California Integrated Seismic Network

Report to the CISN Advisory and Steering Committees from the CISN/PMG

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Program Management Group

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Table of Contents

Introduction

The purpose of this short report is to provide the CISN Advisory and Steering Committees with an update about current CISN activities. To keep the report short, we do not include routine operation and maintenance work. The five CISN partners, Caltech, USGS Pasadena, UC Berkeley, USGS Menlo Park, CGS, and OES have contributed sections to the report.

Communications Backbone

We are installing the CISN data communication backbone to improve the capabilities of the CISN institutions to share data and to back each other up in the case of a major earthquake. The backbone consists of five T1 links that form a ring connecting Pasadena, Menlo Park, UC Berkeley, CGS, OES and back to Pasadena.

BSL and USGS/Menlo Park staff has been involved in testing the first element of the CISN backbone. Doug Neuhauser of the BSL has taken the lead on developing and testing router configurations. At this point, he has a working router configuration, which will robustly handle the failure of one or more T1s and the failure of one router at any site. The BSL purchased 8 routers and has deployed 4 (2 at USGS/Menlo Park and 2 at the BSL). The remaining 4 will be deployed by the end of the October at CGS and OES.

Caltech/USGS in Pasadena have purchased two routers and leased two T1 links, to CGS and Menlo Park. The routers have been configured and testing of the ring will start this quarter. USGS Menlo Park also installed 2 routers for the CISN ring and established through communications from the PacBell demark on the USGS campus in Menlo Park to the NCSN building.

Figure 1, Diagram of the CISN backbone.

CGS has leased a T1 link to OES, the last leg of the ring, and the Sacramento end of the link with

Pasadena has been installed. Routers configured by Neuhauser will be installed this quarter.

Seismic Stations Transmitting to Two Data Processing Centers

As part of the TriNet project, CGS and Caltech/USGS Pasadena implemented dual data transmission from several CGS seismic stations in southern California, as a step to increase robustness. One copy of the data is sent to CGS in Sacramento while the second copy was sent to Pasadena. As part of CISN we are taking this mode of data sharing one step further by having 10 southern California stations send data to both Pasadena and UC Berkeley. We are also having 10 northern California stations send data directly to UC Berkeley and Pasadena. This will greatly enhance the robustness and backup capabilities of CISN.

Both Caltech/USGS and UC Berkeley have ordered additional permanent virtual circuits (PVC) for the existing frame relay communications lines. The next step is to reconfigure the dataloggers in the field and the Pasadena and Berkeley data acquisition systems to initiate this data exchange.

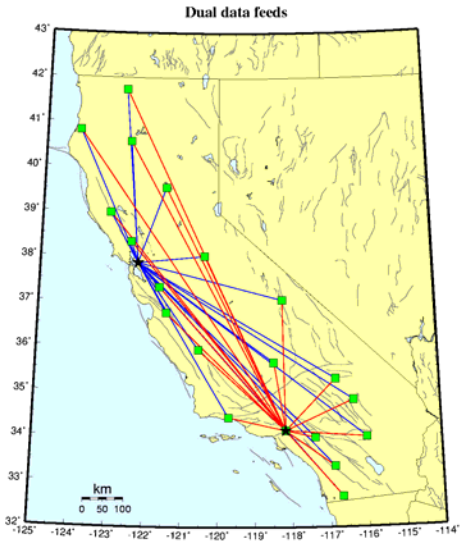


Figure 2. Diagram illustrating dual station data feeds to improve robustness.

Product Standardization

A major goal of CISN is product standardization to ensure that products mean the same across the state. In particular, this includes hypocenters, magnitudes, focal mechanisms, and ShakeMaps.

Both the Northern and Southern California Management Center have implemented in a test mode algorithms to share phase picks that are used in determining hypocenters. Thus both centers have a statewide view of phase picks and are determining hypocenters statewide. The first goal is to ensure that the software can handle the whole data set of statewide picks and to ensure that the quality of locations is not degraded by operating a statewide system.

The issues of standardized statewide magnitudes is also being addressed by CISN. We have established a team to compare the procedures used for magnitude determination in north and south and to provide recommendations about how we can move toward standardization of magnitudes.

A related future issue is also the statewide determination of moment magnitudes and moment tensor or focal mechanisms. BSL and USGS/Menlo Park staff has completed the implementation of version numbers, which allows the BSL system to submit information to QDDS (Quake Data Distribution System) and to routinely release automatic estimates of moment magnitude determined at the BSL.

Likewise, UCB and USGS/MP modified real-time software to track event version numbers, changes in hypocenter parameters, and "end-of-magnitude" messages from UCB. This enhancement enables the duty seismologist to know when UCB has completed all processing of earthquake magnitudes for locations submitted by the NCSN. In particular, it facilitates the occasional release of moment magnitudes (Mw) to OES and the public.

ShakeMap Enhancements

A high priority of CISN is to improve data availability and to improve the distribution of ShakeMap to ensure that it is available following a major earthquake.

To improve the reliability of ShakeMap delivery, USGS/Caltech Pasadena has acquired a new machine to act as a backup in southern California, and have begun porting the ShakeMap software. The southern California ShakeMap web pages will soon be backed up on the USGS Earthquake Program web servers (earthquake.usgs.gov/shake), which provide both remote backup capability and Akamai server distribution. The ShakeMap products and product page were redesigned to decrease space requirements and transfer time. PostScript files are now compressed, redundant copies of many

files have been eliminated, and obsolete products have been removed. All existing ShakeMap events have been rerun to keep the pages consistent.

The BSL and USGS/Menlo Park are working to improve the robustness of ShakeMap operation in northern California. Currently, ShakeMaps in northern California depend on the operation of a single computer, located in Menlo Park. This is in contrast to other earthquake monitoring operations, where 2 parallel systems provide back-up capability should a computer fail. The BSL and USGS Menlo Park agreed to bring up a second ShakeMap system at UC Berkeley, which will be twin or clone of the Menlo Park system. The BSL is currently configuring the ShakeMap software on one of the new computers purchased in FY01/02. We hope to have this backup system operational at the end of October.

With the completion of the T1 ring, ShakeMap will also be routinely generated at CGS in Sacramento, and interfaced with the Internet Quick Report discussed below. The robustness achieved through the generation of products by multiple centers requires coordination for product synchronization, an issue being addressed by the PMG.

The standards group is also working on a determining how to improve the reliability of sharing of amplitude data for ShakeMap amongst the CISN partners.

CISN DISPLAY

The California Integrated Seismic Network (CISN) is developing the CISN display to provide statewide real-time earthquake information. The CISN Display is an integrated 24/7 Web-enabled earthquake notification system. The application provides users with real-time seismicity, and following a large earthquake will make available other earthquake hazards information, such a ShakeMap, automatically. It will replace the Caltech/USGS Broadcast of Earthquakes (CUBE) and Rapid Earthquake Data Integration (REDI) Display as the principal means of delivering graphical earthquake information to emergency responders and 24/7 operations centers within minutes after an event. The application will feature a client/server architecture written in Java, allowing for platform independence and leveraging the full capabilities of the Internet or other data communications facilities.

During this last quarter, we concluded, the incorporation of 'client' feedback into the software specifications document and have implemented the first working beta-versions of the components that makeup the CISN Display distribution infrastructure. For more information, see the attached specification sheet.

Outreach Activities (R. Eisner & J. Goltz)

As a follow-up to the CGS-sponsored development of procedures for the utilization of strong motion data for engineering purposes (ATC-54), the OES Earthquake Program initiated a feasibility study to consider near-real time damage assessment of critical infrastructure using strong motion and other rapidly available data from CISN. Initial interviews were conducted and the format was developed for a facilitated workshop that will include engineers, emergency managers, network operators and modelers to address the potential utility of strong motion and other data from CISN in providing rapid assessments of dams, bridges, hospitals and other critical facilities. The workshop will be held in the 4th quarter of 2002 or the 1st quarter of 2003.

Planning was initiated to identify roles, responsibilities and training needs for OES Earthquake Program staff in the event of a major earthquake in northern or southern California and promote the integration of new real-time information technologies for improved emergency response. Meetings were held with the OES executive staff to clarify roles and responsibilities for Goltz, Eisner, and Bortugno. Progress was made in the integration of ShakeMap and HAZUS with systems established by OES to rapidly obtain ShakeMap shapefiles form the USGS, process loss estimates and sends this information to state, federal, and local agencies over the Response Information Management System (RIMS).

We are planning to hold a seminar in northern California to introduce new CISN technologies to emergency managers. A draft program was discussed and sites were considered for a one-day seminar for the San Francisco-Oakland Bay area in the 1st quarter of 2003. This seminar will be similar in content and format to successful events held in southern California under the TriNet Project. Discussions were held between the OES Outreach staff and the ShakeMap Working Group to hold a workshop to introduce ShakeMap to the northern California news media. This event will be held in the 1st quarter of 2003. During this quarter, the southern California OES Outreach Manager worked with the USGS, OES GIS, and the City of Riverside

in preparing a M7.4 San Andreas earthquake scenario for the city. This scenario will be used for three exercises between October 2002 and June of 2003.

Engineering Data Center

The Engineering Data Center has focused on the CISN Internet Quick Report and center-to-center standards for ground motion information exchange. The Strong Motion Working Group, with members from CGS/CSMIP, the USGS/NSMP and others, arrived at a consensus definition adequate for the exchange of ground motion information among centers. The packet grew from an early version in use at Menlo Park and Berkeley. It is planned that the packet will be introduced as the exchange means beginning in late November.

The Engineering Data Center continues to develop the Internet Quick Report and move toward the automatic transmission of ground motion files needed for the IQR. Issues involved in the conversion between standard seismic formats (SEED) and engineering strong motion formats (V0 of COSMOS) continue to be addressed, with most issues dealt solved. With success here, low-level ground motion records not of immediate engineering value will be nonetheless transmitted to the other two centers, while records important for engineering will be sent to the EDC. The completion of the ring is key to the execution of this process.

Figure 3. The web page for the Engineering center.

A User Workshop on effective engineering use of ShakeMap and strong motion data in post earthquake response (ATC-54) was held in Oakland. A key request was for a long-planned direct link between the ShakeMap and the IQR for an event. Significant progress has been made toward this objective, and the IQR time series and spectra can be obtained by clicking on each station on a special ShakeMap. Now in final development, it is planned that this capability can be provided through each of the ShakeMap distribution sites.

Seismic Stations, Upgrades and New Deployments

One of the major activities of CISN is to maintain seismic stations in California. The CISN is also involved in upgrades and installation of new stations to improve coverage for ShakeMap and other CISN products.

The UC Berkeley has completed permitting for two sites and is negotiating with a contractor to prepare these sites for installation. The installation at GASB and HOME will be similar to those as PKD, HOPS, and JCC, where a buried recycled steel shipping container is used to construct an instrument vault. The BSL has received the Quanterra dataloggers and STS-2 sensors ordered in the previous fiscal year. The upgrades for the Q4120 dataloggers have not been received yet.

The NCSN (Northern California Seismic Network, operated by USGS Menlo Park) completed the migration of telemetry at Mt Pierce (near Cape Mendocino) from analog microwave to digital satellite on 8/29. At this "node" we digitize 7 analog stations at 50sps and transmit two 6-channel broadband stations at 100sps.

The NCSN developed the recording infrastructure at the San Andreas Fault Observatory and Depth (SAFOD) pilot drill hole site at Parkfield. We installed an UPS and generator to power a temporary, multichannel, triggered digitizer system for acquiring data from the 28 15Hz geophones deployed the hole. We also installed a second digital data acquisition system to bring back continuously 6 channels of 2Hz data from a second geophone string to Menlo Park. Unfortunately, the geophones in this second string progressively failed over a 6-week period.

The NCSN implemented continuous seismic data exchange with the University of Nevada Reno. We now receive 56 channels of their data for UNR stations in eastern California. Likewise, we export NCSN channels to UNR for use in their monitoring. These data now enable the CISN to reliably report to OES on all earthquake activity in central and northern California.

The NCSN established telemetry to 4 ANSS urban sites in the San Francisco Bay (Livermore; Mt Pleasant High School, San Jose; Mission College; Painter School, San Jose). We

established telemetry to a 6-channel borehole station (Coyote Hills) at the eastern end of the Dumbarton Bridge. We installed 2 new broadband/strong motion stations (Casa and Mammoth Lakes Knolls) in the Mammoth Lakes region. The data are digitized at 100sps and transmitted continuously back to Menlo Park via a dedicated Frame Relay circuit. While at Mammoth Lakes we performed extensive maintenance on the instruments located at the 3 borehole stations to reduce interference from the low-frequency satellite telemetry systems that are co-located with the high-frequency seismic digitizer systems at these sites.

To fill in holes in TriNet in southern California and to upgrade some of our older dataloggers, we have purchased Q330 dataloggers, the next generation of Quanterra dataloggers. These dataloggers require about 1 Watt of power and are only 20% of the size of previous Quanterra dataloggers. A significant effort is being invested in establishing data communications to these new devices. Two new stations are scheduled to be installed using these new dataloggers, Lone Juniper Ranch, near Gorman, and Desert Studies Center, near Baker in the Mojave Desert, which is located to the north of the Mw7.1 1999 Hector Mine earthquake. We are also working with UCSB to install a downhole station located at the Jensen Filtration Plant in San Fernando Valley and to provide data communications to the TriNet acquisition systems in Pasadena. As an example of ongoing maintenance, we analyzed the data from the 3 September 2002 ML4.8 Yorba Linda earthquake and identified several strong motion sensors that needed to be repaired. These repairs have been completed.

As part of our network maintenance we must keep TriNet computer operating systems up to date. The TriNet data acquisition is done by SUN Microsystems servers using UNIX Solaris operating system. We have completed upgrading one of our main servers from Solaris 2.6 to 2.8 and all the TriNet application software. In the past all the TriNet computers have been located in one room on the second floor of Caltech Seismology Laboratory building on the Caltech Campus. Because the rehab of the USGS building on campus has been completed, we are in the process of moving our backup computers to the new computer room in the USGS building, located across Wilson Avenue, opposite to the Caltech Seismo Lab.

CISN partners continue to develop station instrument response inventory. Instrument response information is now available at the Northern California Earthquake Data Center for all channels of data digitized since 1984. However, extensive Q/C is still underway to resolve errors in the maintenance history files. Similarly, instrument response information is being collected and made available at other centers.

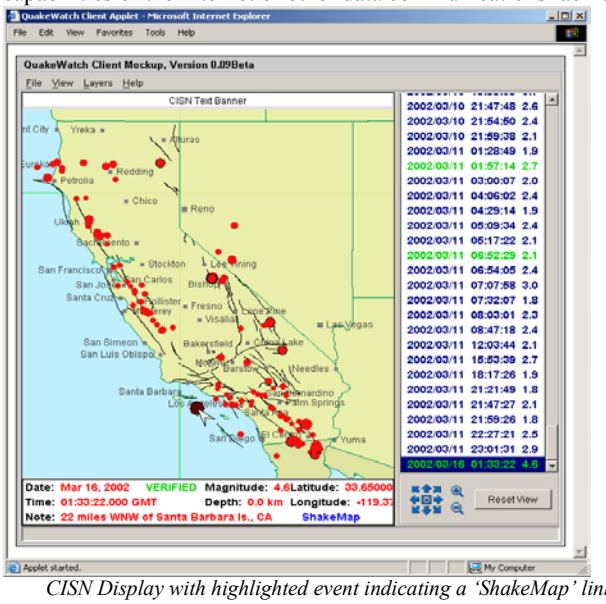
Upgrade of strong motion stations in Central and Northern California to CISN caliber continues, but on a cost-shared basis during the interim period before the new contracts are in place. Sites at distributed locations, critical for reducing the interpolation necessary for open gaps in a future ShakeMap, are underway (e.g., central valley sites, including Bakersfield, Fresno, Modesto, and Redding; and along the coastal ranges, Big Sur, Greenfield, Monterey, etc.) Since these are upgrades of existing analog (film) instruments, new permits are not needed.

Several dual transmission stations are being brought on line. Three stations offshore will be transmitted to both CGS and Pasadena, and should come on line within a quarter. Additional stations will be brought on line over a longer time window. Alternate communication technologies continue to be explored for robustness through independent channels, and for economy over the long run. Evaluation of data transmission from field stations via digital cellular now looks promising, while CDPD (cellular digital packet data) on the analog cellular network no longer appears to have long-term promise.

Reliable Delivery of Real-time CISN Earthquake Information to Critical Users

Project Summary

The California Integrated Seismic Network (CISN) is developing the CISN display to provide statewide real-time earthquake information. The CISN Display is an integrated 24/7 Web-enabled earthquake notification system. The application provides users with real-time seismicity, and following a large earthquake will make available other earthquake hazards information, such a ShakeMap, automatically. It will replace the Caltech/USGS Broadcast of Earthquakes (CUBE) and Rapid Earthquake Data Integration (REDI) Display as the principal means of delivering graphical earthquake information to emergency responders and 24/7 operations centers within minutes after an event. The application will feature a client/server architecture written in Java, allowing for platform independence and leveraging the full capabilities of the Internet or other data communications facilities.



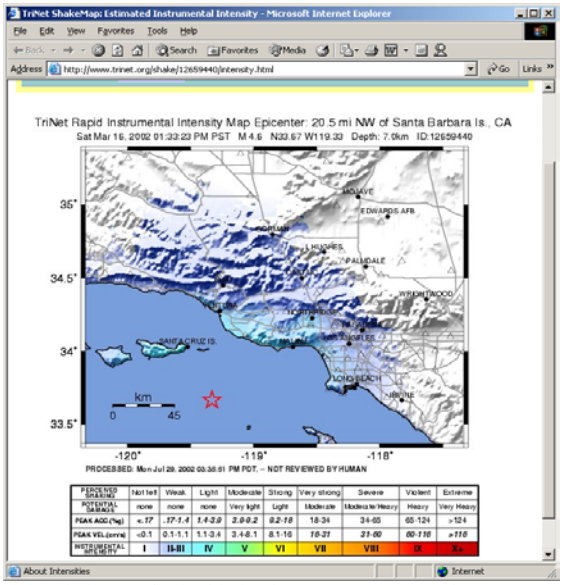
CISN Display with highlighted event indicating a 'ShakeMap' link

Gateway to Other Earthquake Products

What distinguishes the CISN Display from other tools currently available on the Web is that it can automatically associate specific events on its display map to other available earthquake products as soon as they are generated for circulation. Analytic information presently feasible for deliverable to the CISN display are:

- ShakeMap
- Focal Mechanisms
- Ground Displacement Information
- Rapid Earthquake Notification
- OES Reports
- Earthquake Commentary
- And custom Java applets written for a particular task

These products will be made available through clickable hyperlinks, or users may configure their clients to automatically download these files, above a given magnitude threshold, for analysis.



ShakeMap for highlighted event on CISN Display

Technology

Central to the CISN Display's role as a gateway to other sources of information is its comprehensive XML messaging schema. The message model starts with present CUBE format, and then extends it by provisioning additional descriptive attributes for currently available products, and many others yet to be considered. The supporting metadata in the XML-message provides the information necessary for the automated creation of hyperlinks on the client.

At the heart of the CISN Display's robustness is a well-established and reliable set of communication protocols for best-effort delivery of data. The application employs several CORBA methods that alert users of changes in the link status. Loss of client connectivity to the server triggers a broad strategy that attempts to reconnect through various physical and logical paths. For critical users this effort is further enhanced by the use of a stateful connection via a dedicated signaling channel.

Additionally, using an open source GIS mapping tool organizations can plot assets on the CISN Display map, key to operational readiness. This allows critical end users the ability to overlay organizational information against ground accelerations following a significant earthquake. Emergency response mangers can use this information in allocating limited personnel and resources during a recover effort to restore functional operations.

Partnerships

The CISN Display is being developed as part of CISN, a cooperative project of Caltech, CGS, USGS, UCB, and OES. The CISN is funded by OES, USGS, FEMA/OES Hazards Mitigation Grants Program, and other partners. For information regarding the CISN Display and to signup as a beta test site contact Margaret Vinci, ERA/Caltech Programs Manager, at 626 395-6318 or Hugo Rico, project lead, at 626 395-2407.