Earthquake prediction
...what we cannot do

Earthquake forecasting
...what we can do

Earthquake early warning
...what we could do

Reading: Seconds count, Nature Commentary, October 2013
Additional reading: Seconds before the Big One, Scientific American, April 2011
(both available on the class website)
What is earthquake early warning?

The Earthquake Rupture

Realtime animation for a magnitude 8 on the San Andreas fault

big earthquake ruptures take a long time

August 25, 2014

http://earthquakes.berkeley.edu/eps20
Shake Alert
System operation today
Demonstration system now operational ➔ Alerts delivered to external partners

Napa Performance
Sunday August 24th, 2014. 3:20 am PDT, M6.0
Alert at San Francisco 911 center on Turk St

http://earthquakes.berkeley.edu/eps20
Earthquake early warning

Applications

Using seconds to tens of seconds warning for...

1. Personal safety
   – moving to a safe zone

2. Automated control
   – slowing/stopping/isolating sensitive systems

3. Situation awareness
   – initiating response before shaking

ShakeAlert

Current users

- Automatically slowing trains

  Rush-hour:
  - 10 car train: 1000 passengers
  - 64 trains operating
  - 40-45 traveling at 70 mph
  - How many might derail?
  - Automatic deceleration reduces risk

Post-earthquake recovery:
- $2.1B retrofit so BART remains operational
- Can evacuate people
- Can bring in supplies
- Only if derailed trains are not blocking the tracks
**ShakeAlert**

**Current users**

- City of San Francisco
- BART

**Today:**
- Alerts in operations centers: 911/Police, Fire, Public Works

**Planned:**
- 911/Police center: Start emergency generators
- Fire Dept: Notify and open doors
- Public Works: Construction equipment and bridges into safe position
- Public Health: Bed count to emergency responders
- SFO & Port of S.F.: Developing response plan

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**ShakeAlert**

**Current users**

- City of San Francisco
- BART

- Crisis response team
- Displayed in operations center

**Planned:** generator start up
UC Berkeley Today:
• Police: “Code red” notification

Planned:
• Data center: Generator start-up, disk shutdown
• Haz Mat: Secure material and activities
• Chem Labs: Auto restart of fume hoods to prevent asphyxiation

http://earthquakes.berkeley.edu/eps20
Napa Performance
Sunday August 24\textsuperscript{th}, 2014. 3:20 am PDT, \textbf{M6.0}

Groups who received a warning

Alert issued 5.1 sec after earthquake began, 3.3 sec after the P-wave at the closest station

Blind zone: 16km

LA Habra Performance

LA quake: Friday March 28\textsuperscript{th}, 2014. 9:09 pm PDT, \textbf{M5.1}

Alert issues: 4 sec after origin time
Blind zone radius: 8 miles
Vast majority of those who felt it could have had a warning

...if this was a public system
La Habra Performance

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Similar performance for
– M4.4 March 17th, 2014 Santa Monica Eq
– M4.2 June 1st 2014 Westwood Eq
...1st alert 4 sec after origin time

Performance – Speed and Accuracy
ShakeAlert from Demonstration System to a Public System

and CEEWS: California’s Earthquake Early Warning System

California’s Earthquake early warning law

Introduced by Senator Alex Padilla

Passed both houses unanimously

September 24, 2013
Signed into law by Governor Jerry Brown

What does this mean?
The law requires the Governor’s Office of Emergency Services to

• develop a comprehensive statewide earthquake early warning system
• develop standards for the system and a mechanism to review compliance
• identify funding for the system, but not from taxes (General Fund)
Federal Earthquake early warning activity

House Natural Resources Committee Subcommittee on Energy and Resources

Whole Lotta Shakin’: An examination of America’s Earthquake Early Warning System Development and Implementations – June 10, 2014 hearing

Lamborn (Chair, R-CO) “The lack of focus and investment in early warning ... is a deep concern.” “It is so obvious to me we have to find the money to do this.”

Lowenthal (D-CA) “When we prepare, lives are saved. ... An earthquake early warning system is just another common sense investment that can save lives and mitigate damages.”

DeFazio (D-OR) “It is pretty darn pathetic when countries like Romania, Mexico and Mongolia are doing more to protect their citizens ... than the United States of America.”

3rd International EEW Conference
California’s Earthquake Early Warning System
a public-private partnership

Building on ShakeAlert
Leverage State’s existing seismic network:
• 400 stations today
• additional stations in gaps
• some equipment upgrades

$80 million: complete and operate for 5 years

Parallel statewide processing centers
alerts

Multiple distribution paths
inc. value-added information
inc. action automation devices

Additional data

Integrated Alerts