California Integrated Seismic Network

Report to the CISN Advisory and Steering Committees from the CISN/PMG 3rd Report: 4Q 2002

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Program Management Group

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Introduction

The purpose of this third report is to provide the CISN Advisory and Steering Committees with an update on 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.

San Ramon Earthquake Sequence

In late November 2002, a small swarm of earthquakes occurred near the Calaveras fault in San Ramon. The largest event was a Mw 3.9, with 4 events over M3.5. The pre-Thanksgiving events were felt over a large area - the Community Internet Intensity Map reports approximately 2400 responses for the M3.9. The CISN Northern California Management Center put together an Internet report on the sequence and posted it on the CISN Web page:

http://www.cisn.org/special/evt.02.11.24/

Over 8148 hits were reported to this URL in November and December. This marked the first official CISN special event report.

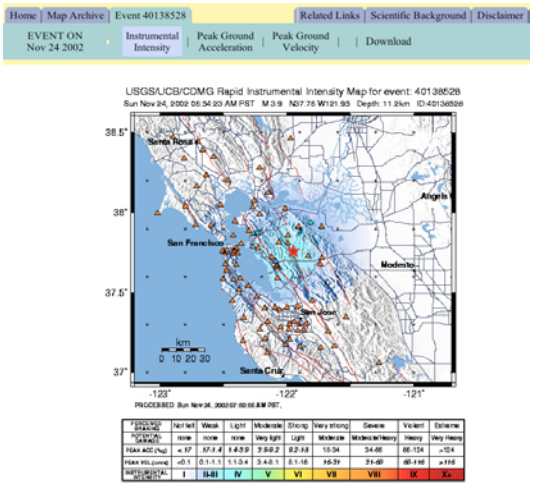

Figure 1. CISN ShakeMap from the November 2002 M3.9 earthquake in San Ramon.

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.

The BSL and USGS/Menlo Park worked with other CISN partners toward completing the

implementation of the communications ring. In the Q3 of 2002, Doug Neuhauser developed and tested router configurations over the connection between Berkeley and Menlo Park. In this quarter, the remaining 4 links were brought online (after much finger pointing between MCI and SBC over the Menlo Park to Pasadena link) and the new router configurations installed at all sites. Doug Neuhauser has tested the router configurations to demonstrate the failover capabilities of the ring to the Internet.

We are currently limited to low-volume traffic on the CISN backbone circuit between the BSL and USGS/MP due to errors on the backbone circuit extension to the USGS NCSN operations building. The USGS/MP is working to migrate the circuit extension from copper wire to fiber optics.

Figure 2. Diagram of the CISN backbone.

The CISN partners have begun to migrate services from their existing communications links to the ring. A working group was established, consisting of one member from each institution, to begin an orderly transition. Nearly all of the Berkeley-Menlo Park traffic has been migrated from the frame-relay link to the CISN ring and portions of the traffic between other partners are now using the ring.

One major service that still needs to be addressed is the transfer of ShakeMap to OES. Both the northern and southern California management centers currently use the Internet for this transfer. During this quarter, Lind Gee and Doug Neuhauser contacted OES staff on this issue. OES staff reported that OES was waiting for the delivery of new computers and firewall systems and that this hardware is required before the ShakeMap transfer could be migrated to the ring. We plan to make progress on this important issue in 2003.

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, this mode of data sharing, by having 10 southern California stations send data to both Pasadena and UC Berkeley and 10 northern California stations send data directly to UC Berkeley and Pasadena, will greatly enhance the robustness and backup capabilities of CISN.

In a burst of post-AGU energy (December 2002), the BSL and Caltech made significant progress on establishing dual data feeds at the twenty stations. Although the physical communication links were ordered in the summer of 2002, problems with SBC and focus on the CISN ring limited progress in this area until December. As of the end of the year, 16 stations were fully configured for dual data feeds and sending data. A few stations are experiencing problems due to a combination of problems with circuits and configuration of the Quanterra dataloggers. (As of the time of this report, all twenty stations are fully configured and sending data to both locations.)

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.

Following a joint meeting of the CISN Standards Committee and Program Management Group in September, 2002, significant progress has been made on a number of issues related to statewide earthquake processing.

Testing of the statewide association and location algorithm is continuing. When this testing is completed and all the algorithms are calibrated, the two CISN centers will be able to proceed with implementing statewide association.

A working group addressing issues related to magnitude has reported agreement on the methodology for computing ML and a study is underway to calibrate attenuation relations and station adjustments statewide. The working group is now addressing issues related to moment magnitude, such as developing an assessment of quality.

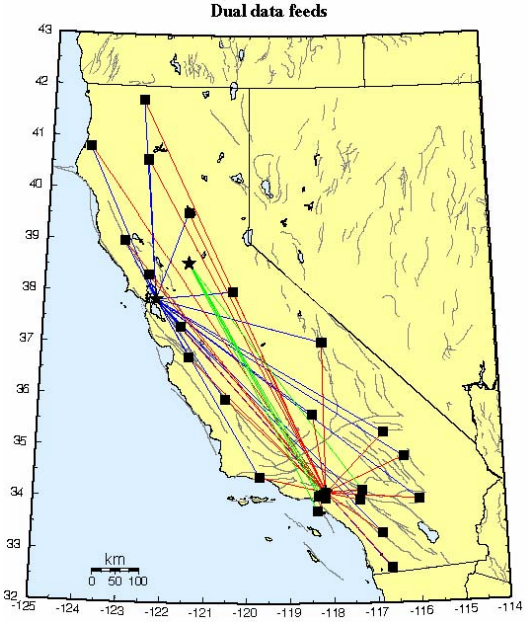

Figure 3. Diagram illustrating dual station data feeds to improve robustness.

A CISN working group has developed a proposal for improving the exchange of ground motion data. When implemented, this will enhance the robustness of data delivery for products such as ShakeMap.

The CISN has started to address some of the multitude of issues related to exchange of metadata (information about sensor types and properties), but this is a very complex problem which will require attention in the coming year.

The CISN Web pages were extensively revised during this quarter. Efforts were made to improve the readability and to bring forward areas of the greatest interest to CISN users. During this time, Lind Gee sought input from Jim Goltz of OES as well as from members of the Advisory Committee. An important issue to be addressed in the coming year is increasing the robustness of the Web server hardware to post-earthquake loading. Plans to bring in a Web designer to address issues such as an "myCISN"-type portal are on hold until until more feedback on the Web site is received and additional funding becomes available.

In addition to a general updating of the pages, the CISN established a Web page for sharing operations information such as, duty rosters and home phone numbers. This information is being shared with neighboring ANSS network at UNR. The goal of this operational Web page is to facilitate contact when problems arise.

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.

CISN ShakeMaps were successfully made for several earthquakes this quarter, including San Ramon, Coalinga, Punta Gorda, San Juan Bautista, Baker, and Calexico.

We began porting of ShakeMap system to the FreeBSD operating system to facilitate the distribution of ShakeMap systems and backups using more cost effective hardware solutions.

Also in Q4, the BSL and USGS largely completed the effort to establish a second ShakeMap system in northern California. As reported last time, the BSL has installed a ShakeMap system to serve as a fully redundant system to the Menlo Park operation. This eliminates what had been a single point of failure in the NC Management Center.

Margaret Vinci (Caltech) is coordinating the revision of the ShakeMap postcard. The postcard has been used extensively for outreach and education purposes. The new postcard will include information for statewide ShakeMaps and CISN.

CISN DISPLAY

The CISN is developing 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 automatically make available other earthquake hazards information such as ShakeMap.

We solicited user feedback at the California Emergency services Association (CESA) October 2002 conference (see below) and generated a list of client enhancements to implement. In addition, we received more feedback from local test users as well as project advisors. We compiled all comments and remarks on enhancements to the client and work

on implementing the bulk of these before the AGU December 2002 conference deadline.

We identified and addressed the client-to-server disconnects that were hanging the client. We determined that the problem was due to server instabilities resulting from unclean client to server disconnects. Initially, we tested our first choice CORBA messaging middleware called ORBACUS, and it did not meet the needs of CISN display. We found and tested its replacement, OpenORB, which proved to be a remedy for the CORBA event channel problems we were experiencing.

Outreach Activities (R. Eisner & J. Goltz)
We prepared a poster explaining the operation of CISN in the context of the historical operation of seismic networks in California. The poster was displayed at the California Emergency Services Association annual conference in Palm Springs October 6-10, 2002. The conference was attended by approximately 250 emergency services representatives. This conference and the CISN exhibit were also opportunities for the distribution of informational materials. The poster will be used for additional conferences in 2003 including the Disaster Resistant California Conference April 20-23 in San Jose.

Outreach continued this quarter with planning and technical assistance provided to the City of Riverside in preparing for and holding a tabletop exercise on October 16, using a ShakeMap/HAZUS scenario for a M7.4 earthquake on the southern San Andreas fault. Additional exercises are scheduled using this scenario in 2003.

Procedures were approved for the CISN Outreach Manager to respond to a significant earthquake in southern California by reporting to the Southern Regional Office of OES at Los Alamitos and providing support to the Disaster Intelligence function and providing public information, as needed.

A multi-agency committee was assembled and plans were made to hold a workshop designed to introduce ShakeMap to the northern California news media. Materials and a letter of invitation were prepared this quarter for the workshop which will be held at the USGS in Menlo Park on January 23, 2003.

Engineering Data Center
A key activity of the Engineering Data Center in the last quarter was carrying forward the development of the data exchange and conversion issues necessary for the Engineering Data Center's exchange of data with the other two data centers. The CISN has adopted a standard earthquake engineering file format for center-to-center transmission of files to and from the EDC. This has allowed moving forward on tasks necessary to accomplish the conversion of ground motion times series between formats common in classic seismic networks and the engineering format, and this resolved some fundamental differences in how data is traditionally handled in these two communities.

Signal polarity standards (i.e., the convention for recording positive ground motion) should be well defined in the seismological community, but the convention is different in seismology and earthquake engineering. However, progress has been made, and the data exchange within CISN for engineering and seismological purposes will now have consistent, correct polarity.

Ground Motion Packets. Immediately after an earthquake, small files or packets, describing in a brief way the ground motion at a station, will be sent from center to center on the CISN T1 ring. These will be used to rapidly generate ShakeMap and the initial Internet Quick Report, and are complemented by full waveform files following later. The packet format has been defined within CISN, building on earlier exchange files, and though it may see minor revisions yet, consensus has been established on the basic definition of the fundamental file. Software is now being finalized to accommodate the packets at each center so automated post-earthquake distribution can occur.

The Engineering Data Center has put the CISN T1 communication backbone to initial use sending data packets from the Sacramento to Pasadena centers. During this initial phase, this transmission will be done in parallel with the existing, Frame Relay circuit that uses less robust software. This is a transitional step, and perhaps in the next quarter the Frame Relay method will be retired.

Linking the ShakeMap and the Internet Quick Report. Two products are central to the CISN mission after a significant earthquake. The first is ShakeMap, which is well established in CISN and discussed in previous progress reports. The second, the Internet Quick Report (IQR), complements the regional map view of shaking provided by ShakeMap by providing detailed seismological information on the shaking at specific sites. The Internet Quick Report has

been in development and is currently available for recent earthquakes at the URL http://www.conservation.ca.gov/cisn-edc. The Internet Quick Report for the January 7 M4.3 event in Hollister for example, has strong motion records from seven stations in the IQR. However, the two CISN post-earthquake products have not yet been linked. The value of linking is illustrated in the example below, in which an actual recorded accelerogram from one station is shown on the same screen with the ShakeMap. To bring up this image, a user clicks on a station symbol on the ShakeMap in order to get a panel showing the record obtained there. This linkage enables a user in need of engineering response information to click on a symbol near a location of concern (a school, hospital, bridge, *etc*.) to view the record and spectrum. The user can use this information to assess whether the site warrants a high priority response action based on the duration of the shaking in the record and the frequency spectra. The value of the linking is that the map provides the regional and local view, and the records from the IQR allow drilling down to the data at a site.

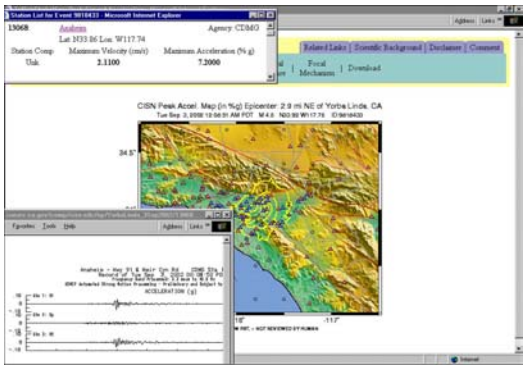

Figure 4. Web page from the CISN Engineering Data Center showing linking of ShakeMap, and Internet Quick Report for engineers.

The importance of the measurements made by CISN for event response is clearly shown by the IQR of the recent January 7 Hollister earthquake. The Hollister Airport, 13 km from the event, experienced shaking of 7%g, while San Juan Bautista, 1 km farther, experienced only a small fraction of that (1%g). Farther away, the shaking at Salinas, 25 km away, is back up to 6%g, almost the same as the Hollister Airport. In this event the accelerations are low and not of engineering importance, although the difference varies by a factor of 6. Unexpected differences like this will be very important in strong earthquakes, but such variations in shaking can only be observed with the station spacing planned in CISN.

Seismic Stations, Upgrades and New Deployments – Northern California Management Center

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.

Winter storms kept BSL staff busy during December. Power and/or telemetry outages were experienced at a number of sites. Similarly, the USGS has been battling outages on its satellite system in the Cape Mendocino region this winter. Severe storms caused outages at 2 satellite hubs (Pierce and Edson), and several other inaccessible sites are currently off the air for unknown reasons. In addition, strong storms caused persistent rain fades for days.

The USGS Menlo Park has been working with SBC to bundle their Frame Relay and DSL telecommunications bills to achieve lower costs. Two of the ANSS instruments failed due to flooding during the December rains. A direct lightening strike took out 6 stations at Sonoma Mtn; the spread-spectrum radios were damaged, and the modem settings were all erased.

The USGS Menlo Park completed the first of 3 remote Earthworm nodes in the Parkfield region. The site at Carr Hill communicates to Menlo Park via a 128 Kbps Frame Relay circuit. It digitizes 55 channels of data from 18 local stations with an Earthworm digitizer. In the next few months we will convert two other nodes (Black Mtn and Williams) to satellite telemetry. The conversion of these 3 nodes will allow the NCSN to decommission its microwave system in this region.

The BSL has received the upgrade boards for the Q4120 dataloggers. Power and calibration boards (and various combinations thereof) for 23 Quanterra dataloggers were ordered with FY01/02 OES funds with the goal of improving our ability to monitor and diagnose problems remotely.

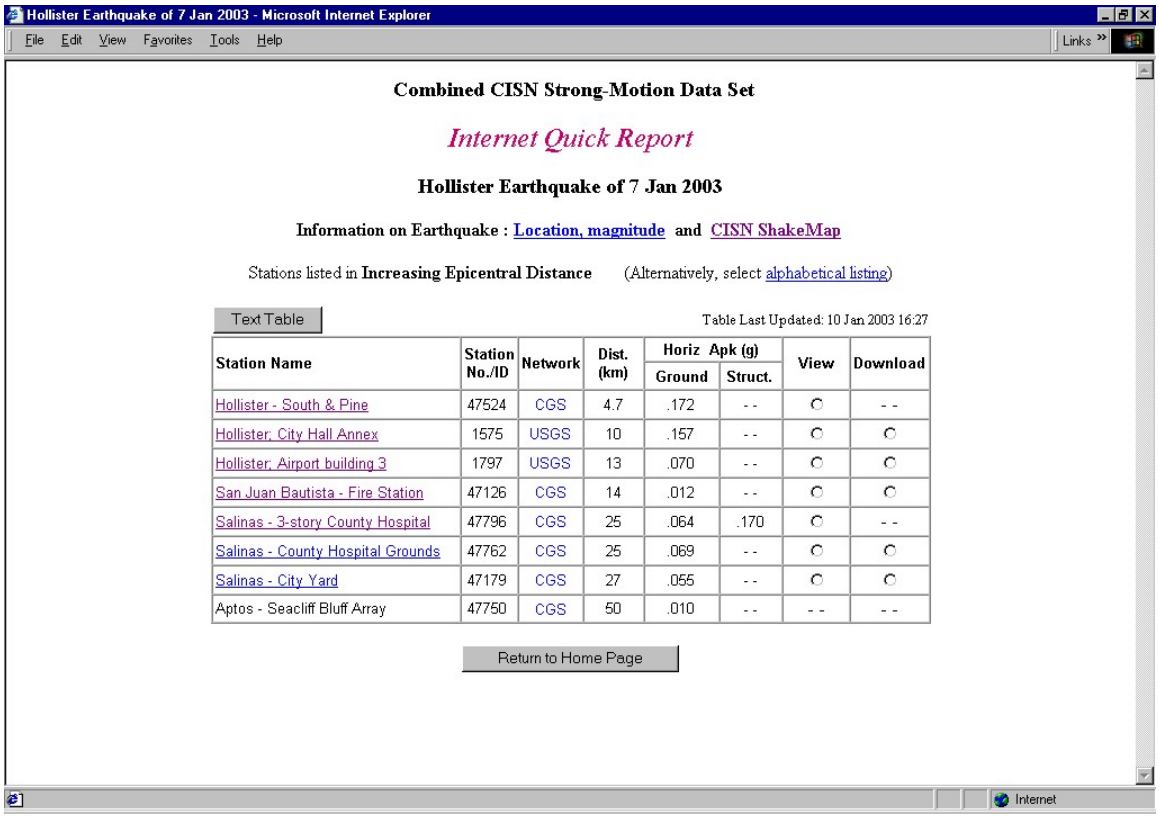

Figure 5. A sample CISN Internet Quick Report for earthquake engineering applications.

The BSL engineers have upgraded 4 dataloggers and the first will be deployed early in January 2003. Since nearly all of the BSL dataloggers are deployed, we are developing a plan to allow for the phased upgrade of the 19 remaining dataloggers.

The BSL replaced the two main earthquake processing systems at UC Berkeley with computers purchased with FY01/02 OES funds. The new SunFire computers replace a Ultra2200 and Ultra2170, which were over four years old. The increased processing speed and disk capacity are necessary for the expanded data exchange and statewide earthquake processing.

On the negative side, the BSL has experienced problems with insufficient air conditioning in their computer facility. Extremely, warm temperatures in November led to "temperature alarm" pages. A secondary AC system is scheduled for installation in mid January 2003.

BSL and USGS/Menlo Park staff completed the implementation of version numbers in the joint notification system. This change to track version numbers allows two important improvements to earthquake reporting:

1) Both the BSL and the USGS Menlo Park can submit events to the Quake Data Distribution System (QDDS). This modification takes advantage of the physically separate locations of the BSL and USGS to improve the robustness of information distribution. As currently configured, the BSL reports to the QDDS hubs geo-www (in Reston) and at IRIS, while the USGS reports to the hubs qdds1 (in Menlo Park) and at IRIS.

2) The joint notification system is now routinely reporting Mw for events of M3.5 and higher. The first event for which an automatic Mw was reported was an M4.0 in Parkfield.

The NC Management Center completed the implementation of expanded data exchange with UNR. As part of this change, new boundaries were established for the rapid reporting of earthquake information by QDDS, pager, and email. In addition, northern and southern

California revised the reporting boundary between them.

CISN partners continue to develop station instrument response inventory. In particular, in northern California instrument response information is now available at the Northern California Earthquake Data Center for all channels of data digitized by the USGS/Menlo Park since 1984. However, extensive Q/C is still underway to resolve errors in the maintenance history files.

Seismic Stations, Upgrades and New Deployments – Southern California Management Center

The SC Management Center installed two new stations using Q330 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 also worked with UCSB to complete installation of a downhole station located at the Jensen Filtration Plant in San Fernando Valley and to provide data communications to the SCSN/CISN acquisition systems in Pasadena. We also replaced the station sensor vaults at Burnt Peak and Victorville. In addition, numerous maintenance visits were performed to fix problems associated with sensors, dataloggers, and data communi-cations.

As part of our network maintenance we must keep the SCSN/CISN computer operating systems up to date. The TriNet data acquisition is done by SUN Microsystems servers using UNIX Solaris operating system. We purchased two SUN SunFire servers to facilitate software maintenance and calibration for statewide processing. The old TriNet disk RAID systems used for our real-time processing are failing frequently and need to be replaced.

We completed upgrading both of our main servers from Solaris 2.6 to 2.8 and all the TriNet application software. We also upgrade our Oracle databases to Oracle 9.i. The current size of the SCSN/CISN Oracle parametric database is 42.79 GB.

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 continued moving our backup computers to the new computer room in the USGS building, located across Wilson Avenue, opposite to the Caltech Seismo Lab. This equipment move and formal implementation of the backup facility are scheduled to be completed in early 2003.

The SC Management Center finished step two in the consolidation of the Local Area Networks through the Seismology Lab and the USGS Computer room. There are currently 6 LAN's running through the lab (one includes the CISN private network). Two of the 6 LAN's will be removed upon the completion of the IP migration for the dataloggers. All RT machines on the east side of the street are on the 68.0 net. All RT machines on the west side of the street are on the 66.0 net. (Migrated off the 65.0 net). We also created configurations for the new Sonic Wall Virtual Private Network router. This implementation of the VPN router will allow staff access from remote locations to the private SC CISN LAN and thus make stations troubleshooting and maintenance easier.

Seismic Stations, Upgrades and New Deployments – Engineering Management Center

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.