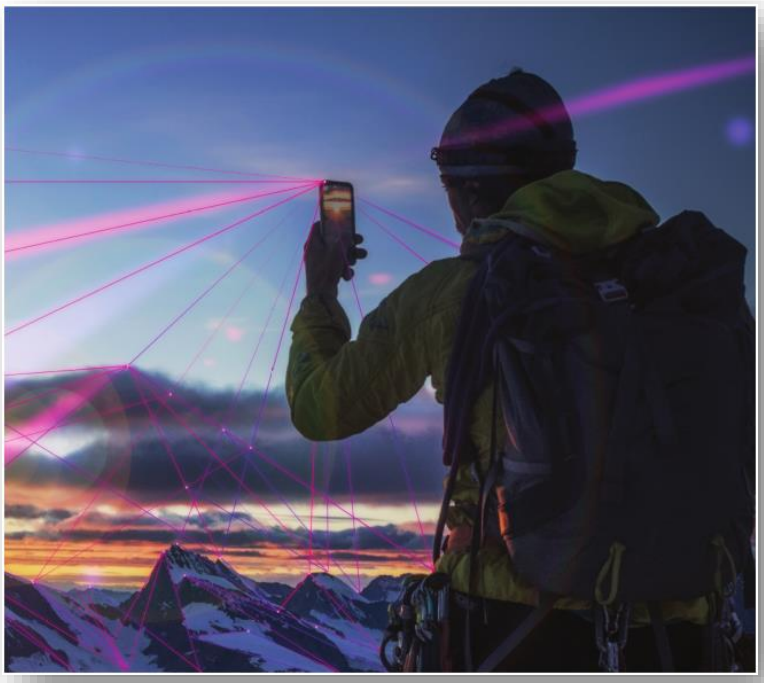

HD Radio Emergency Alerts

Nationwide Test Report

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Document Number:	SY_TRPT_4389
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Version History

Version	Date	Status & Description
1.0.0.0	17DEC2021	Initial draft
1.0.0.1	12JAN2022	Content update
1.0.0.2	21JAN2021	Formal release

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1 Executive Overview

HD Radio broadcasting currently transmits digital Emergency Alert messaging. This service expands public safety infrastructure for alerting services. Digital emergency alerts delivered through HD Radio broadcasting offer diversity, reliability, and resiliency of public safety messages. The delivery of alert messages was evaluated during a nationwide emergency alert test initiated by the FCC and FEMA in the U.S. on August 11, 2021. Xperi's digital radio team evaluated the reception of these test alerts via HD Radio broadcast, ATSC broadcast, and Wireless Emergency Alerts (WEA) cellular service. The HD Radio alert system performed as well as the other digital alert services and demonstrated significant market coverage and low-latency delivery.

Through participation in this national test, Xperi sought to demonstrate that HD Radio technology is an efficient state-of -the-art methodology for wirelessly broadcasting alert messages throughout the United States. The test would illustrate reception coverage of digital radio alerts and measure any time latencies between radio alerts and cellular wireless alerts. Broadcast radio is not subject to the network congestion delays and outages imposed by natural disasters associated with cellular standards such as LTE and 5G. Furthermore, anecdotal observations indicate that wireless alert latencies can vary across cellular carriers. While HD Radio alerts may have latency in different markets, the message notification to devices is generally consistent within a geographic region. Therefore, it is presumed that HD Radio alerts may, in many cases, be detected before wireless alerts are detected.

While not an exhaustive or comprehensive test, the results summarized in this report demonstrate the variable latency of wireless emergency alerts. Across a city or radio market, both radio and wireless alerts were detected in reasonable time. In some cases, the digital radio alert was received prior to the wireless alert. In other cases, the wireless alert was detected prior to the digital alert. On average, both HD Radio alerts and wireless emergency alerts were generally received within a 20 second window when measured at the same location. It is important to note that precise time measurement was not possible in all locations and there is +/- 30 second variability in the times recorded with 1 minute resolution.

This report provides details of the Xperi test results. As a complement to other emergency alerting methods, HD Radio technology can enhance EAS with many of the advanced features and attributes recommended by the FCC and FEMA to provide greater resiliency, redundancy, and accessibility in the nation's public alerting ecosystem. With HD Radio technology, federal, state, local, and tribal authorities can significantly improve the nature and quality of their critical efforts to notify the public of Presidential directives, national security alerts, AMBER alerts, weather-related events, and other emergencies. Radio broadcasters can utilize the HD Radio signal's audio and data channels to send various enhanced alert information, including text notifications, image data and location information (e.g., maps), and multilingual announcements.

Well beyond the alerting capabilities of analog radio transmissions, HD Radio technology allows digital broadcasters to upgrade the usefulness of the emergency information and ensures that such information reaches people when and where they need it most. HD Radio's enhanced emergency alerting:

- Integrates with IPAWS through standard endpoint equipment at radio stations;
- Provides emergency alert notifications based on CAP-II message formats;

- Enables efficient transport for transmission of alert protocol and text announcements; and
- Supports device “wake-up” functionality with alert codes.

Additional information about the enhanced functionality offered by HD Radio digital emergency alerting can be found in Xperi’s white paper, “Upgrading the Emergency Alert System: HD Radio™ Digital Emergency Alerting”[1] and in Xperi’s comments in response to the Notice of Inquiry in this proceeding[2].

[1] Xperi Corporation, Notice of Ex Parte Communications, PS Docket Nos. 15-195, 15-91 (March 13, 2019)
[2] Comments of Xperi Corporation, PS Docket Nos. 15-195, 15-91 (May 11, 2021)

2 Evaluation Sites

2.1 Locations and Participants

The HD Radio emergency alert response test was observed at various locations around the country, primarily at Xperi office locations. The tests were designed to evaluate how commercial HD Radio receivers responded to emergency alert signaling. The evaluations were conducted by Xperi engineering personnel.

Additional evaluations were conducted via Xperi's HD Radio monitoring network. This network utilizes professional receivers at fixed monitoring locations in a market to evaluate signal quality and content availability. In some cases, commercial receivers and professional monitors were evaluated in the same market.

Table 1: HD Radio Alert test Locations

Test Site	Market	Call Sign	Frequency	Receiver	Alert Type
Beverly, MA	Boston, MA	WBOS	92.9MHz	Commercial Monitor	Digital alert
Clarksville, MD	Washington, DC	WTOP	103.5MHz	Commercial	Digital alert
Columbia, MD	Washington, DC	WETA	90.9MHz	Commercial	Digital alert
Columbus, OH	Columbus, OH	WCKX	107.5MHz	Monitor	Digital alert
Ellicott City, MD	Baltimore, MD	WBAL	101.5MHz	Commercial	Analog alert
Genoa, OH	Toledo, OH	WIOT	104.7MHz	Commercial	Analog alert
Jacksonville, FL	Jacksonville, FL	WCRJ	88.1MHz	Monitor	Digital alert
Los Angeles, CA	Los Angeles, CA	KPWR	105.9MHz	Monitor	Digital alert
New York, NY	New York City, NY	WCBS	101.1MHz	Commercial	Digital alert
Salt Lake City, UT	Salt Lake City, UT	KSL	102.7MHz	Monitor	Digital alert
San Jose, CA	San Francisco	KOIT	96.5 MHz	Commerical Monitor	Digital alert

Test Site	Market	Call Sign	Frequency	Receiver	Alert Type
Somerset, NJ	New York, NY	WCBS	101.1MHz	Commercial	Digital alert
Somerset, NJ	New York, NY	WBLS	107.5MHz	Commercial	Digital alert
Troy, MI	Detroit, MI	WCSX	94.7MHz	Commercial Monitor	Digital alert

Additional test locations were utilized for WEA wireless alert testing. WEA alert observations were recorded by Xperi personnel.

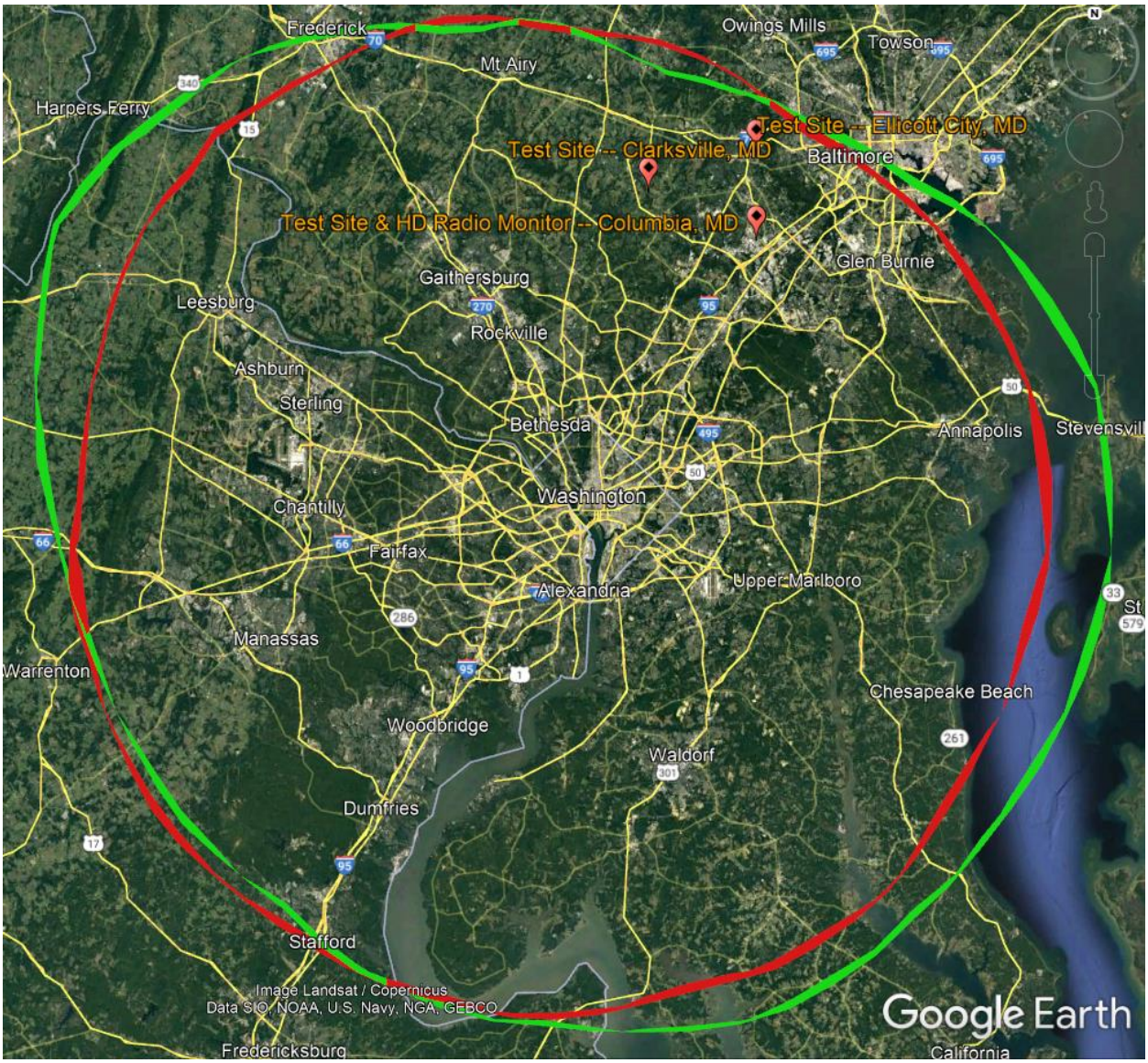

Figure 1: HD Radio Coverage Area and Test Sites for WETA 90.9 MHz (Red) and WTOP 103.5MHz (Green) Washington, DC

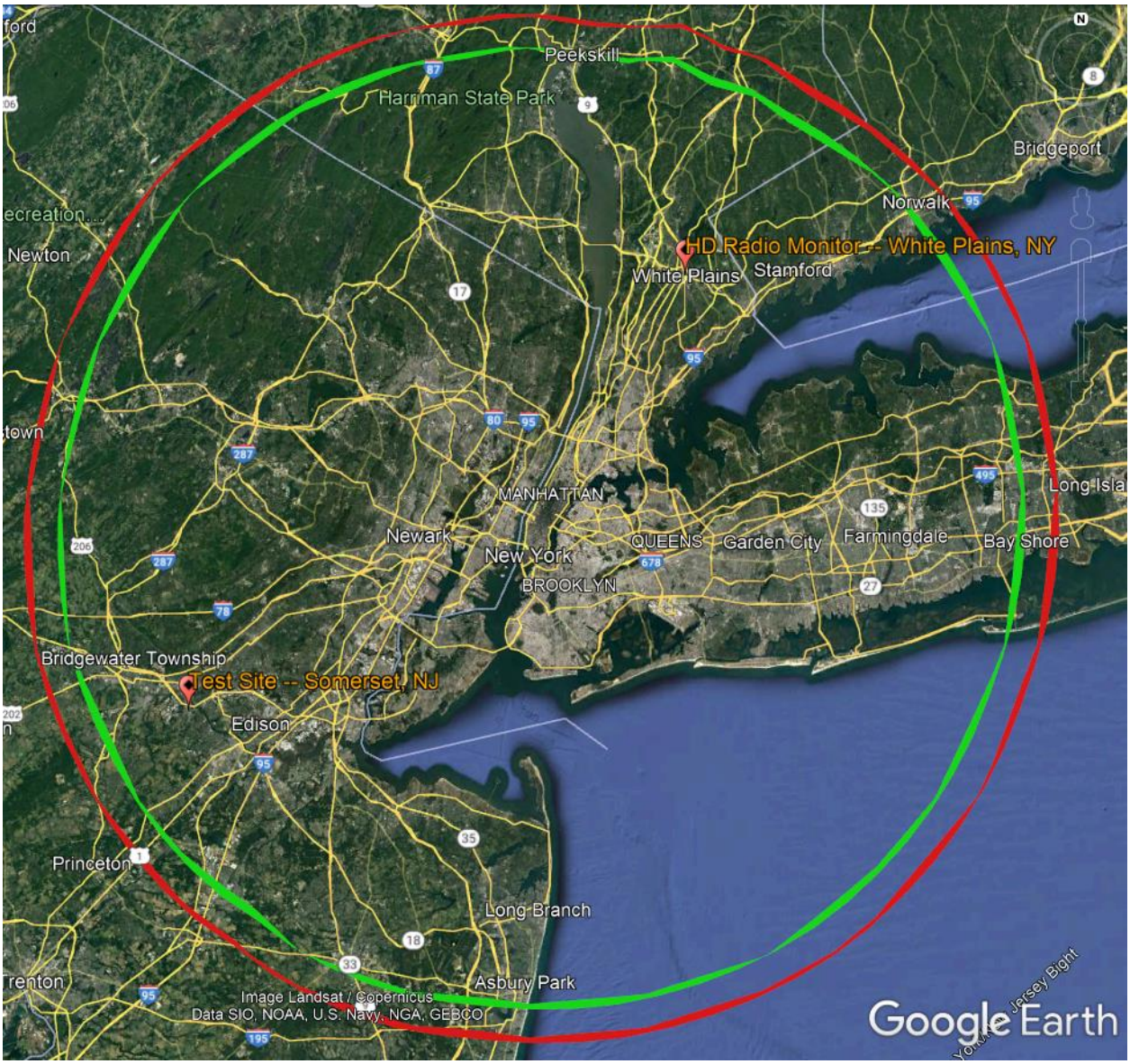

Figure 2: HD Radio Coverage Area and Test Sites for WCBS 101.1MHz (Red) and WBLS 107.5 MHz (Green) New York City, NY

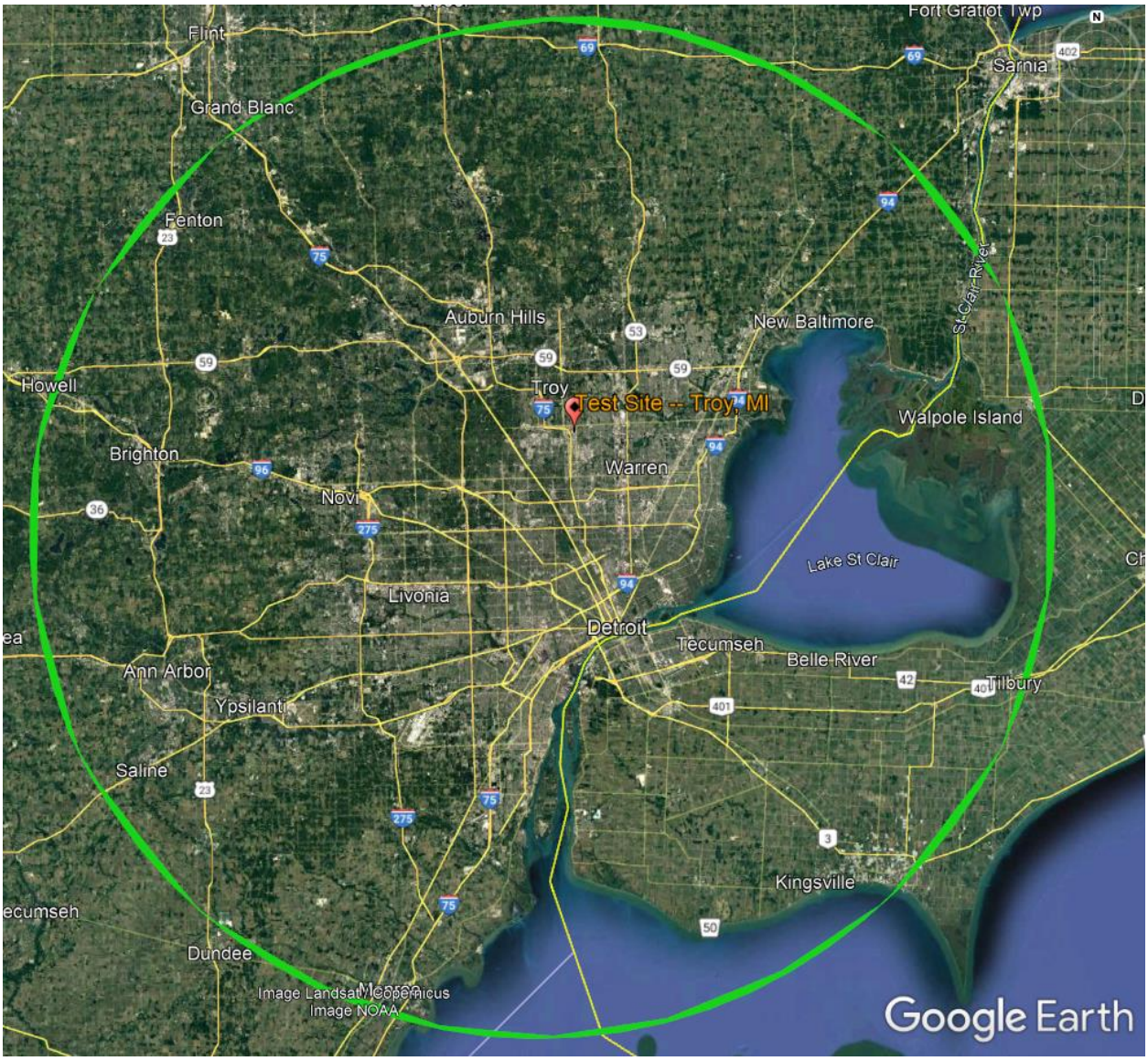

Figure 3: HD Radio Coverage Area and Test Site for WCSX 94.7 MHz Detroit, MI

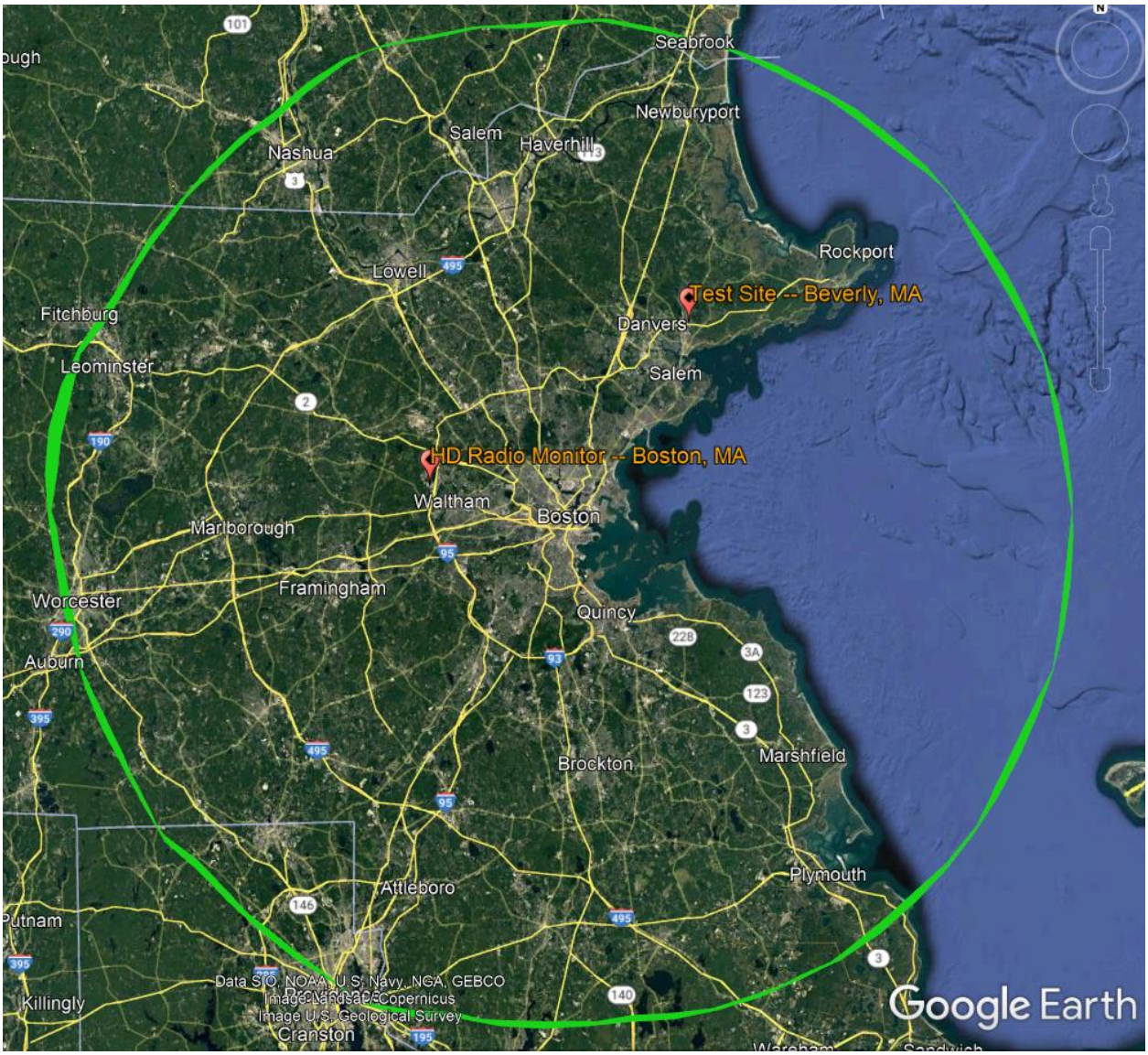

Figure 4: HD Radio Coverage Area and Test Sites for WBOS 92.9 MHz Boston, MA

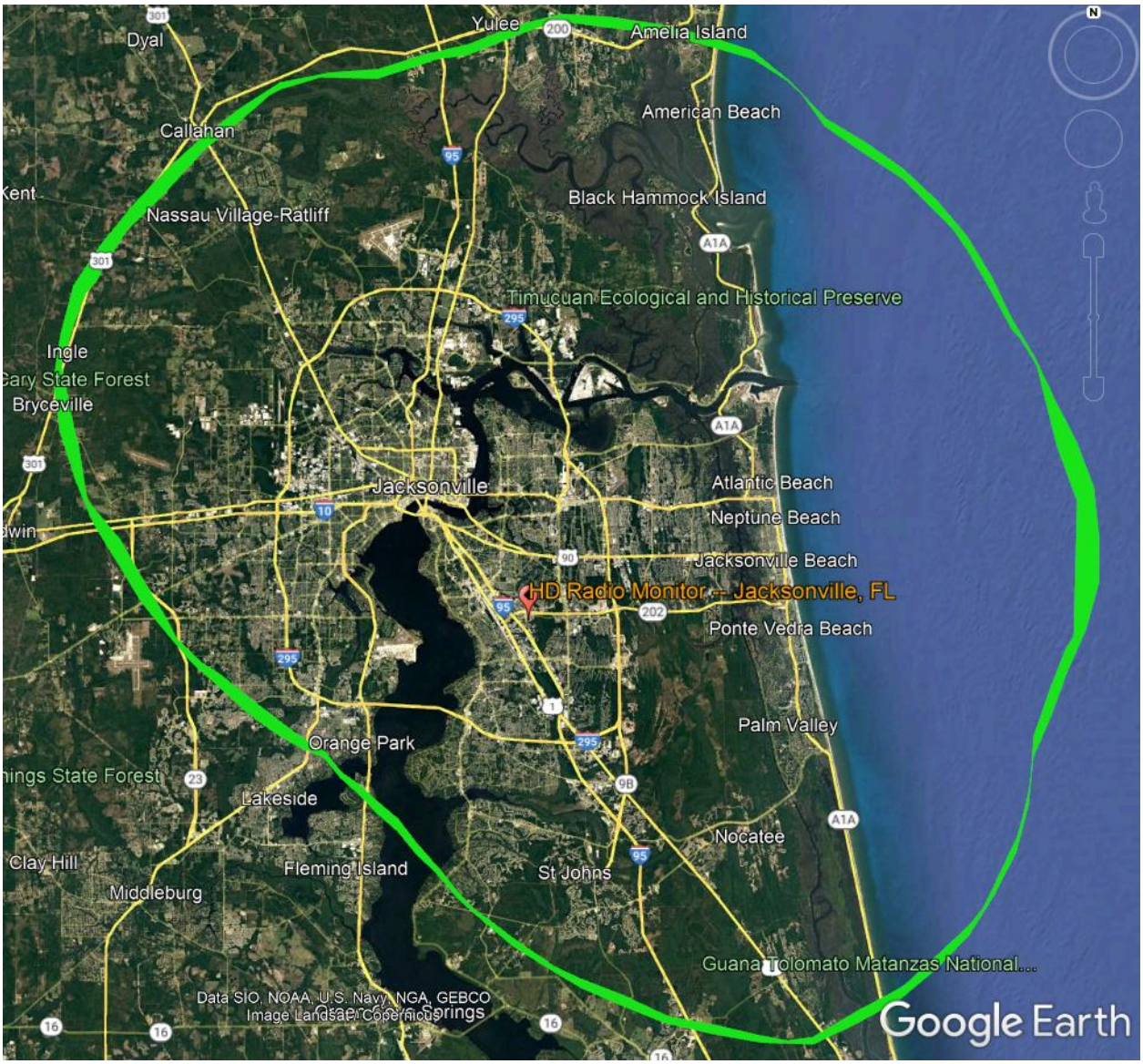

Figure 5: HD Radio Coverage Area and Test Site for WCJR 88.1MHz Jacksonville, FL

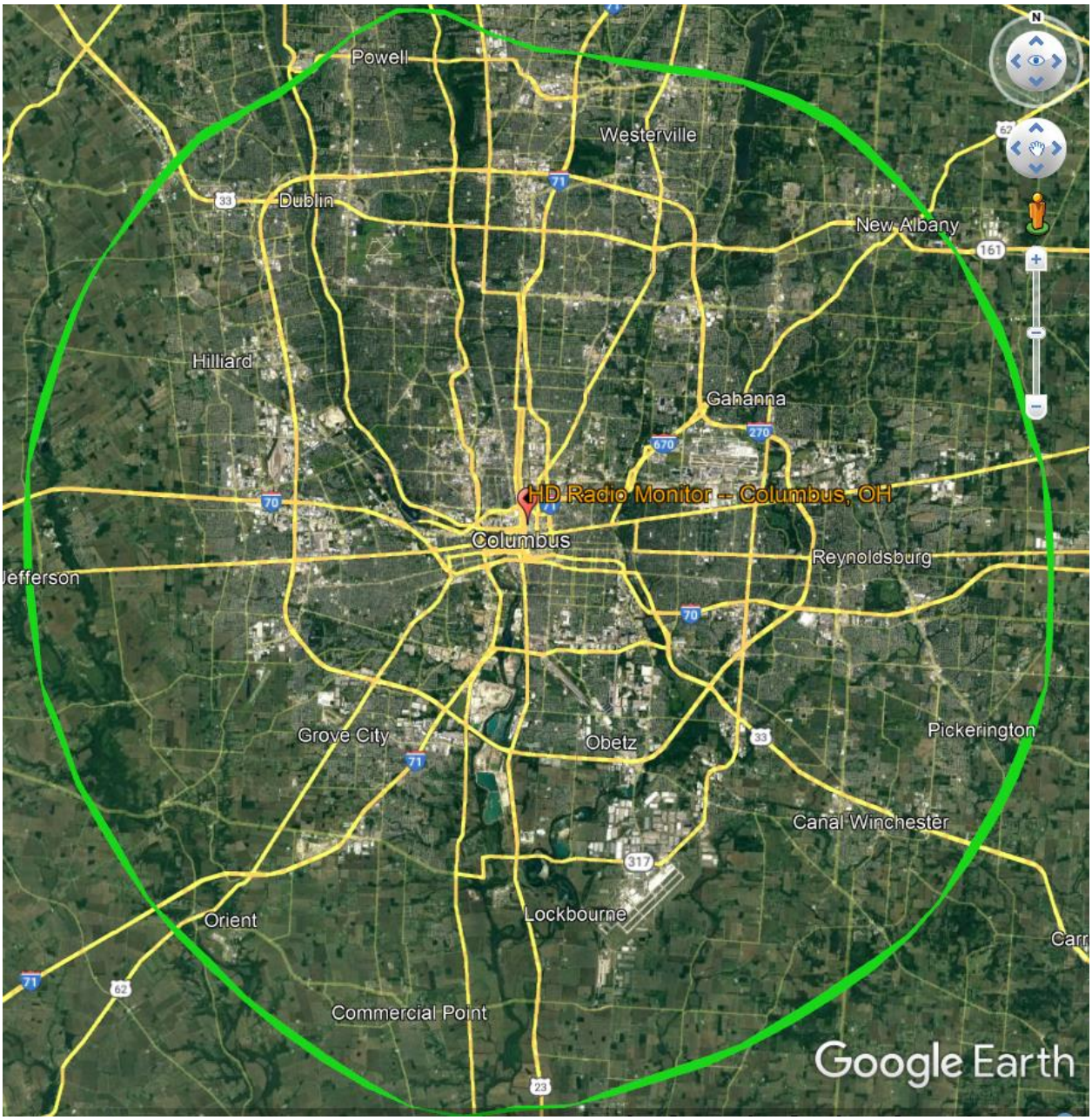

Figure 6: HD Radio Coverage Area and Test Site for WCKX 107.5MHz Columbus, OH

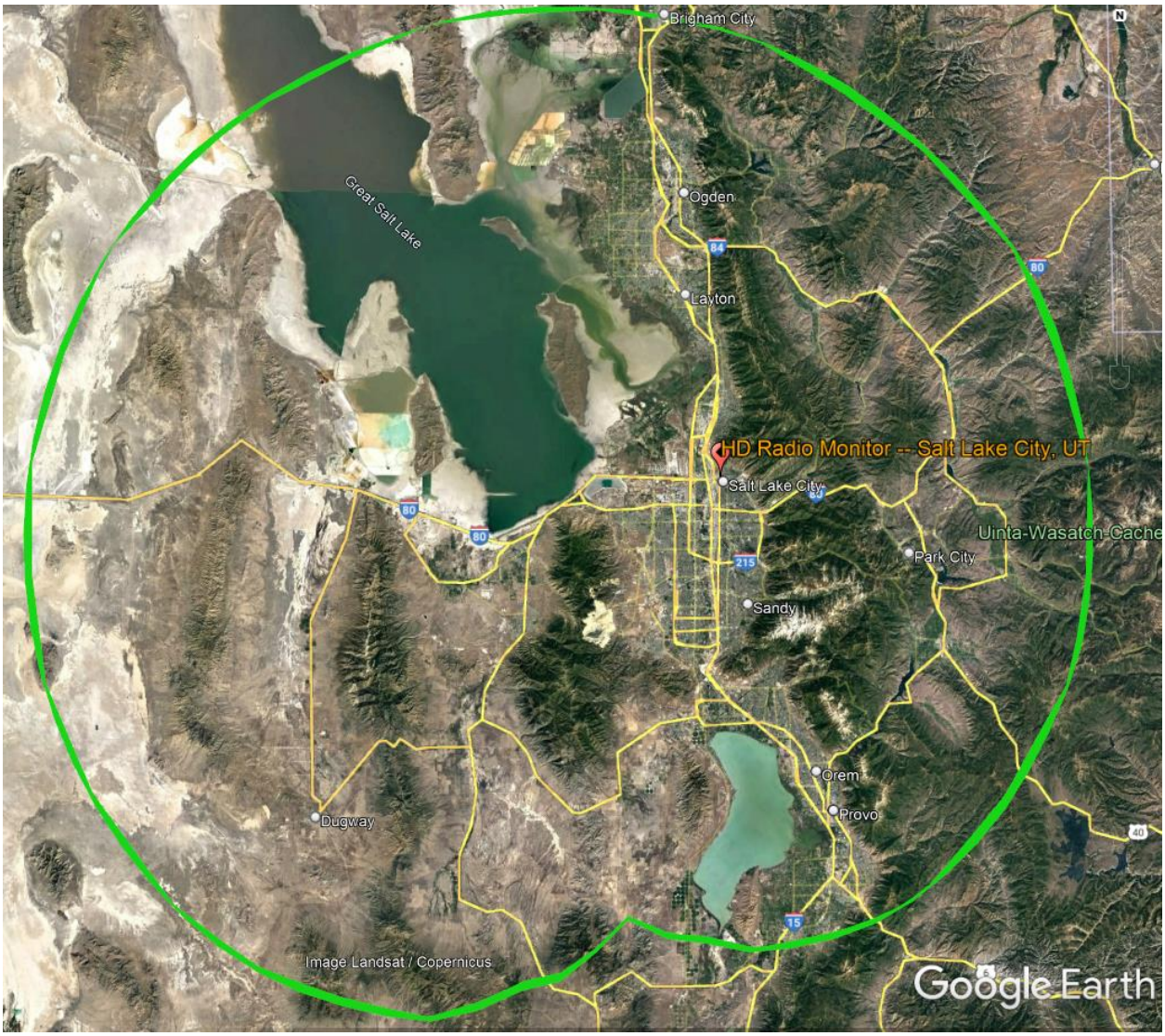

Figure 7: HD Radio Coverage Area and Test Site for KSL 102.7 MHz Salt Lake City, UT

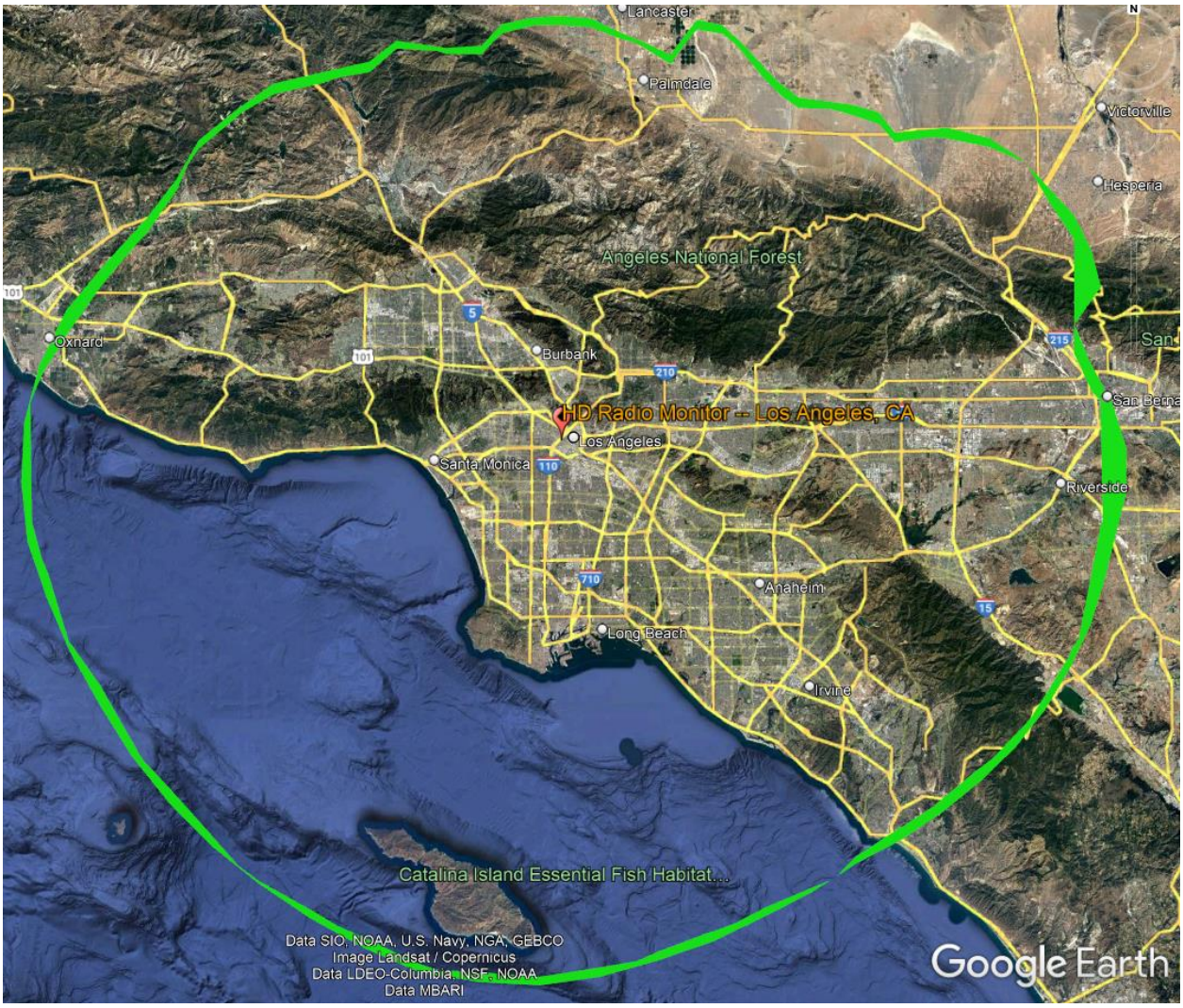

Figure 8: HD Radio Coverage Area and Test Site for KPWR 105.9 MHz Los Angeles, CA

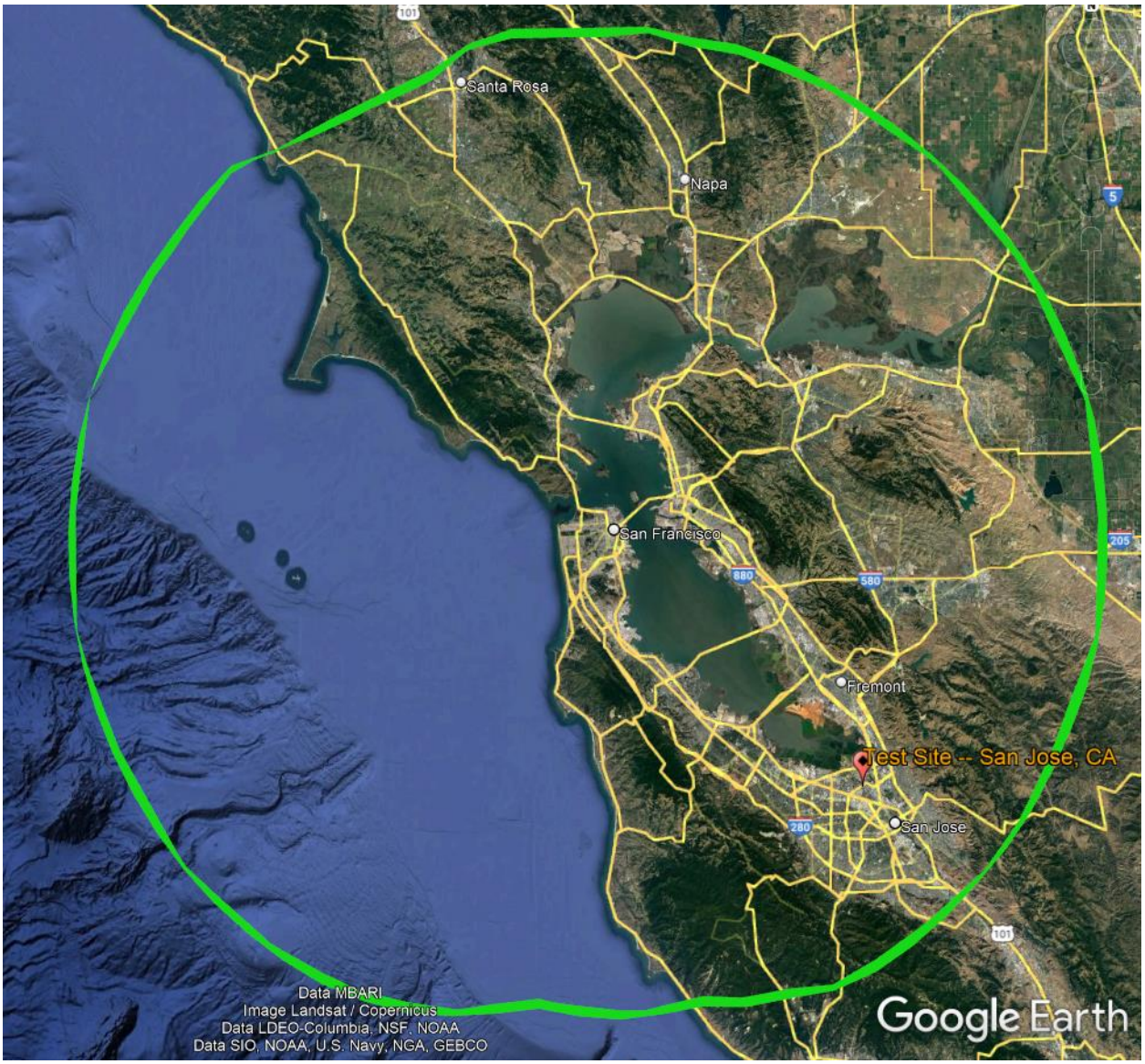

Figure 9: HD Radio Coverage Area and Test Site for KOIT 96.5 MHz San Francisco, CA

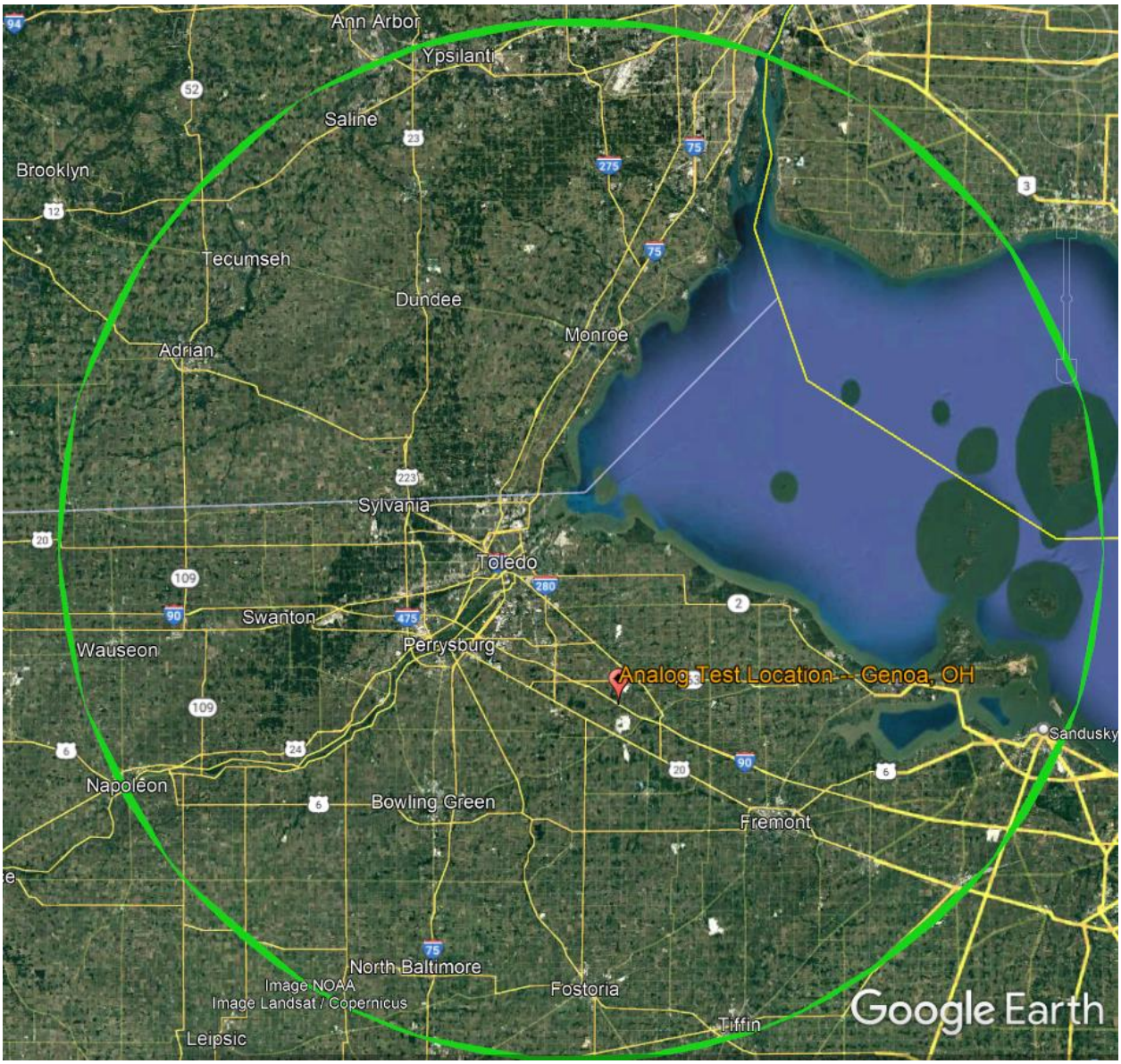

Figure 10: Analog Coverage Area and Test Site for WIOT 104.7MHz Toledo, OH

3 Test Receivers

The tests evaluated digital radio alert message reception on a variety of portable, table, aftermarket car, and OEM car receivers. Test alerts were detected on the following HD Radio products:

Table 2: HD Radio Emergency Alert Receivers

Manufacturer	Model	Radio Type
Inovonics	Sofia 568	Broadcast monitor
Sangean	HDR-14	Portable radioCl
Sangean	HDR-15	Ock radio
Sangean	HDR-18	Desk top radio
SPARC	ITR	Desk top radio
SPARC	SHD-TX2	Portable radio
JVC	KW-NT510HD	Aftermarket car radio
Harman Becker	NTG7 M620	Car radio
Harman Becker	NTG7 M609	Car radio
Visteon	MFA2	Car radio

4 Observation Data

4.1 HD Radio Observations

HD Radio digital alerts were transmitted through active radio stations during the nationwide tests. The HD Radio team evaluated reception of digital alerts on both consumer radios (car, table/home, portable) as well as through the HD Radio market monitor network across multiple markets.

4.1.1 Commercial Receiver Observations

HD Radio digital emergency alerts were detected on HD Radio receivers with the Emergency Alert function enabled. The tester documented the time the alert was received. Most measurements were made to within a 60-second resolution. In some cases, more accurate time could be determined through video recordings with a synchronized clock or time source.

Table 3: XPERI Table Theme, in the Table Styles Gallery | with Style Table Columns

Market	Location	Building Type	Antenna Location	Station	Radio Model	Time Alert Received
Baltimore / Washington DC	Ellicott City, MD	Residential	Indoor	WBAL 101.5 ANALOG	ASI Industries Emergency Alert Sentinel	14:20:00 EDT
	Clarksville, MD	Residential	Outdoor/Auto	WETA 90.9	JVC KW-NT510HDT	14:21:57 EDT
	Clarksville, MD	Residential	Indoor	WETA 90.9	Sangean HDR-15	Alert not detected – poor antenna connection
	Clarksville, MD	Residential	Indoor	WETA 90.9	Sparc SHD-TX2	14:20 EDT
Boston	Beverly, MS	Residential	Indoor	WBOS 92.9	Sparc SHD-TX2	14:20 EDT
Detroit	Xperi – Troy, MI	Office	Indoor	WCSX 94.7	NTG7 M620	14:20:38 EDT
	Xperi – Troy, MI	Office	Indoor	WCSX 94.7	MFA2	14:20:41 EDT

Market	Location	Building Type	Antenna Location	Station	Radio Model	Time Alert Received
	Xperi – Troy, MI	Office	Indoor		NTG7 M609	Alert not detected – poor antenna connection
New York	Xperi – Somerset, NJ	Office	Indoor	WBLS 107.5	Sparc SHD-TX2	14:20:02 EDT
	Xperi – Somerset, NJ	Office	Indoor	WBLS 107.5	Sangean HDR-16	14:20:02 EDT
	Xperi – Somerset, NJ	Office	Indoor	WCBS 101.1	Sangean HDR-18	14:20:05 EDT
	Xperi – Somerset, NJ	Office	Indoor	WCBS 101.1	SPARC ITR2-BT	14:20:32 EDT
San Francisco	San Jose, CA	Office	Indoor	KOIT 96.5	Sparc SHD-TX2	11:21:10 PDT
Toledo	Genoa, OH	Driving	Outdoor	WIOT 104.7	Analog alert (audio)	14:20 EDT

HD Radio receivers with Emergency Alert functionality are designed to display a text alert when the digital alert is detected. The examples below show the text alert message from automotive radio displays.

Figure 11: Example HD Radio Visual Alert JVC KW-NT510HDT

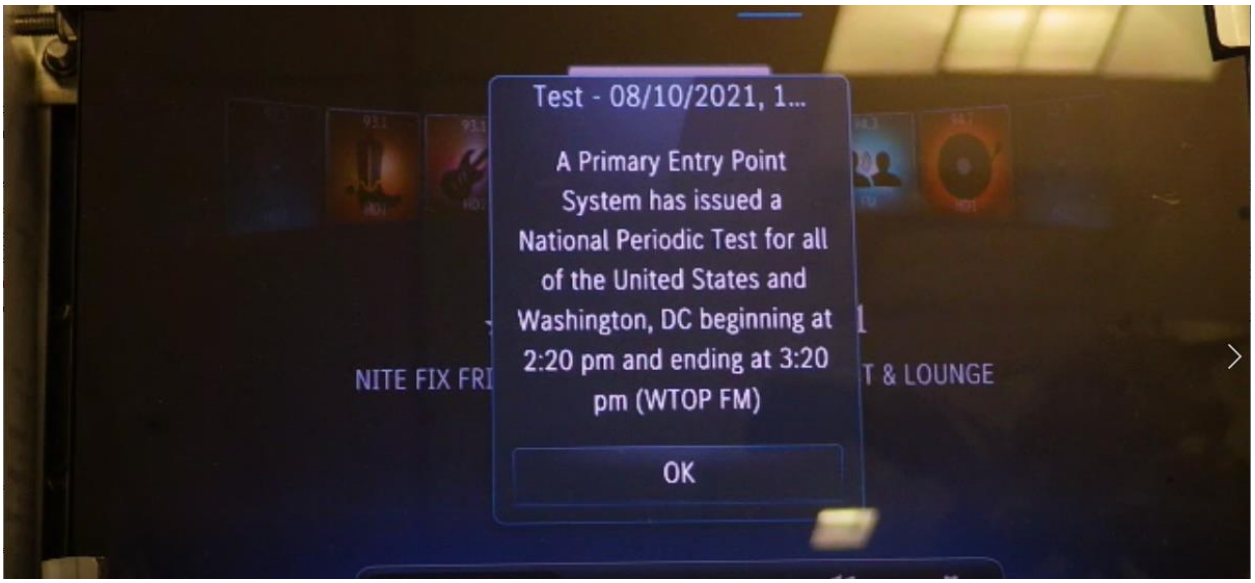

Figure 12: Example HD Radio Visual Alert Harman NTG7

4.1.2 Market Monitor Observations

Xperi maintains market monitors across the U.S. to record the HD Radio experience from local stations. We utilized this monitor network in several markets to log the HD Radio Emergency Alert messages during the test period. Table 4 lists the detected time and received message from these units.

Table 4: HD Radio Monitor Alert Data

Market	Station	Time Alert Received (EDT)	Time Alert Ended (EDT)	EA Message
New York City	WCBS 101.1 MHz	14:20:34	15:20:37	A Primary Entry Point System has issued a National Periodic Test for all of the United States and Washington DC beginning at 2:20 pm and ending at 3:20 pm (WCBS FM)
Washington, D.C	WTOP 103.5 MHz	14:20:xx	15:20:xx	A Primary Entry Point System has issued a National Periodic Test for all of the United States and Washington DC beginning at 2:20 pm and ending at 3:20 pm (WTOP FM)
Columbus, OH	WCKX 107.5 MHz	14:20:50	15:21:39	A Primary Entry Point System has issued a National Periodic Test for all of the United States and Washington DC beginning at 2:20 pm and ending at 3:20 pm (WCKX)
Salt Lake City, UT	KSL 102.7 MHz	14:20:54	15:21:38	A Primary Entry Point System has issued a National Periodic Test for all of the United States and Washington DC beginning at 12:20 pm and ending at 1:20 pm (KSL(A/F))
Jacksonville, FL	WCRJ 88.1 MHz	14:20:47	15:21:30	A Primary Entry Point System has issued a National Periodic Test for all of the United States and Washington DC beginning at 2:20 pm and ending at 3:20 pm (WCRJ)
Boston, MA	WBOS 92.9 MHz	14:20:33	15:20:39	A Primary Entry Point System has issued a National Periodic Test for all of the United States and Washington DC beginning at 2:20 pm and ending at 3:20 pm (WBOS)
Los Angeles, CA	KPWR 105.9 MHz	14:20:34	15:21:31	A Primary Entry Point System has issued a National Periodic Test for all of the United States and Washington DC beginning at 11:20 am and ending at 12:20 pm (KPWR)

4.2 WEA Observations

The HD Radio team evaluated reception of the WEA alerts through mobile phones with the WEA test message capability. Cellular alerts were monitored in locations where we had test personnel at the time of the event. We were not able to get broad distribution across all test markets.

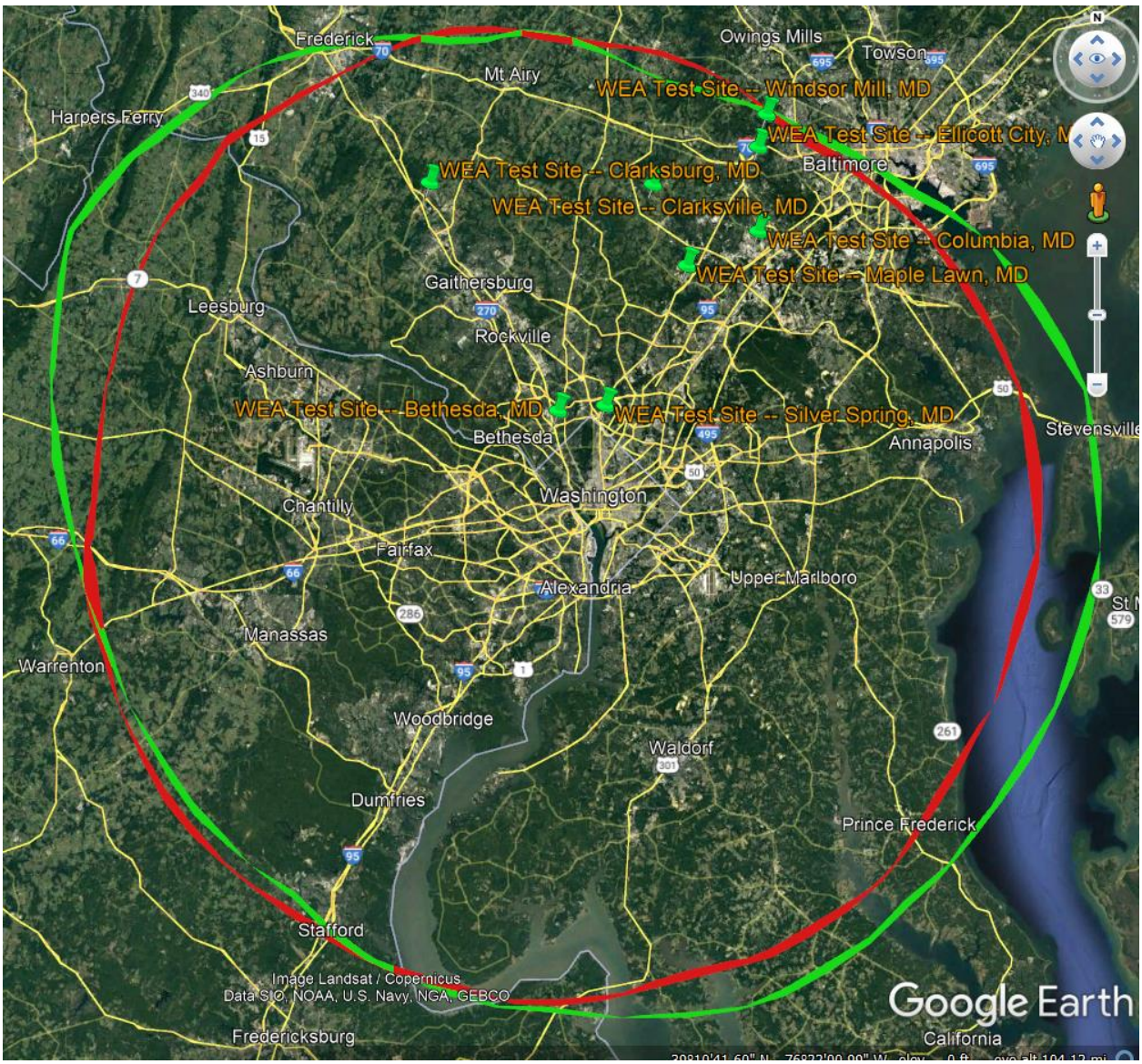

Figure 13 WEA Test Sites and HD Radio Coverage Area for WETA 90.9 MHz (Red) and WTOP 103.5MHz (Green) Washington, DC

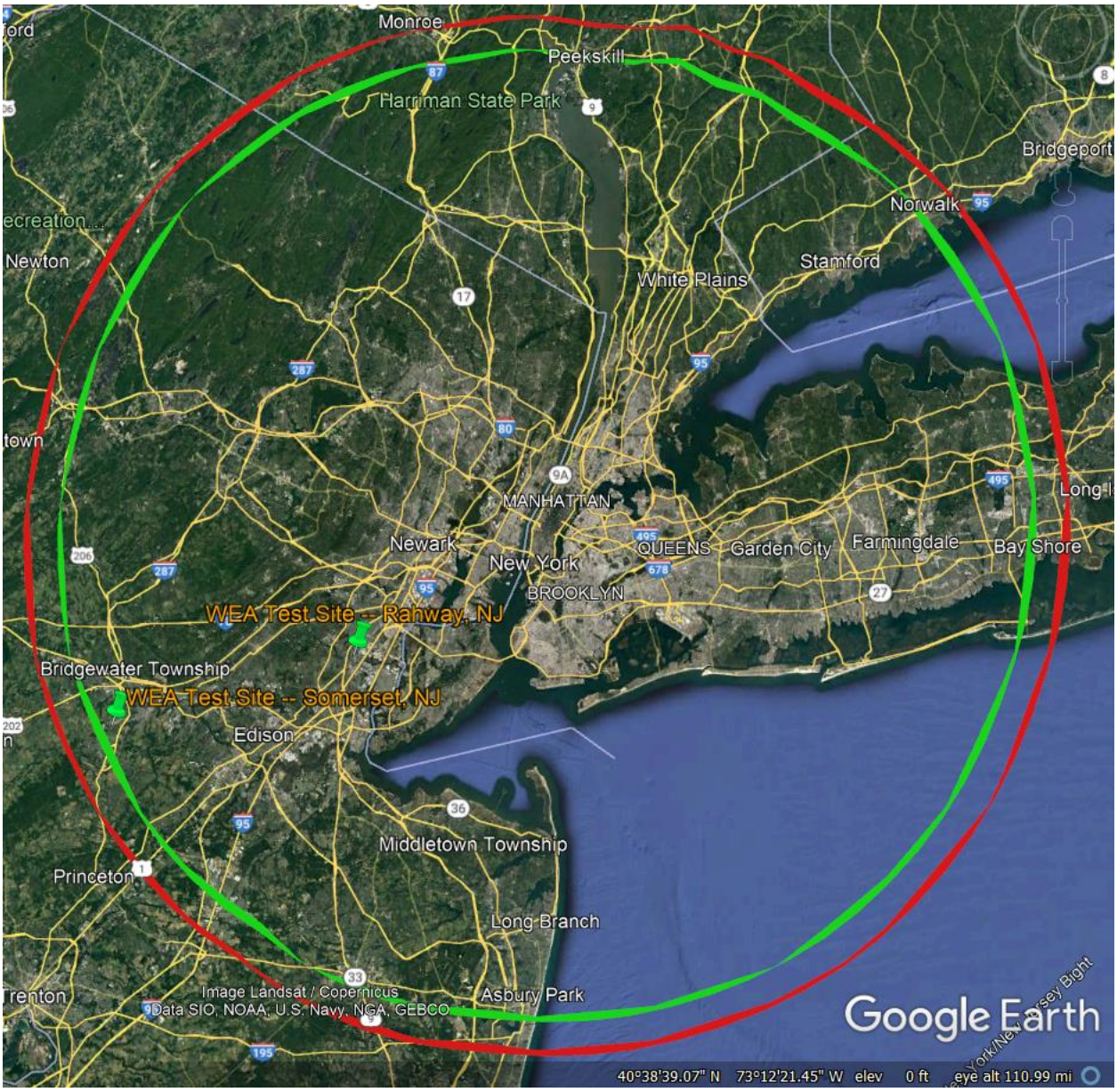

Figure 14 WEA Test Sites and HD Radio Coverage Area for WCBS 101.1MHz (Red) and WBLS 107.5 MHz (Green) New York City, NY

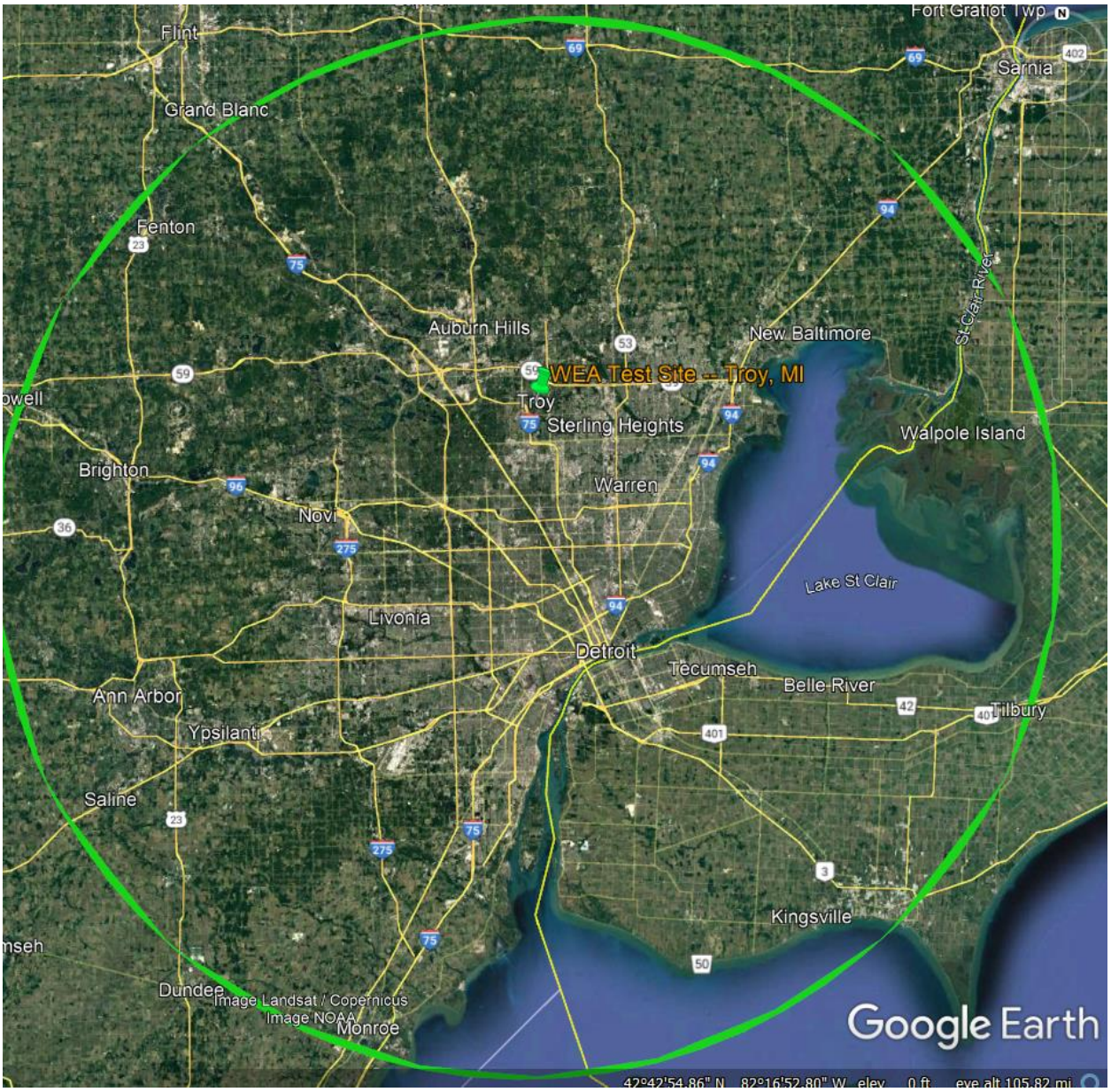

Figure 15 WEA Test Site and HD Radio Coverage Area for WCSX 94.7 MHz Detroit, MI

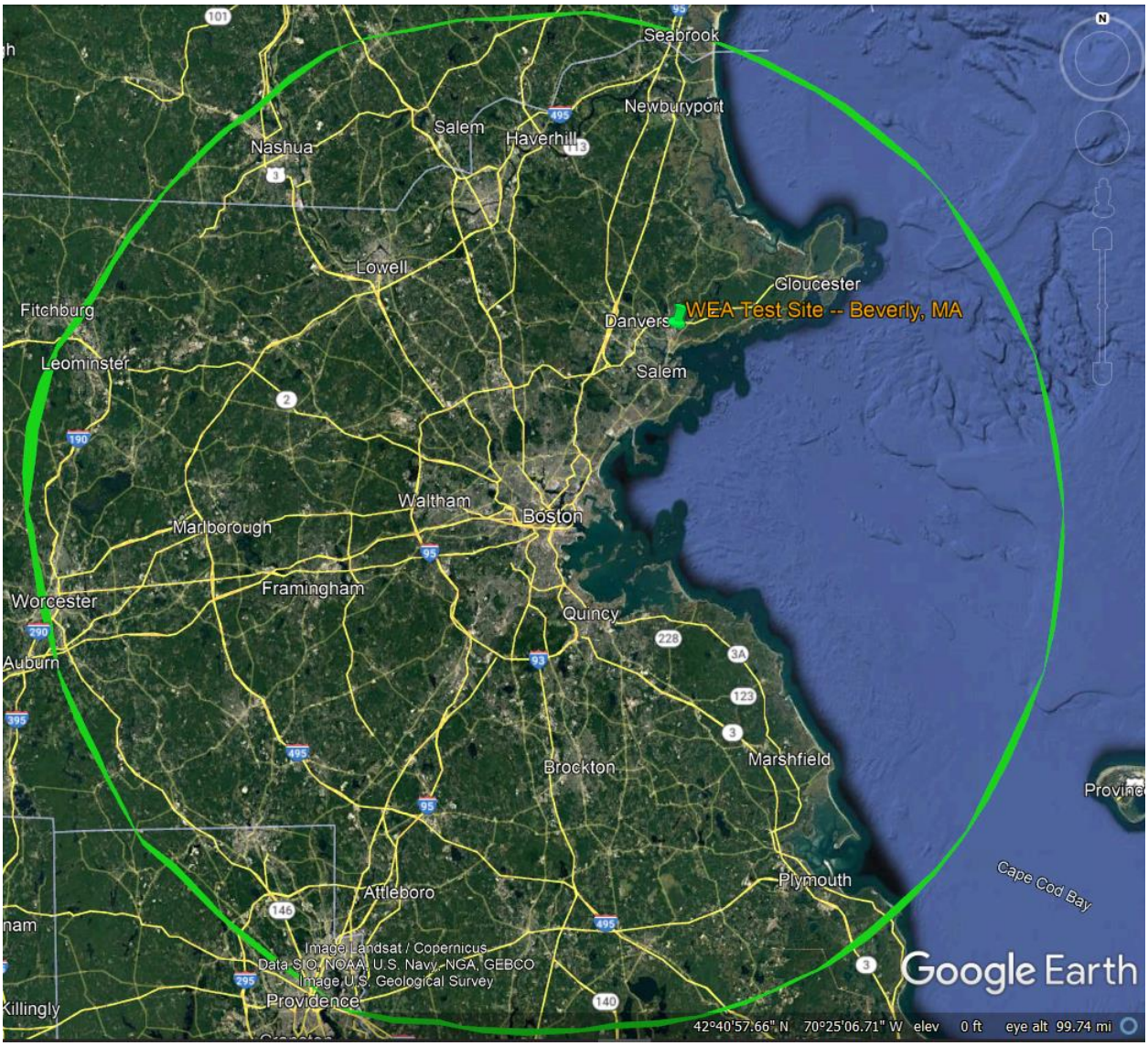

Figure 16 WEA Test Site and HD Radio Coverage Area for WBOS 92.9 MHz Boston, MA

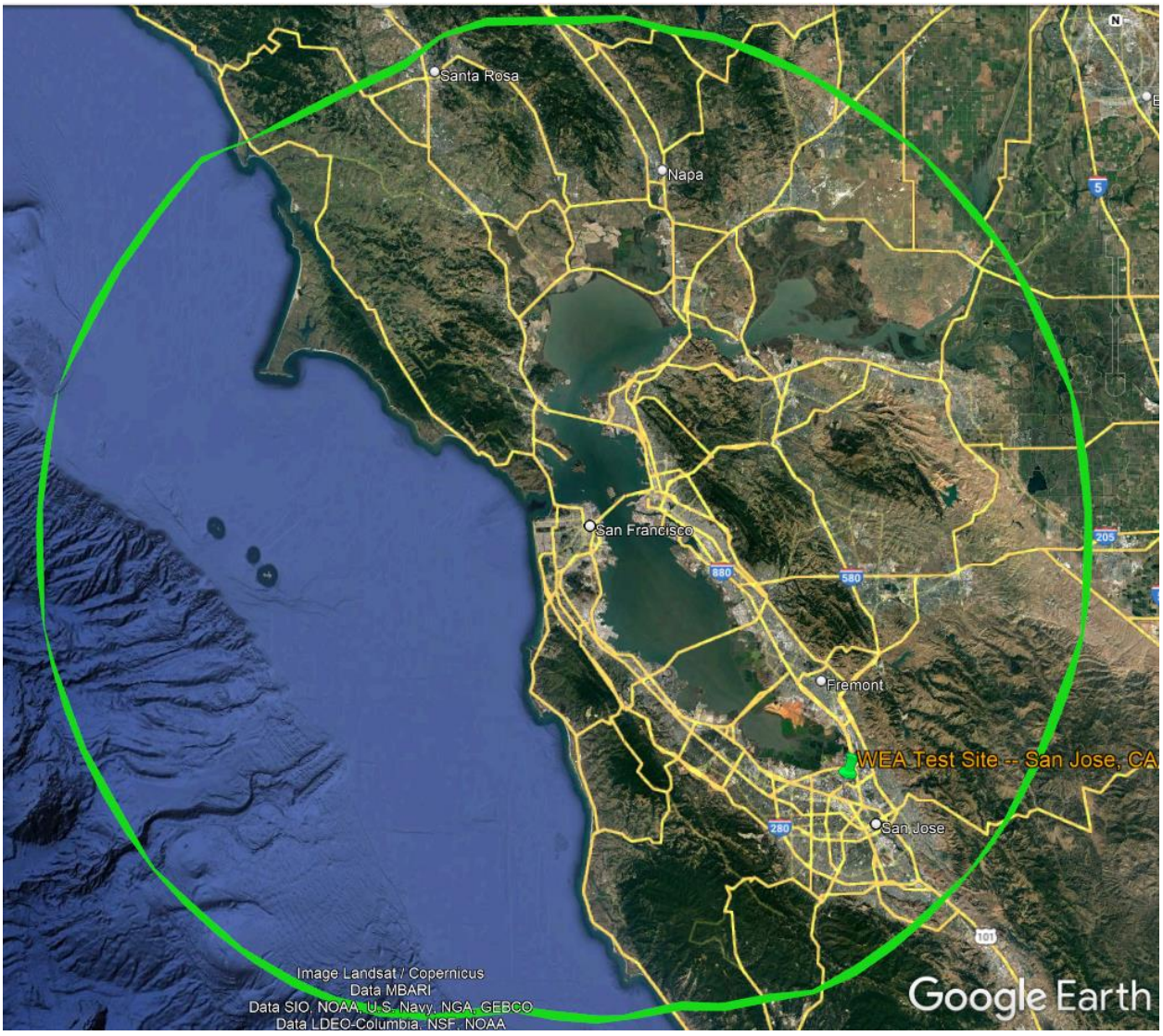

Figure 17 WEA Test Site and HD Radio Coverage Area for KOIT 96.5 MHz San Francisco, CA

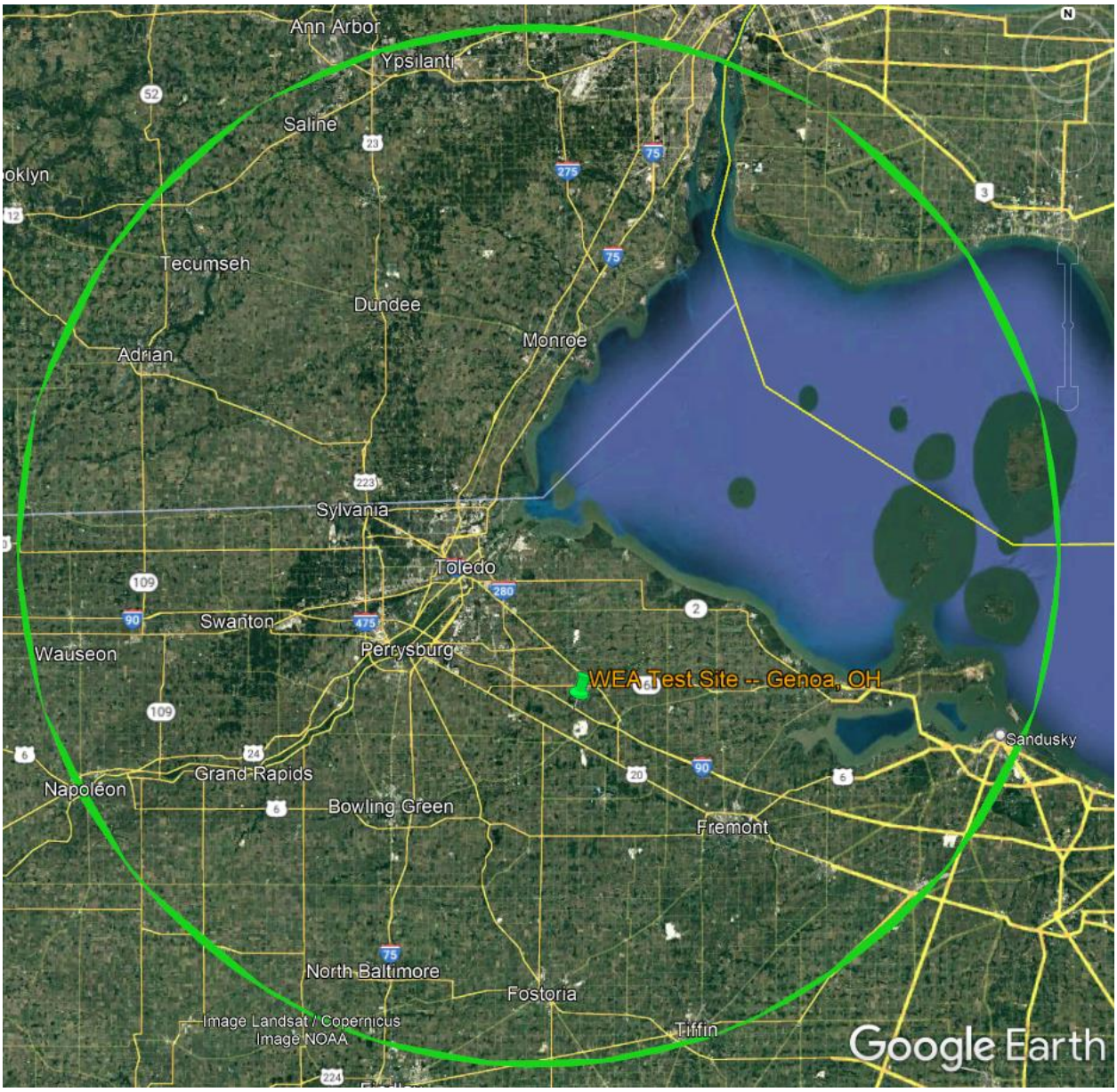

Figure 18 WEA Test Site and Analog Coverage Area for WIOT 104.7MHz Toledo, OH

The test participants noted the time their phones alerted to the test message. Note that many times are approximate +/- 30 seconds due to the time resolution of the device. When possible, the participants noted the time offset between WEA alert and radio alerts. These are reflected in the notes.

Table 5: WEA Alert Data

Market	Location	Carrier	Device	Alert Detected	Notes
Baltimore, MD					
	Clarksville, MD	T-Mobile	Galaxy S20	14:20:20 EDT	Alert detected 3 seconds after HD Radio alert
	Columbia, MD	Cricket Wireless	LG G8 ThinkQ	14:20:00 EDT	
	Columbia, MD	Verizon	iPhone 11	14:30 EDT	
	Columbia, MD	AT&T	iPhone XR	14:22 EDT	
	Columbia, MD	AT&T	iPhone 7	14:21 EDT	
	Columbia, MD	T-Mobile	iPhone 8	14:21 EDT	
	Columbia, MD	AT&T	iPhone 8	14:20 EDT	
	Ellicott City, MD	AT&T	iPhone 12	14:20:30 EDT	
	Ellicott City, MD	AT&T	Apple Watch Series 3	14:20:45 EDT	
	Maple Lawn, MD	AT&T	iPhone 12	14:20:50 EDT	
	Silver Spring, MD	Verizon	Google Pixel 5	14:21 EDT	
	Windsor Mill, MD	Google Fi	Pixel 5	14:21:00 EDT	

Market	Location	Carrier	Device	Alert Detected	Notes
Boston	Beverly, MA	Verizon	LG G8 ThinQ	14:21 EDT	Alert detected after HD Radio alert
Detroit					
	Troy, MI	T-Mobile	Galaxy S10	14:20:48 EDT	About 9 seconds after HD Radio alert
	Troy, MI	Verizon	iPhone 12 Max	14:21:01 EDT	About 20 seconds after HD Radio alert
	Troy, MI	AT&T	iPhone 11 Max	14:21:01 EDT	
New York					
	Rahway, NJ	T-Mobile	Galaxy S10e	14:20 EDT	
	Somerset, NJ	AT&T	Galaxy S9	14:20:15 EDT	
	Somerset, NJ	AT&T	iPhone 12	14:20:33 EDT	
San Francisco	San Jose, CA	AT&T	iPhone 6	11:20:53 PDT	About 18 seconds before HD Radio alert
Toledo	Genoa, OH	T-Mobile	Samsung S20	14:20:30 EDT	About 20 seconds after analog alert
Washington, DC					
	Bethesda, MD	Verizon	iPhone SE	14:21 EDT	
	Clarksburg, MD	Verizon	iPhone X Max	14:21 EDT	

4.3 ATSC Observations

The HD Radio team evaluated reception of emergency alert messages through ATSC digital TV broadcast. This service was evaluated at only one location in Clarksville, MD on WBAL.

In this test scenario, the ATSC alert message was visible on the TV screen approximately 19 seconds before the digital alert was detected on the HD Radio receivers.

5 Analysis

Xperi's HD Radio team had previously determined through anecdotal observation that wireless emergency alerts are subject to variable latency due to network operations. Casual observations in a group setting highlighted that different cell phones and carriers react at different times to WEA messages. Xperi believes that broadcast HD Radio technology is subject to lower and more consistent system latencies and is not as likely to experience outages such as those caused by network congestion during natural disasters. Based on these observations, Xperi sought to generate a comparison of alert message latency between HD Radio broadcast and WEA services. Specifically, Xperi intended to determine if there was a great variability between digital radio alerts and wireless alerts.

The tests confirmed that the latency for alerts to reach an HD Radio receiver was comparable to the latency for WEA alerts. There generally was a 10 to 20 second difference between the receipt of the emergency alert on the HD Radio receiver and on a mobile device – with the HD Radio emergency alert arriving first in some instances and the WEA arriving first in others. In some cases, no WEA alert was received at locations where an alert was received on the HD Radio device.

Table 6: Comparative Analysis of HD Radio Alert, ATSC Alert, and WEA Alert Times

Location	HD Radio Alert	ATSC Alert	WEA Alert	Comments
Clarksville, MD	14:20 EDT	14:20 EDT	14:20 EDT	Video shows ATSC alert followed by HD Radio alert (19 seconds) followed by WEA (3 seconds)
Boston, MA	14:20 EDT	N/A	14:21 EDT	WEA alert detected after HD Radio alert
San Jose, CA	11:21:10 PDT	N/A	11:20:53	WEA alert detected 18 seconds before HD Radio alert
Detroit, MI	14:20:38 EDT	N/A	14:20:48 EDT 14:21:01 EDT	WEA alert detected 9 seconds and 23 seconds after HD Radio alert
Somerset, NJ	14:20:02 EDT 14:20:05 EDT 14:20:32 EDT	N/A	14:20:15 EDT 14:20:33 EDT	WEA alert detected 12 seconds and 30 seconds after HD Radio alert

6 Discussion

The nationwide emergency alert test on August 11, 2021, confirms that HD Radio emergency alerts provide needed redundancy and corroborate messages received from other sources. For example, in a configuration designed to replicate the home user experience, the same alert was received through digital television (WBAL Baltimore), HD Radio reception (WETA 90.9MHz FM on SPARC SHD-TX2 portable), and wireless emergency alerts (T-Mobile on Samsung Galaxy S20). This redundancy between WEA, digital radio, and digital television ensures that users receive timely notice of emergency information no matter what devices they are using. In some instances, alerts not received by other media were correctly received using HD Radio technology.

While not an exhaustive or comprehensive test, the results summarized in this report demonstrate the variable latency of wireless emergency alerts. Across a city or radio market, both radio and wireless alerts were detected in reasonable time. In some cases, the digital radio alert was received prior to the wireless alert. In other cases, the wireless alert was detected prior to the digital alert. On average, both HD Radio alerts and wireless emergency alerts were generally received within a 20 second window when measured at the same location. It is important to note that precise time measurement was not possible in all locations and there is +/- 30 second variability in the times recorded with 1 minute resolution.

Future testing will include a wider distribution of digital radio markets and a deeper evaluation of digital TV (ATSC and ATSC3.0) message delivery.

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