**United States Geological Survey**
**Department of Interior**
**525 So. Wilson Ave.**
**Pasadena, CA 91106**

August 23, 2019

James W. Wiley, III
Attorney Adviser
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Public Safety & Homeland Security Bureau
Federal Communications Commission

Dear Mr. Wiley,

As discussed in our phone call between FCC and the United States Geological Survey (USGS) on August 8, 2019, we are following up with this letter in response to your request for written technical information that helps explain the USGS rationale for requesting a FCC waiver exempting earthquake early warning (EEW) messages from the requirement of geo-targeting.

In the official letter from USGS Director Reilly to Chairman Pai dated June 21, 2019, the USGS requested an FCC Rule Waiver for exemption from the geo-targeting rule described in 47 CFR § 10.450 (a) as amended February 28, 2018. This waiver is requested by the USGS not because we object to precise alert targeting but because the carriers' technical implementation of the rule, namely device-based geofencing (DBGF), will delay alert delivery so as to reduce or nullify the value of earthquake early warning alerts from the USGS ShakeAlert system.

The ShakeAlert system can identify significant earthquakes seconds after they begin by detecting the resulting ground shaking at sensors near the epicenter of the quake. The destructive shaking waves moves out from the epicenter and the developing fault rupture at about two miles per second. If alerts can be delivered with minimum delay they can reach some people seconds to several tens of seconds before destructive shaking arrives at their location. The amount of warning people receive depends on their distance from the event and the speed with which alerts can be delivered. A key component of ShakeAlert design is for the fast delivery of alerts to the public via Wireless Emergency (WEA) messages. The USGS and the California Governor's Office of Emergency Services (CalOES) plan to begin public alerting in California via IPAWS/WEA in October 2019. To be effective, WEA messages must be transmitted with the smallest possible delay because each second used to deliver the alert is a second lost for the public to take action. This challenging speed requirement is unique to EEW. For each second that alert delivery is delayed the area shaken before the alert is received expands by about two miles, potentially excluding thousands of people from an advance warning of ground shaking. The protective action that is carried in the WEA message is *"Earthquake! Expect shaking. Drop,* *cover, hold on. Protect yourself now."* [1] On average it takes people about nine seconds to drop, cover, and hold on and doing so can substantially reduce injury.[2] Other protective actions may be more appropriate depending on an individual's situation or physical limitations.[3] Regardless of what actions people take in response to receiving a ShakeAlert, time is of the essence if EEW is to be effective in reducing injuries from earthquakes.

ShakeAlert uses eight-sided polygons (rather than counties or circles) in its Common Alert Protocol (CAP) messages to the IPAWS gateway to define the area that is expected to experience damaging shaking for earthquakes of magnitude 5.0 or larger. For small events these polygons approximate circles, but earthquakes greater than magnitude 7.0 have long fault ruptures and the alert polygon is stretched into an oblong shape that cannot be approximated by a circle. Use of county-level alert areas could bypass the geotargeting requirement and not require a waiver, but this is not practical for ShakeAlerts because it would result in significant over-alerting. An extreme case is San Bernardino County, California which, at 20,105 square miles, is larger than nine states in the US. Social science research shows that overalerting for natural hazards leads to "alert fatigue"[4], which undermines public confidence in the system and causes people to not act on future alerts that will affect them.

CalOES and USGS have conducted two tests of the speed of the current WEA system, which maps the set of cell sites that "best approximates" the alert area. Preliminary results from these two tests and last year's national test indicate that WEA messages can be delivered in as little as 4-7 seconds; however the average time is about 13 seconds.  While not ideal this suggests WEA alerts will arrive before strong shaking in some cases and this mechanism is suitable for EEW. The larger an earthquake becomes the longer it take to complete the fault rupture, therefore it is

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[1] State-Of-The-Art Knowledge of Protective Actions Appropriate for Earthquake Early Warning: Michele M. Wood, with Maximilian Dixon, Earthquake Program Manager at Washington State Military Department, Emergency Management Division; Althea Rizzo, Geologic Hazards Program Coordinator, Oregon Emergency Management Agency; Pascal Schuback, Executive Director, Cascadia Region Earthquake Workgroup; Jennifer Thamer, Director, Nusura, Inc.; Brian Terbush, Earthquake/Volcano Program Coordinator at Washington State Military Department, Emergency Management Division, October 29, 2018.  https://crew.org/wp-content/uploads/2018/11/CREW-EEW-Protective-Action-White-Paper.pdf

[2] Porter, K. A. and J.L. Jones, 2017, How Many Injuries Can Be Avoided in the HayWired Scenario Through Earthquake Early Warning and Drop, Cover, and Hold On?, in Detweiler, S.T. and Wein, A.M. eds., 2018. The HayWired Earthquake Scenario--earthquake Hazards. US Department of the Interior, US Geological Survey, Scientific Investigations Report 2017–5013–I–Q https://pubs.usgs.gov/sir/2017/5013/sir20175013ah_v1.2.pdf
A brief rational for "Drop, Cover, and Hold on" is provided at https://www.earthquakecountry.org/dropcoverholdon/

[3] Protective actions are described in Step 5 of the Seven Steps to Safety, Earthquake Country Alliance, https://www.earthquakecountry.org/step5/

[4] Kordek, M.E., 2013, Alert fatigue by other names—Review of contributing fields regarding the 'cry wolf' effect: Scholar Archive, no. 910, accessed on September 14, 2018, at https://digitalcommons.ohsu.edu/etd/910.

necessary to send rapid EEW updates to adjust or expand the alert area as the earthquake grows over time.

DBGF introduces delay because it takes time for a device to determine its location. In 2015 the Alliance for Telecommunications Industry Solutions (ATIS) published a *Feasibility Study for WEA Cell Broadcast Geo-targeting* (ATIS-0700027) in which they stated, “For mobile device geo-targeting to function, the mobile device must first determine its current location. The determination of the current location could delay the presentation of the WEA Alert Message by seconds or even minutes.” They further stated, “The time to acquire a GPS position can be over 13 minutes for a cold start (no or expired GPS related data on the mobile device) and up to 30 seconds for a warm start (some initial expired GPS related data on the mobile device)”. Finally, they noted that, “There will also be a delay as the mobile device will have to receive both the WEA Alert message and the WEA coordinates prior to processing and displaying the alert.” Also, according to a DHS report[5] up to 19% of smartphone users disable location services, presumably to increase battery life or due to privacy concerns. In this case DBGF will not function and WEA behavior will default to the old “best approximates” model, where users will receive the alert if they are connected to an activated cell site but are outside the alert polygon, resulting in overalerting.

ATIS recognized the adverse impact the DBGF strategy would have on ShakeAlert and designed into the WEA 3.0 specification the technical capability for an alert originator to bypass DBGF. That specification (ATIS-0700037.v002) as follows[6]:

### *6.6 DBGF Bypass Request*

When circles or polygons are included by the alert originator, the WEA alert message requires DBGF by default. The alert originator can request that DBGF be bypassed for this alert. The Invocation of DBGF is specified in *Wireless Emergency Alert (WEA) 3.0 via EPS Public Warning System Specification* ATIS-0700010.v003 [Ref 49].

> [WEA-C-RQMT-2940R3A] The Federal Alert Gateway shall be able to indicate that bypassing DBGF is requested in the CMAC alert or update.
>
> [WEA-C-RQMT-2950R3A] If DBGF bypass is requested in the CMAC alert or update and bypassing DBGF is allowed by regulatory policy, then the CMSP shall bypass DBGF procedures for the WEA.
>
> [WEA-C-RQMT-2960R3A] DBGF bypass requests shall be ignored for CMAC messages without polygon or circle elements.
>
> [WEA-C-RQMT-2970R3A] If DBGF bypass is requested in the CMAC alert or update and DBGF bypass is not allowed by regulatory policy, the CMSP Gateway shall ignore the DBGF bypass request.

A DBGF request is indicated by the Federal Alert Gateway by the inclusion of the string "Bypass Device-Based Geo-Fencing" in an instance of CMAC_note as shown below.

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<CMAC_note>Bypass Device-Based Geo-Fencing</CMAC_note>
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[5] Wireless Emergency Alerts Arbitrary-Size Location-Aware Targeting Final Report, June 2015, Homeland Security, Science and Technology. https://ecfsapi.fcc.gov/file/60001427188.pdf

[6] CMAC is the “Commercial Mobile Alert for C-Interface” format used by IPAWS to pass messages to CMSPs, Commercial Mobile Service Providers.

ATIS has noted that the FCC would have to waive the geo-targeting requirement and allow use of this flexible DBGF bypass capability before CMSPs would allow DBGF bypass for WEA alert from the USGS ShakeAlert system.

When ShakeAlert begins public alerting, it will also send follow-up messages after each alert with final information about the earthquake that caused the alert and where to get additional information or to cancel the alert if it was issued in error. These will be sent as a "public safety" message a few minutes following the alert, after a final estimate of the earthquake's size and location is determined by traditional (non-EEW) earthquake analysis. These messages will also include the DBGF bypass indicator to guarantee they are delivered to the same area as the original alert. If DBGF is applied to these follow-up messages they will reach a smaller area than the original alert area and some people will not receive them.

The USGS has public alerting authority under the Earthquake Hazards Reduction Act PL 95-124, 42 USC 7701 and has a Memorandum of Agreement with FEMA as an alert authority through the Integrated Public Alert and Warning System (IPAWS).

Sincerely,

Douglas D. Given

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