Earthquake warning system will come with some false alarms and missed alerts

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In a land where the mildest rumble elicits an anxious question — “Did you feel that?” — having even a few seconds of warning before an earthquake has long been a dream.

Now, California is getting closer to what scientists say will be the world’s most sophisticated earthquake warning system, with officials this week announcing they were expanding the test program in the coming months in advance of a future public rollout. Even a warning time of a few seconds can save lives, allowing utilities to turn off large high-pressure fuel lines, doctors to stop surgeries, transit agencies to slow trains and schoolchildren to shelter under desks.

But the new system is expected to bring its own questions and frustrations.

As residents of Japan, Mexico and other places that already have the alerts have learned, the system comes with false alarms and missed warnings. There are also concerns that the wireless phone networks are too slow to send out alerts to the public before shaking is felt.

Earthquake warnings work on a simple principle: Seismic shaking travels at the speed of sound through rock — which is slower than the speed of today’s communications systems. Earthquake sensors that detect a big earthquake that starts at the Salton Sea and has begun to travel up the San Andreas fault can sound an alarm in Los Angeles, 150 miles away, before strong shaking arrives in the city, giving Angelenos perhaps more than a minute to prepare.

BART has tested the ShakeAlert system, designed to trigger trains to stop in the event of an earthquake, in Oakland.

Officials say raising public awareness — and setting realistic expectations — is crucial for the system’s credibility. In a recent report, the U.S. Geological Survey

made clear the system's limitations: "False and missed alerts are likely, and there may be little to no warning near the earthquake's epicenter, where the shaking is strongest."

Users who want longer warning times will need to act when it's still uncertain how big the quake will get.

"We're making sure we're upfront [on] what we can or can't do," said USGS scientist Robert de Groot. "The last thing we want is to have people lose faith in the system."

Japan, which has one of the world's most sophisticated earthquake warning systems, offers an idea of what California should expect. The Japanese system has sent out false alerts of a big quake and failed to issue warnings ahead of authentic temblors.

"Trying to make a very rapid analysis within seconds — while all hell is breaking loose — is pretty challenging," said Caltech engineering seismology professor Tom Heaton.

In 2016, an erroneous alert of a magnitude 9 earthquake was sent by the Japan Meteorological Agency, according to local media. This year, two minor earthquakes were incorrectly interpreted to be a single, larger temblor and triggered a warning of strong shaking that did not come.

In Mexico City, just weeks before the devastating magnitude 7.1 earthquake of Sept. 19, 2017, a technician working on the system sent out an erroneous alert on the capital's 12,000 sirens.

Yet the systems still have the support of the public in Japan and other nations because the benefits far outweigh the disappointments when it works. The system helped prevent deadly derailments of high-speed trains in Japan before the shaking arrived from the magnitude 9.1 earthquake of 2011, for instance, signaling the trains to slow down. Memorably, the national Japanese broadcaster NHK aired an earthquake warning about 90 seconds before the strongest shaking arrived in Tokyo.

Warnings that buzzed in classrooms gave some students enough time to drop, cover and hold on. According to accounts collected by Richard Allen, director of the Berkeley Seismological Laboratory, students in an elementary school classroom in the

northeastern Japanese city of Sendai had 10 seconds to get under their desks before the shaking arrived.

One study found that several million people near the epicenter received an early warning 15 to 20 seconds before the strongest shaking hit. A poll found that 90% of those surveyed approved of the Japanese early warning system after that quake.

“You’d rather have some information and do something with it, than just be taken completely by surprise,” Heaton said.

Residents of Mexico City have been generally positive about their earthquake early warnings, even when they received an alert that wasn’t followed by shaking, American scientists studying that system said. Residents would rather get false alarms than no warning before shaking hits, the researchers found.

“There seems to be general acceptance of the technical limitations of the early warning system in exchange for some measure of peace of mind,” the scientists wrote for the journal Earth & Space Science News.

One big question, however, is how well Californians will tolerate any initial hiccups in the system given the fact that there has not been a major quake in the state in about a quarter of a century.

Mexico and Japan built their systems after the 1985 Mexico City and 1995 Kobe temblors, respectively — severe earthquakes that each killed at least 5,000 people.

“In those cases, the country has been so traumatized, and so terrified, by the earthquakes that they’ve been happy to have the system — warts and all — including false alerts,” Heaton said. “In the United States, we haven’t seen a real [catastrophic] earthquake since almost 1906. So are Americans ready to put up with the irritation of false alarms? I guess we’re going to find out.”

Setting expectations can be important. In Japan, a public awareness campaign led to 78% of the public understanding the possibility of false alarms.

That's why the USGS wants to gently roll out the alerts to certain test groups before a wider release. Testers will be required to receive training in what they can expect from the system and its limitations.

Among the first group of test users will be employees of the city of Los Angeles. The city contracted with AT&T to develop and operate its own app, ShakeAlertLA, which will first be tested soon by tens of thousands of city employees with government-issued cellphones. If the system withstands the strain of those users, the city hopes to offer the system to residents in the greater Los Angeles area.

A private company, Santa Monica-based Early Warning Labs, is also working with the USGS to get permission to offer a pilot version of its early warning app to as many as 100,000 California test users soon.

One reason for false alerts or missed alarms is how sensitive the warning system is set.

Setting the system to sound an alarm for any earthquake magnitude 2 and above in a given area will mean getting lots of alerts — including many for quakes you won't feel. But if that small earthquake grows into the Big One within seconds, you'd have more time to prepare.

Setting the system to sound an alarm for only the strongest earthquakes, like a magnitude 6 and above, would mean alerts might arrive too late.

Take the hypothetical example of an earthquake that begins moving the San Andreas fault first near Eureka and toward San Francisco, about 200 miles south, as outlined in a USGS and Caltech study published in March in the journal Science Advances.

Four seconds after the shaking begins, the temblor is just a magnitude 6 earthquake. If the quake stopped there, San Francisco wouldn't feel a thing. If someone in the city got a seismic early warning, they might feel quite annoyed at what they could consider a false alarm.

This simulation of a hypothetical earthquake that begins on the San Andreas fault near Eureka, Calif., takes about a minute before shaking arrives 200 miles away in San Francisco. An early warning system set to sound the alarm in San Francisco for w

But if the quake lasts as long as 20 seconds, it has become a magnitude 7, and someone in San Francisco could feel light shaking, just enough to rattle dishes. An alert set at that threshold of light shaking would give the city 48 seconds of warning.

Say the earthquake lasts at least 67 seconds. Now it's a magnitude 7.7 earthquake, and San Francisco is about to get very strong shaking, USGS research geophysicist Sarah Minson said. Waiting for the certainty of that level of shaking — the kind that starts causing building damage — however, forces a delay. And that San Francisco resident would only have eight seconds to prepare.

Initially, the USGS is proposing a conservative approach for warnings to the general public — wherein alerts go off only for earthquakes of magnitude 5 and above in regions expected to observe at least light shaking, the kind that can awaken those sleeping and rattle dishes, windows and doors, known as intensity level 4 shaking.

The public might get less time to prepare, but the alerts would come with a greater chance a user would actually feel shaking.

Institutions might prefer more warning time, even if it means a higher chance of false alarms. Those institutional clients will be allowed by USGS to get warnings for earthquakes of magnitude 3.5 and greater.

The system, however, is designed to follow up with swift messages noting a false alert when it happens and an explanation why it might have happened. Scientists say people are more likely to tolerate false alerts rather than missed alerts and can use the opportunity of a false alert to train for the real thing.

Another big challenge faced by the system is how slow cellphone networks and other communications can be in transmitting warnings to the public. The Federal Emergency Management Agency's Wireless Emergency Alert system is not fast enough to support earthquake early warnings; there have been reports of tens of seconds to even minutes of delays in receiving such messages.

The government and phone carriers are working to improve speed, but an ideal fix could take years to implement.

A prototype system has proved successful in many recent minor and moderate California quakes, notably the 2014 magnitude 6 temblor that hit Napa, giving San

Francisco eight seconds of warning. Earlier that year, scientists in Pasadena got six seconds of warning when a magnitude 5.1 earthquake hit La Habra.

There are 865 earthquake-sensing stations online for the early warning system on the West Coast, including 615 in California, but 810 more are needed, officials said. Too few sensors could mean, for instance, that Los Angeles would experience delays in warnings from an earthquake that starts in Monterey County and barrels south along the San Andreas fault.

This year's state budget authorized an additional $15 million to build out the remaining sensors that are needed for California to have a complete warning system. By next spring, California's network will be 70% complete, and by 2021, officials hope, all 1,115 seismic sensor stations intended for California will be online, said Ryan Arba, earthquake program manager for the California Governor's Office of Emergency Services.

Officials are still looking for funds to expand the sensor network in Oregon and Washington state, as well as for long-term sources of funds to maintain and operate the system and construct and maintain a reliable data-delivery system.