Earthquake Early Warning Research

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Path to a Public EEW System

CISN California Integrated Seismic Network

ShakeAlert

Evolutionary Approach

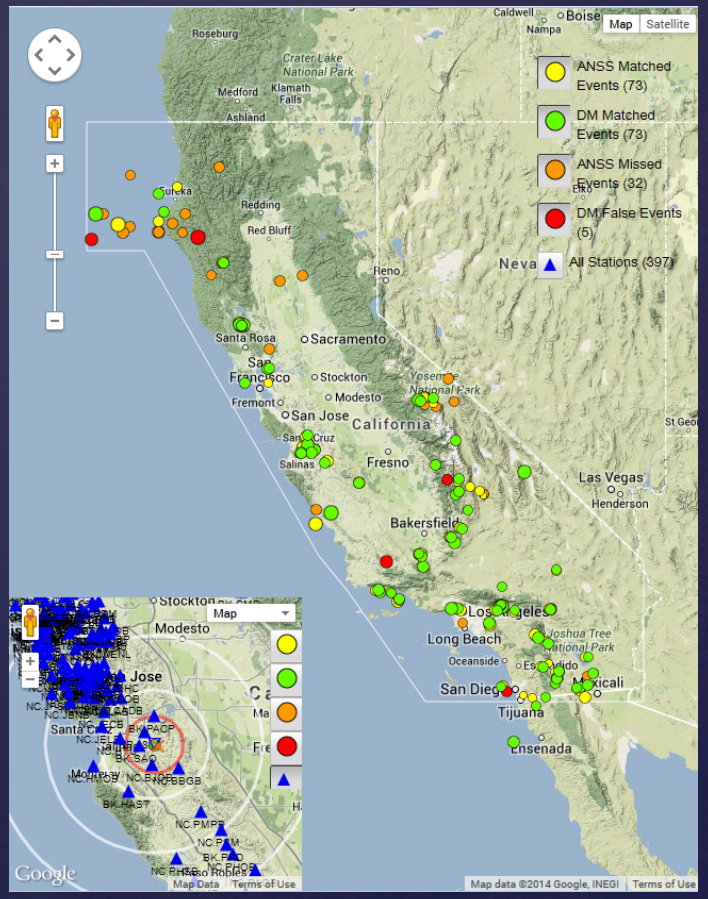
→2006-now – R & D

→Jan. 2012 – Demonstration System Live

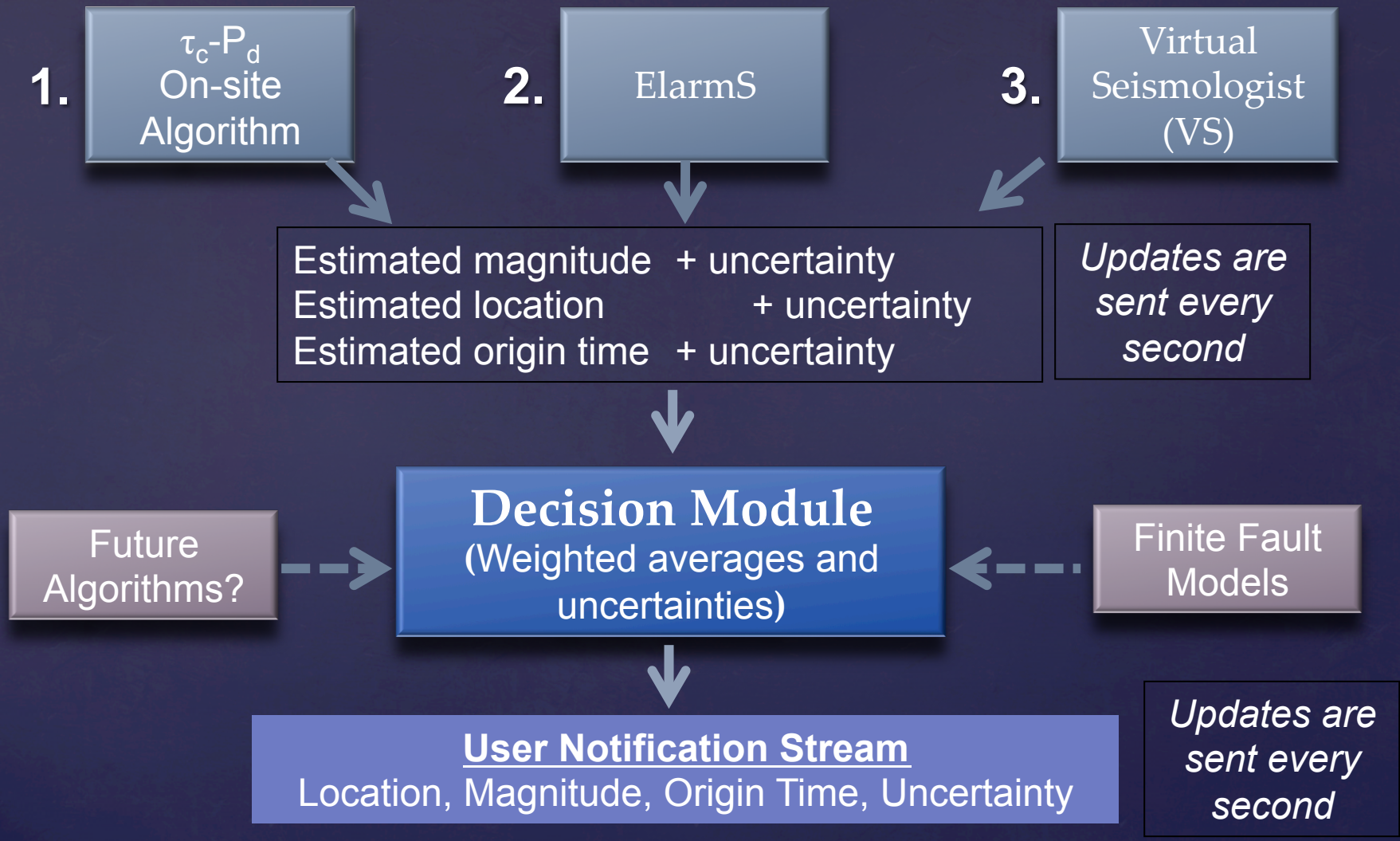
→2014? – Production Prototype

→? – Limited Regional Rollout

→? – Full Operation



Current ShakeAlert System Architecture



What do we really need from an EEW system?

Accurate predication of expected shaking intensities across a region before strong shaking arrives.

Take-away: Many of the existing and proposed SCEC priorities can contribute to EEW

Science Priorities

1. Realistic Synthetics

- P and S wave energy at a wide range of frequencies, e.g. 0 Hz (realistic static offsets) to 100 Hz, seismic and geodetic algorithms.
- Wide range of event scenarios and station distributions.
- Unusual/complex sequences.
- Range of source properties reflecting different fault properties, e.g. high versus low stress drop, geometrically complex events.
- Simulated and validated ground motions for seismological, geodetic, and engineering EEW applications.

Take-away: Extension of the capabilities of the broadband platform

Science Priorities

2. Physics of large earthquakes

- How quickly can the eventual size of an earthquake be determined?
- Are the first few seconds, or perhaps microseconds, of ground motion sufficient to determine the difference between a M6 or M8? And, if so, what does that tell us about the underlying physics of the rupture process?
- Do the initial second or two of the ground motions include information that allows us to determine the orientation (strike and dip of the fault) and type (strike slip, thrust, normal, oblique) of rupture?

Take-away: Fundamental questions about earthquake source behavior

Science Priorities

3. Earthquake Statistics and Bayesian Analysis

- Earthquake forecasts, such as those provided by UCERF, can be used to assign probabilities to a particular event is, especially in the case where different algorithms provide conflicting alert information.
- Likelihoods assigned to different scenario events used to compute synthetics for evaluation of algorithms.
- Short-term evolution of background seismicity, such as that used in operational earthquake forecasting, can be used as prior information to improve rapid event location estimates.

Take-away: Links to UCERF, OEF

Science Priorities

4. Improve Ground Motion Estimates

- Optimal attenuation equations for both point sources and finite fault solutions
- Ground motion prediction from detailed slip distributions
- Modify GMPEs based on regional variation in stress drops.
- High resolution mapping of site terms

Take-away: Application for current SCEC research in GMPEs and site effects

Additional Tie-ins: VISES

SCEC has fostered strong collaborations with Japanese researchers through the VISES program that could be extended to include earthquake early warning research.

A fruitful collaboration would include sharing of data, joint algorithm development and testing, as well as lessons learned from public response to alerts.

Additional Tie-ins: CEO

As EEW is rolled out across the west coast of the U.S., it will be critical to provide appropriate additional content on earthquake alert response actions.

ShakeOut exercise provides an obvious venue for introducing earthquake early warning to businesses, schools, emergency management agencies, and the public

Summary

Science Priorities

1. Realistic Synthetics
2. Physics of large earthquakes
3. Earthquake Statistics and Baysian Analysis
4. Improved Ground Motion Estimates

Additional Tie-Ins

1. VISES
2. CEO

Take-away: Many of the existing and proposed SCEC priorities can contribute to EEW