PNW ShakeAlert overview

- Past and expected performance of ElarmS-2 algorithm
- Bottom line – should work for all events close enough and big enough to cause damage.
- But we will do more extensive testing to be sure, and issues with smaller and farther-away events are to be expected.
- Extension to GPS in next year will improve accuracy for biggest events.
- For now, there may be a “no-warning zone” close to shallow events.
- Speed, accuracy, integration with California, and sustainability require full funding by Congress.
Three evaluation datasets
Testing ElarmS-2 with configuration as in California

- ~130 alerts generated in real-time
  - Test period: Feb 2013 to Feb 2015
  - Magnitudes 3+
  - Minus 10% system downtime during development

- 28 past earthquakes that we can replay:
  - Test period: 2004 to 2014
  - Magnitudes 3.3 to 7.2
  - Caveat - more recent events have more and better data

- In future, we’ll test many scenario quakes
  - Focusing on large, threatening events that haven’t been recorded yet.
Local earthquakes

Magnitude 1+ earthquakes from 2013-02-26 to 2015-01-27 (white circles)

and

replay events (gray circles)
Seismic Network

Our stations (green)

Others’ stations (blue)
M3+ missed events

Few that we care about, and in the future unlikely to be missed.
Bloopers: Multiple M3+ Alerts

Again, in the future this problem should not recur.
Bloopers: False M3+ Alerts (just 1 for real)
First alert accuracy (N=128)

Location error

Magnitude error

Median: 19.6

Median: -0.1 std: 0.4
M3+ first alert
mislocation vectors
mostly very good
Goodness of magnitude estimate

Initial ElarmS2 magnitude vs. Catalog magnitude

- × × × accelerometer traces
- + + + broadband traces
- □ □ averaged per event
Earthquakes with M3+ alerts

- Good solution (N=96)
- Poor solution (N=31)
- Flagged as distant (N=14)
- Distant earthquake (N=3)
- Multiple alerts (N=3)
- False alert (N=1)
- Missed events (N=4)

Summary of real-time data
How long after the earthquake did the system send an alert?

Reasonable detection + alert times (< 15 s) in the Puget Sound region

Alerts many places takes > 30s, will be improved in the future by new instruments with less latency
How long after the earthquake did the system send an alert?

QuickShake – realtime seismograms tested with Seahawks games

Also coming soon for Portland and Seattle
Recent example of EEW

M3.5 event near Nisqually quake
11s to detect, 13s warning

Station KDK in South Seattle near stadia
Refinements

- Search larger geographic box for earthquake location.
- Allow a larger inter-station distance when a new event is created (250 km vs. 100 km).
- More sophisticated split-event check to prevent multiple solutions for an event.
- Allow magnitude measurements from farther stations.
- Improved teleseism filter:
  - Assume short period signals are NOT teleseisms, and
  - wait longer before starting TauP measurement.
Replay events

Before refinement

After refinement

- Good solutions (N=18)
- Poor solution (N=4)
- Flagged as distant (N=0)
- Multiple alerts (N=0)
- Missed events (N=9)
After adjustment, replay events without alert (missed)
After adjustment:

Mislocation vector of replay events with single, correct alert
What to expect

- Alerts several times a month with default settings
- Most alerts are for events that too far away to feel
  - Being in “No Warning Zone” (too close to event) also possible
- The system may send a few false alerts (M<5) due to:
  - Distant earthquake (<1/year?)
  - Multiple alerts for a single earthquake (<1/year?)
  - Noise triggers (<1/year?)
- Accurate, quick alerts for earthquakes in dense part of network
  - Less reliable warnings for offshore/CA/NV earthquakes
Thanks

Near-realtime tools to check EEW alerts:

PNSN QuickShake
* http://pnsn.org/quickshake/coastal

PNSN Recent Earthquakes page
* http://www.pnsn.org/earthquakes/recent

USGS Did You Feel It? page
* http://earthquake.usgs.gov/earthquakes/dyfi

Plus tweets, CISN Display, Facebook page.