1 ElarmS Earthquake Early Warning

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1.1 Introduction

ElarmS is a network-based earthquake early warning (EEW) algorithm developed at UC Berkeley for rapid earthquake detection, location and hazard assessment. ElarmS operates as part of the greater ShakeAlert EEW system, an ongoing project by the California Integrated Seismic Network (CISN). ShakeAlert combines three different EEW algorithms, one of which is ElarmS, into a unified system for providing warnings for events throughout the state. Output from the three algorithms is compared and consolidated by the ShakeAlert Decision Module into a single alert messaging system. In fiscal year 2011-2012, these alert messages will be sent to industrial test users of the ShakeAlert system.

ElarmS consists of two primary parts: (1) a waveform processing algorithm, which runs in parallel at UC Berkeley, Caltech, and USGS Menlo Park to continuously filter real time seismic data, and (2) a single state-wide event detection algorithm which operates at UC Berkeley. The event detection module analyzes the incoming data from the three waveform processing streams and identifies earthquakes in progress.

1.2 Current Progress

In March 2011, ElarmS began sending event messages to the ShakeAlert Decision Module for events in the greater San Francisco Bay Area and Central Coast. Between March 17th and July 26th, 2011, there were 49 events of magnitude 3.0 or greater in the ElarmS alert region. ElarmS sent alert messages for 45 of them, and missed 4 (Figure 2.2). ElarmS also sent two false alerts. In both false alert cases, there was a single real event which ElarmS processed as two separate events - associating some triggers with one event and some triggers with the other. The alert message sent for the second “event” is thus a false alarm, although based on real seismic activity.

In 2010 and 2011, we developed second generation ElarmS waveform processing and event detection algorithms, based in C++ for speed and adaptability. The new event detection module (E2) utilizes the established location and magnitude relations, but has an updated method of associating triggers together to form events. One goal of the new associator is to prevent split events such as those that caused the false alerts mentioned above. E2 has been processing statewide real-time data in test mode since December 2010 and will become the authoritative ElarmS version in fall 2011.

In addition to the second generation ElarmS algorithms, we developed a KML-based method of visually inspecting and assessing system performance. The assessment software automatically evaluates station latencies, promptness of alerts, accuracy of magnitude/location/ground-shaking estimates, and number of successful event detections, false alarms, and missed events. This information is displayed in Google Earth for quick, intuitive understanding of system health.

1.3 Investigation of GPS

In 2011 we also began investigating the use of GPS for earthquake early warning, focusing on the $M_w$ 7.2 El Mayor-Cucapah earthquake, which had both real-time GPS and seismic data available. We developed a simple algorithm to extract the permanent displacement at GPS sites starting one oscillation after triggering on the dynamic long period signal. The estimate is continually improved with time. These permanent displacements can then be inverted for source characteristics given an approximate estimate of the fault plane. Initial results suggest that GPS would provide a valuable contribution to EEW. The new approach provides an independent estimate of magnitude, which is particularly important for the largest events.
1.4 Acknowledgements

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1.5 References

