



## 2004 Disaster Resistant California Conference

### **New Tools from the California Integrated Seismic Network (CISN) and Advanced National Seismic System (ANSS)**

The CISN and ANSS Integrated Products Team<sup>1</sup>

#### **Abstract**

To better serve the earthquake emergency management and response, engineering, and scientific communities, several agencies in California have formed the California Integrated Seismic Network (CISN). The CISN is one region of the Advanced National Seismic System (ANSS), a larger system being developed under the auspices of the U.S. Geological Survey (USGS) in cooperation with CISN and seismic network operators in other areas of the US. In this paper we highlight ongoing development of new CISN and ANSS products and web pages, with emphasis on the utility of these products as they pertain to disaster resistance. In addition to an improved web presence, the CISN partners are currently working on improving the robustness of statewide earthquake notification and developing applications to facilitate interpretation of rapid earthquake information and damaging ground motions. One such notification product is *CISN Display*, an application for visualization of seismicity and ground shaking for critical users. The ANSS is complementing CISN activities by focusing ongoing development of *ShakeMap*, a tool used to portray the extent of potentially damaging ground shaking following an earthquake, and *ShakeCast*, an application for automating ShakeMap delivery and triggering established post-earthquake response protocols.

#### **Background - CISN and the ANSS**

A modern seismic system is vital for providing timely and accurate information about earthquake activity and earthquake effects and for reducing loss of life and property from earthquake disasters. The partners of the California Integrated Seismic Network (CISN), a component region of the United States Geological Survey's (USGS) Advanced National Seismic System (ANSS, U.S. Geological Survey, 1999), are committed to rapidly providing advanced earthquake information for disaster mitigation. The members of the CISN are the California Geological Survey, the California Institute of Technology Seismological Laboratory, the University of California, Berkeley Seismological Laboratory and the USGS offices in Menlo Park and Pasadena. The California Governor's Office of Emergency Services is a partner in the CISN and is supporting efforts to improve the robustness and reliability of earthquake information in California as well as to assist in the transfer of this technology to first responders.

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## Advances in Web-based Information

A number of new developments and applications are available via our web sites. We discuss these advances in detail below, but since these and other applications are changing and improving rapidly, we provide more up to date information at the CISN website <http://www.cisn.org>, and at <http://earthquake.usgs.gov>, the website of the USGS Earthquake Program which is the umbrella organization for the ANSS. We emphasize Web-based delivery because of the needs of bandwidth and redundancy: both CISN and the ANSS have multiple servers in geographically distributed locations. The CISN is also developing a prototype Web site dedicated to emergency managers.

**Recent Earthquake Maps.** For most users, the seismicity maps (Figure 1) provide the starting point for earthquake information. Users typically select a specific region and "drill down" to more detailed maps and summary information about specific earthquakes. The Recent Earthquake website provides general background as well as direct links to additional information and products. Maps of current earthquakes are available for the USA as a whole at <http://earthquake.usgs.gov/recenteqs/>. We are experimenting with automatic webpage refreshing of the Recent Earthquake pages, allowing users to see new events show up automatically within minutes of their occurrence. A new feature of the *Recent Earthquake Maps* is the ability to select a fault of interest and follow a link to a detailed USGS Fault Activity Database for that fault.

**Earthquake in the News.** For earthquakes that are strongly felt or that result in damage and casualties, we create a Special Report that appears on the front page of the CISN & ANSS homepages (Figure 1, M5.0 WYOMING earthquake). This webpage includes links to products, such as geographical and tectonic summary maps of the region, aftershock probabilities and maps, earthquake fault models, hazard maps, and links to news and other information. Informative background information summaries—called *Rapid Tectonic Summaries*—are now produced automatically in many areas of the country and the world, and are delivered through the *Earthquake in the News* mechanism.

**Earthquake Summary Posters.** For major or damaging events, we also produce a new GIS-based product (Figure?) within a day or two of the event, which summarizes figures from *Earthquake in the News* in a poster form (web and downloadable PDF formats). These high quality event overviews provide the basis for briefings and post-earthquake evaluation.

**Earthquake Notification Services.** Automatic notification in near-real time is available in text messages for email, cell, and pagers. Sign-up can be done at the CISN Notification Services (<http://www.cisn.org/services/signup.html>, Figure 2). Formerly, notification was made via an email *List Server*, which limited the range of possible notifications. These services are currently undergoing modifications to improve customization of the range of conditions under which automatic notification occurs (e.g., location, magnitude threshold, time of day, etc.). We are undergoing testing of a *Customized Notification Service*, which entails a database for associated specific users with more detailed notification conditions. We are also allowing users to sign up for *Really Simple Syndication (RSS)*, a notification service that brings earthquake information to their screen automatically. Users may be familiar with RSS for getting delivery of breaking news headlines. Finally, for 7x24 operations centers we

provide a fundamentally improved automatic notification product, *CISN Display*, as discussed below.

***Did You Feel It?*** We create an online questionnaire for any felt earthquake, on which users indicate the perceived level of shaking at their location, specified by zipcode (<http://earthquake.usgs.gov/> under “Did You Feel It?”). The software uses this information to generate an intensity map that provides a rapid assessment of the extent of shaking from the human perspective. For regions with sparse seismic station coverage these maps provide a stand-in for ShakeMap (see below).

***Strong Motion Data Center.*** The CISN Engineering Strong Motion Data Center (<http://www.cisn-edc.org>) is operated by CGS in cooperation with the USGS National Strong Motion Program. The goal of the Engineering Data Center is to provide rapid access to strong motion data for engineering applications. The *Internet Quick Report (IQR)* and the *Internet Data Report (IDR)* are based on the concept of the traditional “Quick Report”. The IQR is typically produced for earthquakes of magnitude 4.0 and above; the release of the IDR is for significant historic earthquakes.

## **CISN Display**

This near real-time, interactive Graphical User Interface (GUI, see Figure 3) provides seismicity, ground shaking information (via ShakeMap), and other earthquake products for the 24/7 operations center. Unlike web pages, earthquake information is pushed to *CISN Display* in near real-time that receives data over the Internet. It is a stand-alone software application (written in Java) and can be run on several operating systems. Central to the GUI is a GIS mapping engine that is capable of plotting user-customizable themes (facilities, roadways, etc.) that allows comparison of user’s infrastructure along with seismic hazards to help evaluate the situation interactively. The primary application of *CISN Display* is real-time seismicity monitoring; the system automatically posts updates and can provide audible beeps to alert the user.

In addition, other products associated with the event, like ShakeMap, Did You Feel It? Maps, and aftershock probabilities, are provided by the *Display* as they become available. The system can automatically download ShakeMap overlays as GIS layers, which can be modified and joined with other layers to form a clear picture of the severity and distribution of shaking with respect to critical infrastructure. *CISN Display* is currently in beta-testing within several organizations and version 1.0 is expected to be released in Spring 2004.

## **ShakeMap and ShakeCast**

***ShakeMap.*** ShakeMap is a tool used to portray the extent of potentially damaging shaking following an earthquake (see <http://earthquake.usgs.gov/shakemap> or <http://www.cisn.org/shakemap.html>). This is but one end product of a modern seismic network capable of producing near real-time, magnitude, location, and ground-motion parameters. The rapid availability of these maps is of particular value to emergency response organizations, utilities, insurance companies, government decision-makers, the media, and the general public. The ANSS and CISN are continuing the development of the ShakeMap

system. In particular, they are working to integrate the southern and northern California systems for statewide coverage.

We have finished a draft ShakeMap Manual, including a Technical Manual, Users' Guide, and Software Guide (Wald et al., 2004). The Applied Technology Council's *ATC-54: Guidelines for Using Strong Motion Data and ShakeMaps in Post-Earthquake Responses recent* (Applied Technology Council, 2003) provides examples of how ShakeMap can be used. We have also published a new four-page ANSS ShakeMap USGS Fact Sheet, for more general information and outreach (Wald et al., 2003).

***ShakeCast.*** When a potentially damaging earthquake occurs, utility and other lifeline managers, emergency responders, and other critical users have an urgent need for information about the impact on their facilities so they can make appropriate decisions and take quick actions to ensure safety and restore system functionality. ShakeCast, short for *ShakeMap Broadcast*, is a fully automated system for delivering specific ANSS ShakeMap products to critical users and triggering established post-earthquake response protocols. ShakeCast allows utilities, transportation agencies, and other large organizations to automatically determine the shaking value at their facilities, set thresholds for notification of damage states (typically, damage unlikely, moderate, or serious) for each facility, and then automatically notify (via pager, cell phone, or email) staff within their organizations who are responsible for those particular facilities so they can prioritize response. The system will initiate post-processing software applications automatically (for example, loss estimation routines). Currently, USGS "pushes" ShakeMap electronically (using ftp) to utilities and other critical users, but ShakeCast will allow this to be replaced with a subscriber service, avoiding firewall issues, and providing more robust delivery from redundant ShakeMap generation sites and distributed ShakeMap servers. A simplified flowchart of the ShakeMap/ShakeCast system is shown in Figure 4.

### **Prompt Assessment of Global Earthquakes (PAGE)**

*PAGE* is a prototype system that monitors the U.S. Geological Survey's Advanced National Seismic System's (ANSS) near real-time global earthquake solutions and automatically identifies events that will be of societal importance, well in advance of ground-truth news accounts. Events that are likely to have caused human suffering and significant damage, or events that are widely felt and will therefore generate public and media attention, are so classified. *PAGE* makes this assessment within a few minutes of an earthquake's detection based on analysis of estimated shaking levels and evaluation of the vulnerability and the population at risk. For significant events, *PAGE* automatically generates and distributes a summary impact statement to emergency response teams, the media, and the general public. The basic concept for *PAGE* is straight-forward. However, the implementation, gathering of the necessary data sets, testing, and most importantly the effective use of our results will require significant system development and communication with potential users.

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Wald, D. Oppenheimer, L. Gee, H. Benz, W. Leith, J. McCarthy, R. Simpson, S. Schwarz, B. Worden, V. Quitarano, H. Rico, E. Hauksson, P. Earle, and L. Lystoka.

## References

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- U. S. Geological Survey (1999). *An Assessment of Seismic Monitoring in the United States Requirement for an Advanced National Seismic System*, USGS Circular 1188.
- Wald, D. J., L. Wald, B. Worden, and J. Goltz (2003). *ShakeMap—A Tool for Earthquake Response, U.S. Geological Survey Fact Sheet 087-03*. Available online: <http://pubs.usgs.gov/fs/fs-087-0> or Contact L. Wald ([lisa@usgs.gov](mailto:lisa@usgs.gov)) for copies.
- Wald, D. J., B. Worden, V. Quitarano, and K. Pankow, (2004). *ShakeMap Manual: Technical Manual, Users Guide, And Software Guide*, U.S. Geological Survey Open-File Report, in preparation.

## Useful CISN & ANSS Links

Below are links for interest from the CISN and ANSS. In some cases, multiple links are given as these products are hosted on more than one Web site. This redundancy provides enhanced access during periods of heavy usage of Internet outages.

Recent Earthquake Maps – USA

<http://earthquake.usgs.gov/recenteqs/>

Recent Earthquake Maps – California/Nevada

<http://quake.usgs.gov/recenteqs/latest.htm>

<http://quake.geo.berkeley.edu/recenteqs/>

Earthquake in the News

<http://earthquake.usgs.gov/eqinthenews/>

Special Reports on California earthquakes

<http://www.cisn.org/special/>

Earthquake Notification Services

<http://www.cisn.org/services/signup.html>

<http://earthquake.usgs.gov/products/services.html>

Did You Feel It?

<http://earthquake.usgs.gov> under “Did You Feel It?”

Engineering Strong Motion Data Center

<http://www.cisn-edc.org/>

ShakeMap – USA

<http://earthquake.usgs.gov/shakemap/>

ShakeMap – Northern California

<http://earthquake.usgs.gov/shakemap/nc/shake>

<http://www.cisn.org/shake/nc/>

ShakeMap – Southern California

<http://earthquake.usgs.gov/shakemap/sc/shake>

<http://www.cisn.org/shake/sc/>

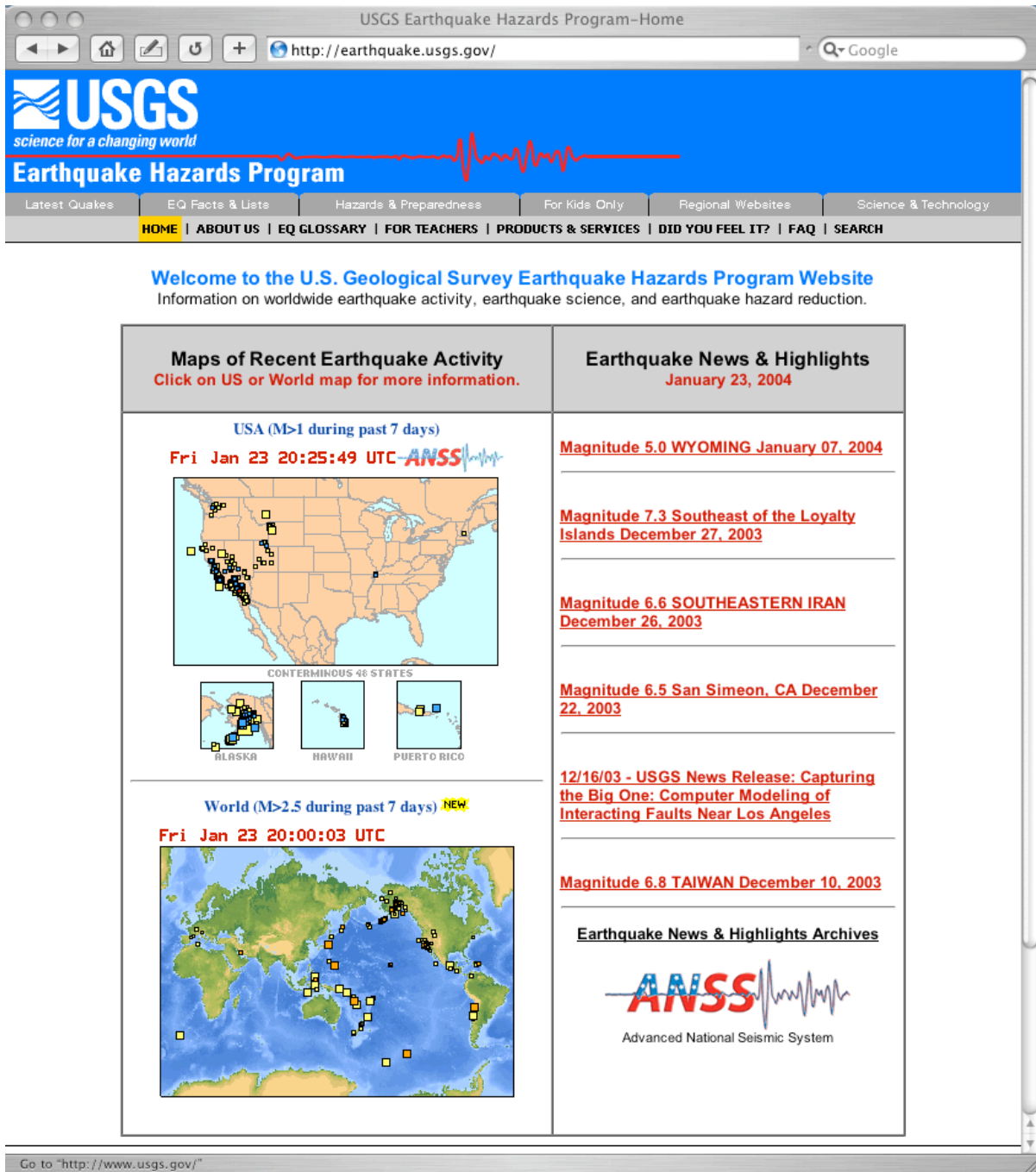


Figure 1. U. S. Geological Survey's Earthquake Program and Recent Activity page. Earthquake News and Highlights (right column) appear automatically for significant earthquakes and have links to many of the other information maps and products described in this article, including ShakeMap, Did You Feel It?, Tectonic Summaries, seismicity maps, and links to other agencies and news services.

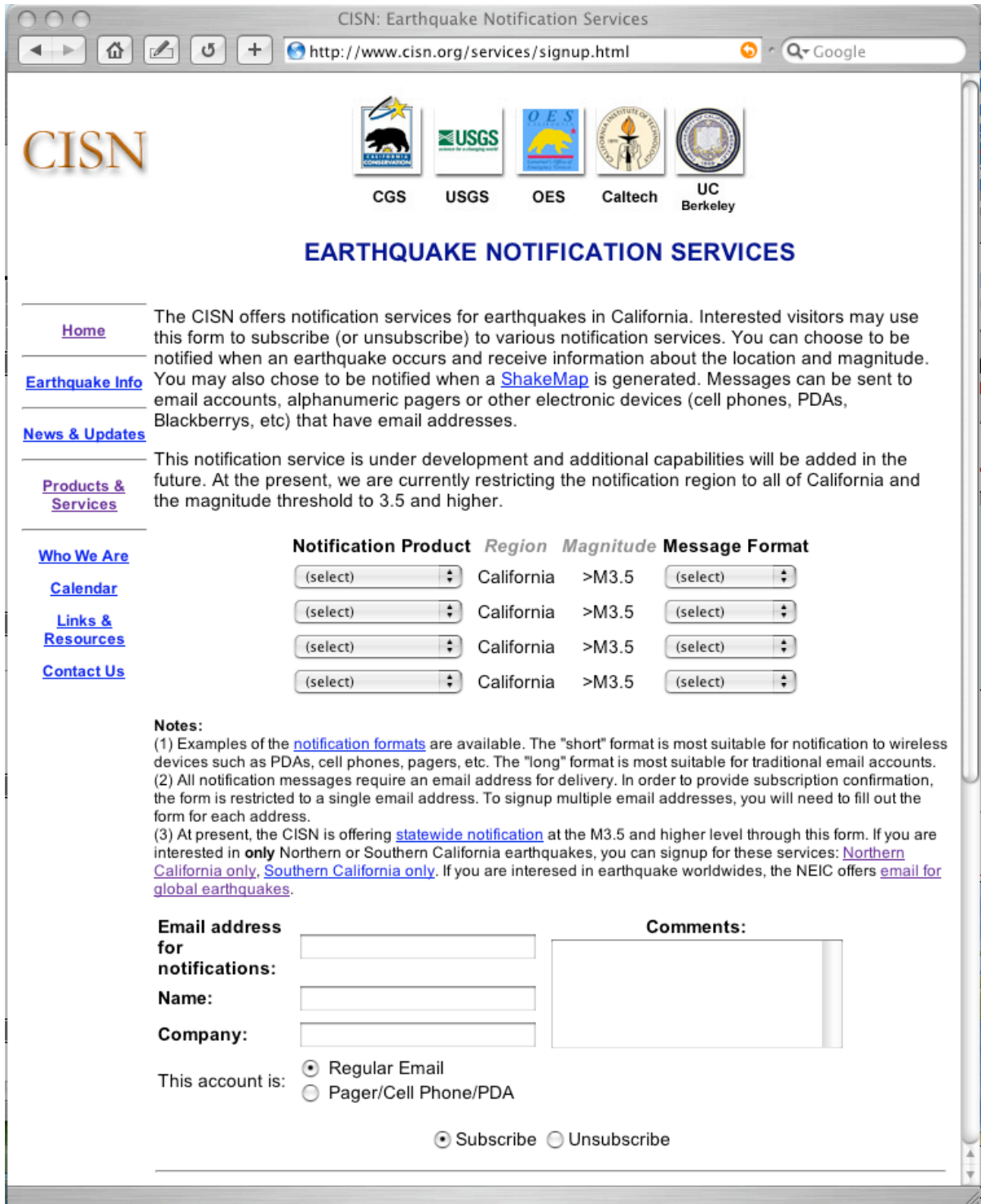


Figure 2. CISN Notification Services web page.

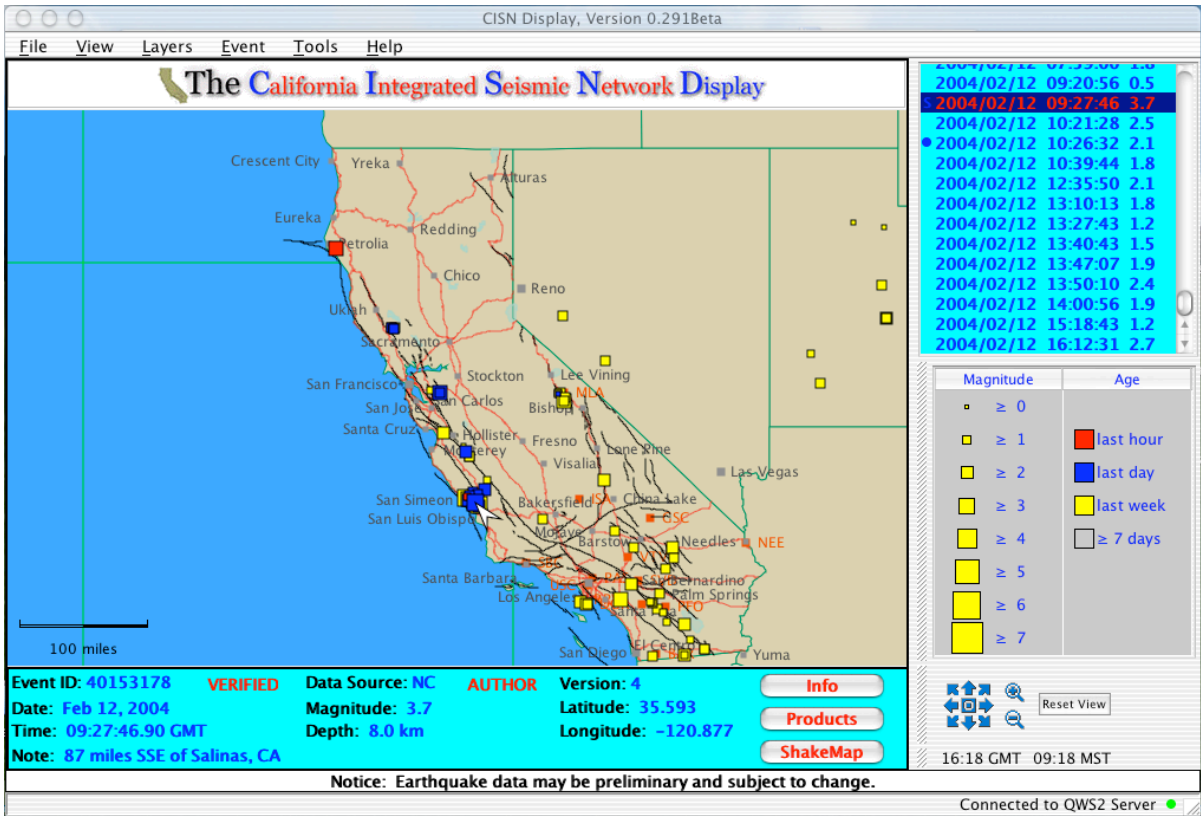


Figure 3. CISN Display’s Graphical User Interface. New earthquakes show up automatically on the map of seismicity; buttons allow views of other products associated with the event, including event summary information, ShakeMap, Did You Feel It? maps, and aftershock probabilities. ShakeMap overlays allow zoom in capacity and the addition of user specified facilities or other GIS layers.

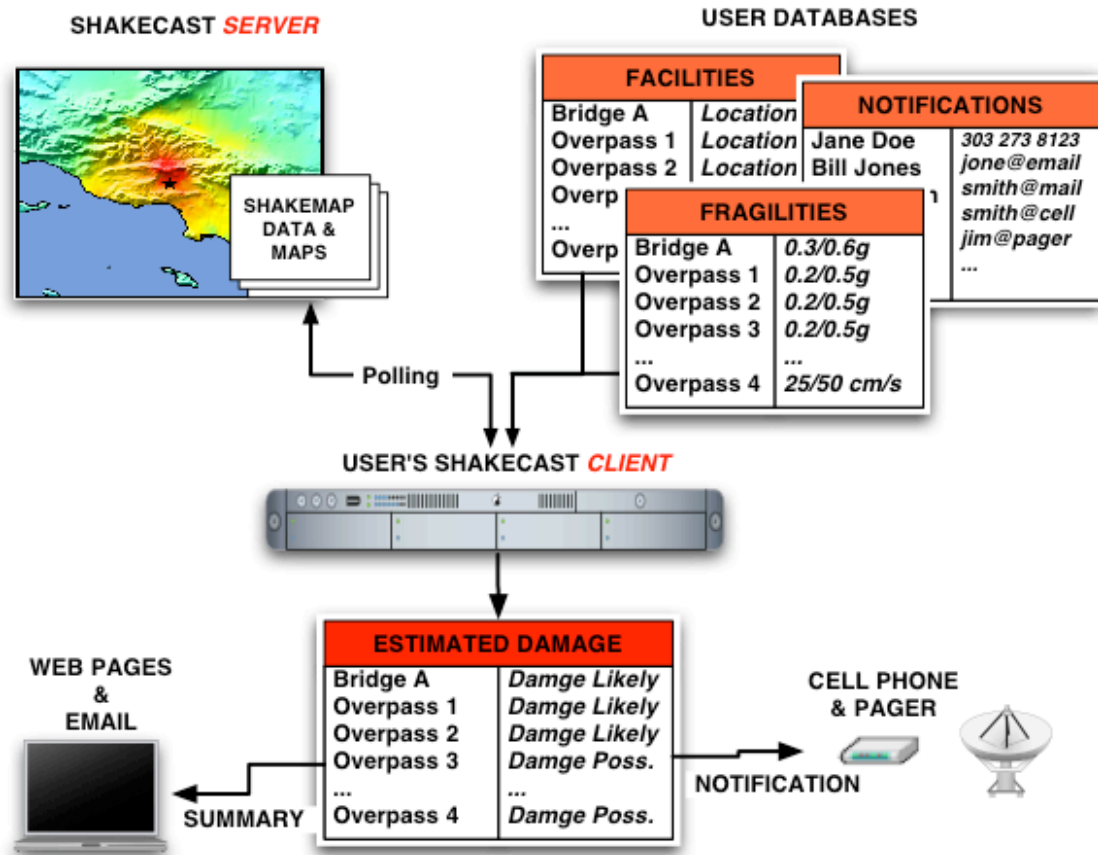


Figure 4. Simplified ShakeCast Flowchart. Facilities or infrastructure locations and their vulnerability to different levels seismic shaking are kept in a database on the user's computer. Immediately after an earthquake, as soon as ShakeMap is available, the user's system automatically downloads pertinent ShakeMap files and determines the shaking value at each of the user's facility. Then, based on preset thresholds for notification of damage states (typically, damage unlikely, moderate, or serious), ShakeCast automatically notifies staff within the organization via pager/cell phone or email. Pager and phone messages are short summaries provided the number of facilities in each damage state, whereas email messages provide complete summaries listing likely damage states in order of severity to help rapidly prioritize response.

