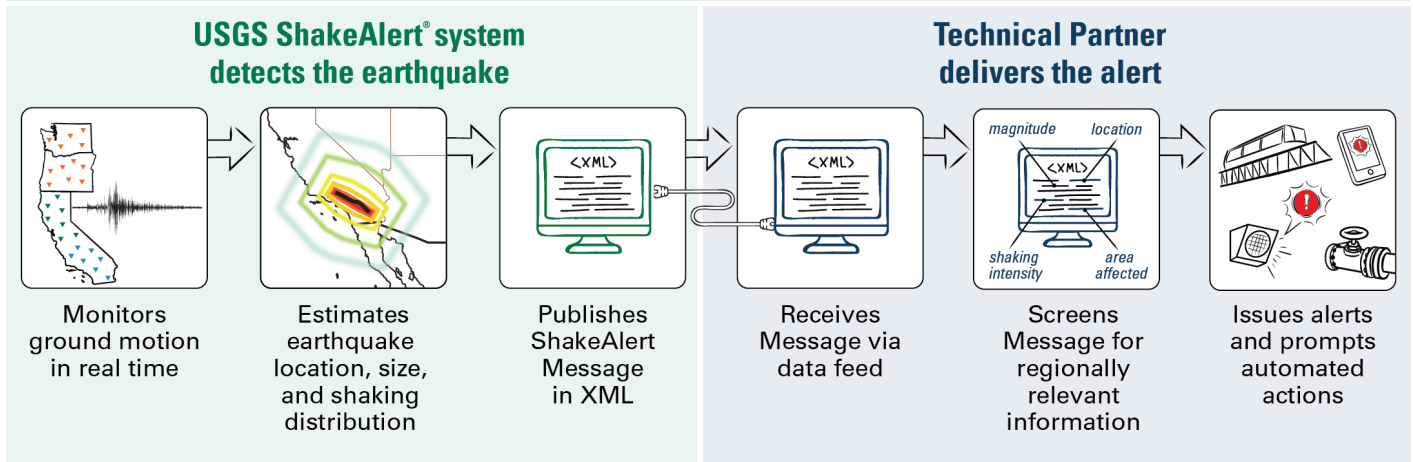# Technical Engagement Start-Up Guide

This Technical Engagement Start-Up Guide is designed to inform prospective ShakeAlert Technical Partners about the ShakeAlert® Earthquake Early Warning System as they consider a Technical Partnership with the U.S. Geological Survey (USGS). This Start-Up Guide describes the flow of information from the USGS to Technical Partners, the contents of ShakeAlert Messages, and considerations to help assess technical needs and requirements of a ShakeAlert Technical Partnership.

Information Flow from the USGS to the Technical Partner

USGS ROLE: The USGS uses information from a network of seismic and geodetic sensors to estimate the location, size (magnitude), and shaking distribution of an earthquake and is published in an XML-formatted data package called a ShakeAlert Message. XML is a structured plain-text format.

TECHNICAL PARTNER ROLE: Technical Partners develop alert delivery and automated control solutions based on ShakeAlert Messages published by the USGS. Technical Partners subscribe to USGS ShakeAlert Message servers (*"Alert Layer" ActiveMQ brokers*) and monitor them continuously for ShakeAlert Messages as they are published. When a Technical Partner receives Messages, they use the ShakeAlert-published shaking estimates to alert end-users — either to people who can take a protective action, or to initiate automated controls via machine-to-machine actions.

Who Does What in the ShakeAlert® System?

USGS ShakeAlert® system detects the earthquake

| Monitors ground motion in real time | Estimates earthquake location, size, and shaking distribution | Publishes ShakeAlert Message in XML |

Technical Partner delivers the alert

| Receives Message via data feed | Screens Message for regionally relevant information | Issues alerts and prompts automated actions |

USGS 03.2025

Note: When referring to "system" vs "System," lowercase "s" refers to the USGS part of the operation (sensors and processing centers), and uppercase "S" refers to the USGS part and the alert delivery Technical Partners (i.e., the entire System).

What is a ShakeAlert Message?

The USGS ShakeAlert system (USGS) publishes ShakeAlert Messages in XML format on its alert servers. These data Messages contain estimated earthquake magnitude, location, and (for some Message types) the areal distribution of expected shaking intensity levels. The first Message of any type is labeled with a Message-type of "New," and updates — labeled with a Message-type of "Update" — follow rapidly, as more sensors detect the earthquake. Minutes after the final update, the results of a human review are published with a Message-type of "Follow-up."

ShakeAlert Messages have three components, as described in the diagram below. Technical Partners may subscribe to one or more components.

ShakeAlert® Messages Have Three Components
Technical Partners can subscribe to one or more components

1

EVENT ONLY

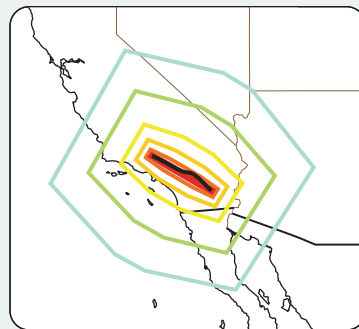*ActiveMQ "topic": eew.dm.data*

Provides estimated earthquake **magnitude** and **location**, along with uncertainty. For earthquakes M6.0+, **fault geometry** is included.

Technical Partner must calculate shaking effects and affected areas.

2

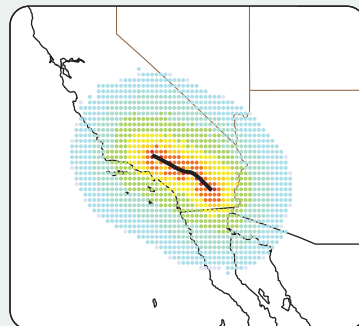**EVENT + CONTOUR**

ActiveMQ "topic": eew.gm-contour.data

Contains **Event Component** plus data for **contours of shaking intensity**.

Polygons enclose areas according to estimated Modified Mercali Intensity (MMI), Peak Ground Acceleration (PGA), and Peak Ground Velocity (PGV).

3

EVENT + GRID

ActiveMQ "topic": eew.gm-map.data

Contains **Event Component** plus data for a **grid map of shaking intensities**.

Grid cells are 0.2 x 0.2 degree (~20 x 20 km) identified by latitude and longitude.

Figures derived from: Given, D.D. et al, "Revised technical implementation plan for the ShakeAlert system—An earthquake early warning system for the West Coast of the United States" (2018), https://doi.org/10.3133/ofr20181155

2

Technical and Coding Considerations

☐ **Provide performance information to the USGS**: Technical Partners are expected to provide basic performance information for their applications to the USGS after alerts are delivered, including whether an alert was communicated to end-users, when it was communicated, and how many end-users or locations were targeted. For earthquake early warning applications, the USGS requires Technical Partners to send alerts to 95% of end-users within five (5) seconds of the Technical Partner's receipt of the ShakeAlert Message.

☐ **Plan for ShakeAlert Message updates**: Magnitude and location estimates can change as more stations contribute data and the earthquake grows. The number of updates could reach 20 or more over a period of less than a minute for a large event.

☐ **Be prepared to adjust**: ShakeAlert Message updates mean that estimated magnitudes and/or shaking intensities can change. For example, the magnitude could start below an alert delivery threshold and grow to exceed it, or start above the alert threshold, but drop below it in later estimates. Estimates of location can also change quickly.

☐ **Plan for Post-ShakeAlert Message Follow-up Messages**: Follow-up Messages are sent after USGS human review and will come several minutes after the initial ShakeAlert Message. Follow-up Messages have a Message-type of "Follow-up," and contain one or more short, pre-written messages. Follow-up Messages will match an earlier event ID.

☐ **Plan for the possibility of a canceled ShakeAlert Message**: In rare occasions, the USGS might publish a ShakeAlert Message, even though there was no earthquake. A Follow-up Message labeled "Canceled" should be sent within minutes.

☐ **Plan to enable further actions based on sequential earthquakes**: Earthquakes can occur in rapid sequence and aftershocks can be either larger or smaller than the initial earthquake.

☐ **Plan to monitor and manage connections to ShakeAlert servers**: Network connections can fail. Plan to fail over and try another connection in a polling fashion over the six (6) ShakeAlert servers. Use the heartbeat aggregator to confirm connection to the ShakeAlert system.

☐ **Do not design systems with the expectation that end-user devices can connect directly to ShakeAlert servers**: The number of connections to USGS servers per Technical Partner is limited. Technical Partners who wish to distribute their product or service should be prepared to host their own alert redistribution infrastructure.

☐ **Understand and target only approved geographic areas**: ShakeAlert Messages contain shaking information that is agnostic of geographical borders. Technical Partners will need to clip sections of the contour that fall out of their approved alerting area to ensure they only alert where they are contractually allowed.

☐ **Follow the ShakeAlert XML schema's definition of "required" elements**: Your code should not fail if optional elements are present or missing, or if undefined elements are encountered. However, "required" elements must be included. This will improve backward compatibility and offer some protection if a Message is missing an optional element.

☐ **Test your implementation using past earthquakes**: A ShakeAlert Message test suite (the ShakeAlert Scenario Server) is available to test a range of realistic outputs from ShakeAlert.

ShakeAlert Resources on GitLab

ShakeAlert documentation and developer resources are available on GitLab, which is an open-source repository hosting platform. This is intended to provide ShakeAlert Technical Partners with accurate and timely information about how to connect to the ShakeAlert system and use ShakeAlert Messages. GitLab also houses other important information.

Among resources on the ShakeAlert GitLab platform are:

- ✓ Server and port information
- ✓ Example Alert Message in XML-formatted text
- ✓ Example Alert Message in CAP format
- ✓ Topic subscriptions
- ✓ Failover example code
- ✓ Scenario server tutorials

Access to GitLab is limited to USGS-approved and Licensed Technical Partners.

Partnership Agreements are available on the ShakeAlert website: shakealert.org/technical-partner-resources/shakealert-licensing-center/

Contact Us

Members of the ShakeAlert team are available to guide Technical Partners as they develop and implement ShakeAlert-powered products and/or services.
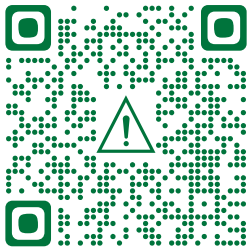
For more information, contact a ShakeAlert Technical Engagement Regional Coordinator. Contact information can be found at www.shakealert.org/technical-contact.