

Earthquakes, Tsunamis, and the International Solid Earth Research Virtual Observatory

The magnitude 9.0 Northern Sumatra earthquake and tsunami of December 26, 2004 dramatically underscored the increasing vulnerability of modern societies to the damaging effects of natural disasters. Understanding and mitigating the effects of such disasters must involve major international collaborations, and must incorporate land- and space-based observations, computational simulations and analysis, and collaborations through large scale information technology enabled by the World Wide Web.

We therefore propose to establish the international Solid Earth Research Virtual Observatory (iSERVO) as an international partnership of primarily Asia-Pacific economies interested in studying, forecasting and mitigating the damaging effects of large and great earthquakes and tsunamis. The founding economies of iSERVO are Australia, Canada, China, India, Japan, Russia, Sri Lanka, Taiwan, and the United States. Other economies will be added during the course of the project.

Intellectual Merit. This project brings together earth scientists and computer scientists to develop new approaches for understanding the physics of earthquakes and tsunamis through computer simulation and data sharing and analysis. The US team includes Indiana University, the University of California at Davis, Irvine, and Santa Cruz, University of Minnesota, Northwestern, University of Southern California, and NASA's Jet Propulsion Laboratory. Geoscience is being revolutionized by the increasing availability of enormous amounts of globally distributed data, and this aspect of the e-science is driving much modern information technology. Scientific progress demands an international collaboration to exploit both the expertise and resources around the globe. We will make significant contributions both to geoscience through fundamental research and to computer science from lessons learned deploying and using cyberinfrastructure.

Broader Impact. Scientists and educators from many economies will use the infrastructure to support new models of international collaborative research, and new geoscience and geoinformatics curricula, exploiting iSERVO resources to bring research into a world-wide, distributed classroom. iSERVO will enhance existing strong programs in graduate and undergraduate research and education, including those for minorities. The general public will have open access to iSERVO products through portals. The project will support extended visits of students and researchers, exchanged between iSERVO sites. This program will increase international awareness in the science and engineering workforce.

iSERVO: A fundamental principle driving this project is the use of information technology to provide open access to all components including observations, simulations, analyses, and their potential consequences. iSERVO will be built upon a web-based foundation of modern, service-oriented cyberinfrastructure. Each economy will be served by one or more iSERVO nodes. The iSERVO collaboratory will support the remote sharing of networks, real time sensor outputs and streaming data, archived data, software applications, visualization services, scientific results and analysis.

The iSERVO framework will allow relevant resources to be easily integrated into the interoperable cyberinfrastructure. This framework will be based on the best practice from organizations such as the Global Grid Forum, large projects such as GEON and QuakeSim in the USA, and the major national projects and Grids in the participating

economies. Visualization services in the framework will be based on services developed by the VLAB and KeckCAVES projects. The compute resources supported by iSERVO will include massively parallel machines, smaller enterprise servers, and an iSERVO@Home desktop Grid. iSERVO will include a Grid Operation Center that supports international deployment and operation of iSERVO nodes.

Typical capabilities and products provided by iSERVO include:

- ❖ Collaboratory functions including audio/video conferencing and collaborative visualization
- ❖ Links to earthquake and tsunami data from Canada, China, Japan, Russia, Taiwan, and the United States.
- ❖ Simulation technologies such as Virtual California (USA), GeoFEST (USA), GeoFEM (Japan), LSMEarth (Australia).
- ❖ Tsunami propagation, arrival times, run-ups, and areal coverage from simulations developed in the US, Japan, and China.
- ❖ Earthquake forecasts using the pattern informatics ("hotspot map") technology developed in the US and Canada, and the precursory chain method developed in Russia and the US.
- ❖ Load-Unload Response Ratio forecasts developed in China.
- ❖ Disaster scenario simulations, hazard estimates, and warning capabilities.

The iSERVO cyberinfrastructure implements these capabilities as interoperable services supporting open access and linkage through grid workflow. These iSERVO products will be disseminated broadly through the portal for use in research, education, and outreach.