HD Radio™
Single Frequency Network
Interim Field Test Results

WD2XAB

Revision 01.06

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TRADEMARKS

iBiquity Digital Corporation
6711 Columbia Gateway Drive, Suite 500
Columbia, MD 21046
Voice: 443-539-4290
Fax: 443-539-4291
E-mail address:
info@ibiquity.com

Doc. No.: TX_FTR_2758

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1 Scope

This document describes the results (to date) of interim field testing the iBiquity implementation of Single Frequency Network (SFN) technology on the following local experimental stations:

WD2XAB

WD2XAB-FM1

2 Executive Summary

In accordance with the previously submitted HD Radio Single Frequency Network Broadcast Test Plan, iBiquity Digital Corporation constructed two local Baltimore SFN test stations:

Main Site (Station)

Booster Site (Station)

The test program examined both digital performance and digital compatibility with the host analog signal.

The performance tests characterized digital coverage of the main station, as well as extensions of digital coverage with the addition of the digital booster.

The analog compatibility tests examined the potential interference from IBOC sidebands on the host analog signal near the booster site. Digital compatibility was characterized principally in the area of signal overlap, where signals from the Main and Booster transmitter were of similar field intensity. Non-aligned waveforms in this area have the potential to cause the carriers from both transmitters to null in a period equal to the inverse of the time alignment differential.

The results of these early tests have been very encouraging.

iBiquity's synchronized SFN Booster technology has the potential to not only extend an FM station's HD Radio signal coverage to the protected contour, but also fill areas of compromised signal, well within the station's coverage area.

3 Transmitter Locations

The map of the Baltimore, Maryland metropolitan area shown in Figure 3-1 shows the Main transmitter site (WD2XAB) in the lower left and the Booster transmitter site (WD2XAB-FM1) in the upper right.

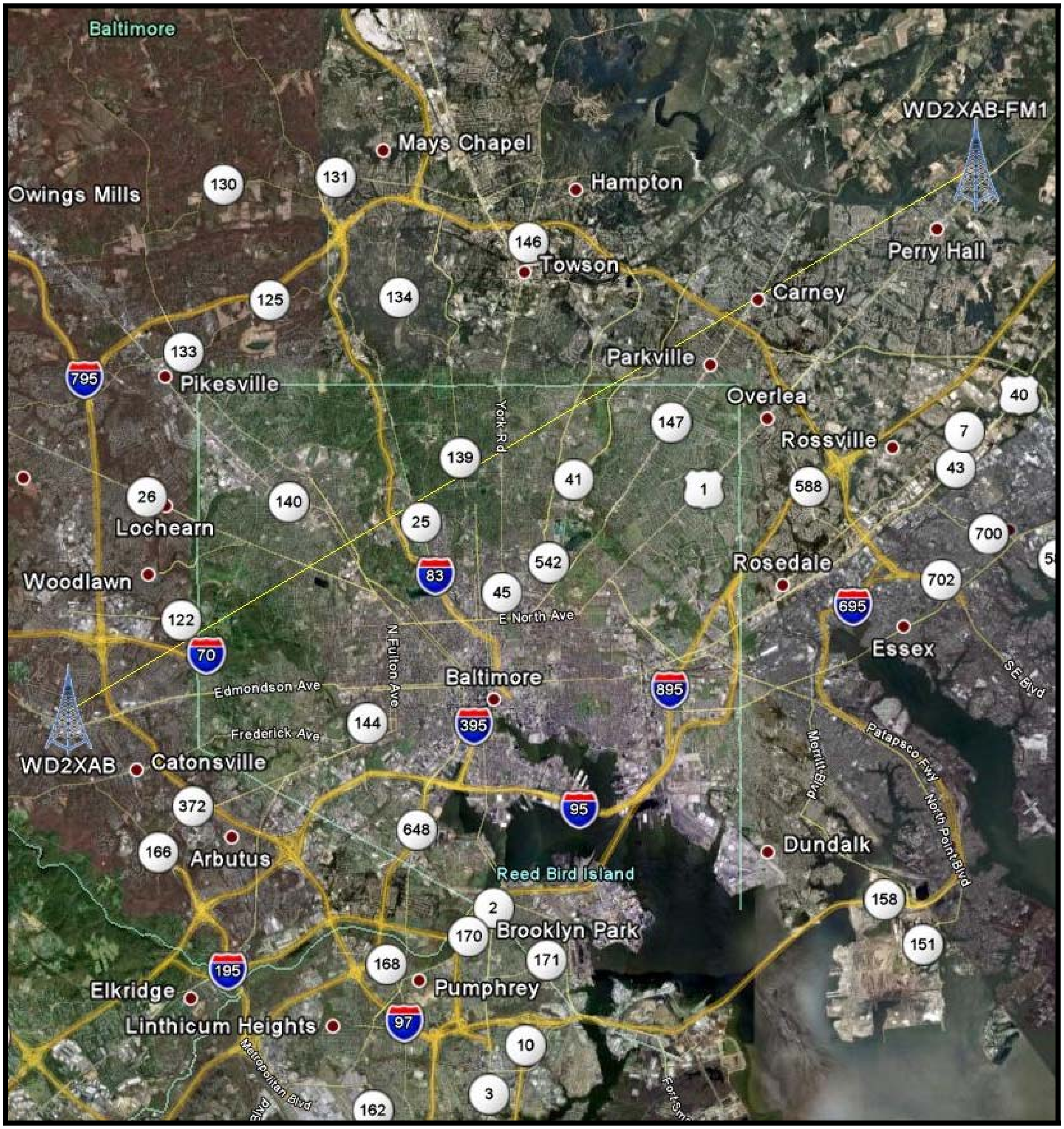


Figure 3-1: Map of the Baltimore, Maryland Metropolitan Area

4 Trial Test Runs and Selection of Test Areas

ComStudy propagation prediction software was used to identify areas of potential overlap of the two signals. Areas in white were *predicted* to receive the HD Radio signal. Separate test runs (green and yellow dots) by the iBiquity test van on the Main transmitter (Figure 4-1) and Booster transmitter (Figure 4-2) refined the individual areas of coverage. A green dot indicates the *measured* HD Radio signal reception.

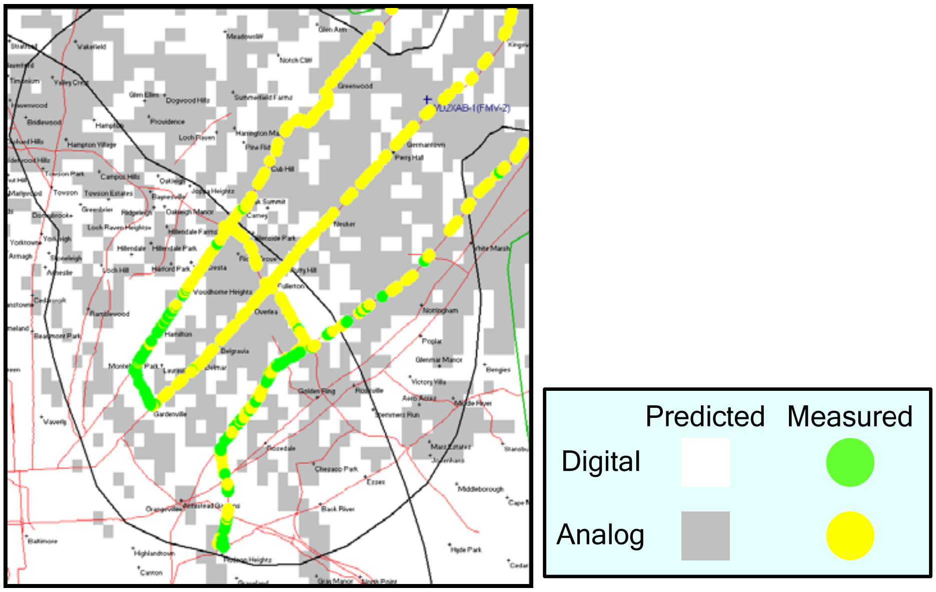


Figure 4-1: Main Transmitter Only

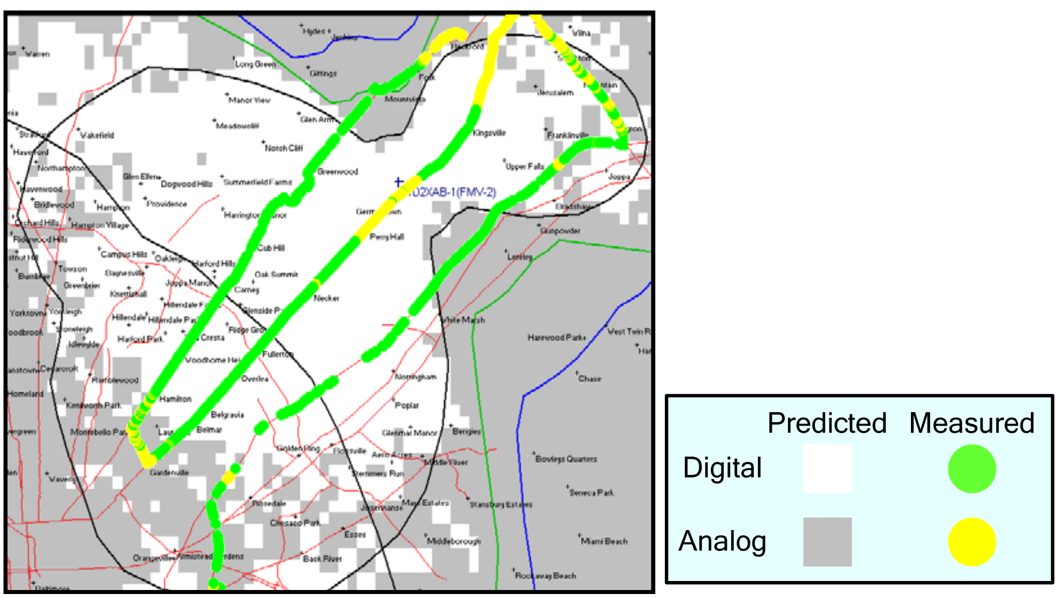


Figure 4-2: Booster Transmitter Only

The map shown in Figure 4-3 was the record for the actual first test runs on the synchronized (but non-time aligned) system; the map shown in Figure 4-4 was the prediction for the ideal performance from the individual test runs. For comparison purposes, the circled area (Harford Road) fared much better in the prediction than in the actual tests because of signal timing misalignment. Section 6 characterizes coverage improvements after the signals were time aligned in this overlap region.

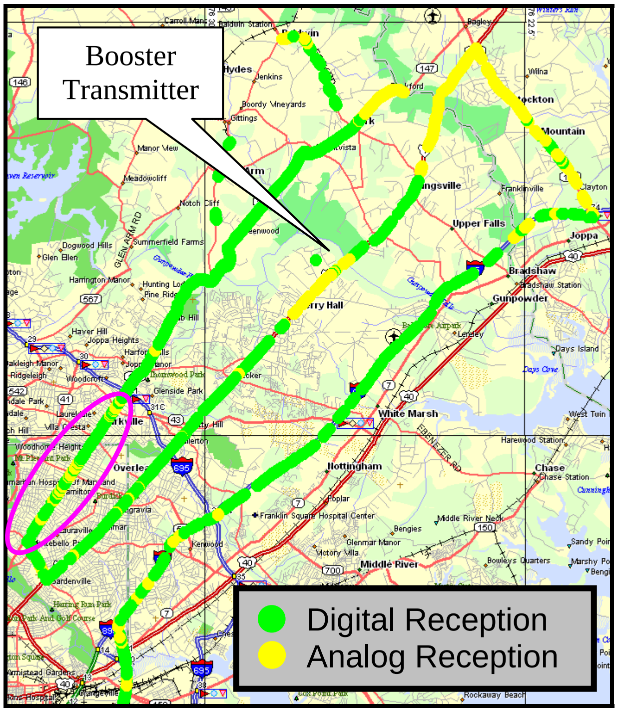


Figure 4-3: Main and Booster – Actual Test Runs on the Synchronized System (Non-time Aligned)

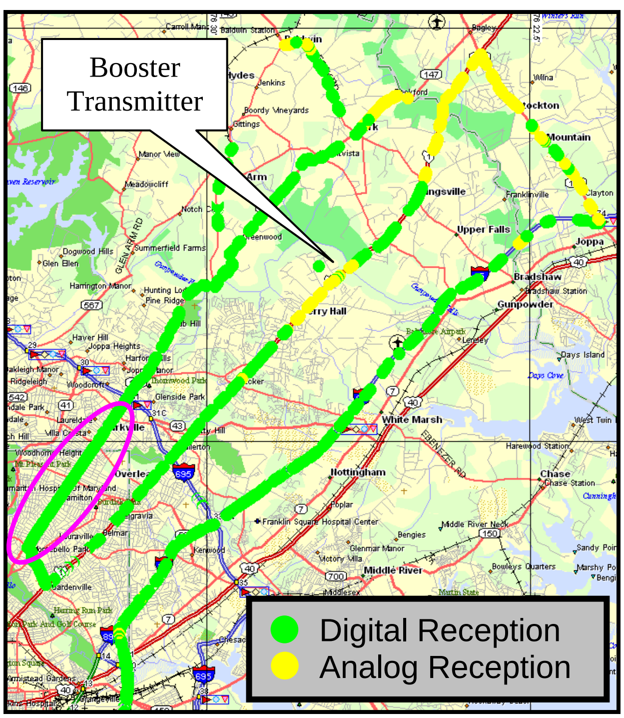


Figure 4-4: Main and Booster – Predicted Ideal Performance

5 Time Alignment

The iBiquity test van was driven to Harford Road which was an area located in the center of signal overlap. The spectrum nulled out at intervals of 49 kHz, as shown in the plot in Figure 5-1.

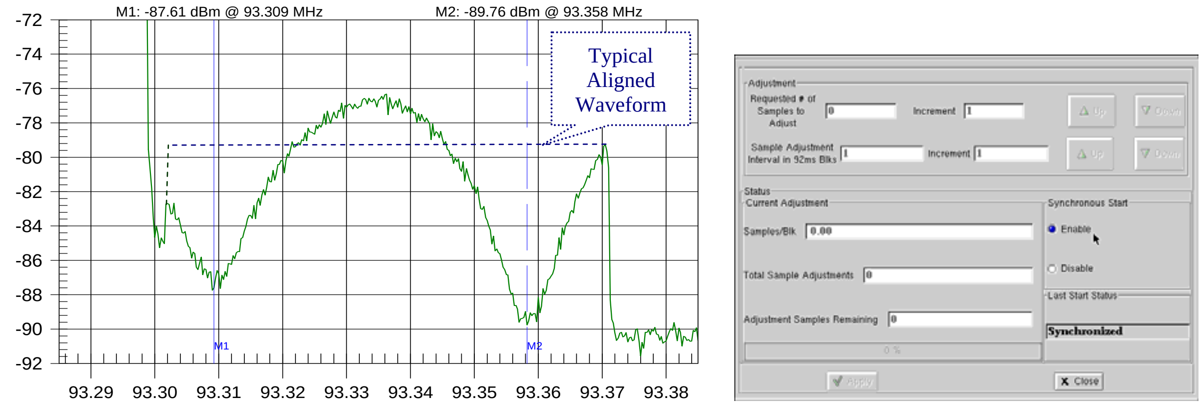


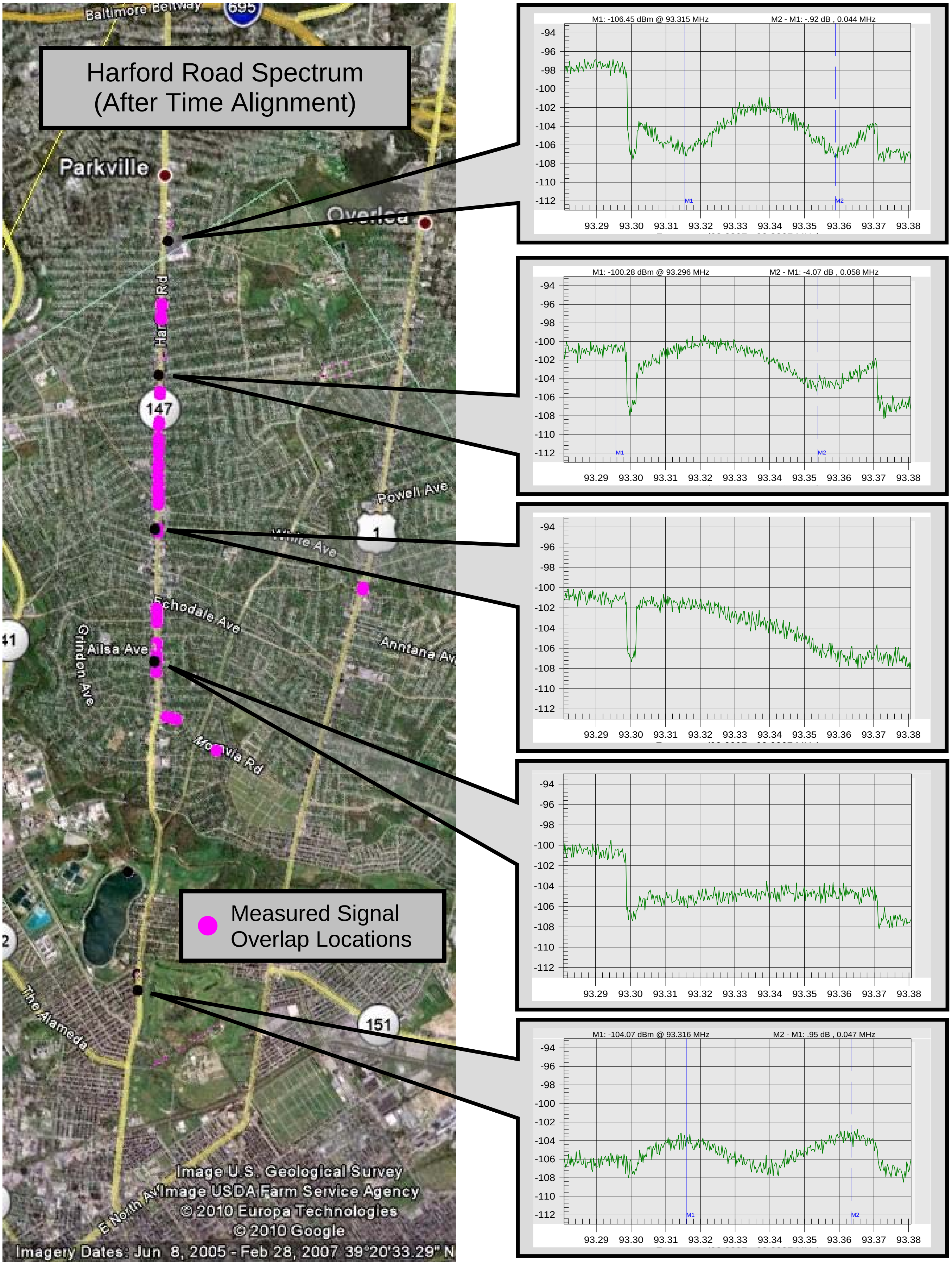
Figure 5-1: 20 microsecond Misalignment / 3.7 miles Delay Spread and Exgine Delay Adjustment Window

This corresponds to a delay spread of 20 microseconds. Since light travels one mile in 5.37 microseconds, this means that the overlap point is 3.7 miles closer to the Booster transmitter site than the Main transmitter site.

A delay offset of 20 microseconds was added to the Booster's transmission to cause the signals to align at the point of reception. Spectra were obtained at a number of locations on Harford Road showing the alignment at the points of overlap (see the next page).

Further testing in Boston should characterize reception performance at multiple locations with various delays.

It should be noted that the HD Radio transmission system uses time and frequency diversity to improve signal robustness and the receiver's equalizer tracks the carrier amplitude variations. The effect of the nulls on the digital signal has far less impact than the "multipath-like" interference that results in analog FM.


Harford Road Spectrum
(After Time Alignment)
Measured Signal
Overlap Locations
Baltimore Beltway
695
Parkville
Overlea
Harford Rd
147
Powell Ave
White Ave
1
Echodale Ave
Ailsa Ave
Grindon Ave
Anntana Ave
Moravia Rd
151
The Alameda
E North Av
Image U.S. Geological Survey
Image USDA Farm Service Agency
© 2010 Europa Technologies
© 2010 Google
Imagery Dates: Jun 8, 2005 - Feb 28, 2007 39°20'33.29" N
M1: -106.45 dBm @ 93.315 MHz
M2 - M1: -.92 dB , 0.044 MHz
M1: -100.28 dBm @ 93.296 MHz
M2 - M1: -4.07 dB , 0.058 MHz
M1: -104.07 dBm @ 93.316 MHz
M2 - M1: .95 dB , 0.047 MHz
-94 -96 -98 -100 -102 -104 -106 -108 -110 -112
93.29 93.30 93.31 93.32 93.33 93.34 93.35 93.36 93.37 93.38

6 Performance After Time Alignment

Following the alignment procedure, test runs were repeated and improved performance was indicated in the overlap areas as shown in Figure 6-1, Figure 6-2, and Figure 6-3.

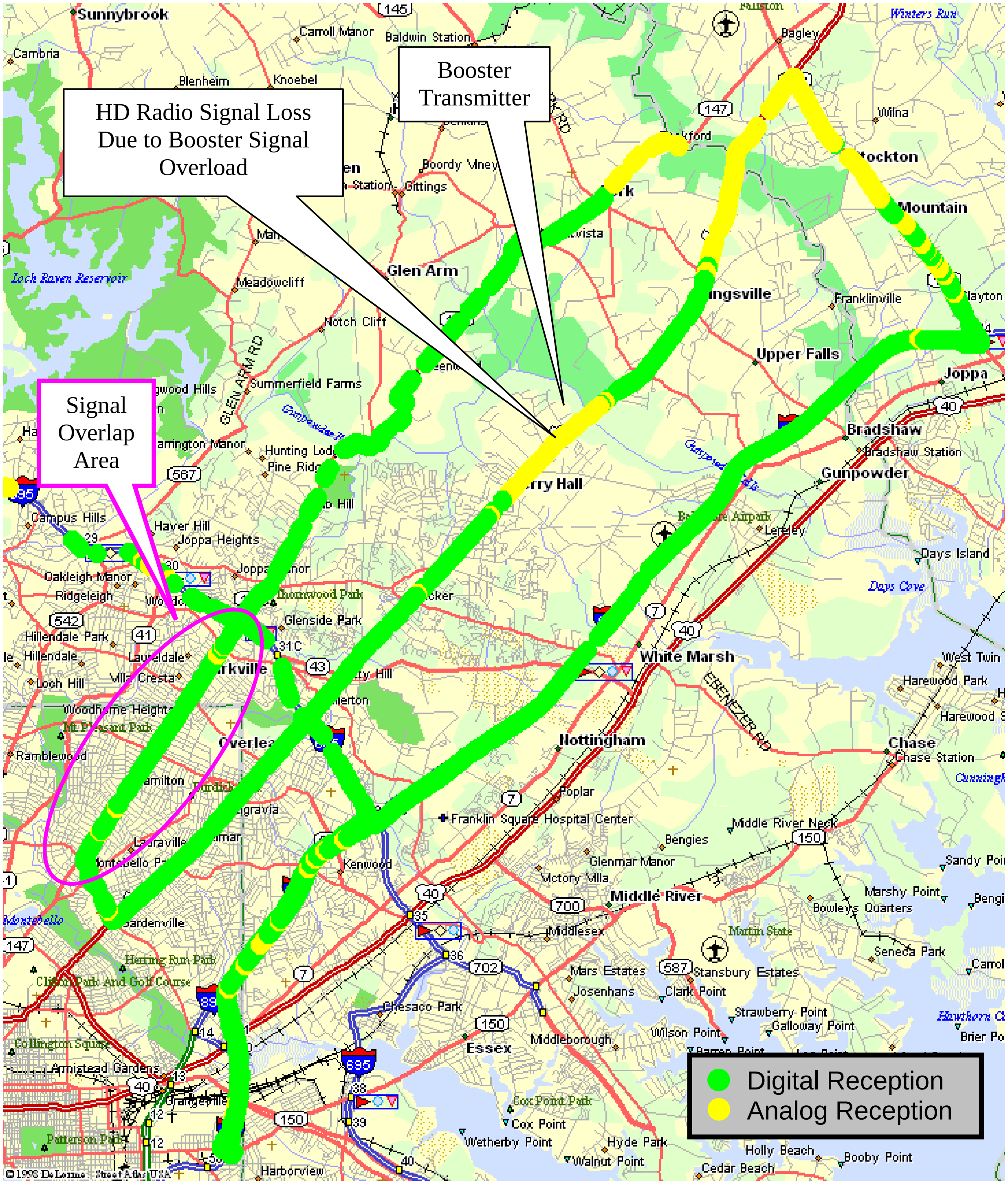


Figure 6-1: Main and Booster – HD Radio Signal Coverage after Time Alignment

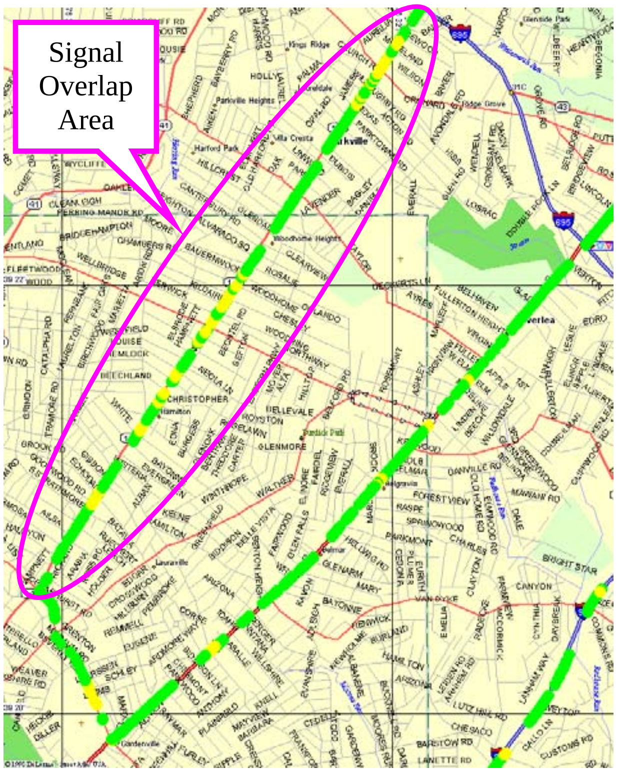


Figure 6-2: HD Radio Signal Coverage before Time Alignment

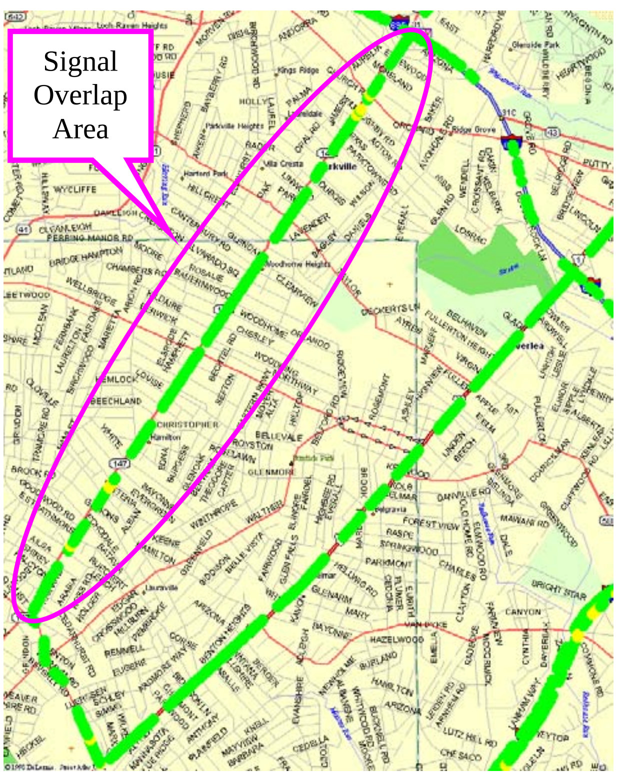


Figure 6-3: HD Radio Signal Coverage after Time Alignment

7 Digital-Only Booster Compatibility with Main Host Analog Signal

iBiquity will soon characterize the effect of a digital-only Booster transmitter's IBOC carriers on the Main transmitter's host analog signal. High levels of digital energy may impact reception on this weak signal close to the Booster site.

It may be possible to mitigate this localized interference by injecting a low-level, synchronized, modulated, analog carrier into the Booster's signal. The interference potential will then be re-evaluated on typical OEM receivers, aftermarket analog automotive receivers, and tabletop receivers.