California Integrated Seismic Network

CGS USGS OES Caltech UC Berkeley

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

The purpose the PMG 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.

Seismicity

The CISN analyzed over 4,700 events in this quarter, including six events over magnitude 4. The largest event was an Mw 4.7 earthquake along the Mendocino fracture zone, 194 km W of Petrolia, CA. A total of 12 ShakeMaps were generated during this time period. The most widely felt event was an Ml 4.3 earthquake 3 km North of Santa Rosa, along the Rodgers Creek fault.

Communications Backbone

We have installed 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.

In the last quarter, we installed the Multi Router Traffic Grapher (MRTG) software package to monitor the CISN backbone (Figure 1). This package collects data for graphical display of traffic on the CISN router interface. We also began using the Big Brother software to establish alarming capabilities – that is, to notify personnel when a problem with the backbone is detected. The alarming system is running in Pasadena and will be installed at Berkeley in the next quarter. Two separate instances of the alarming software should provide reliable notification of problems with the backbone.

This quarter, the CISN partners migrated the transmission of ShakeMaps to OES to the backbone. Use of the backbone for sending ShakeMaps to OES has been a long-standing goal for the CISN but requires coordination with OES personnel to configure machines. This effort was accelerated by the failure of the computer at OES that had been the recipient of ShakeMaps via the Internet. When the computer failed, BSL staff worked with OES and CISN partners to set up an interim system where ShakeMaps were transmitted to a UC Berkeley-maintained computer at OES. This stop-gap provided a local site within OES where the ShakeMaps could be retrieved while more permanent solutions were developed. OES replaced the failed computer and set up a new recipient system on the CISN backbone. As of the end of May, ShakeMaps are being pushed to two separate OES machines, one on the CISN ring and one on the public Internet.

The remaining outstanding issues with the backbone include the connection of the OES routers to the Internet and the development of a security document.

Figure 1. Diagram of the CISN backbone.

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.

Northern and Southern California selected 10 more stations for dual access, bringing the total to 30 (Figure 2). The PVCs for the 10 sites have been ordered and installed and nearly all the configuration details have been completed.

Both the Northern and Southern California management centers are routinely using the shared data streams. This has improved the determination of locations, magnitudes, and moment tensors on a statewide basis.

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.

The CISN continued evaluation of data from a test system that is performing statewide earthquake notification using seismic data from all CISN partners. A 2-week evaluation of results from an exchange of data between northern and southern California networks showed that approximately 95% of the earthquakes were identical. Of the remaining 5%, most were "noise" associations on one system that were rejected on the other. The discrepant behavior can be attributed to differences in the order in which travel-time information is received by the two systems. This type of algorithm behavior may be difficult to eliminate without significant revision to the software design. We have identified several other issues and continue to improve the behavior of the statewide associator.

In parallel, the CISN has been working on issues related to magnitude. Here, the CISN is working in several areas. We have been working together to resolve issues in the software that computes magnitude related to the selection of time windows and stations used in the estimation. Once these issues have been resolved, then the Northern California Management Center will implement the magnitude codes for computing Ml and Me. Similarly, the Southern California Management Center is working on the implementation of codes to estimate Mw and the seismic moment tensor that were developed in Northern California. Also part of the magnitude calibration effort is the computation of station adjustments for Ml and Me on a statewide basis. This effort is underway by BSL and Caltech staff. A final component of the magnitude efforts is the designation of a magnitude reporting hierarchy. There is general agreement at the low end and at the high end, but the working group is still reviewing issues relation to transition points from one magnitude type to another.

The CISN is also working on issues related to metadata exchange. This is an important component of CISN activities, as correct metadata are required to insure valid interpretation of data. A Standards Working Group has developed and initiated testing of a model for database replication of metadata, and are currently reviewing how much of the schema to exchange and how to address metadata from partners such as CGS, who do not currently maintain their metadata in a database.

In the area of longer-term development, Lind Gee and David Oppenheimer were asked to co-chair an adhoc panel to develop specification for an earthquake information system. During this quarter, the panel was put together and a meeting at UC Berkeley was held in July.

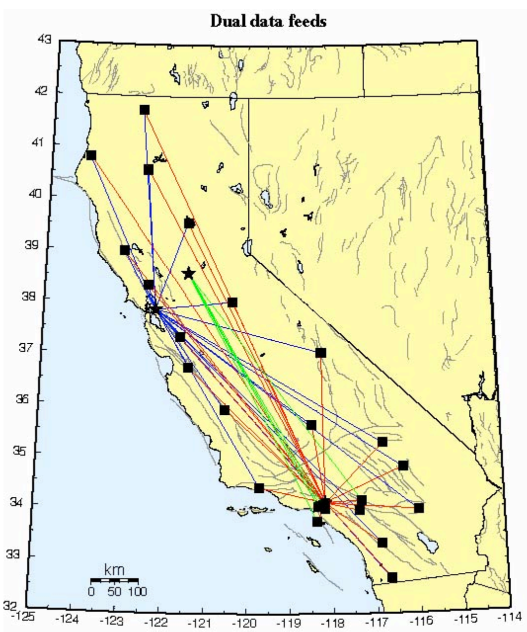

Figure 2. Diagram illustrating dual station data feeds to improve robustness.

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.

The CISN partners completed the first stage of a system to exchange peak ground motion data. Using a common format, the CISN partners are exchanging observations with one another following an event or a trigger. This step increases the robustness of generating products such as ShakeMap, since all CISN partners are now exchanging data directly with one another. It also improves the quality of ShakeMaps on the boundary between northern and southern California, such as the recent events in Lompoc, by allowing the all data to be combined in a single map. Finally, it is a necessary toward the goal of generating statewide ShakeMaps.

Northern California installed a new regression for ShakeMap, based on the study by Boatwright et al [2003]. The new regressions reduce the discrepancy between the standard "small magnitude" and Joyner, Boore, and Fumal regressions. Northern California also installed a series of earthquake scenario ShakeMaps this quarter, as part of the release of the USGS report on Bay Area earthquake probabilities.

It has become clear that, because of the individual approaches the networks in CISN have taken to handle station information, instrument parameters and similar information, a comprehensive approach needs to be taken within CISN to address this. Given the scale of the effort necessary and the immediacy of the need, an Ad Hoc specification of information for each channel in the network has been developed, and each of the networks has adopted it. As a result, this subset of information is available to all networks for use in interpreting the raw data being recorded. This represents a major step forward in integrating the information and metadata underlying the operations of each of the networks. Although this is really a place to evolve from, and not an end, it is nonetheless unprecedented.

With the adoption of the ground-motion data packet by CISN, CGS began to shift from the packet it has used since the early days of TriNet. As a part of this shift, the means of hardware communication within CGS is also being upgraded. The Frame Relay line that has been the sole pathway of communication for data from CGS to Caltech, and from there to Menlo Park and Berkeley, will now be retired after a period of parallel operation with the new approach.

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 drafted first version of a CISN Display 'cliff notes', that will acquaint users with the CISN Display, provide instruction on common user/client interaction, and explanation of general application behaviors.

We installed, ran and tested the QuakeWatch Server software on two new machines (qws1/qws2) meant to be the permanent production servers. In conjunction with this, also installed Red Hat Linux 9.0 to alleviate complications encountered with the Red Hat Advanced Server, to determine the systems performance and reliability under a simulated test environment.

We implemented communications improvements that allow the client software to run behind many firewall/NAT routers without any custom configurations, such as 'address/port translation'. This involves the use of a single port hole for client/server message communications. We also added ability to save and load client configurations. Added dialog window that appears the first time the client is run asking the user if they wan the "Simpson Map" or "CUBE/REDI" style color scheme configurations.

We made aesthetic improvements to Info/Products/ShakeMap buttons. On "Tools > Settings" panels, "Reset" and "Default" buttons now only affect the current tab in view, not a global update as before. We improved log-file management for ease in reading raw earthquake messages. We implemented initial client-to-server login capability. Implemented initial version of ShakeMap to auto-display on client map. We fixed "event-verified" issue; "verified" flag (and other changes) now accepted as long as the event-version number is greater than or equal to previous value. We improved reconnect logic (no longer will simply give up after some hard-code number of attempts). We implemented client request of immediate "Alive" message from server (reduces connection-verified delay; this was a result of the client-to-server login capability). We implemented resend/request of messages at startup to allow the client to catch-up on missed messages. We also added ability to auto-load and display ShakeMap onto the CISN Display map.

The current beta test-organizations now include: OES, USGS, CGS, NMR, Memphis, CALTRANS, LADWP, SBC (San Diego, Sacramento - NOCs), CBS-2 (Viacom), and KTLA5/LA Times (Tribune Broadcasting)

CISN.org

Plans are moving ahead for expanding the capabilities and services of www.cisn.org, including mirroring between BSL and Pasadena. The CISN acquired new computer hardware to improve the response of the CISN Web server. This upgrade is critical to insure that the CISN Web site can respond to post-earthquake traffic. Once the upgrade is complete, the BSL will migrate the "recent earthquakes" and ShakeMap web pages from the NCEDC server to the CISN server. That will make these products available directly from cisn.org. The hardware is scheduled for delivery in July.

In response to requests from CISN Advisory Committee members, we have started the development of a "myCISN" interface, allowing users to organize earthquake and CISN information as they prefer. The first draft is almost ready for primetime.

Outreach Activities (R. Eisner & J. Goltz)

Outreach continued this quarter with planning and technical assistance provided to the City of Riverside in preparing for and holding a field exercise on April 29 and a full-scale (citywide) exercise on June 9, using a ShakeMap/HAZUS scenario for a M7.4 earthquake on the southern San Andreas Fault. We participated in both exercises as part of the planning team (technical advisor) and provided a verbal critique at the conclusion of the exercise. The provision of exercise scenarios using ShakeMap and HAZUS has become a major form of Outreach for CISN and discussions were underway this quarter to develop scenarios for the California National Guard and the Los Angeles County Emergency Medical Services Agency.

The CISN Outreach group made several presentations this quarter including one entitled "Real-Time Emergency Management Decision Support: The California Integrated Seismic Network (CISN)" at the Disaster Resistant California Conference April 21-23. Similar presentations were made for the City of Los Angeles Annual Emergency Management Training Seminar on May 6, to the Coachella Valley Emergency Managers Association on

May 19 and to the OES Earthquake Research Clearinghouse on June 25.

Engineering Data Center

The EDC continued to add records and engineering information to the EDC information base. In preparation for the ASCE Lifelines conference in Long Beach, documentation on all instrumented bridges was loaded into the EDC. The set of bridges (see www.cisn-edc.org/cisn-edc/search/edcstation.asp) includes the 9 major toll bridges in California in addition to 60 other bridges. They are listed in terms customary to Caltrans (e.g., Post Mile) to make them more accessible and convenient to engineers responsible for post-earthquake bridge safety assessment. More information, and earthquake data is being added, and a similar effort for buildings is underway.

A project has been initiated to provide a means of displaying the motion of an instrumented building or bridge, as recorded during an earthquake, to assist in visualizing the structural motion and interpreting the response, for post-earthquake evaluation of structural safety. The project is cost-shared with CGS/SMIP base funding. The effort, slated for completion in mid-2004, will address a recommendation of the Advisory Committee at the July 2002 meeting.

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

Two new broadband sites were installed in northern California with OES funding. PACP or Pacheco Peak is located approximately 20 km N of Hollister, complementing the SAO and MHC sites for monitoring seismicity along the Calaveras fault and to the east. MNRC or McLaughlin Natural Reserve is located approximately 33 km ENE of the Geysers and complements the CVS and HOPS sites in monitoring the eastern side of the coast range, north of the Bay Area. Both stations are operating and at this point in time, we are still finishing some details of installation, particularly the establishment of continuous telemetry from MNRC to the BSL.

BSL engineers are now preparing to install a broadband site at Alder Springs (GASB). Planning is underway for sites near Santa Cruz and Point Reyes, as well as two possible sites in the Sierra Nevada.

With ANSS funding, the NCSN continued installing seismic stations. We completed the installation of 5 more urban stations in the San Francisco Bay area in either schools or fire stations. We also installed a free field ANSS site in the foothills west of Palo Alto. We began recording 6 channels from the roof, base and free-field of the McKelvey library (building 15) on the USGS campus in Menlo Park.

SeisNetWatch that was originally developed with TriNet funding in southern California for monitoring the state of health of seismic stations, is now fully installed at the BSL.

On June 30th, the BSL reconfigured the BDSN Q4120 dataloggers so that causal FIR filters would be applied to the high data rate channels. As a result, all BSL Q4120 dataloggers now apply causal filters at rates of 100 samples per second and acausal filters at lower sampling rates. The older Q935/980 series of dataloggers still use acasual filters for all channels. This change was made to support improved phase picking on the 100 Hz channels, and to make datalogger operations consistent in both northern and southern California.

The USGS is converting the data collection node at Black Mountain (south of Parkfield) from analog microwave to digital satellite. We are now receiving 125 channels of continuous seismic data via the satellite system. We have one remaining microwave node to convert (Williams Hill east of Parkfield) to satellite. The 8 remaining analog microwave nodes are located between San Juan Bautista south of San Jose and Geyser Peak north of Santa Rosa. This portion will be converted from analog to digital next fiscal year upon receipt and installation of microwave modems.

The USGS completed the import/export project with the California Division of Water Resources which operates a sparse network of analog stations around the state. We are receiving 24 channels at from their Earthworm system, but we continue to digitize the DWR data received in Menlo Park via telephone until the DWR resolves time stamp and noise issues in their digital data.

This quarter included the traditional earthquake awareness month. The BSL hosted a wide range of outreach activities including an open house, a public lecture on the new Bay Area earthquake probabilities by Dr. David Schwartz of the

USGS, development of an earthquake scenario for use in the UC Berkeley and City of Berkeley emergency drill, and a tour from the UC Regents. Also during this time, the BSL hosted visitors from FEMA interested in the CISN. Lind Gee joined with Hugo Rico and Rich Eisner for a visit to Caltrans and OES in Sacramento.

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

We installed a new station at Lake Perris near the San Jacinto fault. Initially, this station was planned as part of the TriNet project, but the permitting process took more than two years to complete. We upgraded and improved two stations in the Salton Sea area because the sensor vaults suffered from unusually rapid corrosion. We upgraded our station at Wheeler Ridge, near Gorman, to prevent future flooding of the vault. Initial preparations were made to install a replacement station on Santa Barbara Island.

We continued to upgrade FRAD (Digital modem for frame relay lines) software images to address issues of data congestion. We worked with the Los Angeles Department of Water and Power (DWP) to get them to open up their firewalls to allow certain ports to transmit seismic data over the VPN that is set up between Caltech and DWP. This allows us to use the DWP IP data communications to bring data from stations located at DWP facilities back to Caltech.

Improvements to the real-time systems included upgrade of the Real-time databases from Oracle 8.1.7 to 9i, placing all Oracle configuration files in one directory, configuring the Talarian Smart Socket Real-time servers (Rtservers) to perform dynamic messaging to each other, and improving the capability to transmit aftershock probability messages.

To improve robustness, we have designed data circuit detours that will allow the seismic data from the remote stations to reach Caltech, if the primary data link fails. We configured the station.ini files required for data acquisition for the stations detoured during a circuit detour. We also worked out Network Address Translation Port forwarding (NATP) on the Cisco routers to accommodate communication through the web based data manager for qmaserv stations. We also wrote up a preliminary rough draft of the steps required to perform a circuit detour. Because one of our microwave link failed, we had to implement this detouring of circuits on stations that were detoured from the Southern California Gas site at Monterey Park via a frame relay line instead of the microwave link. Once the link was fixed, the data circuits were routed back to the original path.

We worked on modifications to trimag software to compute near real-time local magnitudes. We implemented the following upgrades, allowed incomplete data windows, improved windowing, added improved distance cut-off, improved the determination of the time of the maximum amplitude, and improved the use of clipping values. Currently, we are testing the improved software, and the results look promising.

We are implementing the same software to compute regional moment tensor solutions, as used at Berkeley. First, we wrote an implementation specification document. Second, we started modifying the software for to work with Southern California Real Time system. These changes include modifications to retrieval of waveforms, waveform processing, removal of instrument response and the plotting of the results. Extensive testing will be needed to determine suitable configuration and input parameters for use by a larger network than the original version.

Seismic Stations, Upgrades and New Deployments – Engineering Management Center

The planned number of ground-response stations was installed (30), as well as one building (Costa Mesa City Hall). The stations were distributed throughout the existing network of stations, primarily being upgrades of existing stations to CISN station caliber (high resolution digital instrument, with communication capability). Stations included ground stations at sites important for local emergency response such as the Gilroy – St Louise Hospital, the Long Beach Emergency Communications and Operations Center (ECOC), and a station near the Upper Crystal Springs reservoir, a water storage facility of the City and County of San Francisco on the San Andreas fault.