotation. When combined with models of buildings, bridges and other non-GIS information, Visualization Center researchers can view their local or global data from any perspective to evaluate the environmental impact of proposed developments and for homeland security planning.

The scalable computing power and large memory of their Silicon Graphics Prism system allows researchers at the Visualization Center to use GeoMatrix tools to process their large datasets directly from memory, while the system's multi-pipe visualization capability allows them to bring together large groups to make critical decisions. By displaying interactive, high performance visualizations on displays with 5 to 50 million pixels of resolution, decision makers are able to rapidly reach conclusions based on shared observations.

"GeoFusion allows us to have hundreds of datasets and hundreds of terabytes of imagery, elevation and vector data available in its global visualization engine. GeoFusion also has a very small web browser plug-in which allows us to share all the data online. To be able to email a URL to someone anywhere on the planet and directly link them to the 3D visualization is an extremely powerful tool," continues Graham.

Scaling to Meet Future Challenges

The scalability of the Silicon Graphics Prism visualization solution has allowed the Visualization Center to expand as quickly as their needs. "We've doubled the number of bricks we had originally," says Graham. "We started out with two pipes, two bricks, and then doubled it, and maxed out with as much memory as we could buy. If we want to add more capacity to the Prism, we can just keep on adding more bricks, more CPUs, more memory, more graphics pipes, a bigger rack. That's a pretty unique thing, to be able to organically grow your computer."

However, not all of the data the Visualization Center researchers need and not all of the consumers of the data they generate are located at SDSU. As a result, SDSU plays a pivotal role in the development of high performance Grid computing. The Visualization Center directly connects into the university's supercomputer center via fiber optic cables that can provide tens of gigabits per second of bandwidth to the San Diego Supercomputing Center and wide area supercomputing networks.

"With 10 gigabit Ethernet in the Silicon Graphics Prism system, we will directly connect into very fast computer networks, including National Lambda Rail, Starlight, through Cal IT2 and TerraGrid, and internationally with a couple of different peering arrangements," explains Graham. "Once connected directly to the fiber network, the Visualization Center joins the OptiPuter concept where you're making your computer power available across a fast glass network. The Silicon Graphics Prism system's shared memory, shared disks and shared applications are accessible across the country or on the other side of the world. That, and the use of open source software on top of these fast, scalable Silicon Graphics computers, is the real story."

San Diego State University's immersive visualization center, the SDSU Center for Information Technology and Infrastructure [CITI], was established to promote the vision of empowering SDSU to take advantage of emerging tools in optical networking, wireless communication, and human-computer interactions through visualization. On behalf of the entire university, it nurtures new technological tools and builds on existing efforts in environmental monitoring, student safety, transportation studies, law enforcement and first responder interaction, homeland security, collaborative education, Internet technologies, and other high interest areas.

GeoFusion, Inc. is a software technology company that develops and licenses high performance 3D interactive earth visualization solutions. GeoFusion's GeoMatrix® Toolkit is a software development kit [SDK] used by GIS industry leaders to build powerful full globe visualization applications that can manage vast amounts of GIS data.

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