The image shows the interior of a car, focusing on the front seats. The seats are upholstered in black leather with visible stitching. The car's interior is dark, with wood trim accents on the door panels and center console. Through the windows, a scenic view of mountains and a valley is visible under a clear sky. The text is overlaid on the lower portion of the image.

Q: Your listeners spend a couple of hours a day in here.
How can you make sure they're listening to *you*?

A: Surround them.

“How can my radio station compete with CD burners, satellite radio, iPods and in-car DVD?”

That’s the question that every terrestrial broadcaster is asking themselves today. And with good reason; more potential listeners are drawn away from radio every day by the lure of new technologies. Arbitron surveys show that since 1996, the average time spent listening to radio by consumers 12 and older has dropped nine percent. Listeners between the ages of 18 and 24 have declined 10 percent as they migrate to on-demand digital content. Radio is at a crossroads!

How can radio bring listeners back to the fold? Surround sound: music presented in multiple audio channels to truly give the listener the feeling of “being there.”

No doubt you’ve been awed in the movie theater by the vitality of motion pictures accompanied by surround soundtracks, or been treated to surround sound in a home theater setting. If so, you already know how compelling and immersive surround audio can be. And while it appeals to all age groups, surround is especially alluring to young, trend-setting listeners. Surveys of audio equipment industry trends show that automobile surround systems are now the fastest-growing segment of the mobile audio market.

Broadcasters can employ this exciting technology to win back listeners in the place where more radio listening occurs than any other: the car. FM HD Radio can bring surround sound to consumers *now* — thanks to the multi-channel system for HD Radio™ developed by Fraunhofer Institute (FhG) and Agere Systems. Known as “Coded-Discrete,” this powerful spatial audio coding system takes advantage of the latest research in aural perception to deliver a distinct multi-channel listening experience to the radio audience. Content is readily available as well, with 5.1 albums both classic and contemporary from artists like Eric Clapton, Seal, George Strait, Sting, SheDaisy, Wyclef Jean, Miles Davis and hundreds more. Serving this captivating content to listeners will make for exciting radio — and help terrestrial broadcasters level the competitive playing field.



“This is not your Father’s surround!”

You may remember the “quadraphonic” systems from the ‘70’s that had a brief and unsuccessful run on vinyl and at a few radio stations. Don’t confuse this modern multi-channel approach with those - or any of its many descendants vying for radio’s attention.

While these latter have new names, they are reheated variations of failed ‘70’s vinyl quad schemes. Because they mix all the channels into two, they have the critical drawback of sounding quite bad on stereo radios. The weird, soft and indistinct quality in stereo was one reason that the ‘70’s era surround “matrix” systems didn’t get very far. Another reason was that the surround channel separation wasn’t very good.

In contrast, the new Fraunhofer “Coded-Discrete” system delivers real surround, with full separation, *and* passes the original stereo mix to stereo listeners unaltered.

Surround: FM's Killer App

The surround system invented by Fraunhofer Institute (FhG) and Agere Systems comes from people who know their stuff. FhG are the folks who created MP3 and MPEG AAC. The Agere people are former Lucent and Bell Labs audio coding researchers.

This surround system will provide a distinct multichannel listening experience to the FM radio audience using a technique which prepares the audio for transmission over iBiquity's HD Radio® system. It takes advantage of the most up-to-date knowledge in aural perception.

Psychoacoustics studies show that the level difference, time difference, and coherence between channels are what create the perception of spatial image. The key to FhG's multichannel system is that these difference values are represented with very compact coding, rather than transmitting the individual audio channels. It is now in the process of being

standardized within MPEG.

An important advantage of the FhG/MPEG system compared to old-style matrix schemes is that the stereo signal is passed perfectly through from source to listener. The HD encoder takes the stereo input in the usual way, and the HD receiver decodes it in the usual way.

Meanwhile, the surround encoder extracts the various spatial cues from the multichannel input, which is transmitted separately in an ancillary data channel. The decoder, if present in the receiver, recreates the original multichannel audio.

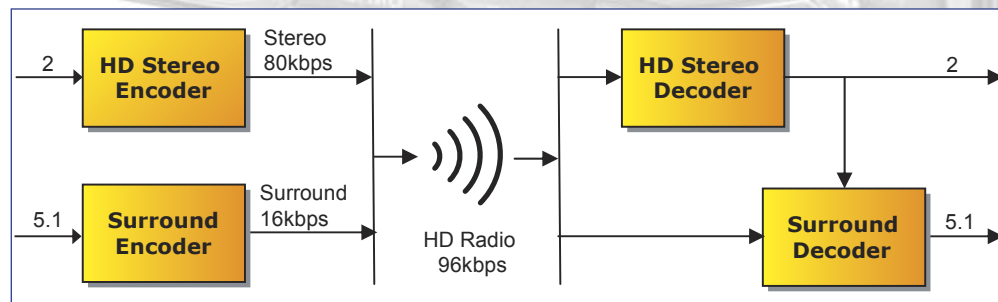
Since almost all music released in surround format also has a stereo version that could be used as input to the encoder, this stereo version

would be heard by listeners with nonsurround radios – with no modification or compromise of any kind.

For our demonstrations, we have recorded both stereo and surround versions from SACD disks and DVD-Audio and stored the 2 + 5.1 channels – 8 total – in Windows wave extensible file format. Upon playback, these are delivered in sync to a Livewire Ethernet network, which passes them on to the next devices in the signal chain.

If you have only a surround source, a compatible downmix is made to create the stereo part of the 2 + 5.1 source file. When you have only a stereo source, it can be upmixed to surround using either simple channel duplication or more sophisticated spatial processing techniques.

How easily could surround sound be implemented in the radio studio itself? Read on.



FhG/MPEG Surround System via HD Radio End-to-End.

Surround in the Studio

Perhaps you are concerned that building surround studios for a discrete system will be too difficult or too expensive. Fortunately, modern PC technology, and audio networking technology from Axia, offer a solution that gets the job done easily and inexpensively.

Delivery System

Most stations already use PC-based delivery systems to play digital music, promos and spots. Today's low-cost, high-capacity hard drives eliminate storage barriers; a 220 Gigabyte drive can store 1200 surround songs with no compression. A software driver interfaces audio applications to the network, supporting the multiple channels needed for surround without soundcards. A single Ethernet RJ-45 simply connects all channels.

Mixing Console

Axia's mixing consoles, consisting of a control surface and a PC-based mixing and processing engine, can be software-upgraded to surround from stereo. The digital mixing is a function of software, so no hardware change is required. Because its display is a PC screen rather than dedicated meters and other fixed indicators, an upgrade from stereo to multiple

channels requires no hardware change. The console connects to the network with one Ethernet RJ-45.

Routing and Distribution Infrastructure

Most facilities need audio routing. Our Axia system turns an Ethernet switch into an efficient, inexpensive audio router. When analog or AES3 inputs and outputs are needed, they are converted in "nodes" to Ethernet. A 100BaseT link can transport 25 uncompressed stereo signals, or three 8-channel surround signals. One RJ-45 can substitute for as many as 100 XLRs! But with so much audio these days being supplied and consumed by PCs that can be directly connected to the switch with Ethernet, you will not need as many analog and AES3 connections as you would with an old-style router.

Surround Encoder

This is yet another Ethernet-connected device. One RJ-45 serves all required inputs and outputs. The 2 + 5.1 channels from the console program output are the inputs; the output is a 16kbps coded surround stream. (The surround encoder could be integrated into future dynamics processors for further simplification.)

Dynamics Processing

Our initial testing indicates that today's stereo

dynamics processing works well for the FhG/MPEG surround system. Processing applied to the stereo channel affects the received surround channels too.

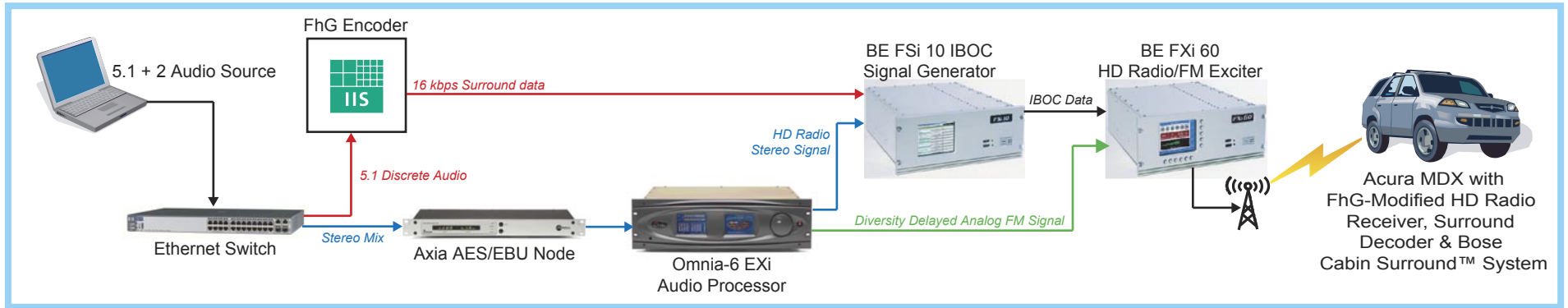
HD Radio Encoding

iBiquity's new HD Radio reference design locates the encoder at the studio. Processing is also located at the studio and the STL needs only convey the encoded HD signal, tremendously reducing bandwidth requirements. The total for each HD radio station is only 96kbps. Additional muxed-in data (PAD, song titles or our 16kbps coded surround stream) can be applied at the studio. The input for this data is via Ethernet.

Studio to Transmitter Link

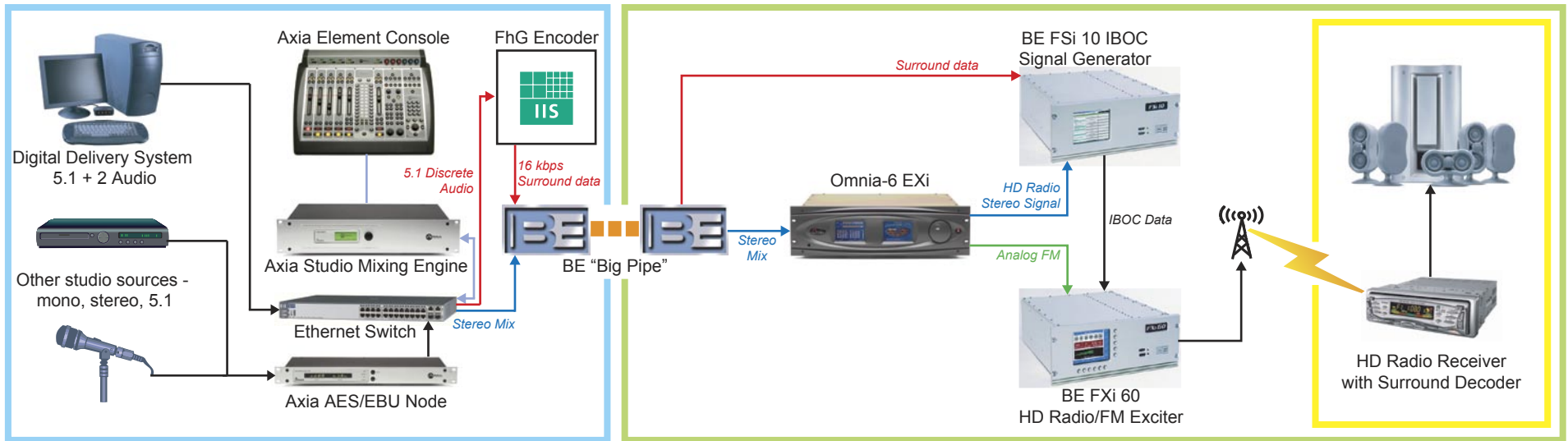
The new Ethernet radios, like the BE Big Pipe, operate with bit rates up to 45Mbps, so there is a lot of capacity for multiple audio channels as well as data, VoIP phone, etc. Since we already have all our facility's audio on the Ethernet, no format conversion is required – connection is as simple as connecting the radio's Ethernet jack to a port on the switch. Many traditional digital STLs could serve this application as well. You would use the normal stereo path for the analog FM feed, and an 96kbps additional data channel for the combined HDFM bitstream.

Look at all you're hearing.



5.1 Pavilion Display

In the Surround Pavilion, a laptop computer stores the 8-channel surround sound WAV files. The computer, using the **Axia IP-Audio Driver**, delivers the real-time, uncompressed audio to the Ethernet switch, where the stereo mix is distributed to the **Axia AES/EBU Node** and sent to the **Omnia-6 EXi** audio processor. After processing, the stereo HD Radio stream is sent to the **BE HD Radio Signal Generator**, and the analog FM signal to the **BE HD Radio Exciter**. Meanwhile, the 5.1 surround mix is routed to the **FhG Surround Encoder**, which delivers the 16kbps surround data stream to the HD Radio signal generator, which combines it with the stereo HD Radio audio stream and delivers the combined IBOC data to the HD Radio exciter for broadcast. The FhG-modified **HD Radio receiver** in the vehicle decodes the discrete 5.1 surround audio, which is presented through a Bose Cabin Surround™ sound system.



Axia Display

Telos / Omnia Display

This two-part demonstration begins in the Axia display, where the digital delivery system delivers 8-channel WAV files to the Ethernet switch using the **Axia IP-Audio Driver**. Other 5.1, stereo and mono sources are connected to the network using the **Axia AES/EBU Node**. The **Axia Studio Engine**, controlled by the **Axia Element console**, mixes the surround and stereo program channels. 5.1 audio goes to the **FhG Surround Encoder**, after which the encoded 16kbps surround data and stereo mix are sent through the **BE Big Pipe** to the Telos/Omnia display. There, the surround data is routed to the **BE IBOC Signal Generator**; the stereo signal is fed to **Omnia-6EXi** and **-5EXi** audio processors. From there, the HD Radio stereo signal is joined with the surround data in the Signal Generator and is sent (along with the conventional FM signal) to the **BE HD Radio Exciter**. A **Visteon HD Radio receiver with FhG Surround Decoder** then decodes and delivers discrete 5.1 surround audio.

Surround for free?

Axia's modern Livewire audio networking technology lets you build a studio to support discrete surround for no incremental cost over stereo.

Output from the playback PC is delivered to the network using a software driver that passes all the required channels to the network. With no soundcard needed, there are no additional costs for outputs or the audio router or console inputs to which they would connect.

The Axia mixing engine is software-upgradable to handle surround on the same hardware as for the stereo version. The companion Element control console is also software-upgradable to add surround metering and control to the user interface.

The FhG surround encoder accepts multichannel input directly over the network, so there are no audio router or console traditional outputs needed, and thus no associated expense.

A stereo Omnia applied to the HD stereo channel will also process the surround channels satisfactorily.

The Ethernet switch at the core of the network has plenty of capacity to handle surround signals, so no change is needed there.

Using iBiquity's current recommended set-up that locates the HD encoder at the studio, only the 16kbps surround ancillary data stream needs to be transmitted over the STL in addition to the stereo signal. Most digital STLs can accommodate this. We are using an Ethernet STL in our demonstration that has plenty of capacity for multiple station feeds and their associated surround streams.

Axia's networked studio concept already let's you build a stereo facility for significantly less than the old way. Its free surround benefit is sweet icing on the cake.

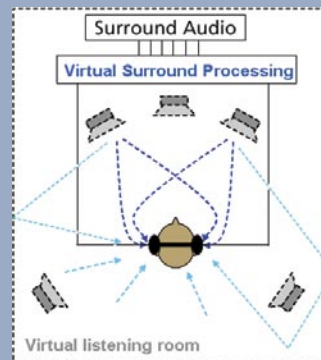
Ensonido®: Surround Sound That Goes Anywhere

5.1 sounds great. But on-the-go listeners get short-changed. After all, you can't carry around six speakers when jogging, or on an airplane. However, there is a solution.

The new Ensonido technology, developed by Fraunhofer IIS in Erlangen, Germany, paves the way for mobile users to enjoy surround sound in the absence of a real 5.1 speaker setup. To enable surround sound listening using normal stereo headphones, Ensonido models the natural reception of surround sound by the human ear, using spatial cues to create a "virtual surround" listening environment. With Ensonido, listeners can experience 5.1 broadcasts that use the FhG surround system on normal headphones. Ensonido also offers listeners a choice of various room simulations to model the sound environment of, for example, a cinema or a church.

For the sound engineer or broadcaster, Ensonido enables the simulation of a favorite listening room, or the auditioning of multi-channel sound during a live recording in the absence of 5.1 speakers.

During NAB 2005, you can hear Ensonido for yourself in the Telos / Omnia / Axia display. And for more information, visit www.ensonido.com.



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www.Telos-Systems.com

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