

Harnessing Earthquake Early Warning & Distributed Sensor Networks

# Richard Allen Berkeley Seismology Lab







Install MyShake on your smartphone Be Quake Ready





![](_page_1_Figure_0.jpeg)

What is earthquake early warning?

![](_page_1_Figure_2.jpeg)

#### What is earthquake early warning?

![](_page_2_Picture_1.jpeg)

## Mexico City M7.1 - September 19, 2017

![](_page_2_Picture_3.jpeg)

![](_page_3_Picture_0.jpeg)

![](_page_4_Picture_0.jpeg)

7.54 0 8 X . .

Byron, CA

Today, 4:11 PM

SHAKING STRENGTH

Share your experience

43 EXPERIENCE REPORTS O

8.423

2,659 mi away

34

![](_page_4_Picture_1.jpeg)

![](_page_4_Picture_2.jpeg)

![](_page_4_Picture_3.jpeg)

Detailed damage information reported by users

![](_page_4_Picture_5.jpeg)

![](_page_4_Picture_6.jpeg)

Preparedness and safety tips Realtime earthquake information around the globe

# MyShake 2.0 Gov. Newson release

![](_page_5_Picture_1.jpeg)

The New York Times California Launches Earthquake Early Warning System It Calls Best in World

October 17, 2019

![](_page_6_Picture_0.jpeg)

![](_page_6_Picture_1.jpeg)

![](_page_6_Picture_2.jpeg)

In specific regions as possible depending on availability

![](_page_6_Picture_4.jpeg)

![](_page_7_Picture_0.jpeg)

Alerts are available for use... ...by technical and industrial users - Oct 2018 ...the public in California - Oct 2019 ...the public in Oregon and Washington - Oct 2020

![](_page_7_Picture_2.jpeg)

## Who could use earthquake early warning?

# **Reducing Falling hazards**

![](_page_8_Picture_2.jpeg)

![](_page_8_Picture_3.jpeg)

**Northridge Solution Soluti** 

## Who could use earthquake early warning?

## **Automated** control

![](_page_9_Picture_2.jpeg)

#### **Slowing and stopping trains**

![](_page_9_Picture_4.jpeg)

Isolating hazardous machinery and chemicals

![](_page_9_Picture_6.jpeg)

Data security

Situation awareness Preventing cascading failures

![](_page_9_Picture_9.jpeg)

![](_page_9_Picture_10.jpeg)

Shake **Alert** Pilot projects >50 End users (taking action) BART + LA Metro: train control **Eugene Water & Electric:** water valve control Menlo Park Fire + NBC Universal: firehouse **Regatta Condominiums:** resident alerting Northridge Hospital Medical **Center:** alerting City of Los Angeles: City Hall alerting + ShakeAlertLA app Many more receiving alerts and considering what actions

### Commercial developers = amplifiers

Actuator + alerting: Early Warning Labs, SkyAlert

#### Mass notification: Everbridge, Regroup, AtHoc, Global Security Systems, +more

#### **Engineering control:** RH2, Varius – Water system control

## In summary

- personal notification
- train control
- water system control
- firehouse alerting

![](_page_11_Picture_0.jpeg)

![](_page_11_Figure_1.jpeg)

# MyShake: smartphone app

![](_page_12_Figure_1.jpeg)

# Distinguishing earthquakes from other shakes on a phone

![](_page_13_Figure_1.jpeg)

- Identify key characteristics measured from 2 second windows of data
- Neural Network trained to classify activity

## 93% success rate on the phone

Then send earthquake trigger into the MyShake cloud

# Distinguishing earthquakes from other shakes on a phone

![](_page_14_Figure_1.jpeg)

## Before MyShake 2.0 Already a global seismic network

Sauth Atlantia

Ocase.

South Adv

Breni Dreni

writes

DORBA1

MyShake 1.0 downloads: 300,000

GC4AR

P B at 625 \$ 100

North Pacifie Coase

Pacific

00445

MyShake

## MyShake Earthquake detection Borrego Springs

#### M5.2 June 10<sup>th</sup> 2016

![](_page_16_Figure_2.jpeg)

Time(UTC) 2016-06-10 08:04:38 Time(Local) 2016-06-10 00:04:38 Triggers 1

#### M5.2 Borrego\_Springs Depth 12.3 km

MyShake phone Triggered phone Used for location True earthquake location Estimated earthquake location P-wave front S-wave front Limit of shaking intensity 4

triggers with P and S

## Alert delivery: Borrego Springs re-run using MyShake detections

![](_page_17_Figure_2.jpeg)

Time(UTC) 2016-06-10 08:04:38 Time(Local) 2016-06-10 00:04:38 Triggers 1

#### M5.2 Borrego\_Springs Depth 12.3 km

MyShake phone Triggered phone Used for location True earthquake location Estimated earthquake location P-wave front S-wave front Limit of shaking intensity 4

Re-run: Warning

## MyShake simulation Indonesia – M7.5 – September 28, 2018

Earthquake and tsunami - 2,200 casualties - smartphone penetration: 40%

![](_page_18_Figure_2.jpeg)

# **Structural Health Monitoring**

#### With a dense in-building seismic network

Sarina Patel, BSL Selim Gunay, PEER Berkeley

![](_page_19_Figure_3.jpeg)

123° W

# **Structural Health Monitoring**

Sarina Patel, BSL Selim Gunay, PEER Berkeley

Modal frequencies tell us about structural integrity

![](_page_20_Figure_3.jpeg)

# **Structural Health Monitoring**

Modal frequencies tell us about structural integrity Sarina Patel, BSL Selim Gunay, PEER Berkeley

![](_page_21_Figure_3.jpeg)

# Our goal?

![](_page_22_Picture_1.jpeg)

30 years ago today a portion of the Bay Bridge collapsed.

Today, I'm proud to stand here and announce that CA is the first state in the nation to launch an earthquake early warning app.

Be prepared. Download the app now! --> earthquake.ca.gov/mobile-applica...

![](_page_22_Picture_5.jpeg)

♡ 1,055 3:08 PM - Oct 17, 2019

460 people are talking about this

California's goal: **4 million** downloads

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![](_page_23_Figure_0.jpeg)