

Earthquake Early Warning and the Loma Prieta Earthquake: First Experiment with a New Technology

James D. Goltz Ph.D.

Earthquake and Tsunami Program Manager


California Emergency Management Agency

Loma Prieta Earthquake Commemorative Symposium

October 17, 2009



Presentation Objectives

- Identify the elements of an earthquake early warning system
 - Describe the use of earthquake early warning for aftershocks in the Loma Prieta Earthquake
 - Discuss efforts to develop and implement earthquake early warning since Loma Prieta
- 

Early Warning \neq Prediction

Earthquake Prediction:

A Statement Including:

- Magnitude
- Location
- Time
- Probability

Of A Future Earthquake

EQ Early Warning:

- EQ already underway
- Geographic distance
- Warning= few seconds
- Ground motion arrival
- Probabilistic statement

Potential Benefits

Even a few seconds of warning may be sufficient to:

- Address life safety: self-protective actions
- Implement rapid mitigation actions

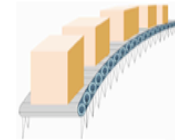
Application of EEW Alerts



Controlling trains



Controlling factory lines
- to mitigate damage



Preventing
Traffic accidents



Controlling elevators
- prevent trapping of people



At home
- enable personal protection



Suspending work in progress
- to avoid mistakes



Hazardous work places
- secure people
- secure resources



Alerting schools & assembly halls
- to guide evacuation

Potential Barriers

- Warning times extremely short
- Longer warnings only available for rare large event
- May be false alerts and missed events
- Potential costs of implementation
- Acceptability in some sectors

Loma Prieta and EEW*

- Operated by the USGS
- Used portable low-gain sensors at 3 optimum sites
- To record aftershocks, including 20 of $M \geq 4$
- Alerts transmitted via radio directly to a central receiver site at Menlo Park then to site of S&R and later demolition at the Cypress structure
- System set to trigger an alert for $M \geq 3.7$, 2 of 3 sites must record event
- System triggered for 12 aftershocks $M \geq 3.7 \leq 5.6$
- Provided search and rescue teams and later debris clearance workers 20-35 seconds advance warning of the approach of ground motion
- Only one false alert due to electronic noise at the central receiver site
- System was in place for 6 months

* Based on "Early Warning System for Aftershocks" by W.H. Bakun, F.G. Fischer, E.G. Jensen and J. VanSchaack in Bulletin of the Seismological Society of America, Vol. 84, No. 2, pp.359-365, April 1994

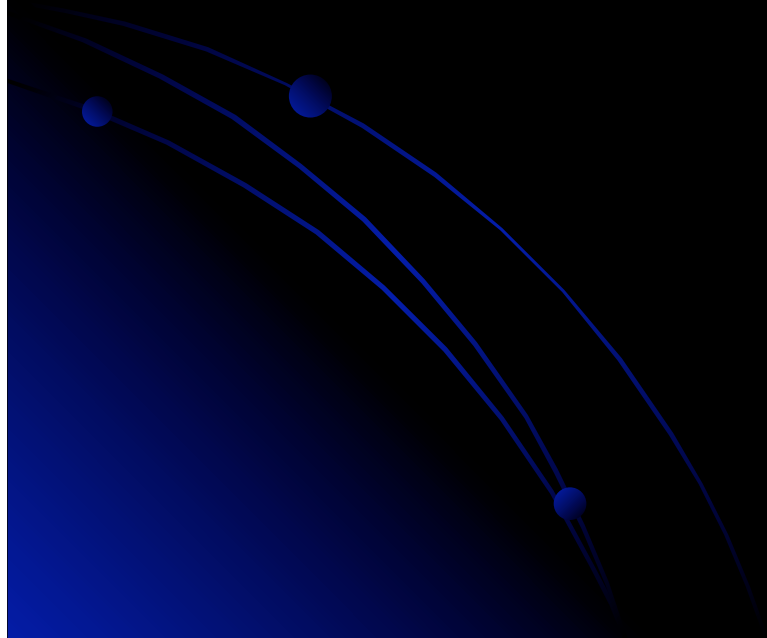
Cypress Freeway Collapse



Demolition of Collapsed Cypress Structure



Earthquake Early Warning Since Loma Prieta



System Development in Other Nations

- Mexico City's Seismic Alert System (SAS)
- Japan's Nationwide System 10-1-07
- Taiwan to Introduce Soon
- Limited systems in Turkey, Italy and Greece

Social Science Studies

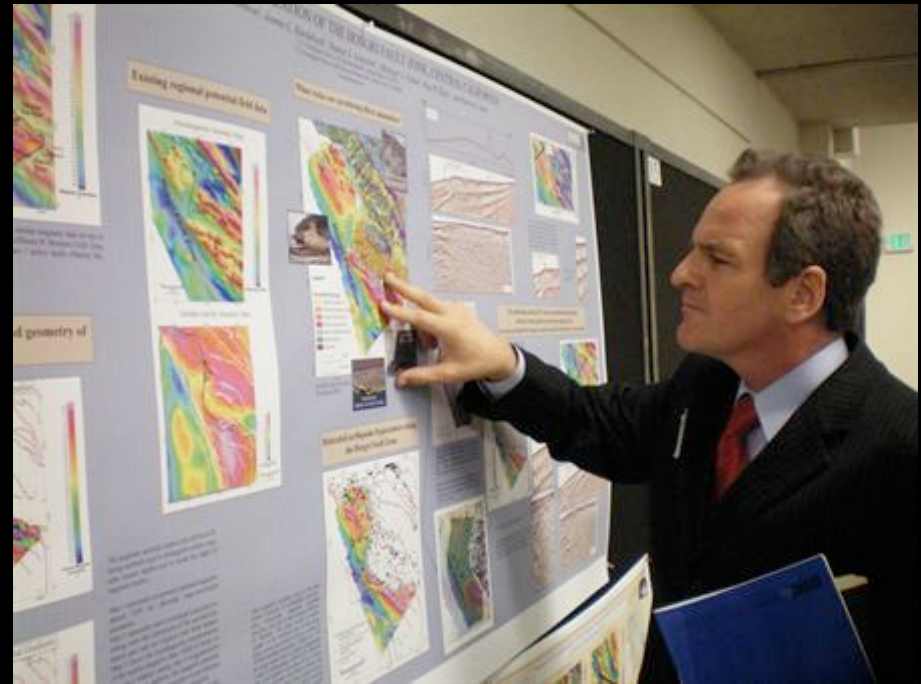
- One of the objectives of the TriNet Project (1997-2002) in southern California was to develop a “pilot earthquake early warning project”
- Was not realized, but three studies were conducted to set the stage for the development of an earthquake early warning system:
 - A survey of 200 potential EEW users
 - A review of the social science literature
 - A policy review to identify opportunities and barriers to implementation
- Studies revealed potential user support for an EEW, provided guidance from social science research literature and some important policy issues (e.g. liability)

Early Warning in the US

- USGS is funding projects at UC Berkeley, Caltech and USC (SCEC) to develop methods to rapidly analyze an evolving seismic sequence
- Several high profile sessions at the American Geophysical Union Meetings in recent years
- In April 2009, scientists and emergency managers traveled to Japan for a workshop on the operation of Japan's national earthquake early warning system

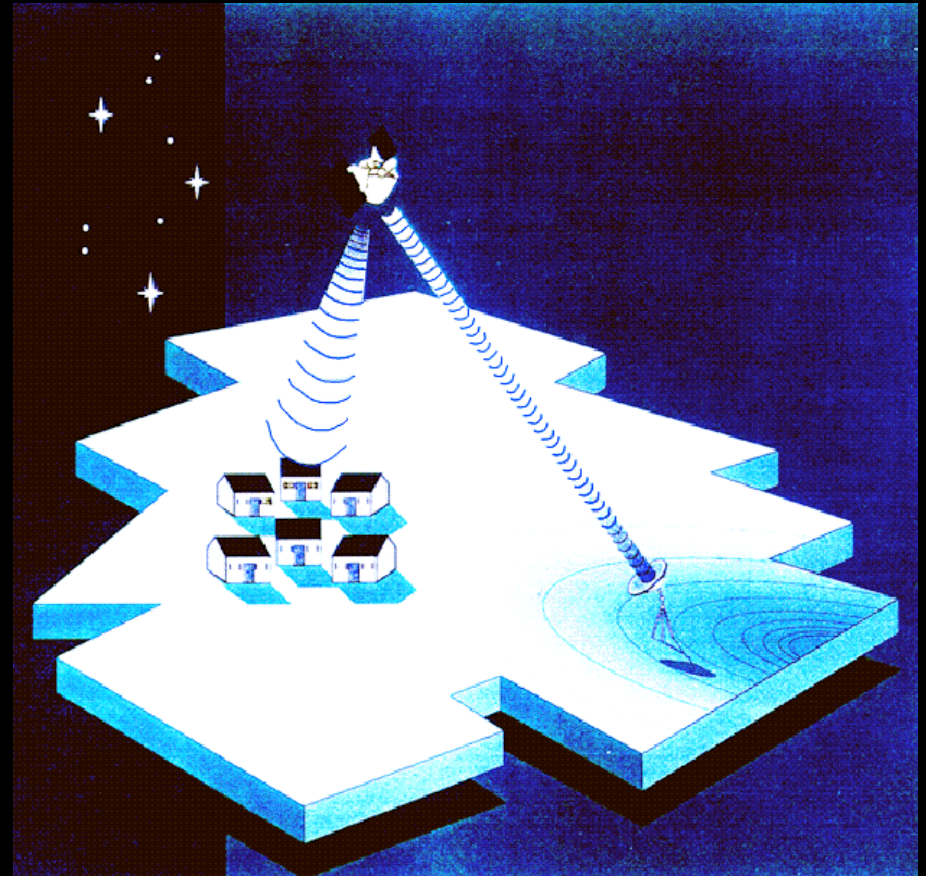
Sam Blakeslee and AB 928

- Sam Blakeslee is a Republican Assemblyman from the San Luis Obispo Area
- He is also a UC Berkeley trained seismologist
- Sponsor of AB 928 that calls for the an earthquake early warning system for the CA high speed rail project
- Bill is currently dormant (last action 4-30-09)



Proposal to Tap Stimulus Funds

- 3 year project, \$53.4 Million from CISN
- Would add 90 new seismic/GPS stations
- Upgrade older equipment
- Redundant communication paths
- Test algorithms
- Identify best practices for EEW



Summary & Observations

- The EEW system for aftershocks in Loma Prieta was an important (though unheralded) first implementation
- Subsequent development in other nations
- US efforts have set the stage but EEW still lacks a coordinated plan and sustained funding
- Organization and management issues including identification of a lead agency are yet to be resolved