IBOC Update

NOVEMBER 7, 2008

HD Radio™ Tech Bulletin

iBiquity Digital is issuing this tech bulletin in an effort to help broadcast engineers maintain quality HD Radio operations and increase the benefits of HD Radio technology to its growing listener base. We plan to issue future bulletins as necessary.

Synchronization

Some form of synchronization is a requirement for putting together a successful HD Radio™ installation. Just like troops marching in formation need a drill sergeant to mark the cadence, packets moving through an IBOC airchain need a reference clock to maintain sequence and timing. Without proper clocking, IBOC packets can start arriving ahead or behind schedule, causing drift. These errors can progress to where the packets are arriving out of sequence, causing dropouts. Proper clocking is best achieved using a single master clock derived from a GPS receiver generating a 10 MHz reference signal. Various broadcast system architectures require different techniques for distributing this master clock. Three are listed here along with iBiquity's recommendations on how to distribute a master clock reference.

Method #1: Everything in one place

Stations that have their studio co-located with their transmitter, or all their HD Radio components located at the transmitter and connected to the studio by an STL, need only one source of GPS clock.

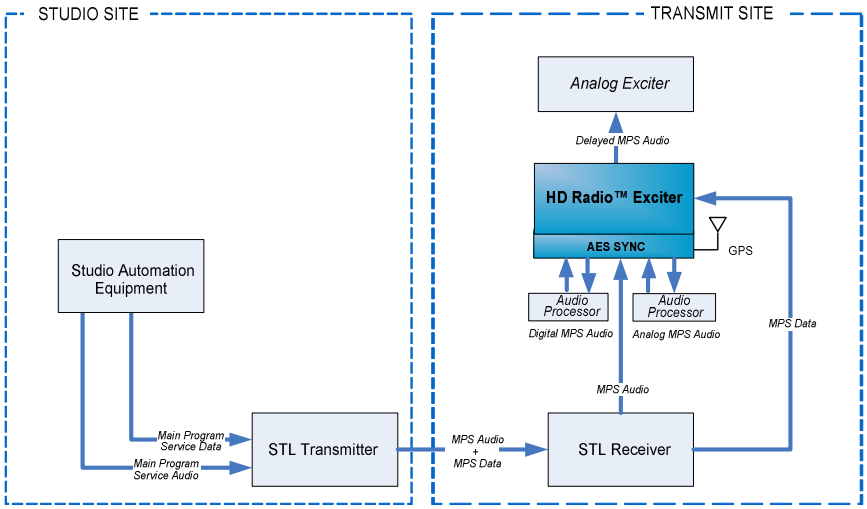

Figure 1: Basic Broadcast System Architecture

This configuration shows an Exciter with GPS and AES word clock providing clocking for the Exciter and word clock for the two audio processors feeding analog and digital Main Program Service (MPS) audio to an Exciter. This is a first generation topology represented by the Harris Dexstar, the Broadcast Electronics ASi-10, and the Nautel NE IBOC.

Here is the same architecture with the addition of an Importer for Advanced Application Services such as multicasting. Notice the 44.1 kHz line from the Exciter providing word clock to the Importer.

Ten best practices for good blend alignment:

- *Use GPS clock everywhere there is an Importer, Exporter, Exciter, Exgine, and processor. Check with your hardware manufacturer if it's not clear how to sync any of these devices, especially the Exgine. There is a way.*
- *Make sure your GPS clock is stable. You can check it with an oscilloscope.*
- *Make sure all IBOC devices are on the same subnet.*
- *Monitor network traffic, try to keep the IBOC traffic as isolated as possible.*
- *Provide 44.1KHz word clock for all your AES audio devices.*
- *Use the latest software from your hardware manufacturer.*

- *When using an off-air monitor to set the blend alignment, tune away and then reacquire your station's signal. Do not try to align using an analog receiver and an HD Radio receiver side-by-side.*
- *When using an external processor for the analog delay, make sure it is stable and there are no issues with ageing capacitors or thermal breakdown of solid state devices.*
- *Don't forget to also watch audio level alignment. Diversity alignment should be < 9ms, audio level alignment should be within 2dB.*
- *When using packet timing, make sure dropouts on your STL are less than 10^{-5}. Jitter should be less than ±3ms.*

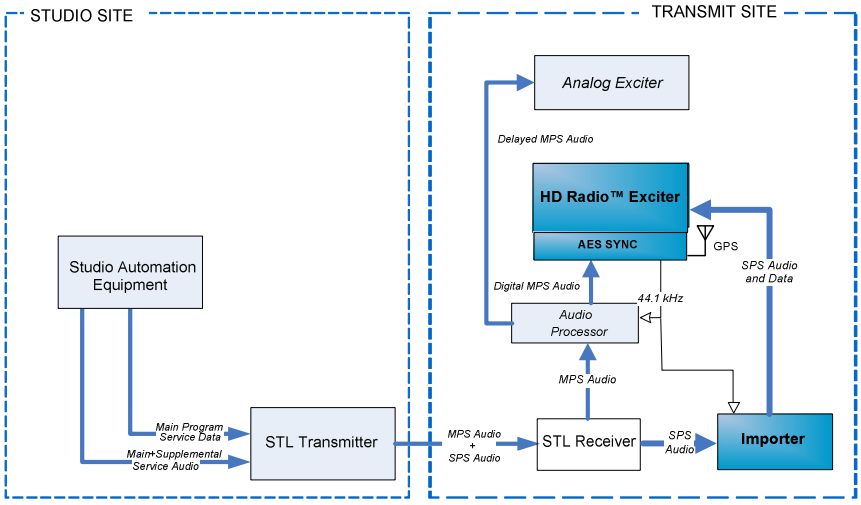

Figure 2: Generation 2 Architecture with Importer for Multicasting

Both of these architectures provide a master clock to maintain a constant bitrate throughout the airchain which minimizes alignment drift. The drawback is the need for a high capacity STL to carry the Main Program Service (MPS) and the one or two Supplemental Program Service (SPS) streams.

Method #2: Two clocks, one source

Current IBOC architecture relocates the Importer back at the studio and divides the Exciter function between the Exporter and the Exciter Engine or Exgine. The Exporter is also located at the studio and the Exgine is at the transmitter. This architecture is shown below.

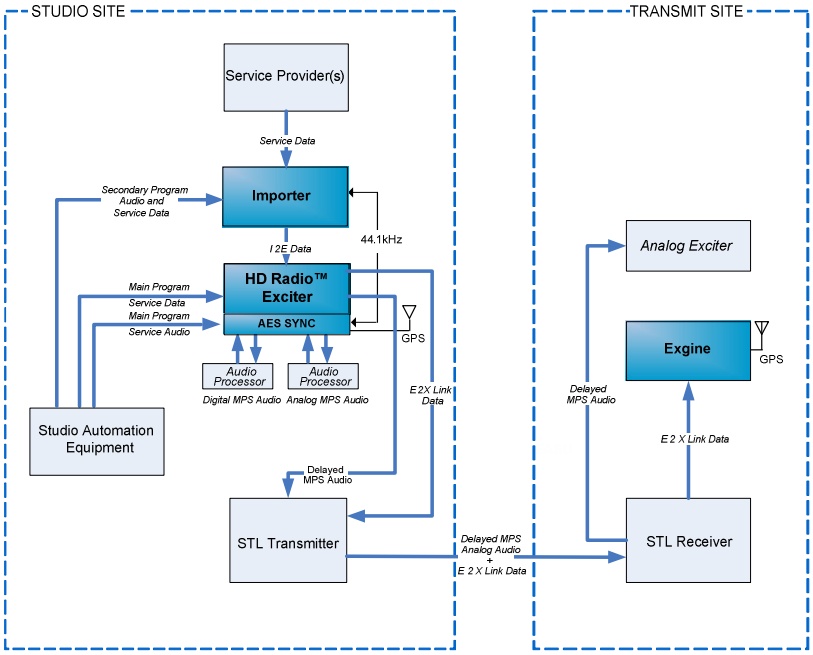

Figure 3: Generation 3 Architecture with Exgine

In this example, more modern installations have Exporters that assume the duties with respect to clocking and GPS. Packets will flow at a constant rate all the way through the airchain to the STL transmitter. However at the other end is the Exgine Exciter which will be free running unless it is also locked to the same master clock, i.e. a GPS satellite. With both sites running with the same master clock, drift should be minimized.

Method #3: Transporting the clock

Several years ago iBiquity did a proof-of-concept study that showed it was possible to send clock packets over the Exporter to Exgine (E2X) link that could provide a reference clock for the Exgine. With this system, a frame boundary clock message is sent leading every IBOC frame about once every 1.486 seconds. There is a synchronizer in the Exgine that creates a 10MHz clock from these packets. The various hardware manufacturers have improved upon this concept to the point where it's offered as a feature in their Exporters and Exgines.

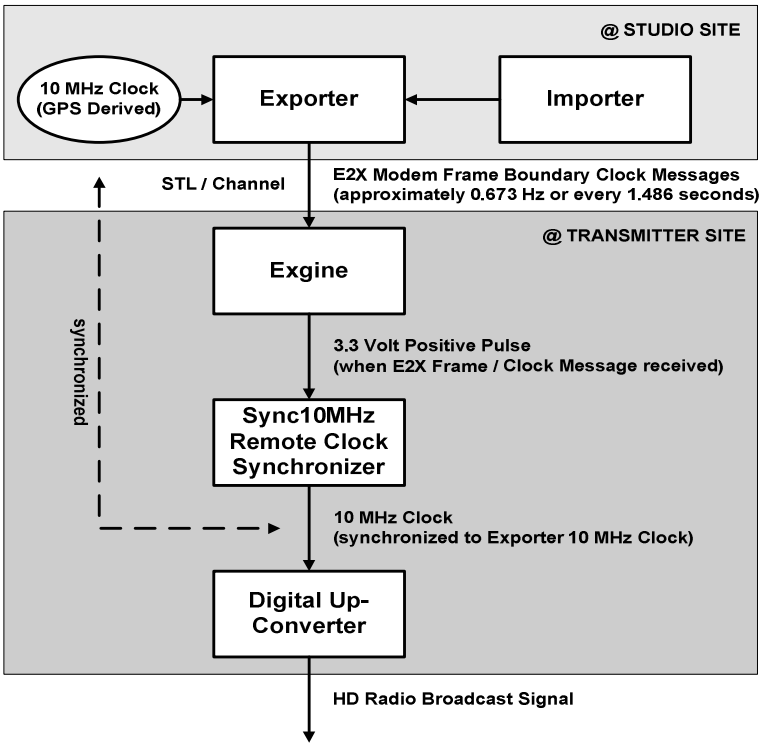

Figure 4: Block diagram of 10 MHz packet timing system

For more information about setting blend alignment, you can follow this link:

Blend Alignment Information

The caveat is the STL link has to be relatively free of jitter and dropouts. The clock message packets will be leaving the Exporter at a constant rate. They need to reach the Exgine at very nearly the same rate or the derived 10MHz clock will drift from the master 10MHz clock which will, in turn, cause the blend alignment to drift. Going back to the analogy of troops marching in formation, this time there's a drummer keeping the cadence. If they're marching over a road full of ruts and potholes, the drummer is going to have a hard time keeping a steady beat.

In Closing

Good blend alignment is absolutely necessary for giving your listeners a good experience when listening to an HD Radio receiver. If your IBOC coverage does not perfectly overlay your analog coverage, car radios will switch back and forth between the analog and digital at the limit of your digital coverage. If these switches are obvious because the audio is misaligned either in time or level, the listener is going to wonder what the problem is. If they hear it on only one station, that's going to reflect more on the station than on the radio. By following all these recommendations, you should be able to achieve close, stable alignment.

Follow these links for more information on best practices for HD Radio networking:

HD Radio Data Network Requirements

HD Radio Networking Implementation Recommendations

HD Radio Networking Best Practices

Thank you for your continued support!

Please direct any questions, comments or report technical issues to: Tom Walker, iBiquity Digital Corporation, 6711 Columbia Gateway Drive, Suite 500, Columbia, MD 21046, (443) 539-4332, walker@ibiquity.com