

Effective and Resilient Alert and Warning Systems for Mobile Devices using 5G Broadcast

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The Need for Effective and Resilient Alert and Warning Systems

- Public alert and warning (A&W) systems are being increasingly challenged by frequent natural disasters, relying on interconnected technologies that must function before, during, and after emergencies.
- Alerting and warning systems need to keep pace with cultural and technology trends to be effective and resilient.
- The establishment and management of public-private partnerships is key to achieving this objective.



[Deadly Maui fire's cause and origin still unknown months later - ABC News](#)



[Hurricane Helene: Why it could rapidly intensify as it nears Florida | Vox](#)

Executive Order 13407 – Public Alert and Warning System

Executive Order 13407 is the basis for the creating the integrated public alert and warning system (IPAWS).

Key Points of this Executive Order

- It is the policy of the United States to have an effective, reliable, integrated, flexible, and comprehensive system to alert and warn the American people in situations of war, terrorist attack, natural disaster, or other hazards to public safety and well-being (public alert and warning system), Integration with the public alert and warning system of Federal, State, territorial, tribal, and local public alert and warning resources.
- Through cooperation with the owners and operators of communication facilities, maintain, protect, and, if necessary, restore communications facilities and capabilities necessary for the public alert and warning system.
- Include in the public alert and warning system the capability to alert and warn all Americans, including those with disabilities and those without an understanding of the English Language.
- Ensure that under all conditions the President of the United States can communicate with the American people.

Executive Order 13407—Public Alert and Warning System

June 26, 2006

By the authority vested in me as President by the Constitution and the laws of the United States of America, including the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (42 U.S.C. 5121 *et seq.*), and the Homeland Security Act of 2002, as amended (6 U.S.C. 101 *et seq.*), it is hereby ordered as follows:

Section 1. Policy. It is the policy of the United States to have an effective, reliable, integrated, flexible, and comprehensive system to alert and warn the American people in situations of war, terrorist attack, natural disaster, or other hazards to public safety and well-being (public alert and warning system), taking appropriate account of the functions, capabilities, and needs of the private sector and of all levels of government in our Federal system, and to ensure that under all conditions the President can communicate with the American people.

[WCPD-2006-07-03-Pg1226.pdf](#)

Executive Order 13407 – Implied Details

- This Executive Order implies the following:
- The public alert and warning system needs to be able to operate continuously under all conditions including before, during, and after an adverse event.
- The establishment of multiple communication pathways is a key aspect needed for resilient operation.
- The communication pathways will be privately owned and maintained, not government owned. *(This sets the stage for public-private partnerships).*
- Communication methods should be adaptable to meet the diverse needs of end users.

IPAWS - Overview

- The IPAWS (Integrated Public Alert & Warning System) is a nationwide public-private partnership.

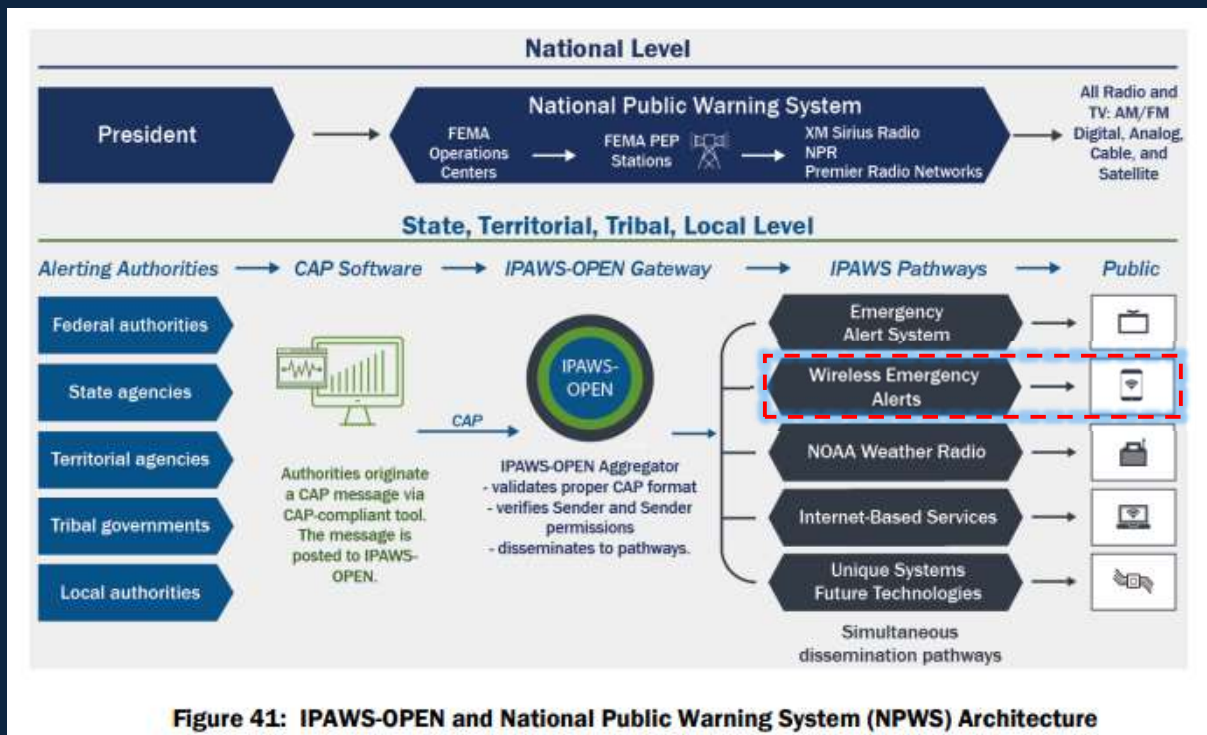


Figure 41: IPAWS-OPEN and National Public Warning System (NPWS) Architecture

[Planning Guidance for Response to a Nuclear Detonation \(May 2022\)](#)

The NPWS Ecosystem:

- Ensures President and FEMA Administrator can broadcast national warnings
- Consists of 77 Primary Entry Point (PEP) Stations

The IPAWS-OPEN Network:

- Consists of over 1,700 Alerting Authority partners
- Delivers over 600 WEA alerts/month
- Saved 130+ children through AMBER alerts
- Delivered 720+ COVID-related alerts in 2020 and 2021

IPAWS Open - Wireless Emergency Alerts (WEA)



[Integrated Public Alert & Warning System | FEMA.gov](https://www.fema.gov/ipaws)

Types of Wireless Emergency Alerts

Presidential Alerts are a special class of alerts only sent during a national emergency.

Imminent Threat Alerts include natural or human-made disasters, extreme weather, active shooters, and other threatening emergencies that are current or emerging.

Public Safety Alerts contain information about a threat that may not be imminent or after an imminent threat has occurred. Public safety alerts are less severe than imminent threat alerts.

America's Missing: Broadcast Emergency Response (AMBER) Alerts are urgent bulletins issued in child-abduction cases. Rapid and effective public alerts often play a crucial role in returning a missing child safely. An AMBER Alert instantly enables the entire community to assist in the search for and safe recovery of the child.

Opt-in Test Messages assess the capability of state and local officials to send their WEAs. The message will state that this is a TEST.

[Wireless Emergency Alerts | FEMA.gov](https://www.fema.gov/ipaws)

Designed to alert every switched-on phone with cell service across the U.S. at roughly the same time.

US Cell Phone Usage Statistics

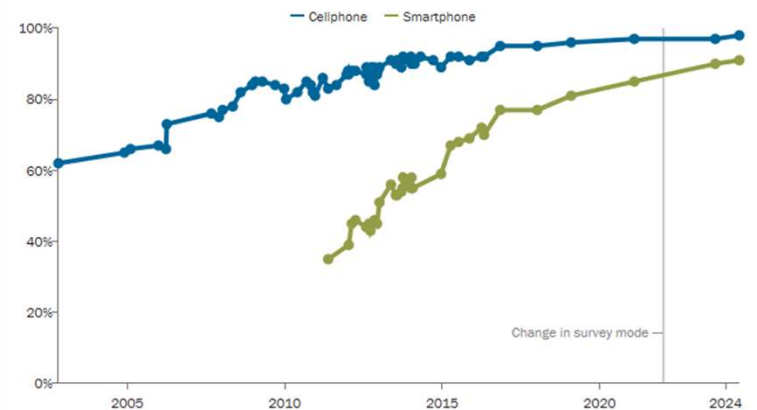
- Americans **check their phones 205 times per day.**
- 80.6% check their phones within the first 10 minutes of waking up.
- 78.2% feel uneasy leaving their phone at home.
- 76% check their phones within five minutes of receiving a notification.
- 65.7% use their phone on the toilet.
- 53.7% have texted someone in the same room.
- 51.3% sleep with their phone at night.
- 43.2% consider themselves "addicted" to their phones.
- 48.3% have never gone longer than 24 hours without their cell phone.
- 39.6% feel panic or anxiety when their phone battery goes below 20%.
- 38.1% use or look at their phone while on a date.
- 27% use or look at their phone while driving.

[Cell Phone Usage Statistics: Mornings Are For Notifications \(reviews.org\)](#)

The vast majority of Americans – 98% – now own a cellphone of some kind. About nine-in-ten (91%) own a smartphone, up from just 35% in the Center's first survey of smartphone ownership conducted in 2011.

Mobile phone ownership

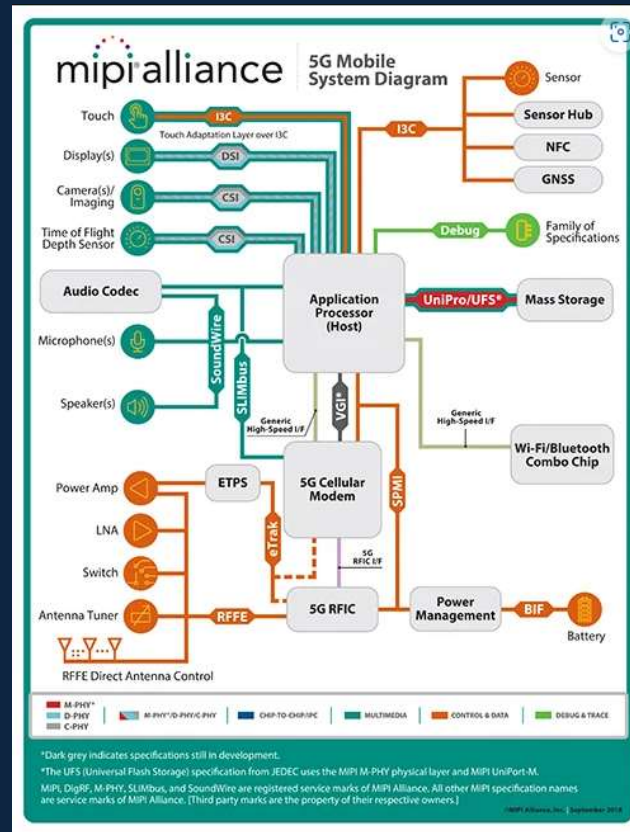
% of U.S. adults who say they own a ...



[Demographics of Mobile Device Ownership and Adoption in the United States | Pew Research Center](#)

Cell phones represent a cultural trend that can be used to enhance alerting and warning systems.

5G Cell Phone Radio Interfaces – Generic Example



Mobile Radio Signals (4G, 5G)



GNSS RF Signals

NFC = Near Field Communications

Wi-Fi / Bluetooth RF Signals

[How MIPI Alliance is Enabling the 5G Future—Today](#)

Consider all possible RF interfaces on a cell phone that could be used to improve IPAWS resilience.

Operational Resilience Topics

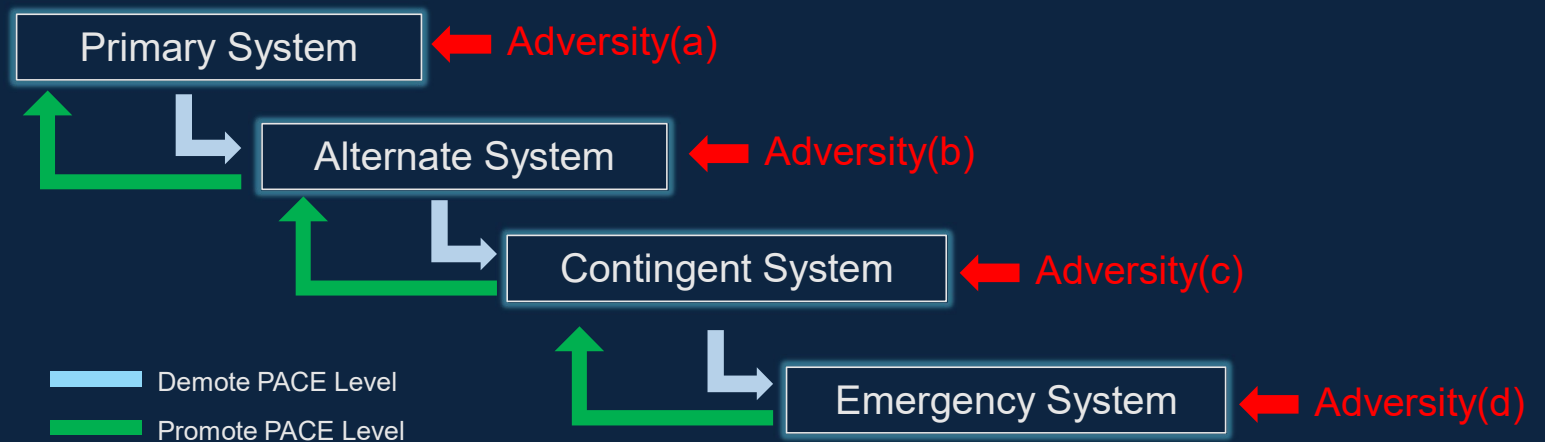
Resilient System Concepts

- Ability to detect, withstand, and recover from one or more adversities and maintain Mission Critical Operation.
- Need to define adversities and where they apply.
- Continuity of Service – Maintain a minimum level operation under adverse conditions.
 - Minimize or eliminate service outage intervals.
- Eliminate single points of failure.
- Identify backup systems or modes of operation to address impacts due to one or more concurrent failures.
- Ensure timely issuance, dissemination, and delivery of the alert or warning.



[Planning Guidance for Response to a Nuclear Detonation \(May 2022\)](#)

The PACE Model and Resilience Concepts



The PACE model relies on a sequential promotion, demotion of end-to-end communication system capabilities. The impact to the end-user (waveform, information, user equipment, timeliness) may affect the overall effectiveness of the alerting/warning system.

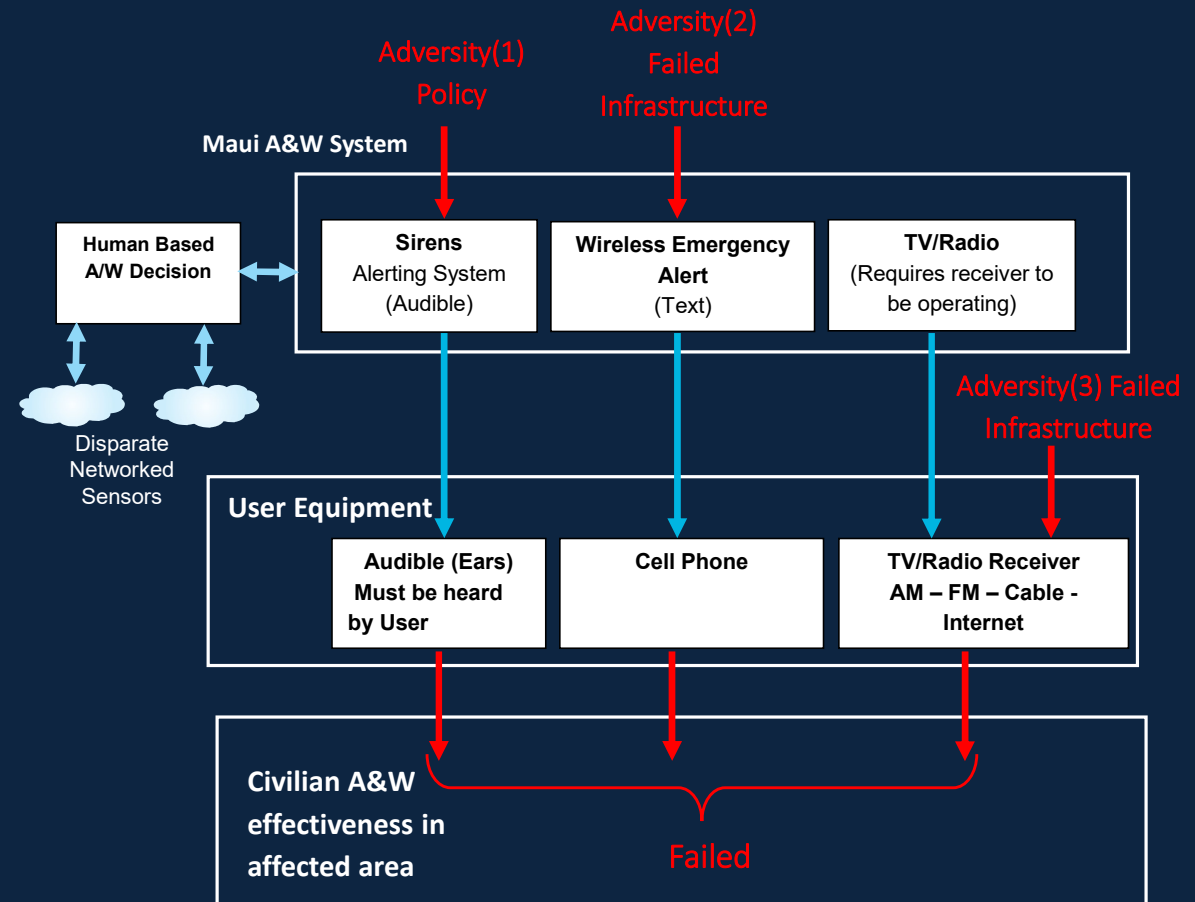
Analysis of the Maui 2023 Wildfire A&W Issues

■ A&W System Issues

- Two of the three A&W systems rely on Commercial Infrastructure (Power, Communications)
- Policy prevented the warning sirens from operating

■ User Equipment Issues

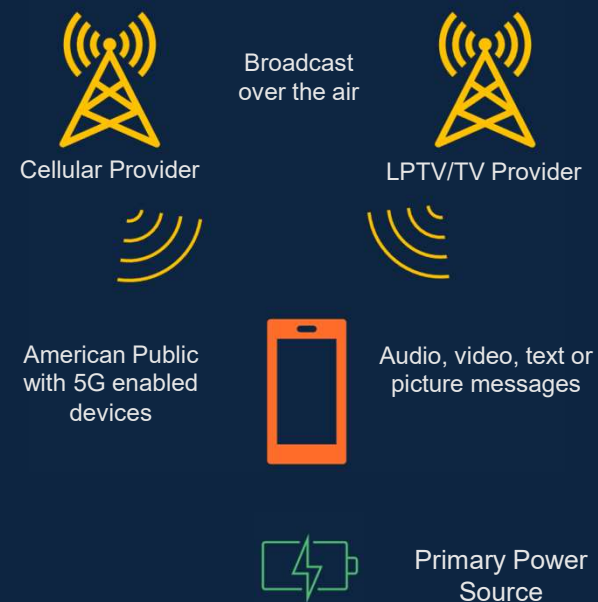
- Alert requires the civilian user to hear the siren (Alerting tone only)
- Different UE are needed to receive details about the alert.
 - Cell phones cannot receive native TV or radio broadcasts.
 - TVs and some radios rely on commercial infrastructure to operate.
 - TVs and radios need to be operating to receive an alert.



5G Broadcast Using Cellular Band 108

- **5G Broadcast (Band 108):** A technology utilizing cellular Band 108 that allows both cellular and non-cellular operators to broadcast voice, video, text, pictures or data directly to a cell phone or 5G enabled device (e.g., IoT devices) – **Per FCC authorization.**
- **User Access**
 - Devices receiving 5G Broadcast are not required to have a SIM card or cellular subscription to receive with free-to-air broadcast signal.
- **Resilient Power**
 - Band 108 Cell phones and tablets operate on battery power.
- **Alerting and Warning Capability**
 - Optimized to transport data, video and audio securely over the mobile frequency band to *any 5G or newer cell phone*
 - Cellular operator compatibility – Cellular operators can transmit WEAs
 - Alternate path for WEAs – Alternate bands to transmit WEAs to cell phones
 - Low Power TV station (LPTV) coverage – Numerous LPTV stations maximize RF coverage
 - Support for audio or video alerts – Could be adapted to support NPWS to cell phones
 - Security and Encryption – Supports advanced security and encryption features
 - Smart Devices – Supports integration into IoT smart devices

Band 108 Capabilities



5G Broadcast could enable new IPAWS pathways to mobile devices

Proposed 5G Broadcast Use Cases

5G Broadcast offload

This use case is also called mixed-mode multicast and is supports the dynamic reconfiguration of the mobile network by simultaneously using supporting band 108 (broadcast) and other 3GPP bands (unicast). Applications include robust video playback user experience.

Venue Casting

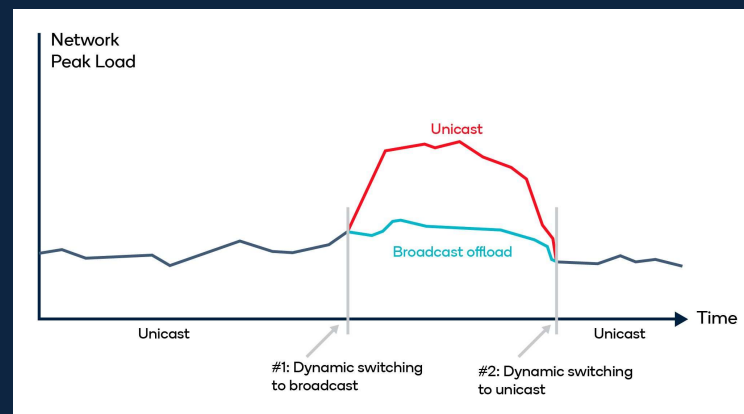
This use case overcomes the limitations of the 5G network to simulations connect to an unlimited number of users requiring high bandwidth and low latency at a venue (e.g., sporting events, conventions). Could also be used to disseminate emergency alerts at these venues.

Mobile TV to Cell Phones

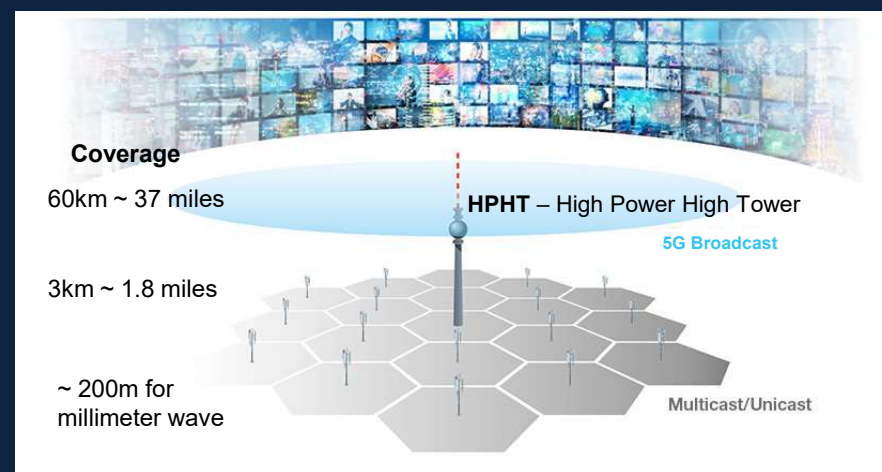
This use case supports the broadcast of video content directly to cell phones. Currently being used by the Low Power TV industry (LPTV) to broadcast video and other services.

Emergency Alert Notifications

This use allows the broadcast of alerts directly to cell phones without the need to connect to a cell tower.



[5G Broadcast: What can consumers expect? | Qualcomm](#)



[SPINNER Group - 5G Broadcast](#)

3GPP Band 108 and Channel Assignments

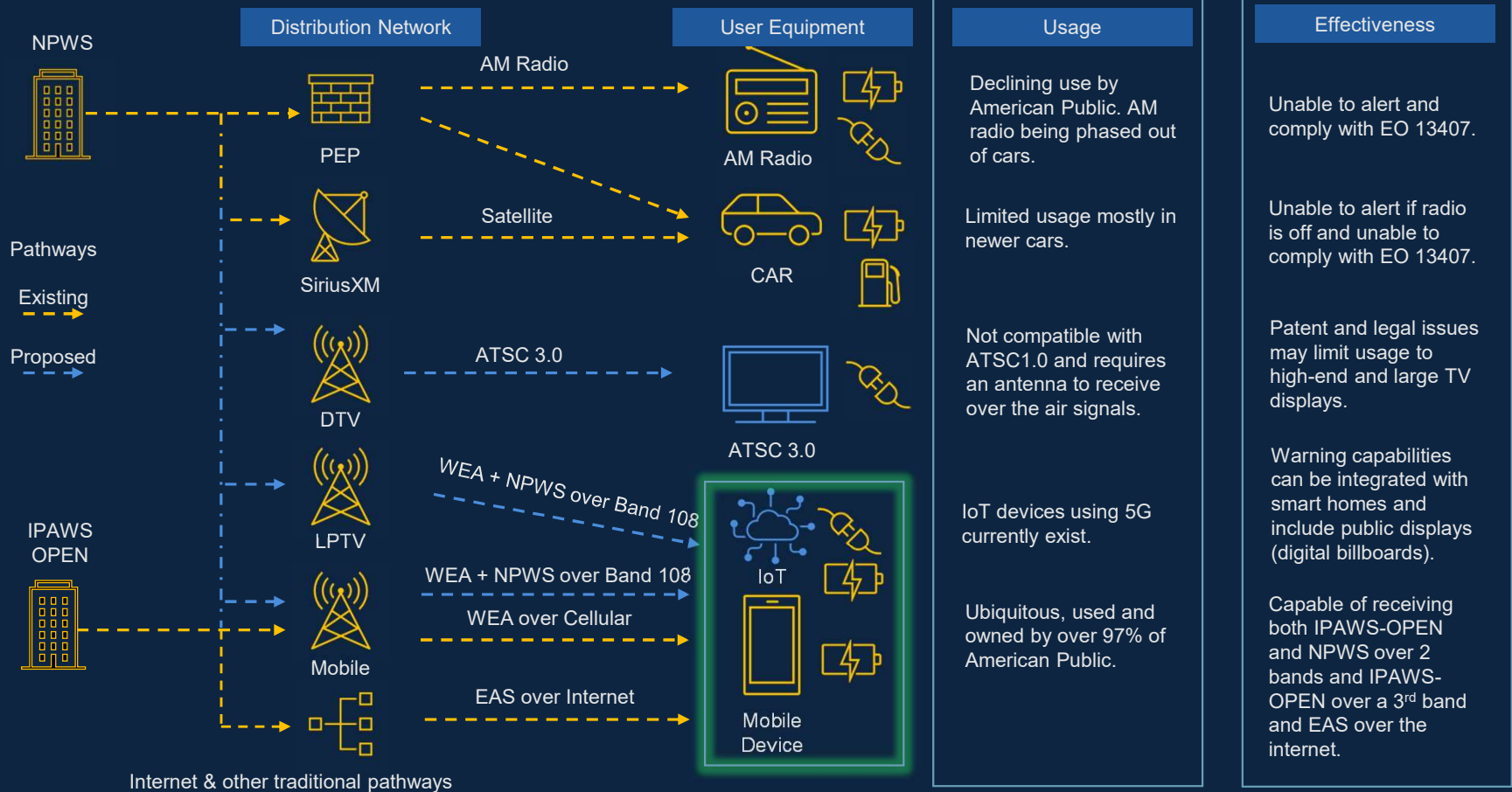
Band 108
470MHz–689 MHz

RF Channels 14 - 36 July 1952 to present			6 MHz BW/Channel				RF Channels 37 - 51 Being Phased-out July 1952 to				RF Channels 52 - 69 July 1952 to June 2020				RF Channels 70 - 83 July 1952 to 1983		
RF Channel	MHz	Band-width	RF Channel	MHz	Band-width	Cell Network	RF Channel	MHz	Band-width	Cell Network	RF Channel	MHz	Band-width	RF Channel	MHz	Band-width	
14	473	470-476	37	611	608-614	Reserved	52	701	698-704	4G/5G	70	809	806-812				
15	479	476-482	38	617	614-620	5G NR	53	707	704-710	4G/5G	71	815	812-818				
16	485	482-488	39	623	620-626	5G NR	54	713	710-716	5G NR	72	821	818-824				
17	491	488-494	40	629	626-632	4G/5GR	55	719	716-722		73	827	824-830				
18	497	494-500	41	635	632-638	5G NR	56	725	722-728		74	833	830-836				
19	503	500-506	42	641	638-644	5G NR	57	731	728-734		75	839	836-842				
20	509	506-512	43	647	644-650	5G NR	58	737	734-740		76	845	842-848				
21	515	512-518	44	653	650-656	5G NR	59	743	740-746	4G LTE	77	851	848-854				
22	521	518-524	45	659	656-662		60	749	746-752	4G LTE	78	857	854-860				
23	527	524-530	46	665	662-668	5G NR	61	755	752-758	4G LTE	79	863	860-866				
24	533	530-536	47	671	668-674	5G NR	62	761	758-764	5G NR	80	869	866-872				
25	539	536-542	48	677	674-680	5G NR	63	767	764-770	5G NR	81	875	872-878				
26	545	542-548	49	683	680-686	5G NR	64	773	770-776	5G NR	82	881	878-884				
27	551	548-554	50	689	686-692	4G/5G	65	779	776-782	4G LTE	83	887	884-890				
28	557	554-560	51	695	692-698	4G/5G	66	785	782-788	4G LTE							
29	563	560-566					67	791	788-794	5G NR							
30	569	566-572					68	797	794-800	2G/3G/5G							
31	575	572-578					69	803	800-806	2G/3G/5G							
32	581	578-584															
33	587	584-590															
34	593	590-596															
35	599	596-602															
36	605	602-608															

23 RF Channels 14 RF Channels 18 RF Channels 14 RF Channels

Television Broadcast Frequencies (otadtv.com)

Proposed IPAWS Notification Pathways with Band 108



Other Technology Considerations

Non-Terrestrial Network Options for Cellular Services

Section 4.7 Non-Terrestrial Network Architecture Options



Figure 4.7-1: NTN featuring an access network serving UEs and based on a satellite/aerial with bent pipe payload and gNB on the ground (Satellite hub or gateway level)



Figure 4.7-3: NTN featuring an access network serving Relay Nodes and based on a satellite/aerial with bent pipe payload

gNB – 5G base station
RAN – Radio Access Network

NGC – Next Generation Core
UE – User Equipment (e.g., cell phone)

Relay node: Relay of Uu radio interface. The relay function can take place at Layer 1, 2, or 3.



Figure 4.7-2: NTN featuring an access network serving UEs and based on a satellite/aerial with gNB on board

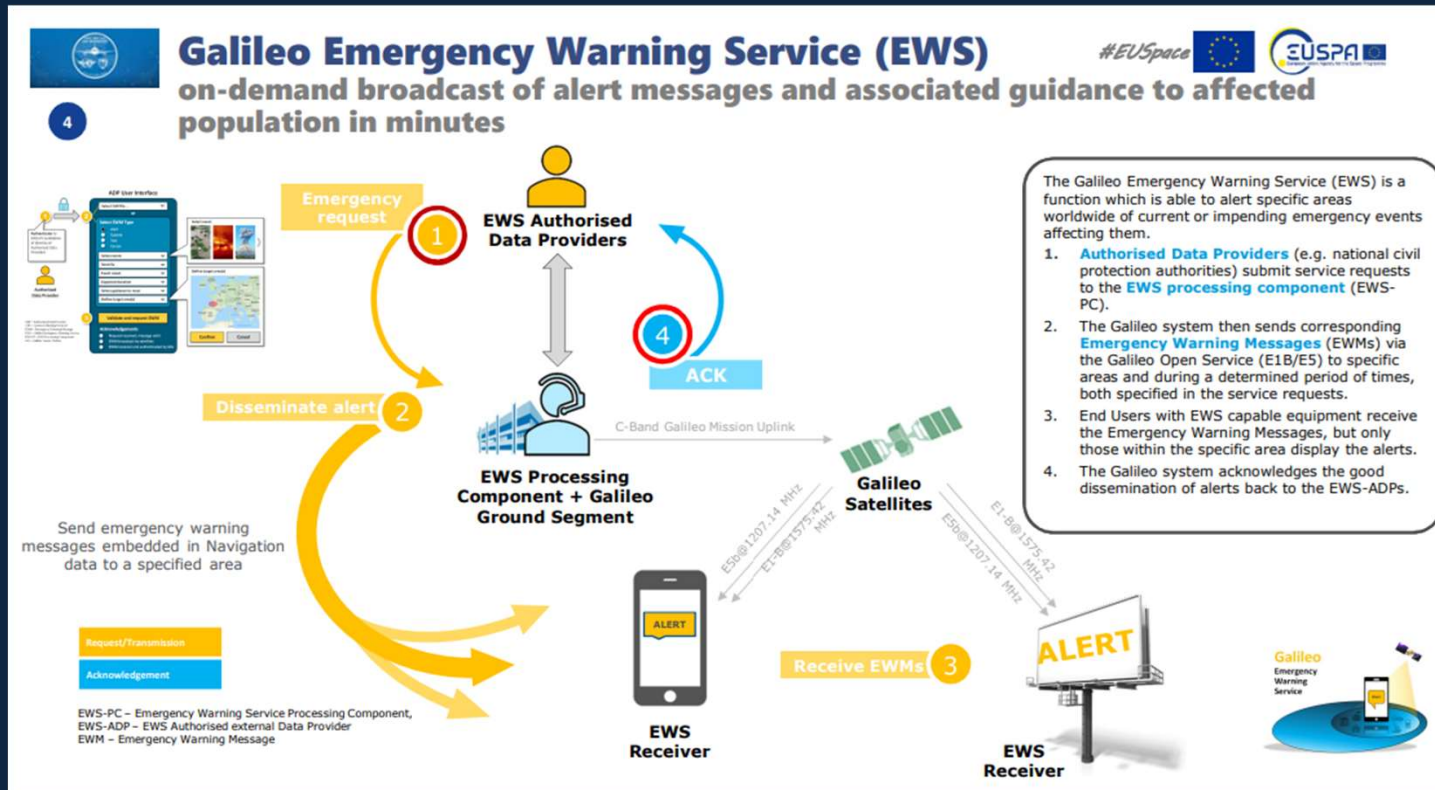


Figure 4.7-4: NTN featuring an access network serving Relay Nodes and based on a satellite/aerial with gNB

3GPP TR38.811 V15.4.0 (2020-09)

These satellite-based 5G scenarios still rely on terrestrial infrastructure to operate.

Galileo Emergency Warning Service (EWS)



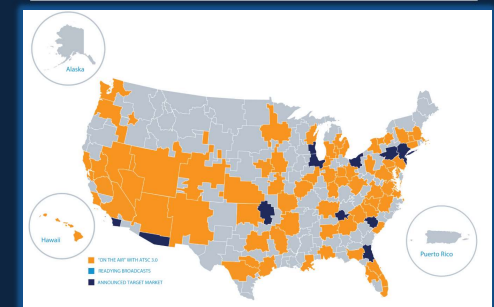
[Europe's Contribution to Emergency Operations](#)

The Galileo satellite-based EWS is only available to EU Member States.

ATSC 3.0 NextGen TV

- **ATSC 3.0 (NextGenTV)** – EAS messages can be sent over the air via the ATSC 3.0 wireless broadcast network to fixed devices (e.g., TVs) that have a compatible receiver and antenna.
- **Coverage:**
 - One pathway: ATSC 3.0 limited to broadcast video over the air to ATSC 3.0-compatible devices with an antenna.
 - Coverage limited to terrestrial infrastructure (no satellite).
 - ATSC 3.0 broadcast range is targeted at 80% of the U.S. population.
- **User Access**
 - ATSC 3.0 user equipment tends to be large and not mobile.
- **Resilient Power**
 - Most ATSC 3.0 receivers require commercial AC power; broadcast towers may or may not have resilient power options against High Altitude Electromagnetic Pulse (HEMP).
- **Industry Support / Adoption**
 - Wireless carriers view ATSC 3.0 as a competitor for the streaming content market.
 - Due to hardware incompatibilities and patent disputes, cell phone chip manufacturers may not integrate ATSC 3.0 support into their chipsets, meaning reducing ability to support IPAWS coverage needs.

ATSC 3.0 provides an additional, limited distribution pathway for IPAWS.



[Advanced Emergency Information Implementation Guide \(atsc.org\)](https://atsc.org)

Conclusions

- Effective, resilient, and timely alert and warning systems must consider the entire communication chain including the user equipment and notification of the end user.
- By following the PACE communications model, the **E**mergency layer should be designed to be resilient to all possible adversities.
- Public-private partnership engagement is an ongoing process needed to address advancements in technology, cultural trends, and enhancements in AWS.
 - These partnerships should include networks and communication pathways as well as resilient user equipment that can securely receive alerts and warnings simultaneously from multiple pathways.
 - Alerting and warning systems should comply with industry standards and regulations to enable widespread adoption and encourage innovation.
 - Partnerships to improve situational awareness are also needed to reduce time to alert.
- **Effective and resilient A&W systems can be achieved through public-private partnerships that promote the dissemination, integration, and use of Band 108 with mobile devices.**