

# Initiating the Surround Sound Era for Digital Radio

About the Coded-Discrete 5.1 System for HD Radio™ Broadcasts

## Overview

HD Radio™ is the new digital radio broadcast standard for the USA. It works in the same channels as traditional FM and AM stations, but delivers digital quality to listeners. About 400 stations are planning HD Radio broadcasts and about 100 radio stations are already on-air with it. Receivers are available now to consumers.



Multi-channel surround is becoming an increasingly hot consumer desire, mostly driven by the DVD Video format, which delivers the experience to consumers at home. Almost all DVD releases have a 5.1 surround option and many high-end television receivers, home theatre and audio systems are being installed with multi-loudspeaker surround capability. Surround is coming to automobiles as well, with a number of manufacturers already having announced 5.1 car audio systems. DVD Audio and SACD Multi-channel disks offer high-quality surround music to consumers.

While there have some proposals for “matrix” systems to add a surround capability to FM radio, these are based on an older technological approach and many discerning artists, music producers, and audio professionals do not consider them to have sufficient quality for a modern multi-channel system. In a matrix system, all of the channels are mixed (matrixed), into the two normal stereo channels. This results in poor separation for the surround presentation and unacceptable compromise for people listening in stereo. Matrix first made an appearance in the 70s with the various quadraphonic systems for vinyl records. Current proponents for matrix radio broadcasting are SRS and Neural Audio.

## The Technology

The system we propose and are demonstrating uses a fundamentally different technology, which delivers an impressive full separation to the surround channels and does not compromise the stereo signal in any way.

The key to the system is understanding that all of the audio that goes to the surround channels are present in the stereo channel. It must be, because a stereo listener needs to hear everything that would be in the surround mix. We just need to pull out the pieces and move them to the correct position for surround presentation. To do

this, the spatial encoder at the studio side extracts the various spatial cue parameters from the multi-channel source and creates a surround cue channel, which is transmitted as ancillary data.

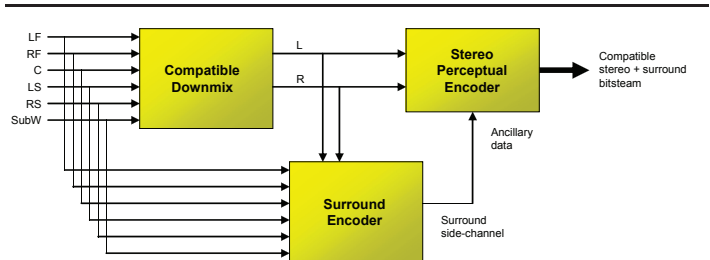


Figure 1: Encoder with internal downmix, used when separate surround and stereo inputs are not available

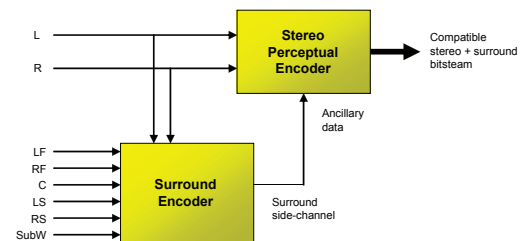


Figure 2: Encoder with independent surround and stereo inputs

The decoder, if present in the receiver, uses this information to recreate the original multi-channel audio.

HD Radio has 96kbps total bit-rate. We are using 80kbps for the stereo and 16kbps for the surround information in a way that is completely compatible with existing HD radio transmitters and receivers.

The coding is based on work that Fraunhofer and Agere Systems (formerly Lucent, with a team formerly from AT&T Bell Labs) conducted in the area of “binaural cue coding”. Researchers in psychoacoustics have learned that only three essential factors are required for the perception of a spatial image: level difference, time difference, and coherence between channels. With this system, these difference values are represented with very compact coding, rather than transmitting all of the individual audio channels. The encoder estimates the values as a function of frequency (that is, within each of a number of sub-bands) and transmits them to the decoder in an ancillary stream that accompanies the main coded audio stream.

The technique can work with any core stereo codec. Fraunhofer has already proposed it as an enhancement to MP3 and work is underway to marry it with other codecs such as MPEG AAC, MP3Plus and AACPlus.

The ISO/MPEG audio group has noted these recent advances and their market potential and has started a new work item with the working title Spatial Audio Coding. Fraunhofer will submit their spatial approach to MPEG for consideration and testing, and chances are good that it or some variation will eventually be approved as an international standard. Thus there will be the usual advantages of MPEG: an independent confirmation of performance, and assurance of fair and equal access to licensing.

## The Demonstration

At the NAB show last April, Telos/Omnia created a stir by demonstrating the system privately to a number of industry insiders. This demonstration used computer files that had been encoded and then decoded with the surround system. Listeners' near universal reaction was, "Wow, that works!"

Now, for the first time, we are publicly showing the system in a set-up that is very close to "real world" with a Broadcast Electronics HD Radio transmitter and an iBiquity receiver.

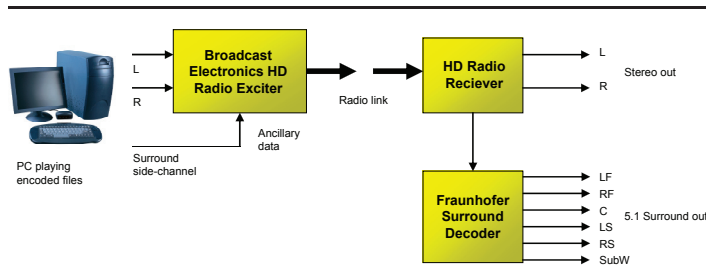


Figure 3: Demonstration setup using BE HD Radio exciter

A computer plays files which have two output parts: 1) normal stereo audio and 2) the encoded spatial information in a 16kbps digital stream. These are both fed into the BE transmitter, the stereo part to the usual audio input and the spatial bit stream into the ancillary data input. The two are time synchronized and sent over the air to the receiver. The receiver has an added decoder processor in a DSP chip that recreates the surround signals.

The original source for the program material was from DVD Audio disks and some material produced by Telos/Omnia that vividly demonstrates the appeal of a real radio station broadcasting in surround.

## The Future

A live real-time encoder, now under development, will complete the system. When that is ready to go, high-quality surround radio broadcasting will be possible.

One lesson from DAB in Europe is that mere "improved digital sound" is not enough to cause listeners to buy new and more expensive radios. Radio needs a significant and clear message to motivate change.

Surround is coming to listeners today via movie theatres, DVD Video and Audio disks, SACD multi-channel disks, satellite radio, television, and the Internet. Radio needs an appropriate technology to compete.

This surround system is it.

## The Participants

*Telos* **Telos Systems**, headquartered in Cleveland, Ohio with offices in Europe and Canada, is a leading manufacturer of ISDN, coded audio and telephone interface products for talk-shows, teleconferencing, audio production, remote broadcasts, and intercom applications.



**Omnia Audio**, a Telos company, is world-renowned for its digital audio signal processing expertise. Omnia audio processors for FM, AM, TV, HD Radio & DAB, Internet, and audio production are setting new standards for professional audio quality.



Fraunhofer Institut Integrierte Schaltungen

### The Fraunhofer Institute for Integrated Circuits IIS

today with 450 staff members, reached international recognition with the development of the audio codec MPEG Layer-3. It provides research services on contract basis and technology licensing. Research topics are: Audio and video source coding, digital radio broadcasting systems, analog and digital integrated circuits, tools for design automation, high-speed camera systems, industrial and medical vision systems, wireless, wired and optical networks, nanofocus X-ray technology, and communications technology in transport and logistics.



**Agere Systems** is a premier provider of advanced integrated circuit solutions for wireless data, high-density storage and multiservice networking applications. Agere's wireless data portfolio enables seamless network access and Internet connectivity through its GPRS offering for data-capable cellular phones, as well as Wi-Fi/802.11 solutions for wireless LANs and computing applications.

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