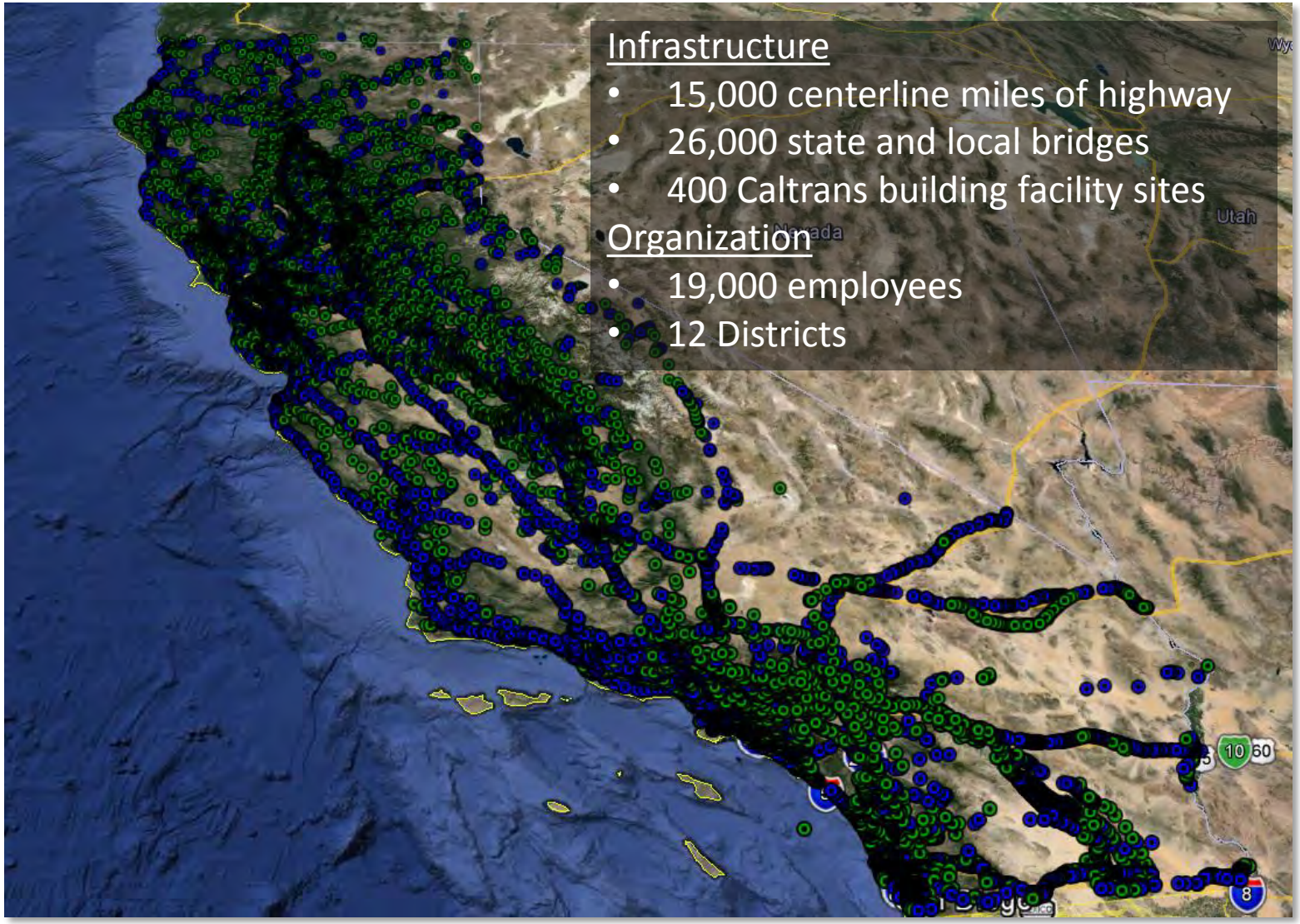
California State Highway System Earthquake Planning and Response

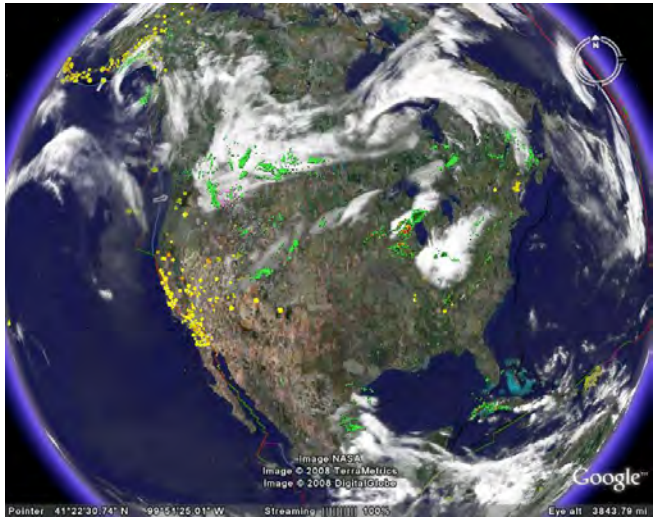
Tri State Commission Meeting
June 17, 2016

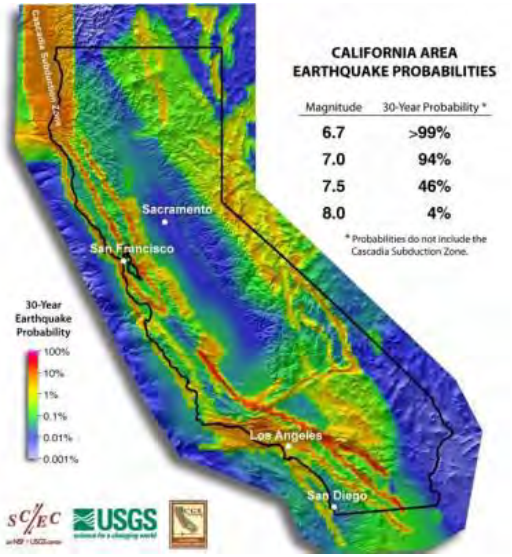
Herby G. Lissade, P.E.
Chief, Office of Emergency Management and Infrastructure Protection
California Department of Transportation

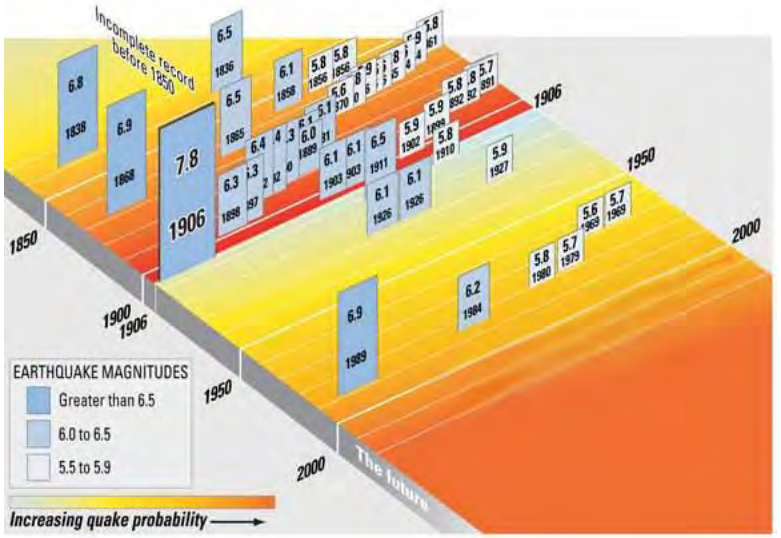
Organizational Profile



California State Highway System
Earthquake Planning and Response







1971 Sylmar/ San Fernando Earthquake

Examples of post-Sylmar retrofit strategies

Column failure

Hinge seat failure

Seat extenders

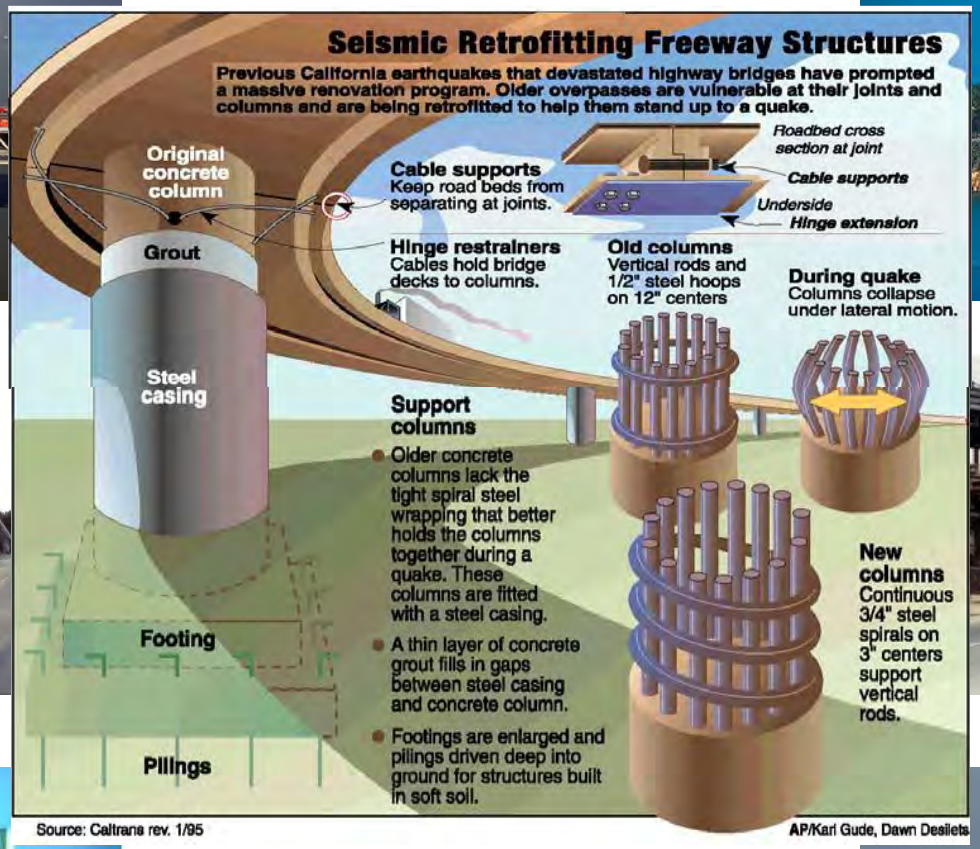
Column jacketing

Cable restrainers

1989 Loma Prieta Earthquake

Earthquake

Response



1994 Northridge Earthquake

1994 Northridge Earthquake

–Southern California

–Magnitude 6.8

–Good performance of retrofit structures

–Seriously damaged structures were scheduled for retrofit in near future

State Highway System Long Span Bridges

Antioch Bridge

Benicia-Martinez Bridge

Carquinez Bridge

Coronado Bridge

Dumbarton Bridge

Richmond-San Rafael Bridge

San Francisco-Oakland Bridge

San Mateo Bridge

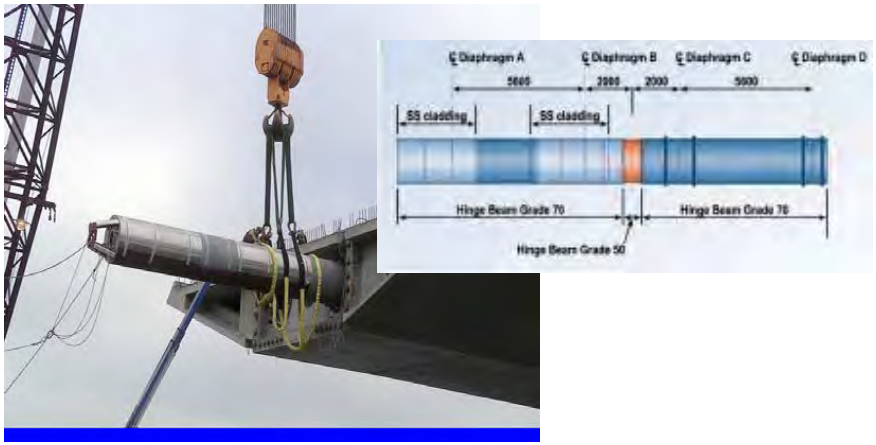
Vincent Thomas Bridge

Examples of long span bridge retrofit technologies

Use of fused connections

Shear Link Beams

sensors



Hinge Pipe Beams

California State Highway System Earthquake Planning and Response

Peer Review

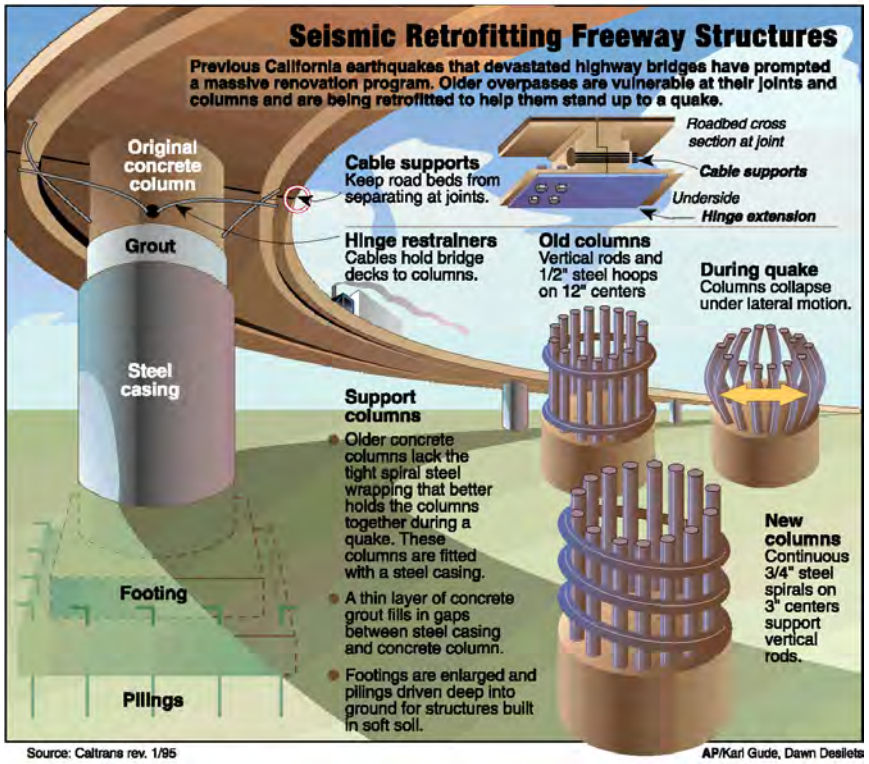
California State Highway System Earthquake Planning and Response

Planning, Response and Recovery

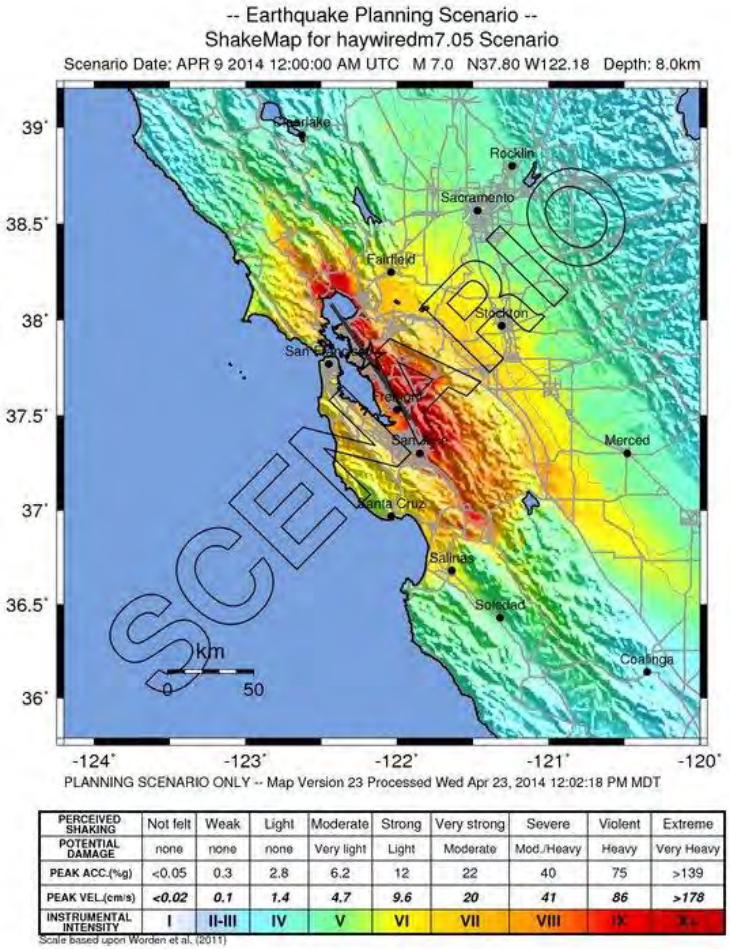
ASSESSING DISASTER RISK - ECONOMIC STUDY
REGIONAL RESILIENCY ASSESSMENT PROGRAM (RRAP)

- **Caltrans is working with the U.S. Department of Homeland Security on a Regional Resiliency Assessment Program (RRAP) Project**
- **RRAP focuses on goods movement through high hazard areas from the Port of Long Beach through the**

  Cajon Pass (I-15) to the State of Nevada - 390 kilometers



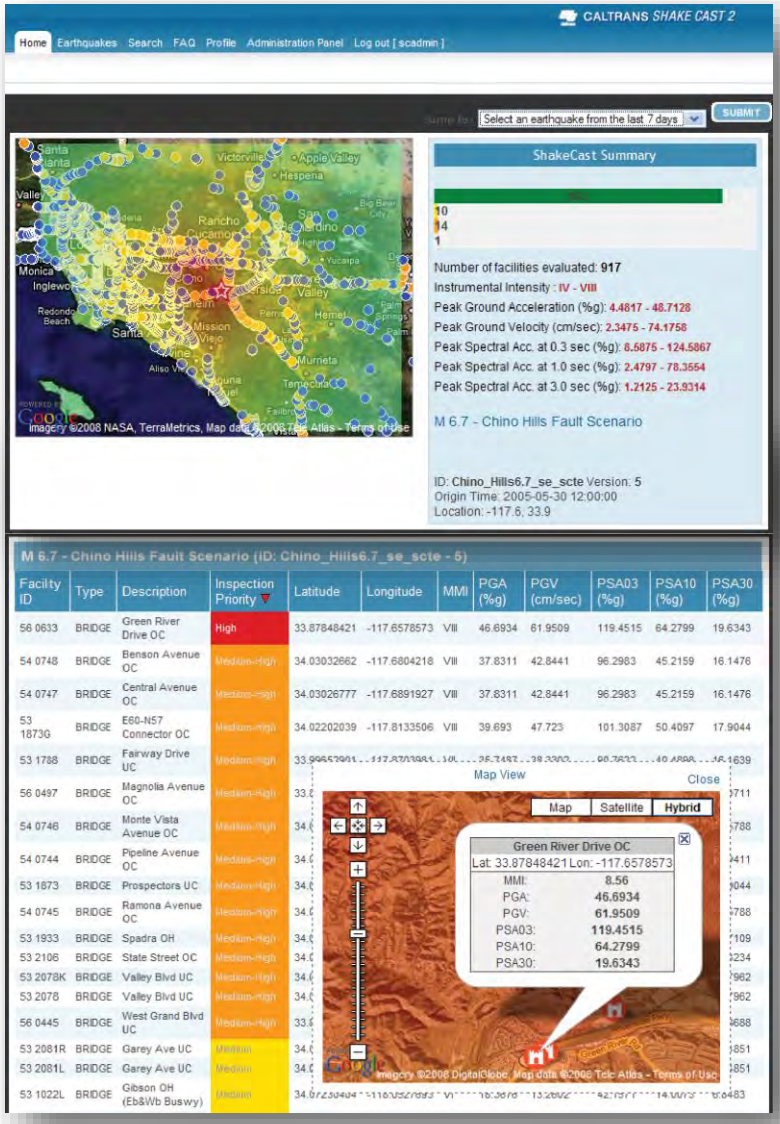
ASSESSING DISASTER RISK - ECONOMIC STUDY
U.S. GEOLOGICAL SURVEY
SAFRR - SCIENCE APPLICATION FOR RISK REDUCTION
HAYWIRED SCENARIO



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

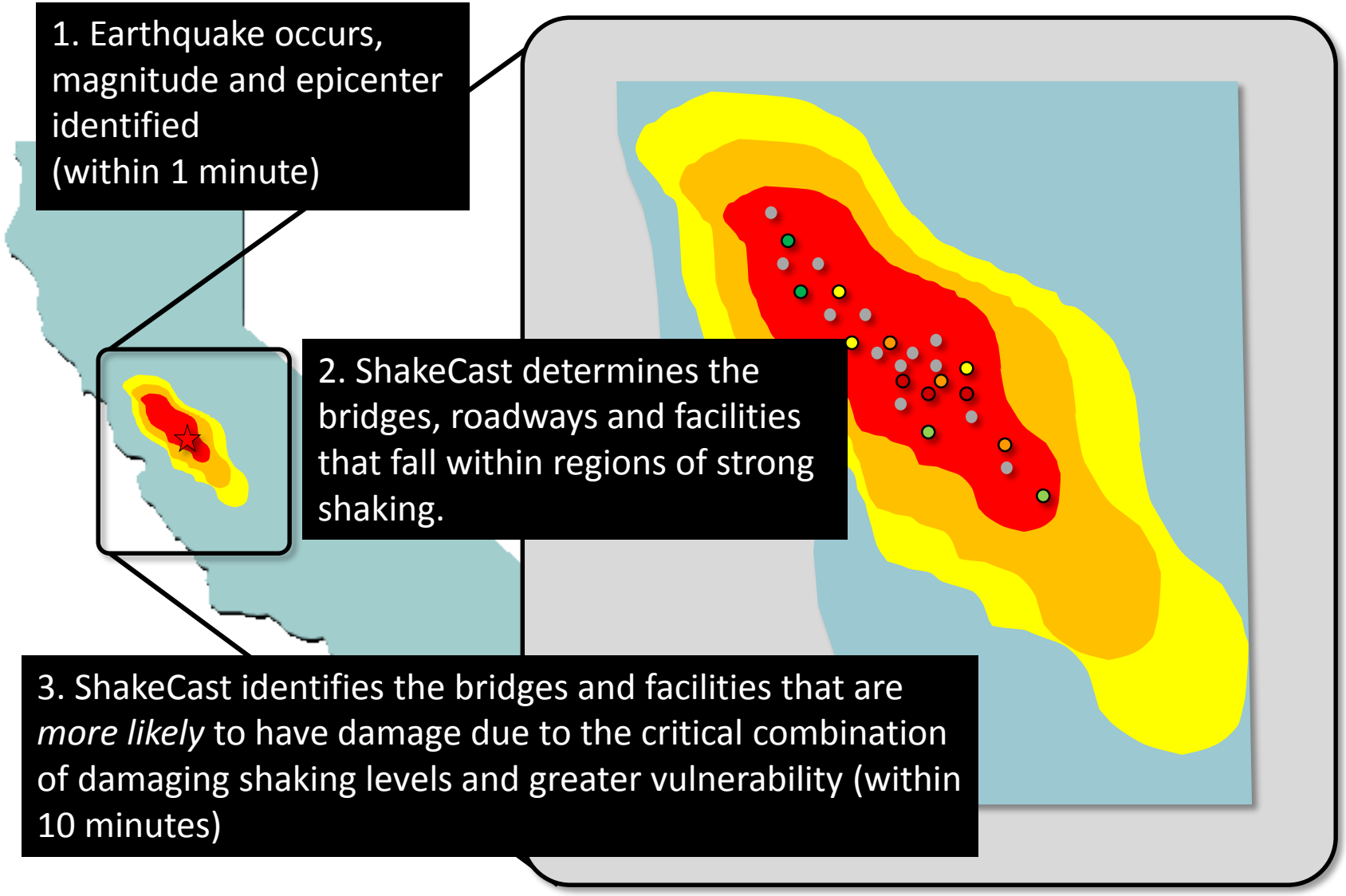
Scale based upon Worden et al. (2011)

What is ShakeCast?



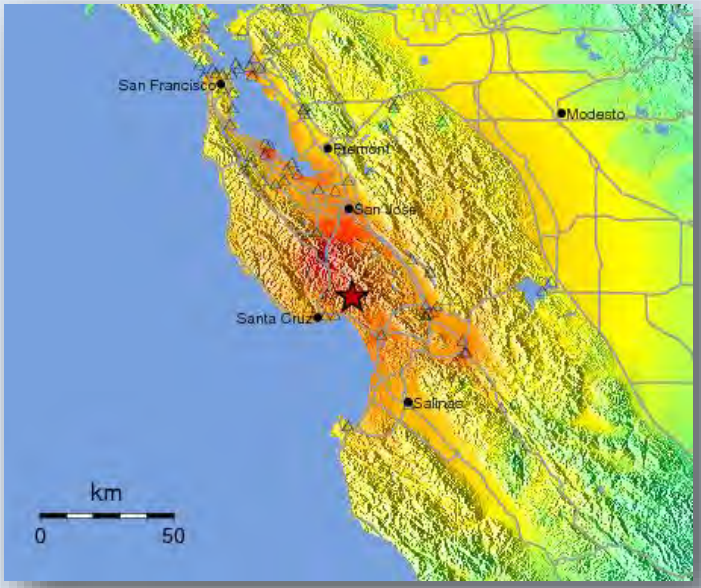
- An application for automating ShakeMap delivery to critical users.
- Real-time alert that provides first responders with notifications and information immediately following earthquakes and helps direct and prioritize emergency bridge, roadway and facility inspections. Retrieves measured shaking data within minutes after an earthquake.
- Planning tool used to generate scenario earthquakes for evaluating system performance and supply chain response capabilities.
- Represents the most reliable information within the first minutes to hours following an event.
- Sends notifications to responders within 10 minutes following the event.
- Developed by the USGS in 2003.
- Caltrans-USGS work resulted in *ShakeCast 2.0* in 2008, and has since been adopted by others.
- *ShakeCast 3.0* (beta) is now available.
- Open-source web application.

ShakeCast Process



How Does ShakeCast Work?

Earthquake shaking forces exerted on bridges, roadway and facility locations are determined from USGS *ShakeMap*. At each bridge, roadway and facility location, ShakeCast analyzes the measured/interpolated ground motion against a pre-determined fragility model.



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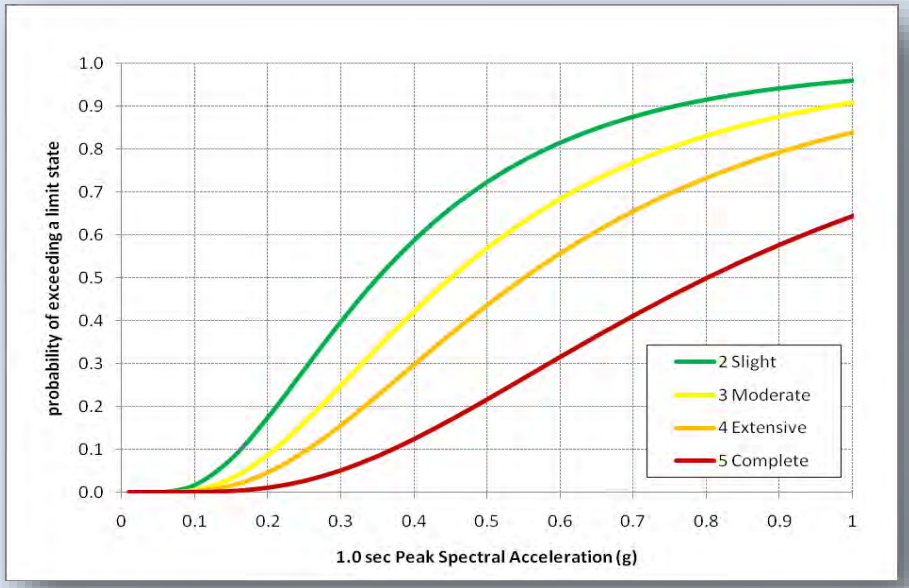
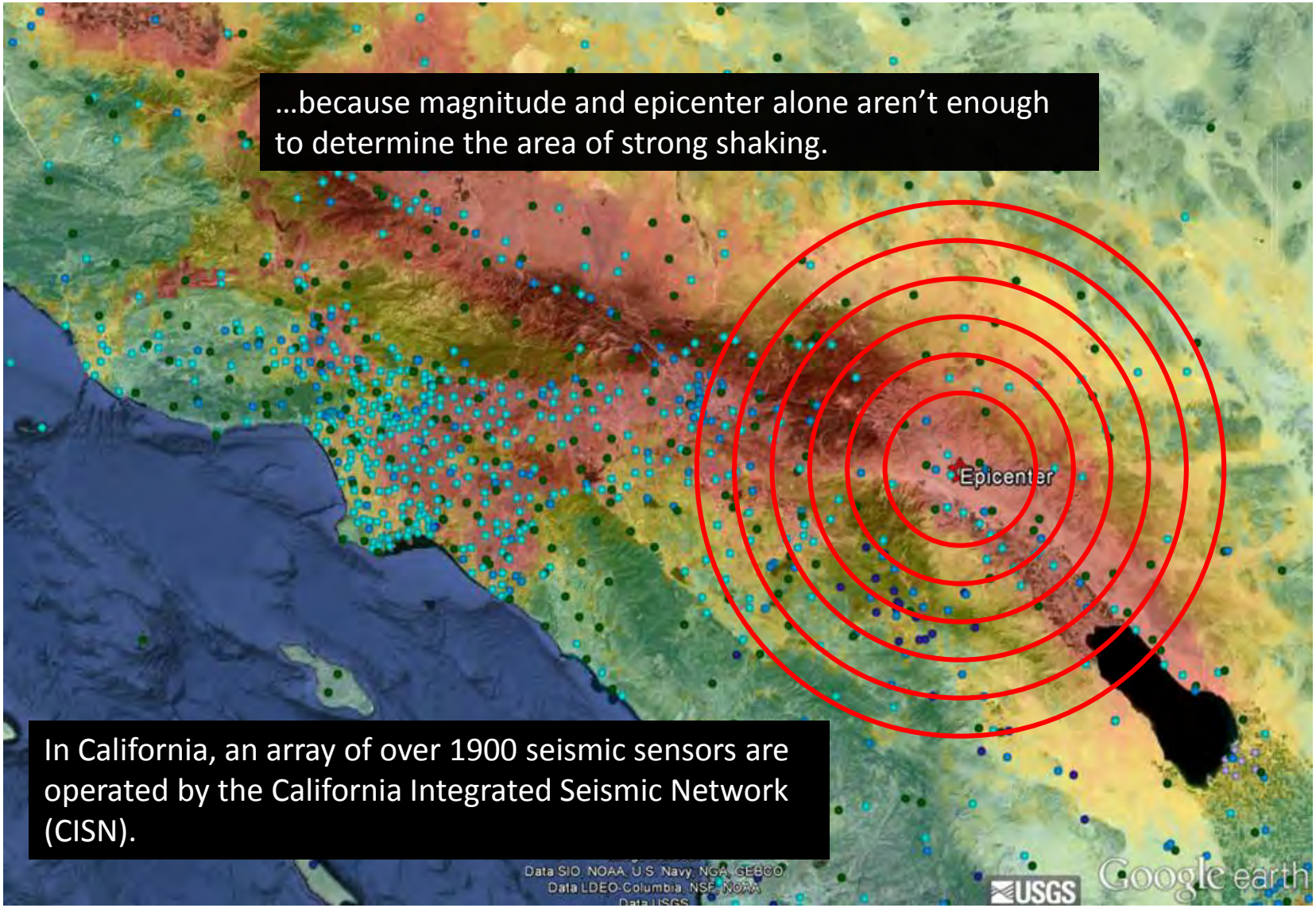


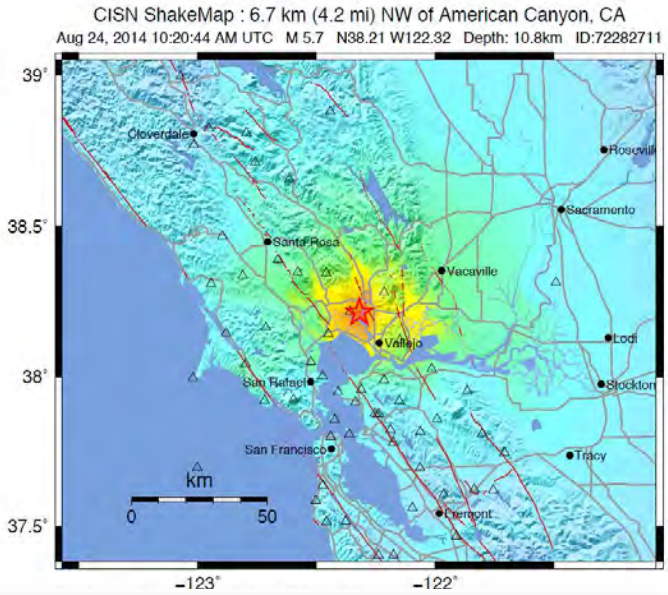
Probabilities of damage relative to varying levels of shaking (or "fragility") can be determined in advance for each bridge.

Why use ShakeMap?



ShakeCast At Work

ShakeCast identified the 9 bridges that sustained minor damage. These bridges were in the top 40% of a ShakeCast list of 87 bridges. Over 2700 state bridges were in the area.



Bridge Assessment Summary

Maximum Peak 1.0 sec Spectral Acceleration: **30.76%g**
Maximum Acceleration: **(not measured)**
Total number of bridges assessed: **87**
Summary by inspection priority:

High	(none)	High Priority for full engineering assessment
Medium-High	(none)	Medium-High Priority for full engineering asses
Medium	(none)	Medium Priority for full engineering assessmen
Low	87	Low Priority for full engineering assessment; qu sufficient.

Bridge Assessment Details

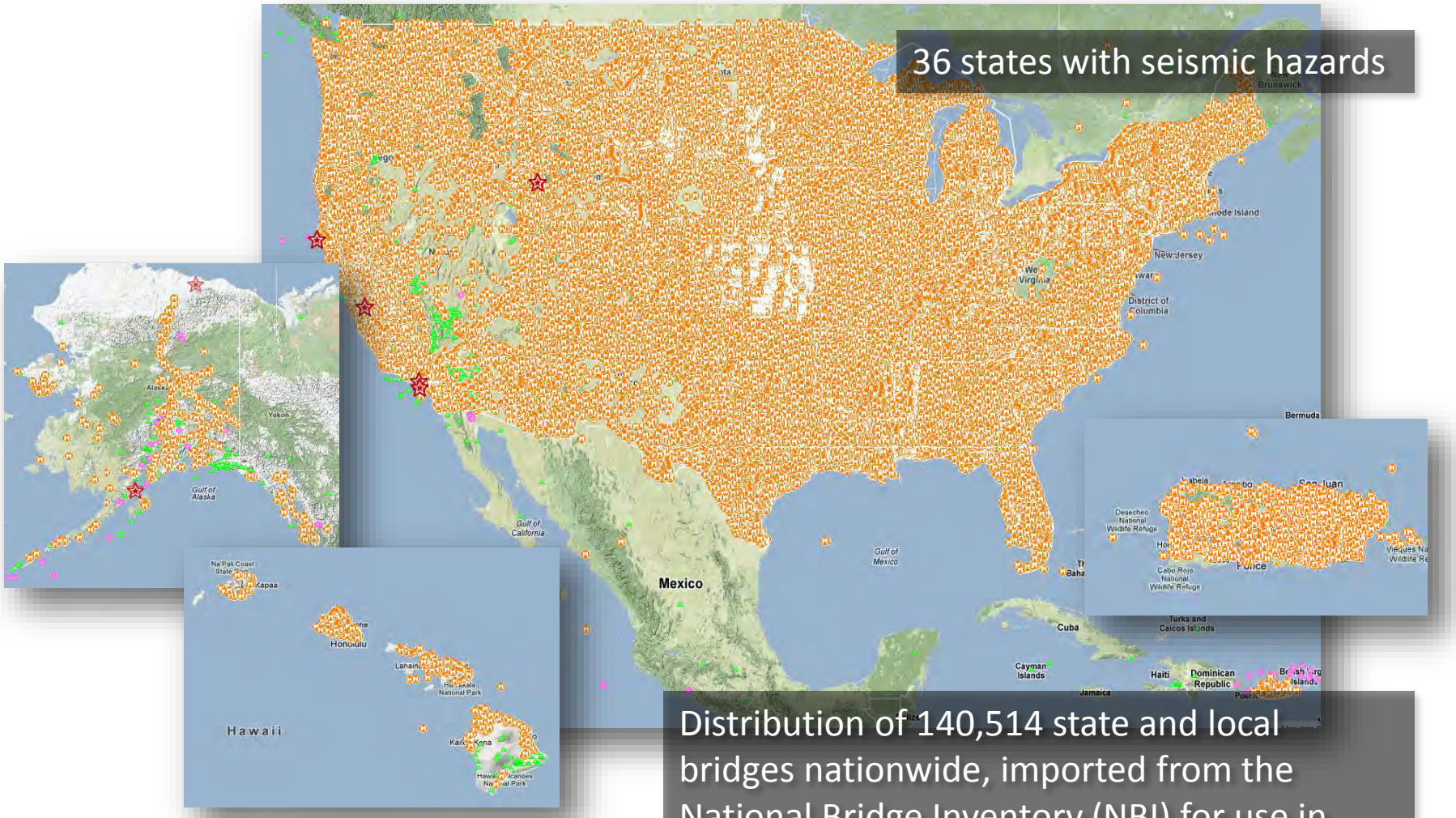
Bridges presented in the table below are sorted in order of severity of impac includes all state bridges in the area of shaking where the 1sec Peak Spectra

Bridge Name	Bridge Number	Dist-Cty-Rte-PM	Inspectio Priority
21 0049 - NAPA RIVER BOH	21 0049	04-NAP-029-R6.99	Low
21 0098 - STANLEY	21 0098	04-NAP-029-R8.33	Low

Exercises, Planning and Training

ShakeCast ‘canned’ maps are available for planning, exercise, and training use. Evaluating system performance and supply chain response capabilities before the earthquake occurs.

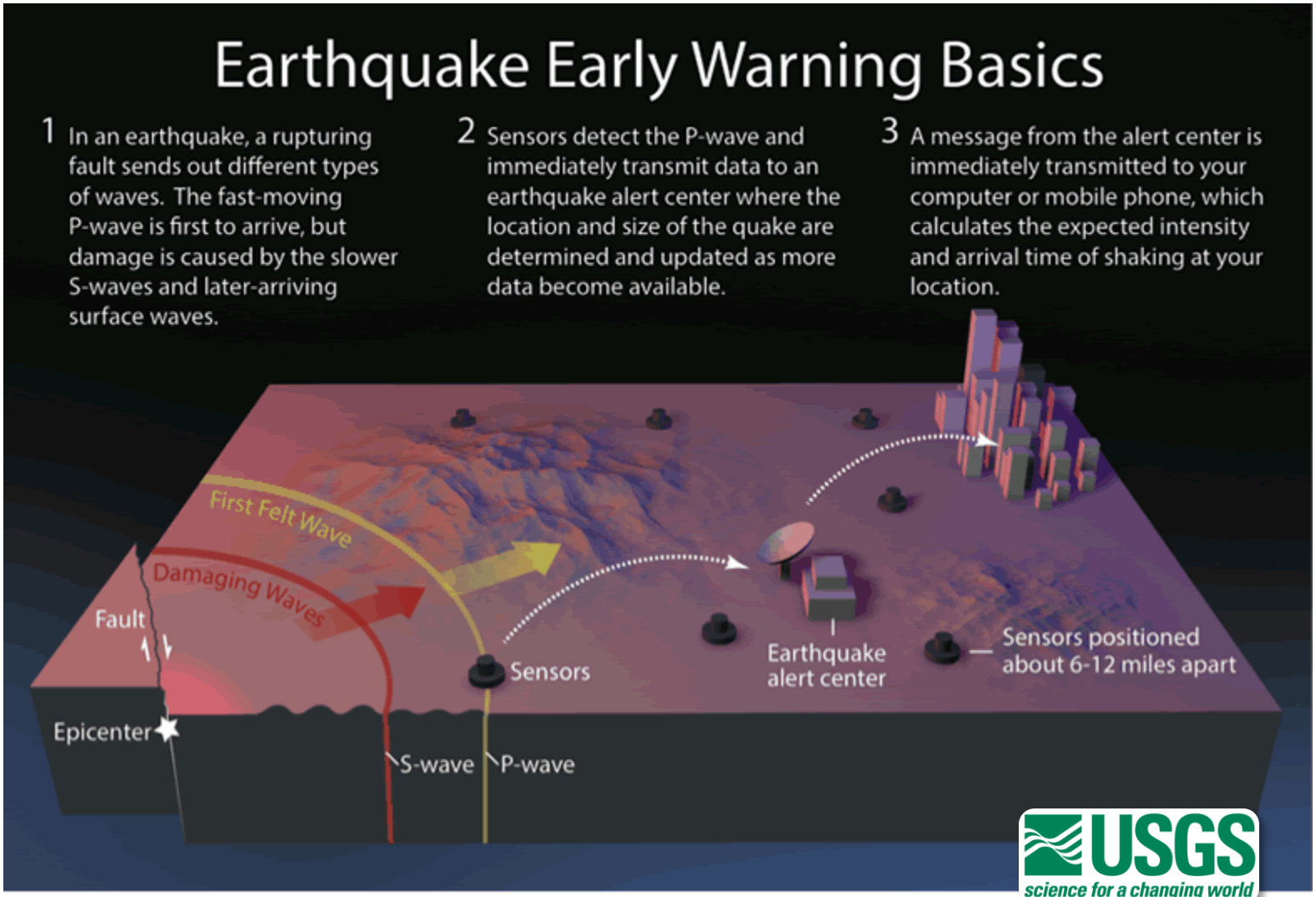
Implementing ShakeCast Nationally



Interested in Getting Your DOT Started With ShakeCast?

- Get your DOT involved in the Transportation Pooled Fund project.
  - TPF Solicitation 1406, *"Connecting the DOTs: Implementing ShakeCast Across Multiple State Departments of Transportation for Rapid Post-Earthquake Response"* (http://www.pooledfund.org/Details/Solicitation/1406)
  - $15k/year per participating state for 3 years ($45k total).
  - Begins late 2016.
  - Provides USGS support to get your state operational with ShakeCast.
  - Guide development of new software features.
  - Collaborate with partner states in ShakeCast deployments.
- Engage the key decision-makers and managers within your DOT for support – State Bridge Engineer, Emergency Operations Manager, Research Coordinator.
- Contact Loren Turner about upcoming project planning meetings (loren.turner@dot.ca.gov)

Earthquake Early Warning (EEW)



California State Highway System Earthquake Planning and Response

Key Points

Thank You!

California Department of Transportation
Office of Emergency Management
Division of Maintenance
We're Here to Get you There!

All Roads ... All Codes?

No Roads ... No Codes!