

ShakeAlert® Earthquake Early Warning in Rail Systems

Metrolink uses the USGS-managed ShakeAlert® Earthquake Early Warning (EEW) System to save lives and reduce injuries by slowing or stopping trains when shaking is expected.

Metrolink (Southern California Regional Rail Authority/SCRRA)* is a commuter rail system that operates in six densely populated southern California counties. Metrolink developed and implemented a way to integrate the ShakeAlert system with its Positive Train Control (PTC) system to automatically slow or stop trains to protect its riders, crews, and infrastructure.

• What is the ShakeAlert System?

The US Geological Survey-managed **ShakeAlert Earthquake Early Warning System** rapidly detects significant earthquakes, estimates the amount of shaking around the quake, and issues ShakeAlert Messages. Then, ShakeAlert Technical Partners, such as Metrolink, use the information contained in these Messages to deliver alerts and trigger automated actions to protect people, vital systems, and infrastructure.

• The Challenge and the Opportunity

Southern California is home to several faults that could be the source of devastating earthquakes. It is only a matter of time until the West Coast experiences a sizeable earthquake that results in harm to people, property, and vital transportation systems. Earthquakes also threaten to interrupt the continuity of services and supply chains that keep people, products, and the economy moving. Shaking from a significant earthquake can be dangerous in a rail setting, as strong ground motion can toss around passengers and crew, twist tracks, and derail train cars.

The potential seconds of advance warning enabled by ShakeAlert EEW allows rail systems to prepare for shaking and protect people by slowing or stopping trains.

METROLINK



Metrolink uses ShakeAlert-powered technology to automatically slow or stop trains when shaking is expected. Image is courtesy of Metrolink.

Rising to the Challenge

“No one knows exactly when or where earthquakes will occur or the harm they will cause. ShakeAlert technology enables automation that enhances safety across our network and offers protection to riders, crews, and infrastructure assets.”

Luis Carrasquero
Deputy Chief Operating Officer
Metrolink

• Getting Started with the ShakeAlert System

In 2015, Metrolink became the first passenger rail system in the nation to implement Global Positioning System-based PTC technology across its entire network. PTC technology can slow or stop trains to guard against train collisions, derailments, and over-speeding. Metrolink's leadership team saw the value of integrating ShakeAlert EEW with its PTC system to perform fully automated actions in the event of an earthquake.

Although it would be possible for train engineers to manually slow their trains when they receive a ShakeAlert-powered alert, Metrolink realized that full automation of this process would mitigate potential human error, including delayed reactions by crew operators.

Working with the California Department of Transportation's (Caltrans) Division of Rail, Metrolink's Earthquake Task Force sought out State transportation funding to make use of the ShakeAlert system. Caltrans fully funded the project, and the Task Force was able to reassure its leadership that the benefits of having ShakeAlert-powered technology during California's next big earthquake would far outweigh the challenges of implementation.

Using the data in ShakeAlert Messages, **Metrolink automatically slows or stops impacted trains within seconds of when the ShakeAlert system detects shaking**, thus reliably reducing the odds that an earthquake could threaten human safety and system infrastructure.

IMPLEMENTATION DETAILS

Metrolink developed the Commuter Railway Seismic Interface (CRSI), which integrates Metrolink's PTC technology and ShakeAlert Messages. Depending on the intensity of the shaking detected by the ShakeAlert system, the CRSI sends different directives to trains, detailing the required response. This can include instructions to reduce speed or to stop the train immediately outside of tunnels, bridges, or overpasses.

Metrolink is implementing this project in a multi-phased approach. Metrolink deployed an initial version of the CRSI in September 2021 for trains operating on its 91/Perris Valley line. In the initial phase, the CRSI processed the ShakeAlert Message data and sent an automated informational alert to train engineers via PTC. However, PTC did not automatically slow trains; crews had to act manually.

In May 2022, Metrolink deployed a new version of this system on its 91/Perris Valley line. Now, trains operating on this line receive enforceable PTC directives that automatically slow or stop trains at safe locations without the need for crew intervention. Each version release was extensively tested utilizing earthquake simulations. Metrolink expects to have ShakeAlert-powered technology integrated across its entire network by the end of 2022.

After shaking stops, Metrolink employs additional functions within the CRSI that produce a rapid post-earthquake report of its rail network's exposure to shaking. This allows repair crews to inspect for damaged assets and restore service as quickly and safely as possible.



Earthquakes can damage rail tracks, as shown in this 1935 image from the earthquake in Taichu-Shichiku, Japan. Metrolink uses ShakeAlert Messages to automatically slow or stop trains before reaching damaged tracks. Image is courtesy of [Wikimedia Commons](#).

ShakeAlert EEW integration had no significant operational impacts during development or testing, nor has it negatively impacted ongoing operations. Metrolink performed an analysis to select MMI (Modified Mercalli Intensity) shaking thresholds for its automated responses that are likely to protect trains from potentially damaging earthquakes but are infrequent enough to avoid unnecessary impacts to operations.

• Cost-Benefit Considerations

COSTS

The \$4.97M project cost was funded entirely by a Caltrans grant. Ongoing maintenance and training costs are nominal and are included in Metrolink’s regular budget for operations and staff training.

BENEFITS

Saves lives and prevents injuries; reduces damage to equipment and infrastructure; speeds return to normal operations

By slowing or stopping trains to avoid harm and possible derailment, Metrolink is poised to save lives and prevent injuries during the next significant earthquake.

Without this technology, Metrolink would be exposed to greater risk of damage and operational impacts during an earthquake, and potential costs significantly larger than the project budget.

Metrolink recognizes the value of ShakeAlert EEW ... because seconds matter.

• Next Steps

- ✓ To learn more about how to boost safety in the transportation sector, see the [Transportation Sector ShakeAlert Messaging Toolkit](#).
- ✓ To learn more about ShakeAlert Technical Partnerships, see the [FAQ: Understanding ShakeAlert Partnerships and the Seismic Network](#), and the [FAQ: How to Become a Technical Partner](#).
- ✓ The ShakeAlert system is one of several tools from the Advanced National Seismic System (ANSS). ANSS provides other information products for seismic events that can be used to understand their effects on buildings and structures. Visit these links to learn more about the [ShakeMap](#) and [ShakeCast](#) products from ANSS.
- ✓ Contact a ShakeAlert Technical Engagement Regional Coordinator (below).

ShakeAlert Technical Engagement Regional Coordinators

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