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A little while ago I talked about CONELRAD, and how its active denial component was essentially too complex to actually be implemented, so it was reduced to only serving as an emergency broadcasting system. This is not to say that CONELRAD was a failure, or at least not entirely. CONELRAD is the direct ancestor of today's Emergency Alert System, which does serve an important and useful role.

Like most government initiatives, though, it is tremendously complex and has had a very rocky path to its present capability. Let's take a look at the post- CONELRAD history of emergency broadcasting in the US, and how it works today.

It was not always obvious that radio was the best way to disseminate emergency information. It had two main shortcomings: first, there were tactical disadvantages to operating radio stations during a military emergency [1]. Second, receiving an alert by radio required that there be a radio turned on somewhere nearby. This was not at all guaranteed, and in a case where minutes mattered presented a significant problem.

"Minutes", after all, was generous. Military and Civil Defense officials prominently demanded an alerting timeline (from origination to the entire public) of just thirty seconds.

alternatives to radio

Two major alternate emergency warning strategies have existed to overcome these downsides of radio: First, sirens. Sirens require no special equipment or preparation to receive and so are an ideal wide-area alerting system, but they were very expensive to maintain in the civil defense administration era (in especially more sparsely populated areas, some sirens were even driven by diesel engines... you can imagine the maintenance headaches). As a result, while many larger towns and cities had siren systems at the peak of the Cold War, today wide-area siren systems are uncommon outside of regions prone to tornadoes, and more recently, parts of the West Coast due to tsunami hazard [2].

The second strategy is a wired system. We have previously talked about wired radio in the context of public broadcasting. A very limited wired broadcast system was proposed for the US, called the National Emergency Alarm Repeater or NEAR. NEAR consisted of a small box plugged into an outlet. In the case of an emergency, an extra 270Hz tone was modulated onto the normal 60Hz AC power lines, which would cause the NEAR 'repeaters' to sound a buzzer.

That's it. Not much of a broadcast system, really, but rather a supplement to sirens that would allow coverage in rural areas and ensure that they were clearly audible indoors [3].

Although NEAR reached an early implementation stage, with testing in small areas and manufacturing of repeaters underway, it was never deployed at large scale. Radio emergency broadcasting was viewed as superior, mainly because of the ability to deliver instructions. The problem of radio broadcasting not reaching the many individuals who were not presently listening to the radio is, to be honest, one that was never meaningfully addressed until the last few years. But I am getting ahead of myself.

the Emergency Broadcasting System

In 1963, the Emergency Action Notification System (EANS) was activated. EANS is almost exclusively referred to by its later name, the Emergency Broadcast System, but it's important to know that it was originally named EANS. In the context of the United States Government, "Emergency Action" has long been specifically a euphemism for nuclear war. Emergency action was first, and other types of emergency were added to the national alerting regime only later.

There is some ambiguity as to whether EBS was a Federal Communications Commission (FCC) system or a Civil Defense Administration (CD) system. The answer is some of both; the system was designed and operated by the FCC based on a requirement, and under authority, from CD. This ambiguity in emergency alert systems remains to this day, although the Civil Defense Administration has, through a very circuitous path, become a component of the Federal Emergency Management Administration (FEMA). A good portion of the ongoing problems with these initiatives relates to this problem: the Federal Government has never done an adequate job of placing emergency alerting under a central authority, which has always lead to competing interests and resource contention.

That's a lot about the bureaucracy, but what about the Emergency Broadcasting System itself?

The EBS was organized into a tree-like structure. At the top were two "origination points," originally a primary and alternate but later equal. The identity of the origination points varied over the life of the system but were typically a relevant military center (Air Defense Command, CONAD, NORAD) and a relevant civilian center (CD, FEMA, and the many acronyms that came in between). We are talking, here, about physical locations--two of them. In the early '60s both the culture of national defense and the technology were not amenable to a substantially redundant system.

At the time, the two origination points were not intended to issue alerts on their own, but rather on the behalf of the President. So, in a way, there was one *true* origination point: the President, wherever they were, would issue the order, via the White House Communications Agency, to one of the origination points. This is one of the reasons (the more significant being reprisal itself) that the President, as they traveled, was always to be in real-time communication with the WHCA.

The origination points, upon receiving a bona fide order from the President, would retrieve a codebook and use a teletype network (dedicated to this purpose) to send the message and an authentication codeword to a number of major radio and television

networks. The same message, called an Emergency Action Notification, was repeated onto the teletype networks of wire agencies such as the Associated Press for further distribution.

Upon receiving such a message an operator at each of these networks would tear open a red envelope issued to the networks quarterly and find the codeword for the day. If the codewords matched, nuclear attack was imminent.

Activation details from this point varied somewhat by network and technology, but in general these national media networks would initiate a corporate procedure to direct all of their member stations to switch their program audio (and video as relevant) to a leased line or radio link from the national control center. This process was at least partially automated so that it could be performed very quickly. These now live national networks would then broadcast an Attention Tone.

The Attention Tone used later on, a combination of 853 and 960 Hz, is still instantly recognizable by most Americans today. Although its purpose was, as we will see, mostly technical, it was intentionally made to be unpleasant and very distinctive so that listeners would associate it with the Emergency Broadcast System and start to pay attention. This worked so well that the same Activation Tone is still widely used by emergency alerting systems today (even as a ringtone for WEA on most smartphones), although changes in the technology have rendered it vestigial.

The Attention Tone was recognizable not just to humans, but to electronics. These national networks were only the first stage of the broadcast component of EBS. Radio and television stations not associated with one of these major national networks would have, at their control points, a dedicated receiver (often more than one) tuned to stations operated by national networks. This receiver's purpose was to recognize the Attention Tone and at least sound an alarm in the control room, and later on automatically switch program audio (and in some cases video) to the received station in order to simply repeat the message on.

In this way, the activation of the major national networks cascaded through the radio and television industry until every AM, FM, and OTA television station was broadcasting the same message.

The national networks were expected to broadcast pre-scripted messages until they received more specific instructions; a typical script went: "We interrupt this program. This is a national emergency. The President of the United States or his designated representative will appear shortly over the Emergency Broadcast System."

EBS was functional and, besides a one major gaffe involving an activation due to a mistake by an operator, encountered few serious problems. As a result it had a long life, remaining in service well into the computer age. The major limitation of EBS was its highly centralized structure: messages were to originate only with the President. This was a logistical challenge for alerts besides nuclear war, and prevented the use of the system to address major emergencies in smaller areas. The similarly named Emergency Alert System made use of similar technology, but more flexible policy, to address these shortcomings.

the Emergency Alert System

In 1997, the Emergency Alert System replaced EBS. Like EBS, EAS was a project of the FCC and FEMA, but added the National Oceanic and Atmospheric Administration (NOAA). NOAA's involvement, being the parent agency of the National Weather Service, was the foundation of EAS's larger scope: EAS was intended not only for military conflict but also for non-military civil emergencies such as severe weather [4].

Technologically, the EAS is largely similar to the EBS, but expanded use of digital signaling and a more flexible hierarchy that allows for messages to be distributed in a more flexible, targeted way.

When you think of the Attention Tone today, you probably think of it as accompanied by three buzzes. You can hear an example here. Those three buzzes, like the Attention Tone originally, are not intended for human consumption. They're actually brief FSK packets containing a digital message in the Specific Area Message Encoding, or SAME. As the name suggests, the main feature of SAME is that it contains a list of locations--expressed as FIPS state and county IDs--to which the alert applies. This allows the the dedicated receivers in "downstream" stations to intelligently decide whether or not the alert is applicable to the location they serve.

In addition, SAME headers include a code identifying the type of disaster, which can be used for a variety of purposes such as for tornado siren controllers to determine whether or not they should activate.

EAS also adds more flexible options for broadcast stations. The technical device used by stations to receive and inject EAS messages, called an ENDEC, is computerized and configurable. It can be combined with other equipment to allow some stations to inject only a brief message (which may be in the form of a text crawl over the normal program feed for television stations) directing listeners to a different station to receive more detailed information.

The biggest change in EAS, though, is the origination of messages. EAS messages enter the broadcast realm through Primary Entry Point radio stations, which are typically major network-operated radio stations with high transmit powers and modest hardening against attack and disaster. PEP stations are fitted with special equipment that can automatically receive an alert (and override the program feed to transmit it) through various methods, but originally through FNARS.

FNARS is the FEMA National Radio System, a network of HF radio stations (using the hybrid digital ALE protocol also used by the military) located at various emergency command points. The primary control station for FNARS is located at Mount Weather, FEMA's primary hardened bunker, and state OEMs and many better-equipped county and city OEMs are connected to FNARS either directly or through regional radio networks.

In modern applications, FNARS is complemented by IP delivery of messages, but that's getting in to a future topic.

This nationwide network that includes multiple organizations allows EAS messages to be originated by different Alerting Authorities at different scopes. The President still has the ability to issue EAS messages to the entire nation, but so can certain federal agencies and military centers under certain circumstances (e.g. NORAD). Importantly, though, alerts can be issued for entire states by the governor or a designee (such as a state director of emergency operations), or at the county or city level by a relevant executive or emergency operations official.

This makes EAS suitable for a wide variety of situations: not just nuclear attack, but civil unrest, severe weather, major transportation disasters, infrastructure emergencies (e.g. contaminated municipal water), etc.

By far the largest user of EAS is the National Weather Service, whose forecast offices routinely issue EAS alerts. While these types of weather alerts are usually associated with tornados, in my part of the country they more often relate to flash flooding, large hail, or particularly severe wind and lightning. The National Weather Service estimates that dozens of lives are routinely saved by timely warnings of imminent severe weather.

the internet age

In most meaningful senses, EAS remains in service today. However, in a technical sense of government funding, it has been replaced by something more ambitious. The reality is that the expectation that alertees have a radio turned on nearby has always been a problematic one, and broadcast radio and television are generally declining in popularity.

To achieve rapid alerting, alerts must now be disseminated through more channels than just broadcast stations. That's exactly the goal of the Integrated Public Alert and Warning System, or IPAWS. I've already gone on long enough, so let's talk about IPAWS next.

Teaser: there's even more radio involved!

[1] This because civilian radio stations could be used as navigation aids by enemy aircraft, helping them to locate major cities despite blackout. This concern became obsolete as air navigation technology improved.

[2] To some degree tsunamis are a retrospective explanation, the state of Hawaii and the city of San Francisco have maintained siren systems since the Cold War and only more recently began to discuss tsunamis as a purpose. Mostly they're still worried about "radiological attack," to quote the SF OEM.

[3] In Great Britain, a more complete wired broadcast system--including voice messages--called HANDEL was installed in various government buildings, but was not extended to homes or businesses. A rather accurate depiction of HANDEL is seen in the 1984 film *Threads*, and in this YouTube clip at 1:07 and again, in alert, at 2:17, but if you are interested in the topics of civil defense and nuclear war the entire film is required, albeit difficult, viewing.

[4] At the time war, civil unrest, and weather represented essentially the scope of the system. Earthquakes have only begun to fall into the scope of emergency alerting very recently, which is interesting because the earthquake scenario is actually much more challenging than nuclear attack: the potential for lifesaving through early warning is tremendous, but seismic methods of detecting earthquakes give warning only seconds before the destructive shaking starts. Although some parts of the US have had earthquake warning systems for a couple decades, they have seldom ever been backed by an alerting system capable of delivering the warning before it is pointless.