ShakeⳆlert™

Preparing for the Big One: Integrating Earthquake Early Warning Technology into Your Infrastructure

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What is the ShakeAlert Earthquake Early Warning System?

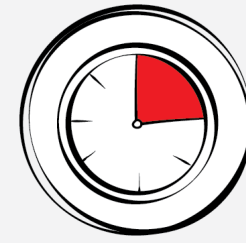ShakeAlert is the U.S. Geological Survey's earthquake early warning system.

Saves lives and minimizes injuries

Reduces earthquake damage to property and infrastructure systems
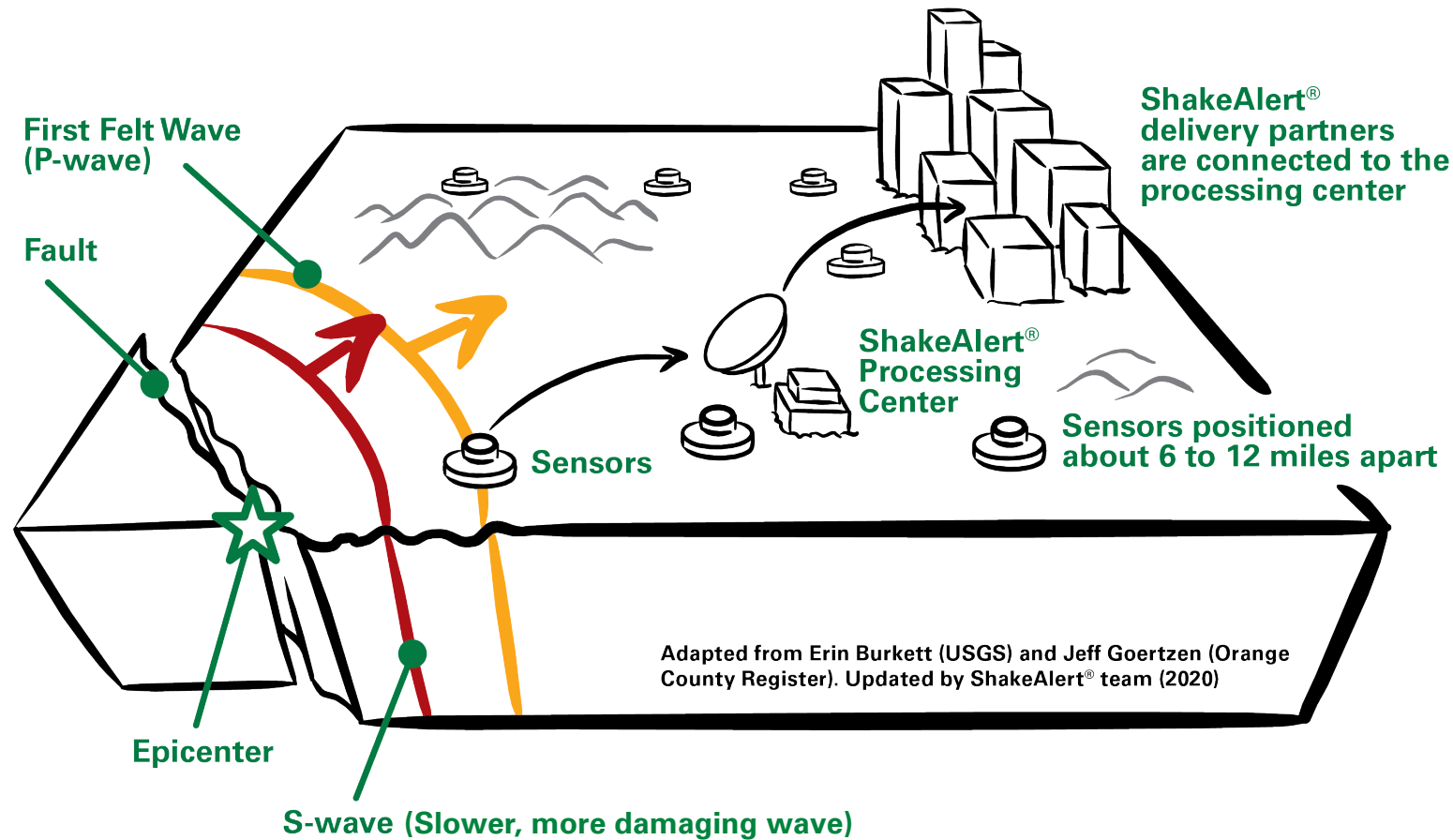
Reduces economic impacts of earthquakes

Speeds the return to normal operations and community recovery

ShakeAlert detects earthquakes quickly so alerts can be sent to people before they feel shaking. It is available in **Oregon, Washington, and California.**

ShakeAlert® EARTHQUAKE EARLY WARNING BASICS

First Felt Wave (P-wave)

Fault

ShakeAlert® delivery partners are connected to the processing center

ShakeAlert® Processing Center

Sensors

Sensors positioned about 6 to 12 miles apart

Adapted from Erin Burkett (USGS) and Jeff Goertzen (Orange County Register). Updated by ShakeAlert® team (2020)

Epicenter

S-wave (Slower, more damaging wave)

1. During an earthquake, a rupturing fault sends out different types of waves. The fast-moving P-wave is first to arrive, followed by the slower S-wave and later-arriving surface waves.

2. Sensors detect the P-wave and immediately transmit data to a ShakeAlert® processing center where the location, size, and estimated shaking of the quake are determined. If the earthquake fits the right profile a ShakeAlert® Message is issued by the USGS.

3. A ShakeAlert® Message is then picked up by delivery partners (such as a transportation agency) that could be used to produce an alert to notify people to take a protective action such as **DROP, COVER, AND HOLD ON** and/or trigger an automated action such as slowing a train.

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How Much Warning Time Does ShakeAlert EEW Provide?

Likely warning times generally range from **seconds to tens of seconds** before strong shaking arrives.

The amount of warning ShakeAlert EEW provides depends on a few factors:

- **Distance from Epicenter:** Warning time increases with distance from epicenter, with areas very close to epicenter possibly receiving late alert.

- **Type of Earthquake:** Crustal fault earthquakes provide less warning time than subduction zone earthquakes.

- **Customized Alerting Thresholds:** Earthquakes grow in magnitude over time, so setting a lower alerting threshold will provide more warning time.

What Types of Alerts Can ShakeAlert Deliver?

Earthquake early warning alerts can be delivered via existing internal communications systems:

- Two-way radio systems
- WIN911 alarm systems
- Fire alarm boxes
- Computer screens
- Electronic message boards
- Paging systems
- Mass notification systems
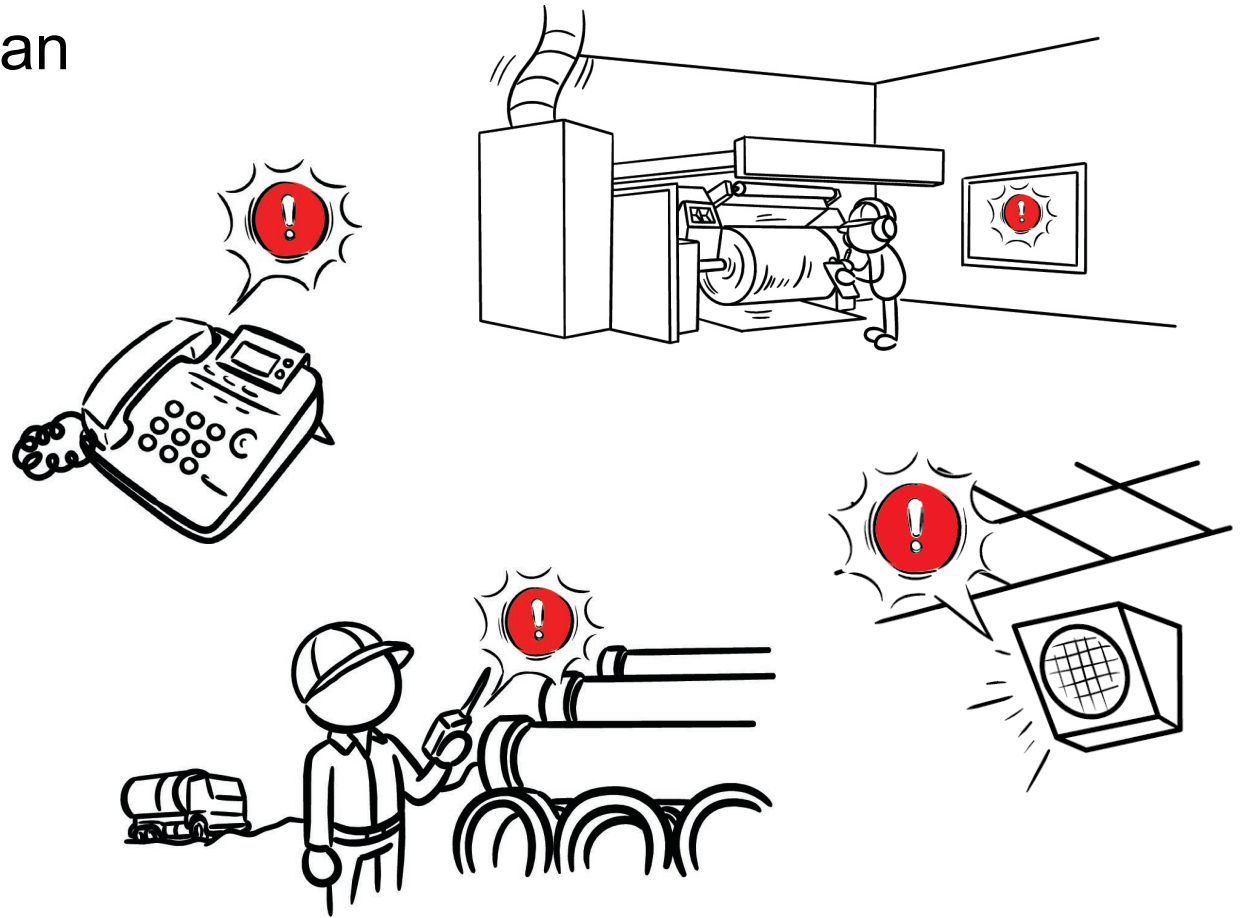
What Other Pre-Programmed Actions Can ShakeAlert Trigger?

SCADA systems can be programmed to trigger actions that protect critical infrastructure upon earthquake detection, including:

- Throttling reservoir outlet valves or liquid oxygen tank valves

- Activating emergency generators

- Slowing down pumps to prevent shaking-induced damage

- Isolating vulnerable sections of pipelines
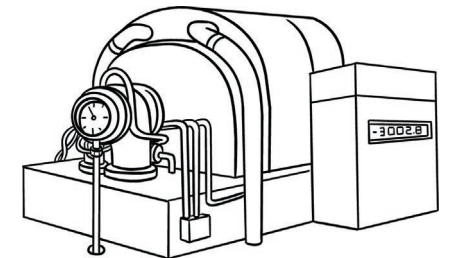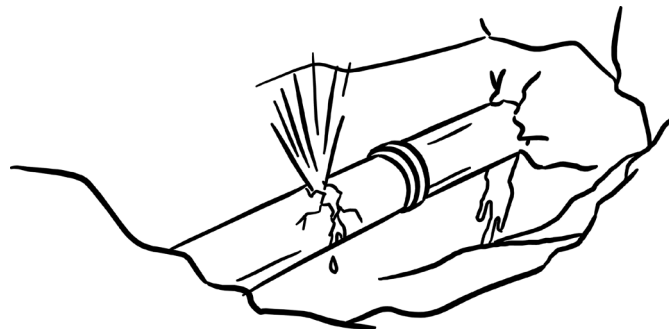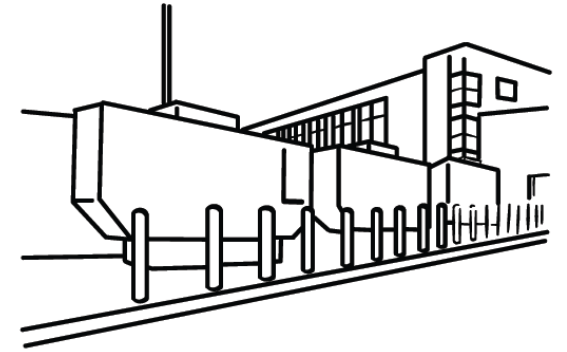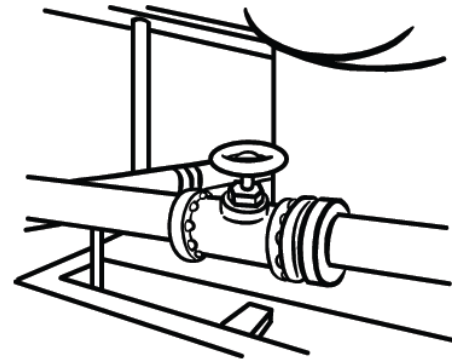
Selecting Opportunities for Using ShakeAlert Technology

Each utility that partners with the ShakeAlert System can choose which alerts and other pre-programmed actions to trigger upon earthquake detection!

Questions to Consider:

- Where will you get the biggest bang for your buck?

- Which facilities, systems, or equipment must be protected to avoid cascading impacts to entire water/wastewater system?

- Can you take a phased approach?

- What actions are fault-tolerant and reversible when shaking stops?

Customizing ShakeAlert Alerting Thresholds

To Alert People

	Who is Alerted	Magnitude Threshold	Intensity Threshold
Automated Alerts through Public Address Systems, Lights, Sirens, In-House Apps, etc.	Institutions that use ShakeAlert to alert people to take a protective action	4.0+	MMI III+

To Alert Systems and Machines

|	Who is Alerted	Magnitude Threshold	Intensity Threshold
Automated "Machine-to-Machine" Alerts	Institutions that use ShakeAlert to automate actions to mitigate damage to vital equipment, systems, and infrastructure	4.0+	MMI III+

Yes! Customizable alerting thresholds allow control systems to deliver targeted results based unique vulnerabilities and existing infrastructure.

Getting Started with ShakeAlert: USGS and Technical Partners
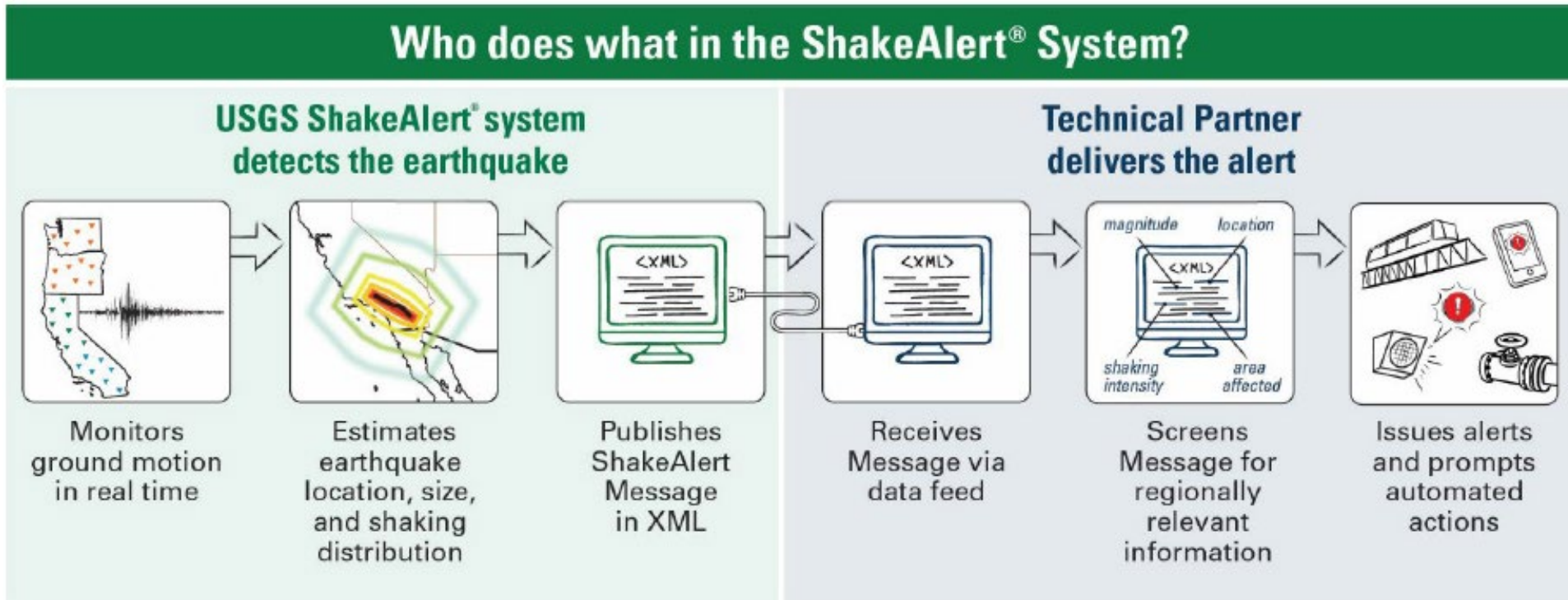
USGS detects earthquakes and publishes data on message servers.
Partners subscribe to servers and use this data to trigger alerts/actions.

**Choose Your Pathway to Connect to ShakeAlert**

Path 1: Build your own alert delivery system and become a licensed-to-operate technical partner of the ShakeAlert system.

Path 2: Contract a licensed vendor of ShakeAlert-powered technology to build an alert delivery system for you.

Both paths: ShakeAlert Engagement Coordinators can answer questions and assist with project development.

Path 1: Build Your Own Alert Delivery System

Utilities must complete a licensing pathway to start delivering alerts.
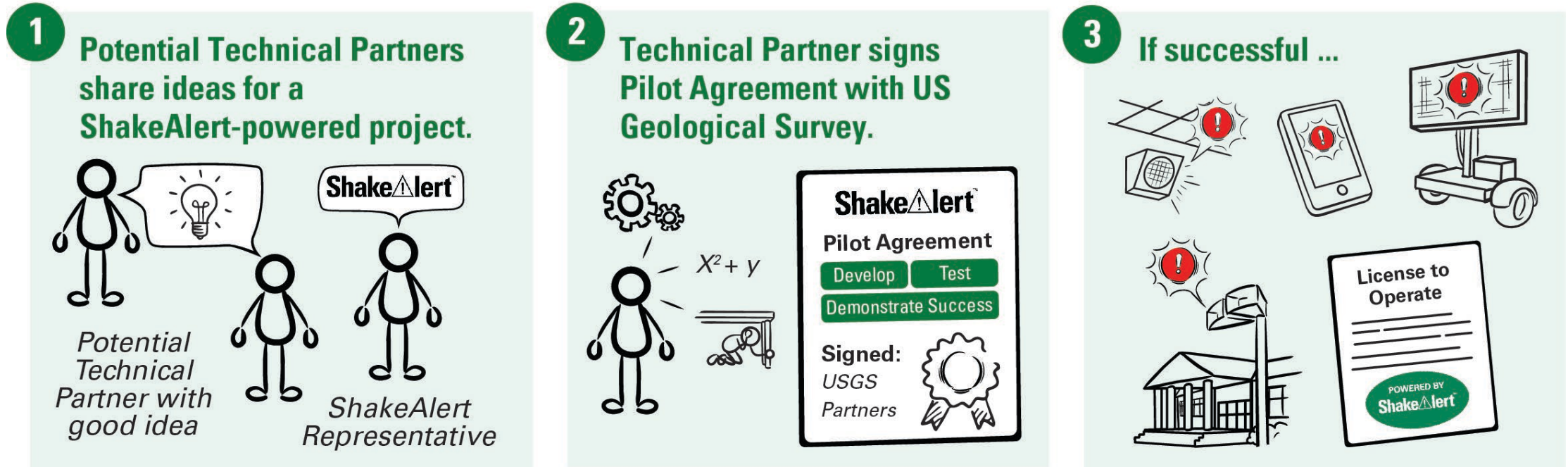
What Performance Standards Must Technical Partners Meet?

1. **Alerts and automated actions must be fast enough to be effective.**

   Latency and performance measurements and benchmarks must be demonstrated; LtO Technical Partners must receive, process, and distribute alerts to end-users in no more than five (5) seconds for at least 95 percent of end-users.

2. **Redundancies, automatic failover, and monitoring must be demonstrated for system reliability.**

   For LtO conversion, Technical Partners must: demonstrate an ability to detect and recover USGS server connectivity; demonstrate failover and redundancy capabilities; maintain system security; demonstrate state-of-health monitoring; and other criteria outlined in the ShakeAlert Technical Performance Review Criteria.

3. **ShakeAlert Message handling criteria must be met.**

   Technical Partners conduct stress tests and demonstrate that their system can process the maximum expected Message volume and handle automated ShakeAlert Message updates and follow-up Messages.

Testing and Development Resources for Prospective Partners

Partners obtain free connection to ShakeAlert servers as well as free access to testing/development tools:

- Subscription endpoints

- Server protocols

- Example code and alert messages

- Scenario server access to test your system with simulated earthquakes

- Quarterly R&D forums to ask questions and learn about updates

Path 1: Build Your Own Alert Delivery System
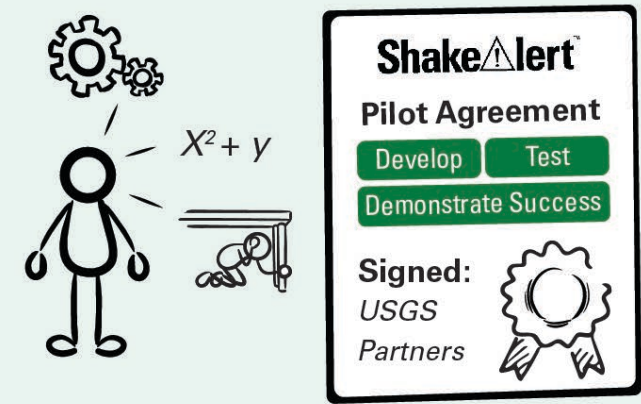
① Potential Technical Partners share ideas for a ShakeAlert-powered project.

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Potential Technical Partner with good idea

ShakeAlert Representative

② Technical Partner signs Pilot Agreement with US Geological Survey.

$X^2 + y$

ShakeAlert™
Pilot Agreement
Develop | Test
Demonstrate Success
Signed:
USGS
Partners

③ If successful ...

License to Operate

POWERED BY
ShakeAlert™

Pros: Free server connection and development tools

Cons: Time/skills needed to build system and complete licensing pathway

Case Study 1: Building In-House Alert Delivery System

The Challenge:

- Water and electric utility concerned that earthquake would damage earthen canals that channel water to hydroelectric projects, as well as turbines that generate electricity.

The Opportunity:

- Integrating ShakeAlert into Hazard Mitigation Control System could proactively prevent damage when significant shaking is expected.

Case Study 1: Building In-House Alert Delivery System

The Project:

- New process logic control system integrates ShakeAlert into HMCS
- Close canal intake gates and open outlet gates to prevent breaches, overtopping, and flooding
- Trip generating units at hydroelectric facilities to slow down turbines

The Cost:

- Time and labor for programming

Path 2: Pay a Licensed Vendor to Build Your Alert Delivery System

- All vendors have met the U.S. Geological Survey's performance standards
- Vendor descriptions and contact information is available at *tinyurl.com/ CurrentShakeAlertPartners*
- Reach out to obtain quotes (costs vary depending on scale of project)

Path 2: Pay a Licensed Vendor to Build Your Alert Delivery System

Pros:

- Faster to implement because no need to complete licensing pathway

- Work with companies with existing expertise in ShakeAlert technology

Cons:

- Direct upfront installation costs

- Possibility of ongoing subscription and maintenance costs

Case Study 2: Contracting a Licensed-to-Operate Vendor

The Challenge:

- Earthquakes can damage pipes, leading to uncontrolled releases of water that is needed for human consumption and fire protection.

The Opportunity:

- ShakeAlert enables utilities to close valves at critical locations before power is lost or infrastructure is damaged.

Case Study 2: Contracting a Licensed-to-Operate Vendor

The Project:

- Water utility uses ShakeAlert to automatically close reservoir output valves (takes less than 1 minute)

- Valves will close partially or fully depending on pre-set thresholds

- Next step is integration into water treatment plant to slow pumps

The Cost:

- $17,000 from 2018-2022

Path 2: Funding Your ShakeAlert Implementation

Federal and State Grant Opportunities

- Apply for FEMA grants (Hazard Mitigation Grant Program, Building Resilient Infrastructure and Communities) through your local emergency manager

- Ex. a water-wastewater utility in WA received HMGP funds to improve their pump stations' seismic resilience and is using part of these funds to purchase ShakeAlert technology

Rate-Funded Capitol Improvement Projects

- Integrating ShakeAlert technology may have a negligible impact on water and sewer rates for customers

Securing Buy-In From Leadership for Implementing ShakeAlert

Every **$1 spent on resilience saves $4** during post-disaster recovery:

- What would be the daily cost of not providing water or sewer services?

- How much would it cost to replace mission-critical equipment if they were damaged by shaking?

ShakeAlert is a long-term investment in emergency preparedness, and it enables utilities to continue providing critical services after a disaster.

SMART INVESTING
MITIGATION SAVES

EVERY $1 SPENT ON MITIGATION SAVES **$4** ON FUTURE DISASTER LOSSES

Natural Hazard Mitigation Saves: 2017 Interim Report
nibs.org/mitigationsaves

National Institute of BUILDING SCIENCES   FEMA

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Three Ways to Receive ShakeAlert-Powered Cell Phone Alerts

Wireless Emergency Alerts

- Sent automatically like an AMBER alert
- Enable Emergency Alerts on your phone
- May be slower than other alerting methods

Google Android Operating System

- Make sure your operated system is updated

Mobile Apps

- MyShake and QuakeAlertUSA in Oregon

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How to Receive Earthquake Early Warning Alerts on Your Phone

Wireless Emergency Alerts

- Like AMBER alerts: no need to sign up, but ensure emergency alerts are enabled

- Text-based alerts delivered to everyone in affected area

- May be slower form of alerting

| Who is Alerted	Magnitude Threshold	Intensity Threshold
General public with WEA-capable devices	5.0+	MMI IV+

How to Receive Earthquake Early Warning Alerts on Your Phone

Android Operating System Alerts

- Delivered to all Android phones in affected area

- No need to sign up, but ensure that operating system is updated

Who is Alerted	Magnitude Threshold	Intensity Threshold
Android cell phone users through push notifications	4.5+	MMI III - MMI IV
Android cell phone users through full-screen takeover	4.5+	MMI V+
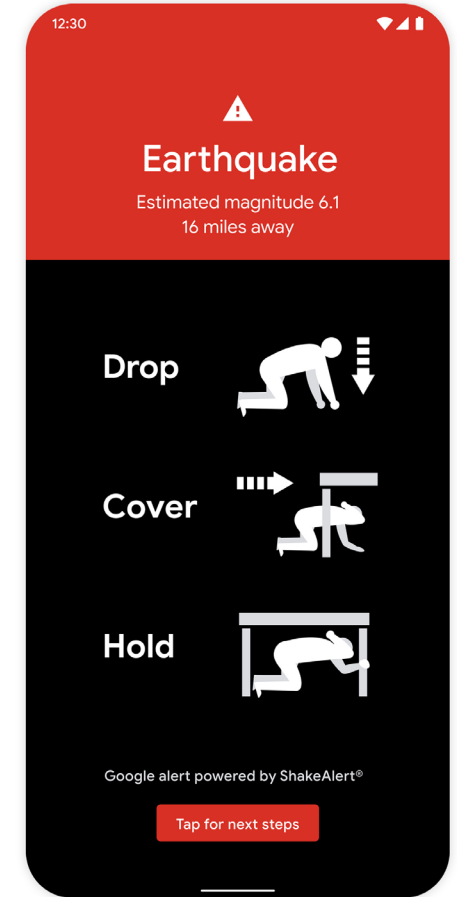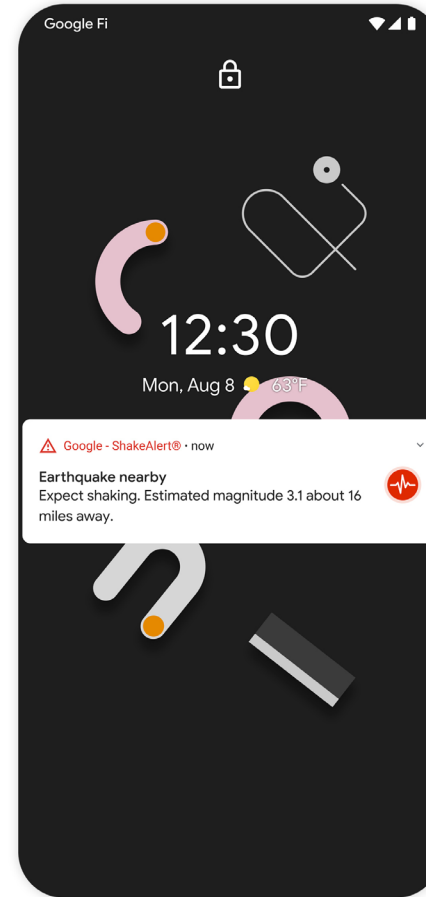
How to Receive Earthquake Early Warning Alerts on Your Phone

Free Downloadable Apps
MyShake and QuakeAlertUSA

- Push notifications to app users only

- Apps contain additional features like customizable alert thresholds, countdown timers, and reports of anticipated local damage
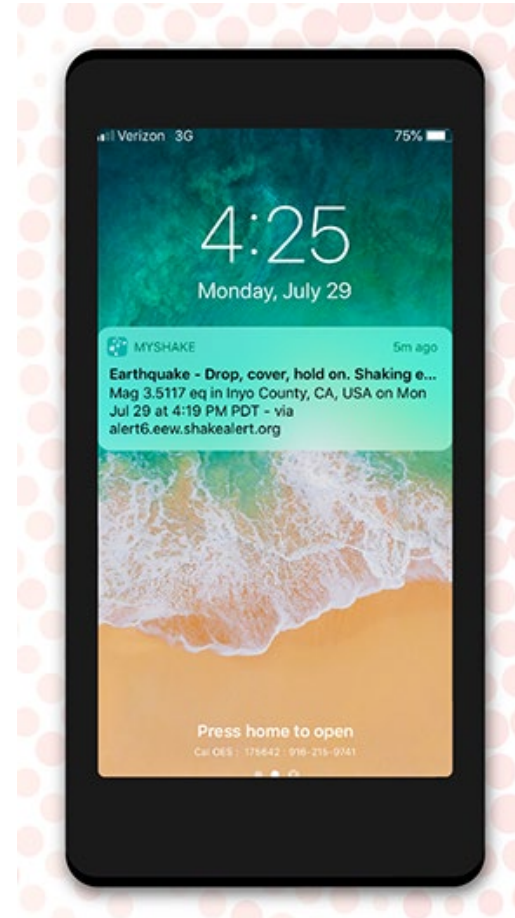
Who is Alerted	Magnitude Threshold	Intensity Threshold
People who have downloaded a cell phone app	4.5+	MMI III+ (user selectable)

Thank you for listening!

Reach out with questions, ideas,
or to learn more about next steps for
implementation!

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