The first European live radio broadcast in 5.1 surround

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Europe's first satellite radio broadcast in "5.1 surround" took place from the *Prix Europa* competition in Berlin on 11 October 2003. This article outlines how the DTS 5.1 mix was produced in Berlin, distributed over the EBU's *Eurovision* network, and delivered by Swedish Radio as a DVB-S satellite radio broadcast.

On 11 October 2003, Europe's first live *Eurovision* transmission and digital satellite radio broadcast in **5.1 surround** was carried out from the historic radio building of RBB (formerly SFB) in Berlin. From 11 October through to 18 October, RBB hosted the *Prix Europa* competition for television, radio and Internet productions. The opening concert to this year's competition was transmitted live in stereo and in DTS 5.1 over satellite radio. The concert took place in the large concert hall of the "Haus des Rundfunks" (Broadcasting House). *Musique à Neuf*, a world music ensemble from Belgium, presented a blend of jazz and folk music, combining influences from different parts of Europe such as France, Ireland and Galicia (Spain).

Broadcasting the concert in 5.1 surround was originally suggested by Bosse Ternström of Sveriges Radio (SR) in discussion with *Prix Europa* during summer 2003. SR has been on-air with a 5.1 programme since February 2003 and has all the technical expertise – but had not yet done a live broadcast over the EBU Network. The *Prix Europa* offered a good occasion for this premiere, as the *Radio Day of European Cultures* also officially started with this concert. Although the *Prix Europa* opening concert has traditionally been transmitted in stereo, RBB Radio agreed to an additional 5.1 mix and provided the staff and technical facilities to do it. Thus, this premiere was the result of a joint effort involving RBB, SR, the EBU, T-Online and *Prix Europa*.

For safety and artistic reasons, it was decided to do the stereo and 5.1 mixes in parallel in two different control rooms, which as yet seems the only way to assure maximum quality of both mixes in a live situation. The stereo mix was performed by Ekkehard Stoffregen (RBB) and transmitted to the Frankfurt Euroradio uplink via Hybnet – ARD's ATM-based wide-area network. Bosse Ternström from SR did the 5.1 surround mix, together with RBB's Peter Avar.

Figure 1
The "room mikes" that captured the ambience of the concert hall

The microphone (mike) setup was mainly determined by the fact that the concert was a public performance, and sound reinforcement and monitoring were to be used. A main mike approach, as normally used in classical music, was therefore not feasible. The five room

Figure 2
The control room used for the 5.1 mix

microphones visible in *Fig. 1* were used to capture the ambience of the fine acoustics of the concert hall.

All microphone signals were split four ways on stage – to supply the two control rooms, the front of the house and the stage monitoring. The split for the surround mix was fed into a base device of the digital audio network, Stagetec Nexus, which was placed on stage. There the signals were digitalized at 48 kHz / 28-bit and transferred via fibre optic cable to the surround control room, which is located in a different part of the building. For the surround mix, a Stagetec Cantus desk was used, which is fully integrated into the Nexus audio network. The Cantus is a very versatile desk and its surface and channels may be configured in many ways.

The line-up of *Musique à Neuf* is Luc Pilartz (violin, bagpipes), Aurélie Dorzée and Nicolas Hauzeur (violin), Cédric Coupeg (accordion), Daniel Stokart (sax, flute), Kurt Budé (clarinet) Christian Laisné (tuba), Pirly Zurstrassen (piano) and Fred Malempré (percussion). All instruments were very closely miked to reduce cross-talk. In order to eliminate the risk of feedback in the sound reinforcement, the violins were each equipped with pickups. Of benefit to the surround mix, these pickups guaranteed maximum signal separation, which gave the producer and sound engineer (Bosse Ternström) the artistic freedom to place them in the rear of the sound field. A demo clip from this concert will be available soon on the SR website < **http://www.sr.se** > as a 5.1 DTS audio file. The Swedish broadcaster already has a large archive of multichannel productions online in either DTS or Dolby Digital format.

When working in surround, one of the main differences to stereo is *panorama control*. When in 5.1 mode, the Cantus desk offers L-C-R (Left-Centre-Right) power panning on all channels. This means that a phantom source can only be created between two adjacent loudspeakers. In order to create a sense of depth and offer a large "sweet area" [1] instead of just a "sweet spot" to the listener, simple L-C-R panning is sometimes not enough. Via the routing capabilities of the desk, a solution was found (i.e. a "work-around") which allowed a centre phantom source to be created on selected channels, and which provided variable front focus control such that a sound source could be spread out to more than one speaker.

Another issue with multichannel audio is dynamic range limiting. There are six channels of audio and the linking of channels for *compression* has to be carefully considered. While it is obviously a creative matter how the sound sources are spread out across the complete sound field, each single channel carries a higher dynamic variation than in a stereo recording. And because sound transparency increases in a multichannel sound field, even less compression is applied in the recording process. One way to stop a dominant signal in one channel from causing the other channels to be compressed, while still retaining a link among all channels, is implemented in the Jünger Audio Orion dynamic range processor that was used for the production. The Orion offers various possibilities for linking channels, creating links between channels, and controlling the direction of interaction. Whether this is the optimum way of processing the dynamic range, or if there are possibly simpler and more intuitive approaches, has yet to be evaluated.

The complete mix was recorded on a high-resolution digital master recorder and, at the same time, encoded to DTS. For this purpose, the sum was fed to the CAE-4 DTS encoder, which encodes the 5 main channels and the low-frequency effects channel into one bitstream of 1.536 Mbit/s. This bitstream is compatible with a

1. The "sweet area" is the listening area in the room with the 5.1 speakers, where the surround effects can be properly heard.

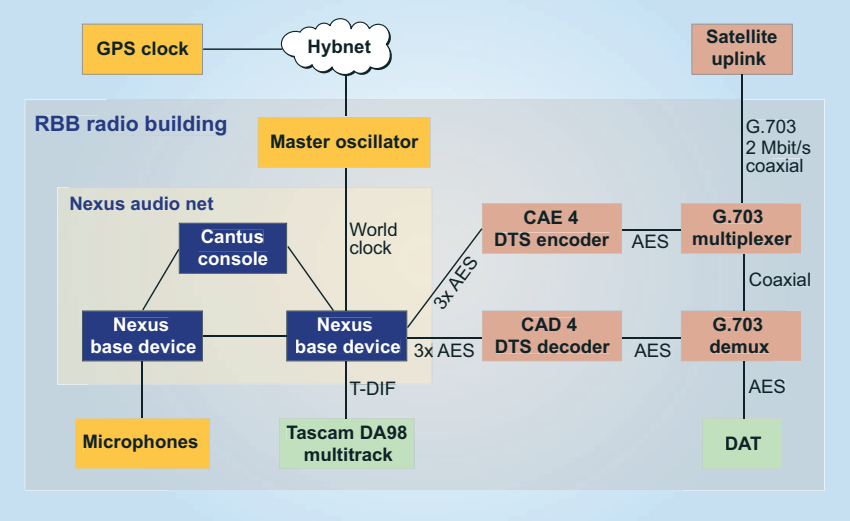

Figure 3
The signal path within the RBB Radio facilities

stereo audio signal of the AES / EBU type at 48 kHz / 16-bit and can be recorded on any DAT machine or other digital recorder. However, coded within the bitstream there are 6 channels of audio at 48 kHz / 24-bit.

This AES-compatible bitstream was then encoded to G.703 at 2 Mbit/s and handed over to the T-Systems satellite van, parked outside the building. From there it was uplinked to Eutelsat W3, 7° east, and could be picked up by EBU Members using a Euroradio decoder. For monitoring purposes, the outgoing G.703 signal was decoded back to DTS and then to AES digital audio.

It is vital for the integrity of an encoded digital audio transport stream that no further processing (such as sample rate conversion or dither) is applied in the signal chain. In other words, the signal chain has to be bit-transparent. This requirement made it essential for the outgoing signal to be synchronous to the house clock of the receiving radio stations. However, this high level of synchronicity hadn't yet been a requirement at RBB Radio. To solve the problem, a GPS-locked clock signal was derived from the Hybnet – the wide-area network of ARD. This GPS-synchronous signal was used to clock the master oscillator, to which the digital audio net was locked.

The signal path within the RBB facilities is shown in *Fig. 3*.

In order to rebroadcast the programme to the public, SR downlinked the signal in Stockholm. It was upconverted to DTS 96 kHz / 24-bit, which is downwards-compatible to DTS digital 5.1 surround and occupies the same bandwidth. DTS digital surround is very common with standard home theatre systems, and DTS 96/24 can be decoded on any system at 48 kHz but still provides better audio quality because of lower jitter distortion.

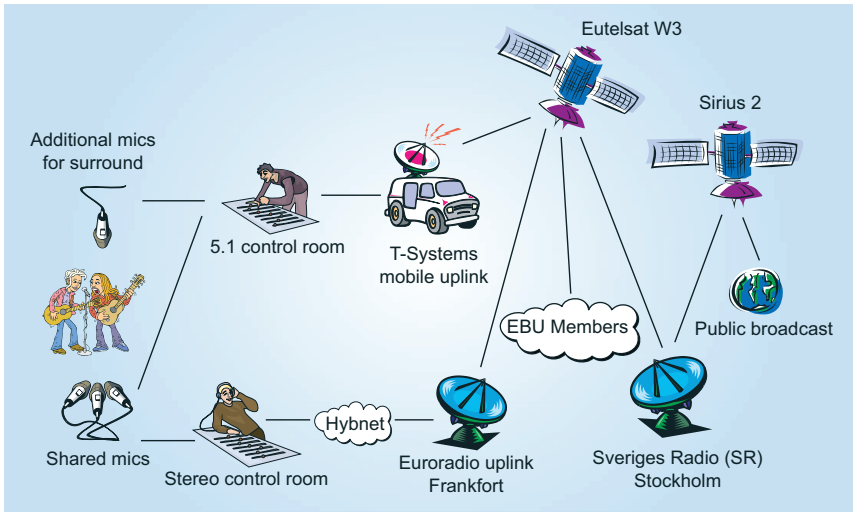

Figure 4
Simultaneous broadcast of the live concert in stereo and 5.1 over the Euroradio network and to the public via the Sirius satellite

The DTS audio bitstream was embedded as a packetized elementary stream in an MPEG-2 video transport stream, according to ISO/IEC 13818-1. The complete signal was broadcast to northern Europe as a DVB-S radio service [2] via the Sirius 2 satellite, 5° east.

At SR, DTS has been in use as a delivery format since 7 February 2003 – it has been providing a 24-hour test 5.1 service via the Sirius satellite. DTS was chosen as the encoding scheme for several reasons:

2. In December 2002, DTS was adopted as an option in the DVB standard, as specified in ETSI TR 101 154. This standard is currently being updated.

Nikolaus Löwe, born on 1 October 1975, studied media technology at the University of Applied Sciences, Mittweida, Germany. He obtained an engineering degree there in 2001. His thesis was written on multichannel music production using digital mixing desks, which included several test recordings conducted at the former SFB Radio (now RBB) in Berlin.

Since 2001, Mr Löwe has been working for RBB as a sound engineer in the fields of classical and jazz music production, and on outside broadcasts.

- it can be stored and distributed via any standard digital medium such as DAT or even audio CD, and transported in the existing digital audio infrastructure;
- with its high data rate, DTS offers high sound quality;
- according to SR, even nine cascaded stages of encode/decode still leave the signal transparent to the ear;
- with DTS 96/24, it is possible to convey high-resolution audio in a standard AES / EBU audio channel.

While multichannel audio has been standard in motion pictures for many years and is also established in television, its use in radio is still rather new. At the time of writing, only two German broadcasters have aired discrete multichannel radio programmes – RBB using DTS, and BR using Dolby Digital.

The author would like to express his hope that more multichannel programmes will follow soon, now that the old excuse ***"we can't transmit that"*** has been proven wrong.

All those currently working with multichannel audio agree that it provides real "added value" for the customer.

Glossary & Web links

ARD *Arbeitsgemeinschaft der Rundfunkanstalten in Deutschland*: a grouping of public service broadcasters in the Federal Republic of Germany – **http://www.ard.de**

BR *Bayerischer Rundfunk*, an ARD member – **http://www.br-online.de**

DTS A discrete digital coding standard for multichannel audio as used in motion pictures and on DVDs. Owned by Digital Theater Systems, Inc. – **http://www.dtsonline.com**

Hybnet The ARD's nationwide ATM-based integrated services network

RBB *Rundfunk Berlin-Brandenburg*, an ARD member – **http://www.rbb-online.de**

SR *Sveriges Radio*, the national public broadcaster in Sweden – **http://www.sr.se**