White paper

Evolution of public warning systems

Innovations with Device-Based Geo-Fencing

Public warning systems have undergone significant transformations over the years, with **Device-Based Geo-Fencing (DBGF)** being one of the latest innovations in this sphere. In this white paper, we will delve into the world of public warnings, examining how technology has revolutionized the dissemination of life-saving alerts.

Public warning systems

Public warning systems play a pivotal role in promptly notifying populations at risk of imminent threats. An effective early warning system not only saves lives but also mitigates damage to property and infrastructure. However, ensuring that the right individuals receive alerts at the right time and place is crucial.

According to the International Telecommunications Union (ITU), approximately three out of four individuals worldwide own a mobile phone, providing continuous accessibility to the majority of the global civilian population. Research by the Global Commission on Adaptation has shown that a 24-hour advance notice of a hazardous event can reduce ensuing damage by 30%.

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The evolution of emergency alerting targeting

The increasing frequency and severity of critical events, including wildfires, floods, riots, uprisings, and the COVID-19 pandemic, underscore the pivotal role of public warning systems in safeguarding individuals. Effective public warning relies on the collaboration between government entities and Mobile Network Operators (MNOs). Governments establish the guidelines for public warnings and specify the target area for alerts through dedicated public warning portals. Concurrently, MNOs are responsible for transmitting these alerts to designated devices within the defined area, ensuring that alerts reach their intended recipients, thereby reducing confusion and alert fatigue.

Organizations like the Alliance for Telecommunications Industry Solutions (ATIS) and 3GPP play a vital role in establishing standards for Wireless Emergency Alerting via Cell Broadcast. Several countries with nationwide public warning systems have adopted Cell Broadcast as the technology for public alerts, with the Netherlands being an early adopter.

Device-Based Geo-Fencing (DBGF)

Device-Based Geo-Fencing harnesses the location technology of mobile devices, such as GNSS or Wi-Fi positioning systems, to determine whether they are located inside or outside the designated target area. The device's ability to precisely determine its location significantly influences the delivery of public warning alerts.

The accuracy of mobile device location determination is generally within a few meters, similar to the precision experienced when using navigation applications for directions.

How does Device-Based Geo-Fencing (DBGF) work?

The implementation of DBGF involves several steps:

01 **Alert origination:** The alert originator employs their public warning system (PWS) to define the target area by drawing polygons or circles on a dynamic map.

02 **Mobile device location determination:** Mobile devices utilize their built-in location technology, such as GNSS or Wi-Fi positioning systems, to determine their precise location.

03 **Cell Broadcast Center (CBC) selection:** Within the MNO domain, the CBC selects the appropriate cells that cover the specified target area based on the MNO policy.

04 **Alert Display:** If a mobile device is located inside the target area or is unable to determine its location, it displays the emergency alert message to the user.

DBGF enhances the accuracy of public warning systems, ensuring that alerts reach their intended recipients during emergencies.

Cell Broadcast with Device-Based Geo-Fencing

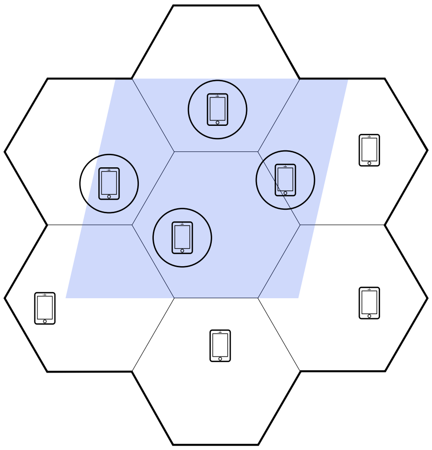


Fig A. Illustrates the process of cell broadcast and Device-Based Geo-Fencing. The blue shaded region represents the target area polygon. This information is transmitted to the Mobile Network Operator (MNO) and then to the Cell Broadcast Center (CBC). The CBC selects the cells that cover the specified target area based on the MNO Policy. Mobile devices determine if they are in the area or not to display the message.

Alerts to older devices

Devices that don't support WEA 3.0, such as older devices with limited location sharing capabilities, receive an alert if it is within the entire cell site (versus the target area polygon). While it's possible these alerts may be irrelevant for the recipient, it is the only way to ensure older devices receive potentially vital information.

Entering an alerted area

If new mobile devices enter the target area, the alert will be presented. Devices which have already presented the specific alert will not present it again.

The journey from WEA 1.0 to WEA 3.0

The U.S. has witnessed significant advancements in its public warning system through the expanded use of cell broadcast: WEA (Wireless Emergency Alerts)

WEA 1.0: The initial version relied on a mandatory geocode to indicate the target area, with geo-targeting implemented at the county level. However, this approach often led to excessive alerting, particularly in large counties.

WEA 2.0: This version introduced geo-targeting requirements by incorporating polygons and circles for cell selection, but still had limitations, allowing devices located outside the intended target area to receive alerts – leading to over-alerting and alert fatigue.

WEA 3.0: This latest version supports Device-Based Geo-Fencing (DBGF), enabling mobile devices to determine whether they are within an alert area or at least 0.10 miles outside, displaying the alert accordingly.

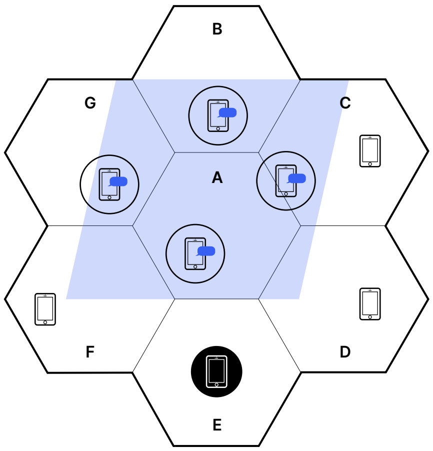
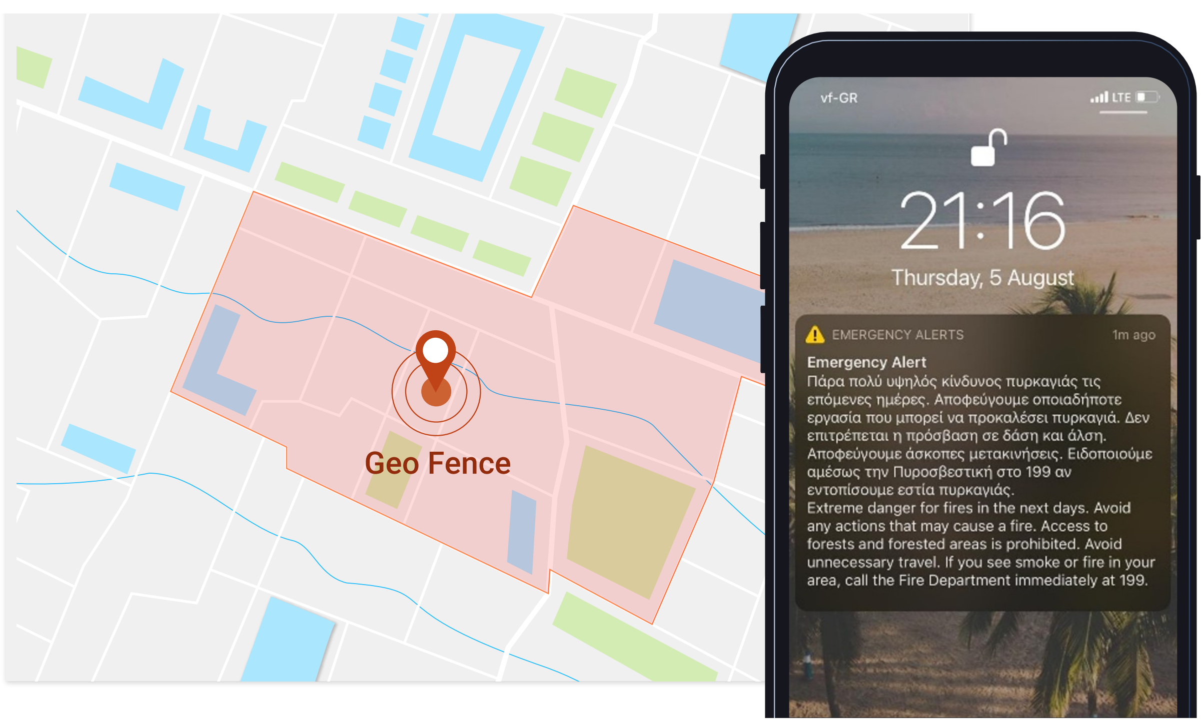


Fig B. Illustrates the process of cell broadcast at a deeper level. As illustrated in Fig A. devices that are in the target area polygon will receive the alert. If devices in cell sites C, F, or D are older or unable to provide their location, they would receive the alert. Phone in cell site E, can share its location but isn't in the targeted area, but if it enters the area within a certain amount of time, it will receive the alert.

Device-Based Geo-Fencing (DBGF) use cases

DBGF can enhance the accuracy of public warning systems in various ways:

- **Enhanced accuracy for small target areas:** DBGF ensures that only devices within the drawn target area shape receive the emergency alert, reducing unnecessary notifications.
- **Improved accuracy for dedicated areas:** Certain emergencies or threats may be specific to areas. DBGF ensures that only devices within the dedicated alert area receive the notification, providing accurate and targeted information.



A deeper dive into Device-Based Geo-Fencing

How does a mobile device determine its location?

Location determination of mobile devices relies heavily on the device's operating system (OS), using multiple sources such as GNSS (Global Navigation Satellite System) or Wi-Fi positioning systems.

Getting the polygon to the mobile device

With DBGF, an element called Warning Area Coordinates, specified in 3GPP TS 23.041, are included in the Write-Replace-Warning Request sent by the Cell Broadcast Center (CBC) to the Radio Access Network (RAN) for broadcasting. They represent the polygons and circles defined by the alert originator. With the Warning Area Coordinates included in the Cell Broadcast message, the mobile device can determine if it is located within the targeted area.

How are repeated messages handled on the mobile device?

When an alert message is received by the mobile device, it will determine if it is located inside the alert area. If that is the case, the alert will be presented to the user. If not, the alert message is stored. Any subsequent rebroadcast of the alert message is discarded as duplicate at the modem layer.

For DBGF, the network utilizes geo-fencing trigger messages to initiate re-checks of stored messages. These messages contain serial numbers and message identifiers of the messages requiring a location re-check. If a mobile device is inside the area covered by a stored message or cannot determine its location, the triggered message is presented. If the device is still outside the area, nothing happens, and the Cell Broadcast message is not shown to the user.

When a geo-fencing trigger message is rebroadcasted, it is discarded as a duplicate at the modem layer. To perform another geo-fencing procedure for stored messages, the network broadcasts a new geo-fencing trigger message with a different serial number. This new message triggers the geo-fencing procedure in the upper layer of the mobile device.

What's the difference between the upper layer and modem layer in a mobile device?

In a mobile device, the modem layer refers to the firmware accompanying the modem chip, while the upper layer represents the operating system layer, such as Android or iOS and native applications. Duplicate messages are checked at the modem layer, as specified by 3GPP, even though the specifications indicate checks at the upper layer. A duplicate message shares the same serial number and message identifier as a previously received message within 24 hours.

Limitations and impact

While DBGF significantly enhances the accuracy of public warning systems, it is essential to consider certain limitations to ensure accurate and timely alert presentation. These limitations include polygon management, GPS interference or scrambling, mobile devices lacking geo-location capabilities, device support for geo-fencing, and network requirements.

Polygons

The CB message polygon has a limit of 100 coordinate pairs. This is managed by the alert originator's front-end system, the Cell Broadcast Entity (CBE). Some public warning solutions, such as the Everbridge public warning platform, automatically check that the number of polygons and circles in the alert does not exceed 10 or the total number of coordinate points does not exceed 100 when sending the alert to the Cell Broadcast Center (CBC). However, not all CBEs have this automatic functionality.

GPS interference or scrambling

The accuracy of the GPS and a device's ability to geo-locate may vary due to environmental factors, affecting the accuracy of alert delivery.

Mobile devices without geo-location capability

In networks with mixed device capabilities, mobile devices that cannot geo-locate themselves will still receive alerts to ensure widespread coverage.

Device support for geo-fencing

Mobile devices need to support DBGF for it to be effective, and while most high-end devices do, there may be a lag in incorporating support among device manufacturers.

Network requirements

It's not just the mobile devices that need to support device based geo-fencing but also the MNO's network. The CBC needs to be upgraded to include the Warning Area Coordinates element in the Write-Replace-Warning-Request message. Everbridge public warning CBCs fully support this. In 4G networks, the MME (Mobile Management Entity) and eNodeB need to support the element for broadcasting over E-UTRA. In 5G networks, the AMF (Access and Mobility Function) is not impacted as the Write-Replace-Warning-Request passes through it transparently. The gNodeB needs to include the element in SIB8 for broadcasting over New Radio (NR).

Conclusion

Public warning systems have evolved and will continue to do so. Choosing the right partner is critical to navigate the complexities of these changes. Everbridge, with its proven track record in deploying and managing public warning solutions globally, and its active contribution to industry standards bodies, emerges as a reliable and competent ally in this regard. By actively participating in standardization efforts, Everbridge contributes to shaping the future of public warning systems, ensuring interoperability, and fostering collaboration across the industry.

About Everbridge

Everbridge, Inc. (NASDAQ: EVBG) empowers enterprises and government organizations to anticipate, mitigate, respond to, and recover stronger from critical events. In today's unpredictable world, resilient organizations minimize impact to people and operations, absorb stress, and return to productivity faster when deploying critical event management (CEM) technology. Everbridge digitizes organizational resilience by combining intelligent automation with the industry's most comprehensive risk data to Keep People Safe and Organizations Running™.

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