

# Captioned Radio

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## *Fundamentals of Digital Radio Captioning*

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For the 2008 Consumer Electronics Show, NPR Labs held a press conference with Harris and Towson University during which the first live, over-the-air demonstration of captioned radio took place. The caption text was sent over the HD Radio Advanced Application Service (AAS) platform, and decoded by a radio and PC on the receiver side. This paper provides technical details about this historic broadcast.

In order to create a captioned radio broadcast, NPR Labs founded the International Center for Accessible Radio Technology (ICART) with the Harris Corporation and Towson University. Together, the center will work on accessibility grants, such as the 2006 grant from the National Institute of Disability Rehabilitation and Research, awarded to NPR Labs to research radio captioning. For the demonstration, NPR utilized Harris' FlexStar HD Radio transmission equipment, and research from Towson regarding user interfaces.

## **Demonstration Broadcast Configuration**

Figure one shows the layout of the broadcast portion of the demonstration. Clock cabling has been omitted from the diagram for readability. A CD of Morning Edition was used as the source for the HD1 channel. The captioner listened to the source material directly from the CD player's headphone output, and typed the caption text on a Stenograph élan Cybra writer. The writer, connected via USB to a laptop, interfaced with Case CATalyst software. CATalyst is a program that interprets machine shorthand from the writer and can save it to a file, or, in our case, redirect ASCII text to another application. A second application running on the laptop received the text from CATalyst and sent it to the Importer as AAS data packets over the network.

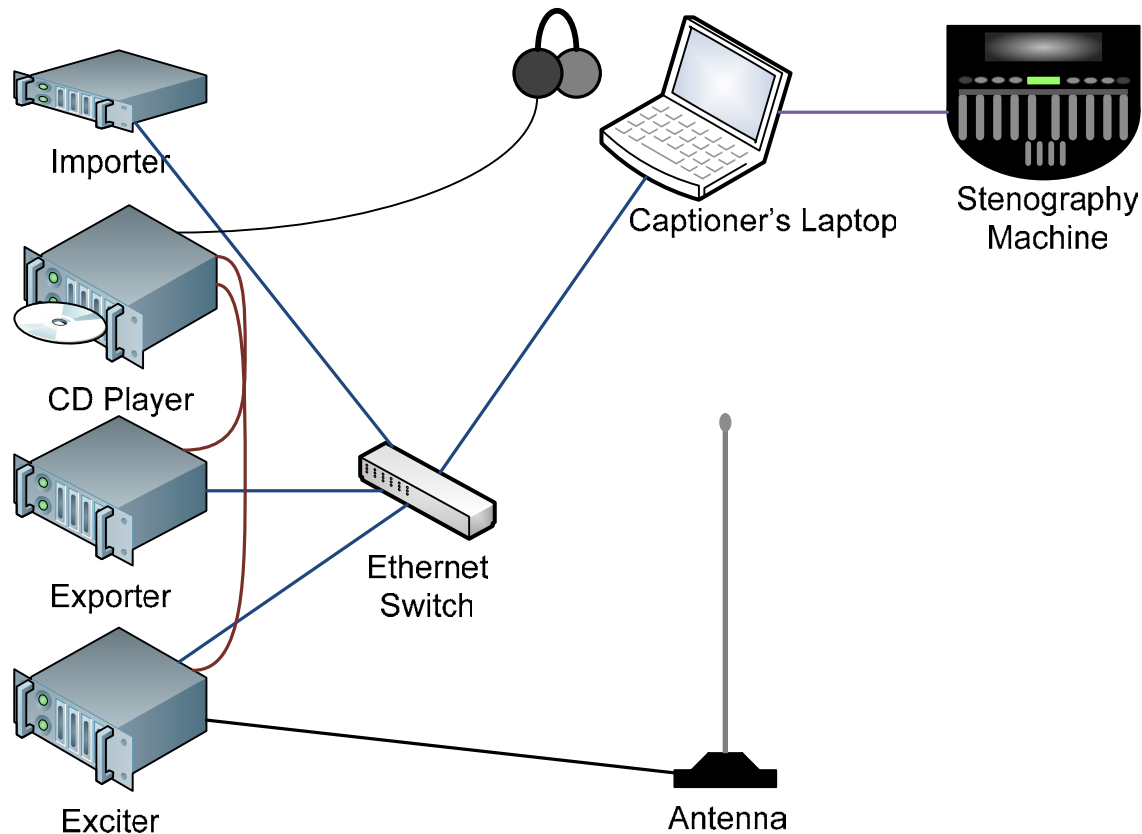


Figure 1: Captioning Broadcast Equipment

This program, developed by NPR Labs, runs on the Java platform, making it compatible with Windows, Apple, or Linux platforms. In addition, since it runs over the network, a captioner could work remotely over the Internet, allowing captioning to be outsourced and lowering costs. The program would cache text from the captioner until either the enter key was pressed or the first space after the 30<sup>th</sup> character was typed. This created “block,” or line-by-line, captioning and allowed the captioner a chance to go back and correct any mistakes before they were broadcast. The program communicated directly with the Ensemble Operations Center (EOC) system of the Importer and did not utilize the Generic Data Client provided by iBiquity.

During tests conducted by NPR Labs, it was determined that the time for transmission of an AAS data packet on the P1 channel, end-to-end was 5.6 seconds when using the UDP protocol. (It should be noted that TCP communication between the Importer and Exporter could not be used in this application as it introduces 18 seconds of delay for buffering, which removes any chance for a near-real-time caption experience.) Since our system was configured with a 7.6 second diversity delay, the captioner had two seconds of “buffer” that allowed for closer synchronization of the text. For this reason, the captioner listened to the programming directly from the CD player, instead of the over-the-air audio.

The Importer, a Harris FlexStar HDI-100, was set up to run in a custom MP1 mode with the configuration listed in table one.

<b>Name</b>	<b>Bandwidth</b>	<b>Function</b>
MPS	65,211	Main Program Service Audio
SPS	30,067	Radio Reading Service Audio
CC	1,001	Carry caption text for MPS
SIG	586	Native Data Management

Table 1: Bandwidth Configuration

## Demonstration Receiver Configuration

On the receiver side, the demonstration used iBiquity’s 1181/1182 reference platform. This development radio connected to a PC using the iBiquity Debugger Pod via USB and interfaced to iBiquity’s CDM software. In the Data Tunneling portion of CDM, port 0x7D8 (Decimal 2008), was enabled and forwarded to UDP port 11000 on the PC. A separate program developed in Java by NPR Labs ran on the PC, listening for data on port 11000. When it received a new message, it removed the oldest message from the screen, shifted all previous messages up one place, and added the newest message to the end. While configurable for different fonts, sizes, and number of lines, four lines of captioning in size 44 font were selected for the demonstration for the best readability.

The VGA output of the PC was then converted to composite video and drove two screens: a Sharp Dual View in-dash display provided by Delphi, and a large screen plasma TV, for audience members to view. The Dual View is unique in that it is capable of showing two different video feeds at once, dependent upon where the viewer is seated. For the demonstration, the portion of the screen that a driver could see was driven with a GPS-style navigation map, while the passenger could see the captioned text. This mitigated concerns regarding driver distraction. The layout for the receiver connections can be seen in figure two.

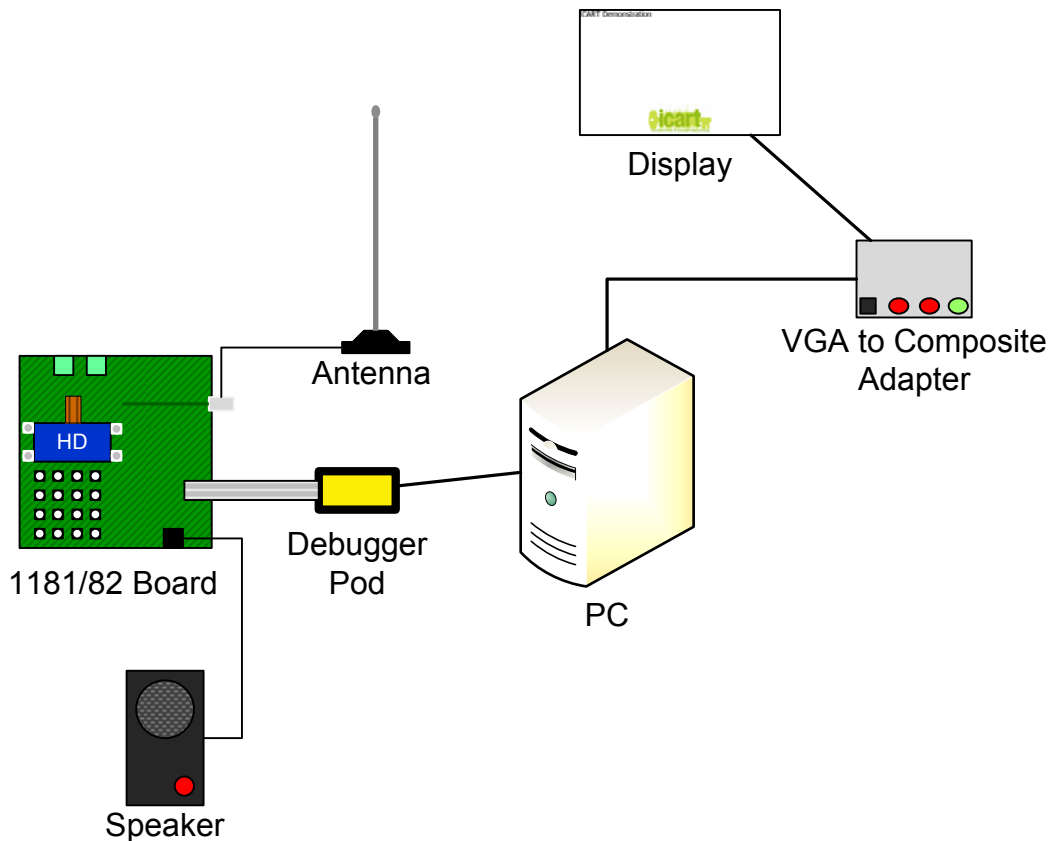


Figure 2: Captioning Receiver Side

Ideally, one radio with a large display would be the only requirement at the receiver side of the system, but no manufacturer has created a radio that supports caption AAS messages. Hopefully, by the end of 2008, manufactures will have prototypes, if not finished products, which support this initiative.

## Implementation Requirements

Of course, there are many additional challenges that must be faced before a system like the one shown above can be applied to a large collection of stations, such as the over 800 NPR Member Stations throughout the country. This section will explore the requirements for distributing captioning nationally.

Fortunately for NPR, all nationally-produced content that is aired by member stations first travels through Master Control and the Public Radio Satellite System (PRSS) uplink in Washington, DC. That would allow captioners based in Washington to create text for all national programming before it goes through distribution and over the air. By creating the captioning before distribution, the text can have tighter synchronization than if it were captioned from an over-the-air feed. Additionally, by having dedicated captioners in one place, NPR can reduce the total cost of captioning.

The overall work flow for national captioning would probably work as follows. Audio recorded in any of NPR's studios is sent to Master Control, which then routes this audio to both PRSS and to a captioner. The captioner can be either a stenographer or a re-speaker, like the BBC uses. Re-speakers listen to audio and re-speak what they hear into a voice recognition program that has been trained to their voice. This increases the accuracy greatly over speech to text programs that are untrained, and removes any background sounds from field reports that might confuse the program. Either way, the text generated from the stenography software or voice recognition application is then converted to HD-AAS caption packets that can be used by stations.

From there, the captioning can go to stations in two ways. For stations that are early implementers of radio captioning, the text will probably be delivered over the internet, as this is the easiest system to implement. NPR would set up a server for captioning, which would stream the text to stations. Stations would then allow one port in their firewall to connect to their Importer and receive the captioning.

Although requiring more work to implement, distributing text over satellite to member stations would be faster, more secure, and easier to implement across all stations. Text would be ingested into the Content Depot system and arrive at stations' satellite decoders. The text would then be stored in automation systems for shows that air at a later time, or sent directly to the Importer for live programming.

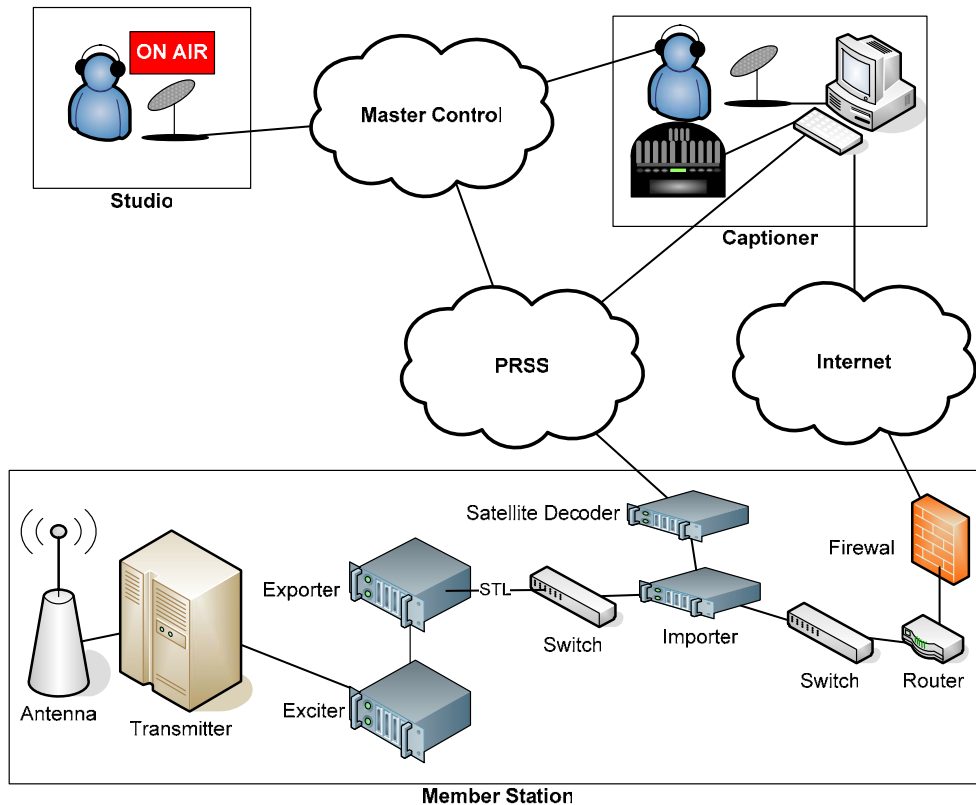


Figure 3: Captioning Work Flow

While the changes to implement captioning for all nationally-produced NPR programming are significant, they are not insurmountable. With the combined efforts of member stations, producers, distribution, and NPR Labs, radio captioning can be achieved.