CISN Earthquake Early Warning 2014

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ABSTRACT

The UC Berkeley Seismological Laboratory is participating in prototype development for an end-to-end, robust, and unified earthquake early warning (EEW) system for the West Coast of the US. This is an effort by CISN and other partners (UC Berkeley, Caltech, U Washington, USC/SCEC, USGS and ETH Zurich), which are funded by the USGS and the Gordon and Betty Moore Foundation. In 2014, UC Berkeley's GPS-based GlarmS algorithm successfully demonstrated is utility during the Mw 6.0 South Napa earthquake. This event was the first large earthquake that occurred within the network of 62 GPS stations in Northern California being used in GlarmS processing. The first distributed slip model and magnitude estimate for the main shock was available 24 s after the event origin time, which, after optimizing the code and reanalyzing the event in simulated real-time, was reduced to 14 s (~8 s S-wave travel time plus ~6 s data latency). ElarmS also successfully alerted on the South-Napa event and on all significant earthquakes and aftershocks in the state (M>=4.5, 7 earthquakes) with no false alarms. This includes events in Napa, Los Angeles, Santa Rosa, offshore Eureka, and San Bernardino County. The magnitude estimates were within 0.5 magnitude units of the catalog magnitude in all cases.

Following improvements to ElarmS based on the review and analysis tools created in 2013, ElarmS now provides the most rapid alerts in the ShakeAlert system. The speed of the alert depends on the density of the seismic network around the epicenter. For the M5.1 Los Angeles Le Habra event the first alert came 4.2 sec after the origin time, which is typical for events in the LA region. For the Napa event it was 5.1 sec, 6.6 sec for Santa Rosa, 7.3 s for the Running Springs event (San Bernardino Co.), and 25.7 for the (offshore) Eureka earthquake. The speed of the ElarmS location algorithm was improved this year through the implementation of a multi-threaded architecture. This allows the location algorithm to be utilized more frequently in the event formation process, which reduces the chance of poorly located and false events. Work continues on implementing a "production" monitoring system that includes multiple instances of the ElarmS system running in parallel on different machines to provide redundancy and reliability in the case of machine or communication failures.

The CISN is now well into the implementation phase of EEW. The statewide end-to-end system is now in place. The demonstration early warning system is fully functional and providing alerts to a growing group of test users. Today about 50 scientists and members from about 20 organizations receive alerts through the ShakeAlert UserDisplay. Recipients include the state's emergency operations center at the California Office of Emergency Services (CalOES), Bay Area Rapid Transit (BART), Google Inc., PG&E, and the San Francisco Department of Emergency Management (SFDEM). We have also developed a schema for improving both the redundancy and robustness of the early warning system.