Digital Multichannel audio

— live transmission of *Prix Europa* concert in Dolby AC-3 by RBB, and in Dolby E via the Eurovision Network

The Eurovision network is continuing its evaluation of different technical options for multichannel audio (MCA) and, in October 2004, it broadcast a live concert from *Prix Europa* in Berlin using the Dolby E format. The 5.1 surround sound production was carried out by the German radio station RBB *Radio Multikulti* in Berlin.

Part I of this article describes some of the problems in a 5.1 live mixing situation and how the mix was transported via a wide-area network to the satellite uplink in Potsdam for multicast distribution. In addition, some current issues on DVB signalling and set-top box compatibility are discussed, and a perspective on lessons learned for the future is given.

Part II reports on the experience gained by the EBU from the *Prix Europa 2004* Dolby E experiment. It also describes the technical and operational aspects of the trial in some detail and gives a short description of Dolby MCA technology.

Part I

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From 16 to 23 October 2004, Radio Berlin Brandenburg (RBB) hosted the annual European television, radio and Internet festival *Prix Europa*. It was opened on 16 October with a concert by the Danish band *Oriental Mood* at the RBB broadcasting house in Berlin. The festival's opening concert has always been transmitted live on radio. This year, however, RBB *Radio Multikulti* carried out a multicast transmission in stereo and Dolby Digital 5.1 and the EBU distributed the concert to its Members

Figure 1
Oriental Mood on stage

using Dolby E on the Eurovision satellite for the first time.

The historic concert hall in the *Haus des Rundfunks* (Broadcasting House) offered the perfect setting for a visually and acoustically lavish performance. The Danish band *Oriental Mood* transported the listeners on a musical journey from orient to occident, combining traditional oriental sounds and rhythms with modern pop and hip hop elements. The stage performance included twelve musicians and two dancers.

Situation on stage

The concert hall at the RBB broadcasting house seats about 1500 people and offers a pleasing, bright acoustical ambience. Sound reinforcement and monitoring were used for the concert, but kept at a moderate level in order not to destroy the natural acoustical space. This was of vital importance for the live broadcast.

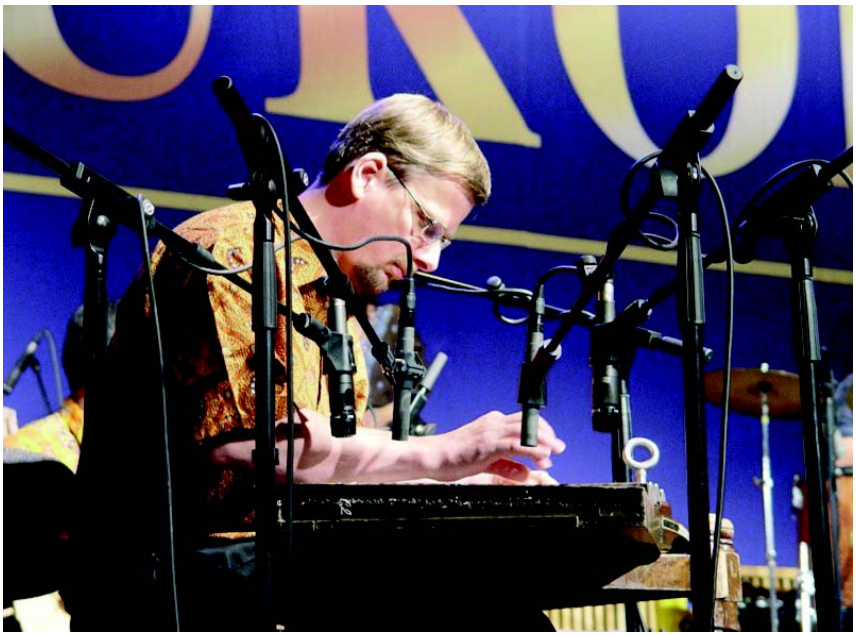

Figure 2
Lars Bo Kujahn, head of Oriental Mood

The Danish band *Oriental Mood* consists of twelve musicians: Lars Bo Kujahn, the band leader, plays the qanoon (an Arabian harp). The rest of the line-up were: Frank Juul (Indian tablas), Nils Raae (keyboard), Niels Lichtenberg (bass), Yasar Tas (saz, a Turkish long neck lute), Jan Andersen (drums), Jesper Løvdal (sax), Kadry Surour and Johnny Kalsi (Indian dhol drum), Gustav Rey (flamenco singing), Zaki Youseef (rap, mouth percussion) and Karima Nayit (vocals). An important part of the show were the two dancers in the centre of the stage, a belly dancer and a dervish.

All microphones were split four ways: towards the front of the house, the monitor mixer, the stereo control room and the 5.1 control room. The latter is connected to the concert hall via fibre optic cable, so all the signals were A/D-converted on stage. There were only few additional microphones for the surround recording, namely four figure-of-eight mikes to capture the room ambience – two above the stage, two above the audience – all of them facing outwards. They were positioned in a way that allowed them to pick up room ambience with as little direct sound from the house p.a. system as possible. In some cases there were separate microphones for recording and sound reinforcement, for example for the qanoon, to reduce the risk of feedback from the monitors.

Mixing live for 5.1

For the multicast, that is the simultaneous live transmission of a stereo and a 5.1 mix, two separate control rooms were used. This guaranteed the best possible quality for both mixes. Although it is theoretically possible to derive one mix from the other by upmixing or downmixing, the quality of at least one version will always suffer. Especially in a live performance, an engineer can only focus on one mix at a time, having to neglect the other. And, as it turned out in this case, the engineers for the stereo and for the 5.1 mix had different musical approaches to the concert, so downmixing would

have been completely unsatisfactory.

Peter Avar, RBB sound engineer in charge of the 5.1 mix for Oriental Mood, made extensive use of the rear channels. By spreading out the instruments of the band around the 360° sound field, he gave the listener the chance to hear the whole breadth of the complex instrumentation of the musical arrangements. In several instances, corresponding voices were placed opposite to each other. This allowed for a much clearer sound image than could possibly be achieved in stereo. The full live mix was recorded to DTRS multitrack cassette and to DTS-encoded DAT.

Figure 3
Peter Avar (RBB) doing the surround mix

Signal distribution

The satellite multiplexing and uplink facility for the ARD's digital television and radio programmes, i.e. the Play Out Centre, is located in Potsdam near Berlin. There are several connections from the Berlin broadcast facilities to the Play Out Centre, but none of them was suitable for transporting an encoded multichannel audio stream such as Dolby E or Dolby Digital. A bit-transparent line is required for this purpose. However, at the time of the transmission there were no devices available on the market that were capable of transporting encoded audio transparently over an E1 wide-area network infrastructure. There were some systems that had been discontinued, and at least one manufacturer had announced the development of a new unit, but at the time of the concert there was no other choice than to transport all six audio channels of the 5.1 mix discretely to the Play Out Centre in Potsdam and to encode them there for the broadcast. For this transport, T-Systems provided two 2 Mbit/s E1 lines with ITU T-J.41 audio codecs.

In a J.41 codec, each single audio channel is encoded at 384 kbit/s. Four channels of the 5.1 mix were transported on the first E1 line, the remaining two on the second one, with the option of synchronously sending along the stereo mix over the remaining line capacity. Synchronicity errors or latencies between channels were not measurable, which may be due to the fact that both E1 lines used the very same infrastructure.

In Potsdam, the incoming audio was monitored and then encoded to Dolby. For RBB's own broadcast, Dolby Digital encoding (AC-3) at 448 kbit/s was required. For the additional transmission via the EBU network, a Dolby E encoder was employed. Both units were operated by Mick Dwyer (Dolby Labs), who also configured the Dolby metadata. A Dolby LM-100 loudness meter was employed to measure the programme loudness and to set the dialnorm parameter in the metadata, which controls playback loudness and compression thresholds for reproduction on home cinema and stereo systems. The metadata was configured for optimum playback on large surround systems, with no compression applied to the surround mix and no rear channel phase shifting. This parameter improves the compatibility of a stereo downmix with Dolby ProLogic decoders that reinflate the sound field, but reduces the localization of phantom images involving the rear channels in a proper Dolby Digital 5.1 listening environment. Again, this broadcast only involved a single event, and the aim was to provide the best possible listening experience to all those who tuned in to the concert using their home cinema system.

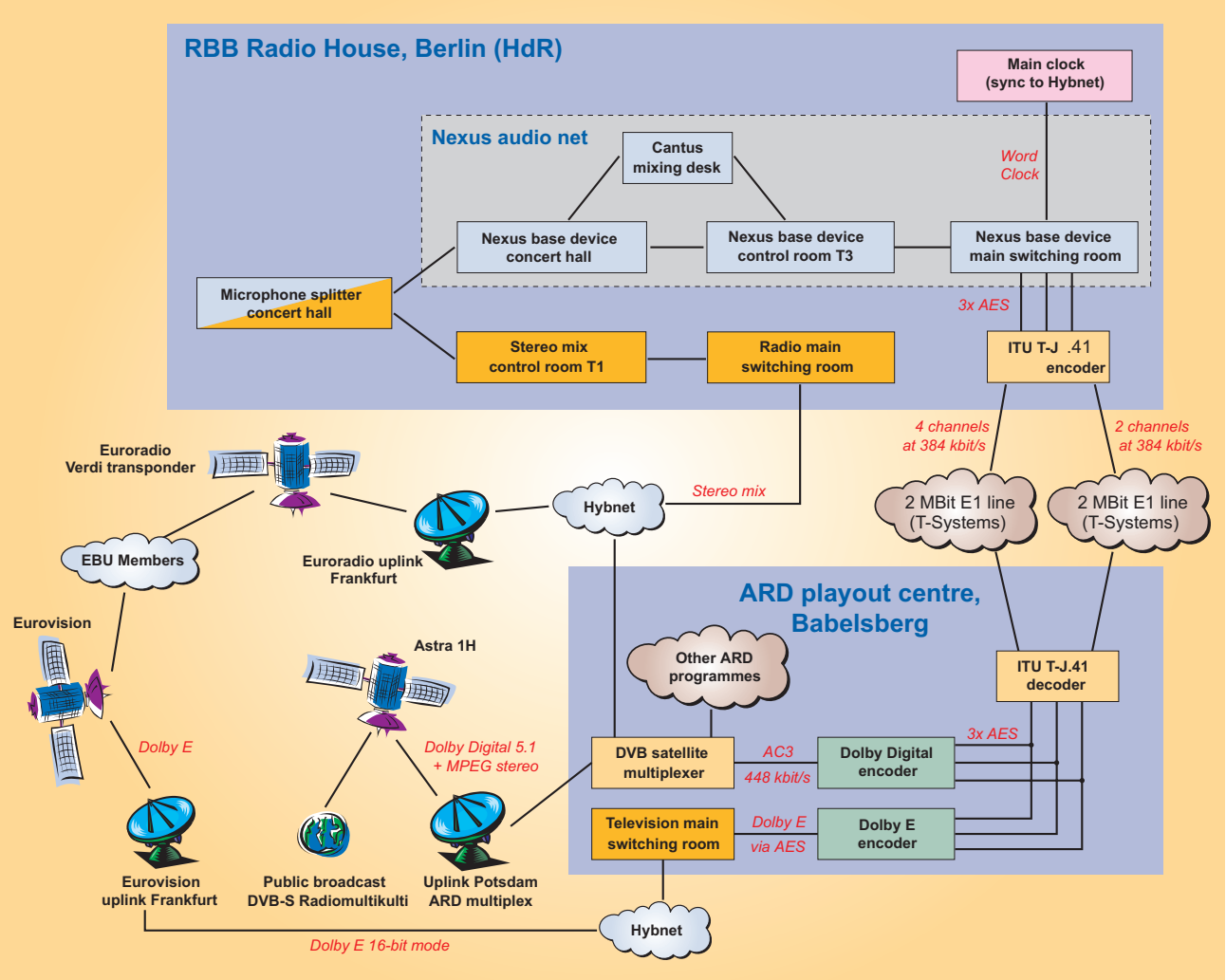

Figure 4
Signal flow diagram for the simulcast live broadcast of the *Prix Europa* opening concert, 2004 — in stereo, Dolby Digital 5.1 and Dolby E

The concert was broadcast live via five different transmission paths: First, it was delivered via regular FM stereo to the region of Berlin and Brandenburg on the frequency of *Radio Multikulti*.

For the satellite multicast, two transmission paths went to the ARD's digital transponder on the Astra 1H satellite. For the satellite radio service of *Radio Multikulti* there was the normal DVB-S stereo MPEG layer 2 transmission at 192 kbit/s. Additionally, another audio stream containing the Dolby Digital 5.1 (AC-3) data stream at 448 kbit/s was configured under the same radio service, but just for the duration of the concert .

Because the performance was also distributed by the EBU, there were two additional delivery paths via their satellites. The stereo mix was available for broadcasters on the Euroradio satellite, Verdi transponder. The 5.1 mix was offered to EBU Members in Dolby E over the Eurovision satellite. This was the first time Dolby E has been distributed on the Eurovision Network.

Table 1
Overview of distribution paths

1	Stereo FM *Radio Multikulti* in Berlin and Brandenburg
2	Euroradio stereo satellite channel, VERDI
3	Astra satellite, ARD bouquet, DVB-S radio service of *Radio Multikulti*, stereo MPEG layer 2
4	As 3, but encoded in Dolby Digital 5.1 (AC-3)
5	Eurovision satellite transmission encoded in Dolby E (5.1)

Figure 5
Mick Dwyer (Dolby) supervising the encoders

The previous *Prix Europa* opening concert (October 2003) had been broadcast live from Berlin in 5.1 by Swedish Radio in cooperation with RBB. However, DTS was used as the coding format on that occasion. Although DTS is part of the DVB standard for radio and television broadcasting, ARD has taken to Dolby Digital as the delivery standard for multichannel audio. This is for a number of reasons, one of them being the higher flexibility in data rates. While DTS at the time offers data rates of 768 kbit/s or 1,526 Mbit/s at 48 kHz, Dolby Digital is scalable towards considerably lower data rates. The limited available bandwidth on broadcast satellites and the expected cost of maintaining several channels for multicast purposes influenced the choice towards Dolby Digital at 448 kbit/s. It is an established standard in the world of multichannel audio – for both DVD titles and television broadcasts.

SES Astra, owner of the Astra satellites, claimed that by the end of 2003 there were already 2.7 million DVB-S set-top boxes installed in Germany, most of them equipped with a digital output compatible with Dolby Digital.

Other reasons why ARD has opted for Dolby Digital are the metadata concept that allows storage and transport of technical production information within the audio stream, and interoperability with the Dolby E format, which is a low-compression coding format that can be integrated into existing production and storage facilities, especially in television.

When building the satellite multiplex, a choice had to be made regarding the DVB signalling. The standard procedure would have been to include the new Dolby Digital audio stream in the existing PMT (Programme Map Table) under the radio service of *Radio Multikulti*, and then rely on the set-top boxes to find, recognize and display it in the list of available radio programs. The existence of the new audio stream was also announced in the EIT (Event Information Table). However, the most common set-top box in Germany is the D-Box 2, which is sold by the pay-TV company Premiere AG. This box only recognizes Dolby Digital streams that are associated with a video stream, so none of the users of the Premiere box would have been able to receive the programme.

The choice fell towards signalling a video stream at 0 kbit/s, within the existing PMT, to which the Dolby audio stream referenced. The additional bandwidth for the new audio stream was freed by dropping the sound track of the ARD video text service.

In detail, the configuration for the transmission was as follows:

- ASTRA 1H, 19.2° East
- Transponder 85, 12.1095 GHz
- Transport stream ID: 1073
- Radio Service: Radiomultikulti
- Service ID: 28213
- Audio 1 – Stereo: PID 1301 (192 kbit/s, regular stereo stream)
- Audio 2 – Dolby: PID 1302 (448 kbit/s, 5.1 surround stream)

- Video 1: PID 1303 (dummy video stream at 0 kbit/s)

The programme could now be decoded using the D-Box 2 and also many other modern set-top boxes. There were few reports of non-compatible boxes, all of which were older than a year. In particular, not all set-top boxes equipped with a Dolby Digital output would actually put out the audio stream.

The box used for programme monitoring was a Philips DSR5600. During the whole transmission period of 2½ days, from the start of the test sequence until the end of the concert, there was not a single CRC error in the downlinked Dolby stream.

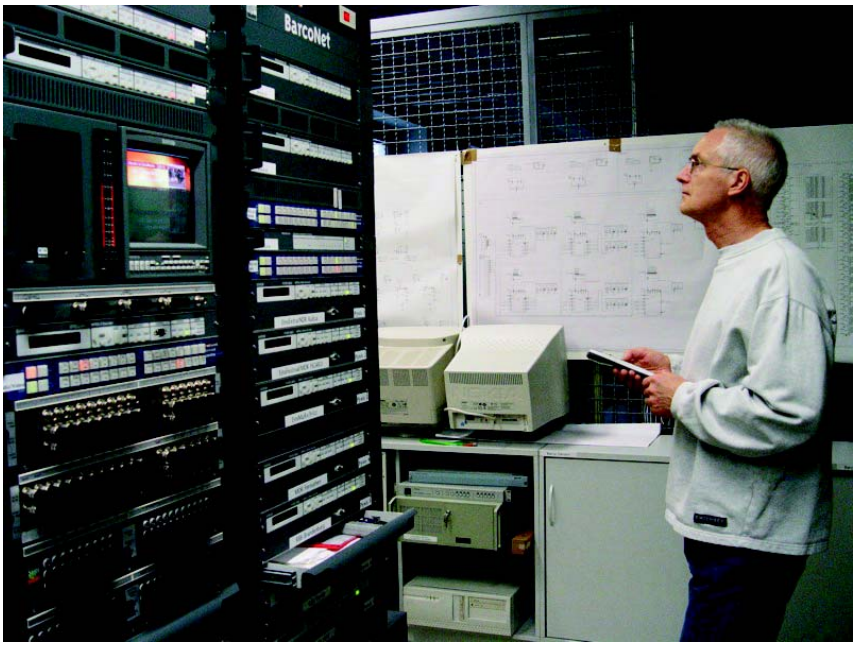

Figure 6
Wilfried Dohmen (RBB) controlling the DVB multiplex

All in all, the first 5.1 live broadcast by ARD was a resounding success.

Perspective

The author honestly hopes that this is not the end of the story! As for the future, the following lessons have been learned:

- The provision of two control rooms and two engineers was possible on this occasion because the *Prix Europa* opening concert is a one-off event. This would certainly not be the case in normal day-to-day broadcasting. It is understood that in future, when 5.1 may be introduced on a broad basis, priority will have to be given to one of the two mixes, presumably the surround mix, demanding compatibility with stereo – as was the case when stereo was introduced. To give an example, ORF (Austrian National Television) is already producing their programmes in 5.1 and rely on an automatic or sometimes a manual downmix for the stereo version.

- Downmixing appears to work reasonably well for classical music, but certainly not for radio drama and pop music. Such programme types rely on the extended creative options of 5.1 mixing, where sometimes even the acoustical focus towards the front is abandoned. The IRT (Institute for Radio Technology) in Munich is currently doing research on downmix procedures, with the aim of finding methods that give acceptable results for most kinds of audio material.

- In the case of pre-produced programme material where a downmix is not satisfactory, but a stereo mix exists, a broadcast infrastructure is desirable that allows simultaneous transmission of the stereo and the surround mix. This applies particularly to high-quality radio programmes that are distributed as multicast.

- For programme distribution, the use of two E1 lines must be considered a work-around. In day-to-day broadcasting it would obviously be more cost-efficient to use only one E1 connection, or some other network type, and transmit an encoded stream, like Dolby E. For future transmissions, appropriate means of signal transport will be needed, especially such means that allow bit-transparent transmission of encoded audio, be it Dolby, DTS, or whatever. Maybe the audio streams could be tunnelled over an IP network, gaining flexibility especially with varying outside broadcast locations.

- Another issue for the future is DVB signalling. The non-standard DVB signalling that was used for the *Prix Europa* transmission will not be upheld in the future, as a more comprehensive support of the DVB standard is called for in future set-top box designs.

And last but not least, we would need a lot more experience if we were to run a 24/7 radio station in 5.1 surround.

Nikolaus Löwe, born on 1st of 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 recordings conducted at the former SFB radio sdtation (now RBB) in Berlin. Since 2001, he has been working for RBB as a sound engineer in the fields of classical and jazz music production and outside broadcasts, and has specialized in multichannel audio.

Part II

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Many EBU radio and television broadcasters have already started producing and broadcasting their music, drama and sports events in a multichannel audio (MCA) format. MCA helps to deliver sound content to the home in a more vivid, transparent and dramatic fashion than the traditional stereophonic (two-channel) sound format.

To this end, the Eurovision network is continuing its evaluation of the different technical options for MCA. In October 2003 it carried a first live concert from the *Prix Europa* opening concert using the DTS (Digital Theater Systems, Inc.) MCA format [1]. This year (2004) Eurovision carried out yet another test from the same event, however this time using an alternative multichannel audio system – Dolby E.

Multichannel audio allows the listener to enjoy a greater sense of realism and improved spatial impression of an acoustic event than conventional stereophonic audio. As the name "multichannel" implies, several discrete audio channels associated with the same sound event are to be conveyed to the listener. Typically, six (“5.1”) loudspeakers are needed to achieve a faithful reproduction of the complex audio scene.

Multichannel sound is becoming increasingly popular for audiovisual reproduction and storage systems used in the home (such as DVD). Today about 10% of European homes have some MCA systems, with growth rates continuing to climb. Over 2400 film titles have been mastered with MCA soundtracks [2]. Although multichannel audio is a well established technology on the DVD platform, it is not yet extensively used in broadcasting. However, EBU members have been performing several MCA trials in recent years [3] and some highlights are listed below:

- On 1st January 2003, the Austrian Broadcasting Corporation (ORF) went on-air with Dolby Digital MCA during the New Year Concert from Vienna. ORF continued to produce the New Year Concert in the MCA format in 2004 and is planning to do so in forthcoming years.
- In September 2003, Bayerischer Rundfunk (BR) and Westdeutscher Rundfunk (WDR) set up a trial on the occasion of the Internationale Funkaufstellung (IFA) from Berlin, using a DVB-S transponder on an Astra satellite.

Abbreviations

A/V	Audio / Video (Visual)	**ID**	IDentification / IDentity / IDentifier
AES	Audio Engineering Society	**LFE**	(5.1) Low-Frequency Extension
dBFS	dB relative to Full-Scale reading	**MCA**	Multi-Channel Audio
CRC	Cyclic Redundancy Check	**PID**	(MPEG) Packet IDentification number
DVB	Digital Video Broadcasting	**MPEG**	Moving Picture Experts Group
DVB-S	DVB - Satellite	**PMT**	(MPEG) Programme Map Table
DVB-T	DVB - Terrestrial	**SDI**	Serial Digital Interface
EIT	(DVB) Event Information Table	**VTR**	Video Tape Recorder

- Since October 2003, BR has been transmitting a serious music programme in the 5.1 Dolby Digital AC-3 format at 448 kbit/s as a regular test service via an ARD transponder on Astra satellite 1H using the DVB-S standard.
- Telewizja Polska (TVP) started experimental transmissions of live concerts in April and May 2003 using Dolby Digital.
- Whilst the BBC is not currently offering any MCA broadcasts, it has been producing a variety of TV programmes in a discrete 5.1 MCA format for more than 20 years.
- Swedish Television (SVT) started Dolby Digital MCA broadcasts on the SVT 1 channel on their digital terrestrial network (DVB-T) in June 2003. The second Swedish TV channel (SVT 2) started to use MCA in December the same year. In March 2004, both SVT 1 and SVT 2 were equipped with Dolby Digital for satellite transmissions using DVB-S.
- Swedish Radio set up a website carrying nearly 40 clips of downloadable MCA material (DTS format). To date, more than 4 million successful downloads have been made.
- German broadcaster ZDF started Dolby Digital pilot broadcasts on both DVB-S and DVB-T in October 2003. Six live shows “Wetten, dass…?” were produced and broadcast in the MCA format.

The above examples show that there is significant momentum among EBU Members to experiment and operate MCA, in particular for big live events such as numerous Euroradio transmissions, the New Year Concert, Bayreuth Festival, Eurovision Song Contest, Popstad, sports events such as the Olympic Games and Football Championships, etc. To this end, there is a requirement to distribute such multichannel audio material to all EBU Members.

However, it should be pointed out that MCA poses a number of challenges to the broadcaster. These challenges are of an artistic, technical, economic, commercial and regulatory nature. Among the most critical issues are undoubtedly the increased cost of MCA production and emission, the need for more transmission spectrum than is required for stereo and the need to adjust the broadcast industry distribution infrastructure to accommodate the appropriate MCA technology.

Part II of this article is just a modest attempt to address the latter aspect.

Which MCA system for Eurovision

Today, several multichannel audio schemes are available on the market, including:

- MPEG-2 Layer 2;
- Dolby Digital (AC-3) [1];
- Dolby E;
- Dolby Prologic 2;

1. Dolgy has recently introduced Dolby Digital Plus, which makes more efficient use of bandwidth than Dolby Digital.

- Digital Theatre System (DTS Digital Surround);
- Audio Processing Technology (APT-X);
- MPEG-4 High Efficiency AAC Audio [4].

These systems have been designed for different purposes (e.g. broadcasting to the general public, contribution and distribution, storage media such as DVD, etc), and they have different quality levels and a range of costs. Differing technologies have differing strengths and weaknesses and "one size fits all" may not exist.

EBU Technical Recommendation R96-2004 [5] recommends that for production, broadcasting and the interchange of multichannel audio programmes, with or without accompanying pictures, the 3/2 format, according to ITU-R Recommendation BS.775-1 [6], should be used.

In order to provide a possibility for the exchange of television multichannel sound among EBU Members, there are in principle two possibilities – either to use (i) a suitable MCA system within the Euroradio Network and invite the TV broadcasters to receive simultaneously both the radio and TV networks, or (ii) to include the MCA stream into an existing MPEG-encoded TV signal. The Euroradio network, which uses a single AES/EBU (2 Mbit/s) channel, will have to be adapted: for the time being, it can only carry one stereo signal [7].

Taking into account all factors including the need to maintain perfect syncronicity between vision and MCA sound, the second option seems to be more appropriate. The choice of a suitable audio format for the exchange of multichannel audio in television is vital. The system is required to give an excellent sound quality to allow for postproduction and additional processing. It must also use an effective compression algorithm to allow transmissions using the existing distribution infrastructure [2].

The choice of a suitable MCA system cannot be made overnight. Following the establishment of the commercial and technical requirements, a carefully engineered solution should be found. A series of technical trials to check the compliance should be conducted before the final decision is to be taken.

The *Prix Europa* trial described in this article is one step in that direction.

Prix Europa 2004 technical trial

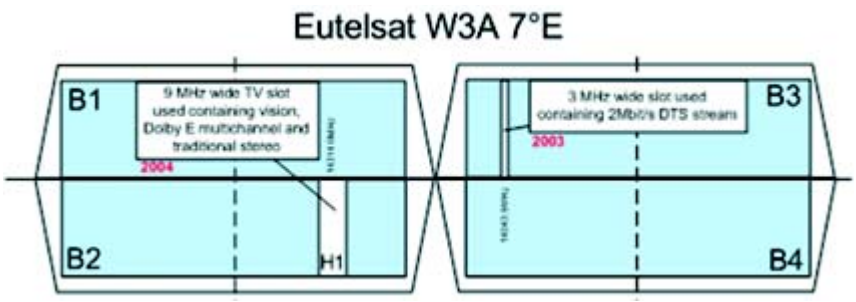

Figure 1
The Eutelsat W3A channel configuration

On the occasion of *Prix Europa* 2003, the Eurovision network carried out a multichannel audio experiment using a 3 Mbit/s transparent data carrier at 11043.5 MHz on the Eutelsat W3A (7° East) satellite – Transponder B4 [1] [3]. This transponder carried the audio signal using the DTS multi-channel audio compression format [8].

In 2004, Eurovision performed yet another technical trial on 5.1 multichannel audio, this time using Dolby E multichannel audio technology [9] [4]. The multichannel audio signal was transported in the transparent data channel as part of the MPEG-2 transport stream which is normally used to carry a complete audio/video television signal, as opposed to the separate data carrier which was used last

2. An uncompressed multichannel sound requires a bitrate of about 9 Mbit/s (24 bits, 48 kHz sampling rate).
3. In fact there was a last-minute change. For practical reasons, the frequency slot had been changed to transponder B3 (the same frequency, but opposite polarization).
4. The *Prix Europa* concert was also transmitted via Euroradio channel Verdi in stereo, and via an ARD channel on the Astra satellite in the 5.1 Dolby Digital AC-3 format.

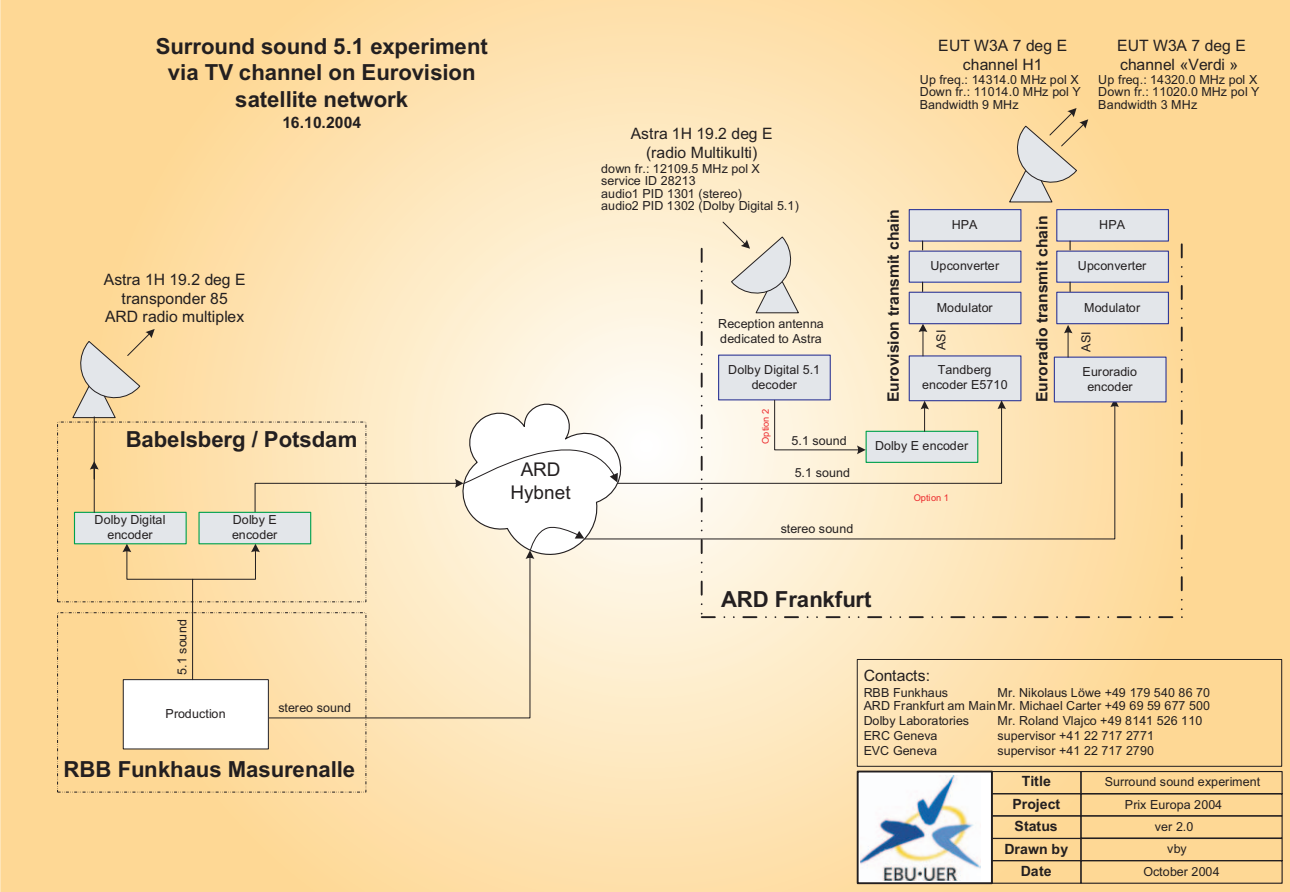

Figure 2
Signal flow diagram of the multichannel audio experiment at *Prix Europa* 2004

year. The major advantage is that the MPEG-encoded vision signal and the Dolby E stream are transported by a DVB-encapsulated signal in perfect synchronism and secured by all the DVB error-correction mechanisms.

Fig. 1 depicts the data transmission channels of the Eutelsat W3A satellite, as used for the multichannel audio trials in 2003 and 2004, respectively.

The Dolby E signal was originated from the 5.1 channel audio source at RBB in Berlin and then moved via ARD's Hybnet to the Eurovision W3A uplink station in Frankfurt *(see Fig. 2)*.

A video test generator signal was inserted on the audio signal at the uplink in Frankfurt, in order to obtain a complete television signal.

Several EBU members are already equipped with Dolby E decoders. The following members were thus able to participate in the 2004 trial: Swedish TV (SVT), Finnish TV (YLE), Norwegian TV (NRK),

Figure 3
Trial set-up at the Eurovision Centre in Geneva

Figure 4
Dolby equipment used in the *Prix Europa* trial

Iceland TV (RUV), the BBC, Polish TV (TVP), several German broadcasters (WDR, HR and ZDF), Austrian TV (ORF), Denmark's Radio and TV (DKDR) and Slovenian TV (RTVSLO). The last two Members benefited from an offer from Dolby Laboratories to borrow a decoder and participate in this experiment.

The Eurovision Centre in Geneva arranged for a surround sound listening room *(see Fig. 3)*. The Dolby equipment used for this experiment is shown in *Fig. 4*.

Some results of the *Prix Europa* 2004 experiment

All EBU Members who participated in the trial reported that the reception of the multichannel audio signals was excellent. Many Members used the Tandberg TT1260 decoder which forms a part of the Eurovision installation in each Member's master control room, enabling the reception of MPEG-2 television signals. The Dolby E signal was available at the digital output of this receiver and was fed into the Dolby E DP572 decoder. In many cases the Dolby E signal was recorded on a VTR synchronized with the TT1260 video signal. In order to improve synchronization between the audio and video, a Dolby Frame Synchronizer (DP583) could also be used although, in most cases, it was not necessary to use it, as the synchronization was good enough. Error analysis could be performed by using either the Dolby DM100 bitstream analyzer or the DP572 directly.

Members were able to compare subjectively the sound quality of the received MCA and the stereo signal which originated in Berlin. Unfortunately, this comparison test could only be conducted during the second half of the concert due to some minor problem at the uplink site in Frankfurt. We were also able to compare the Dolby Digital 5.1 signal quality which was available on an Astra ARD channel with the Dolby E quality available on the Eutelsat satellite. In both cases, Dolby E was judged much clearer, as expected.

In order to calibrate the test set-up equipment in Members' premises, the following test signals were transmitted:

- channel identification;
- correlation between channels (L-C, R-C, R-Rs, Ls-Rs, L-Ls);
- a 1 kHz tone signal (-9 dBFS) in all five channels (the LFE channel's tone signal was at 80 Hz);
- a music sampler.

Our Polish colleagues from TVP observed that, during the test signal transmissions prior to the concert, the Centre signal C was out of phase with the Left and Right channels (about 130°). The L, R, Ls and Rs channels were found to be in phase.

There might have been some confusion about the channel assignment in the music sampler. Namely, when the C and R channels were interchanged, the sound impression became significantly better. Fortunately, this problem did not occur during the live transmission.

The Polish colleagues also observed that the maximum peak level of the MCA signal was 0 dBFS,

while the level of the stereo sound was 14 dB lower. In future, these two levels need to be aligned. This matter, too, requires closer examination in order to avoid any future incoherence.

During the live transmission, no transmission errors were detected. The Dolby bitstream analyzer displayed zero CRC error *(see Fig. 4)*. This is an extremely positive result which shows that the whole Dolby E transmission chain was relatively stable.

Dolby E multichannel audio technology

For a number of years, TV broadcasters over the world have been using the Dolby E system for the contribution of multichannel audio signals. In the Dolby E system, eight channels of audio are compressed to a stream of about 2 Mbit/s [5] and may be transmitted using one AES/EBU interface. This system provides acceptable transparency and concatenation of multichannel audio codecs for professional purposes [6]. Dolby E maintains synchronism between the audio and video across the whole broadcast chain [7]. In addition, recording of Dolby E audio on existing VTRs, e.g. Digital Betacam, and simple A/V editing (cutting) is still possible.

Dolby E offers the possibility of transmitting up to eight discreet channels at the same time. This capacity is sufficient to carry not only multichannel sound, but also compatible mono or stereo international sound in the same Dolby E multiplex. The same capacity could be used for up to eight independent audio signals (e.g. eight commentary channels in mono).

A large amount of professional equipment is already compatible with Dolby E. These involve SDI embedders / de-embedders, VTRs, A/V servers, video mixers, MPEG encoders / decoders with AES/EBU and SDI inputs / outputs etc. Over 30 broadcast equipment manufacturers are members of the Dolby E Partners Programme [8].

ITU-R Recommendation BS.1548-1 entitled "User requirements for audio coding systems for digital broadcasting" gives a number of detailed requirements to be fulfilled by the audio coding systems used for contribution and distribution applications. The only audio codec proven to meet the ITU quality requirements is Dolby E [9]. There are no usage fees applicable for the use of the Dolby E technology.

Summary and conclusions

The present *Prix Europa* experiment should be seen as one in a series of multichannel audio experiments to be conducted by the Eurovision Network in the near future. A number of trials are necessary to gather the required information about the quality of the MCA systems used, reliability of the equipment and operational user-friendliness. This information will be useful when making a choice of MCA format suitable for the exchange of television programmes over the Eurovision Network. It goes without saying that the Eurovision Network requires a high-quality system which has sufficient margin for postproduction and additional processing.

As the process to select an MCA coding system make take several years, it would be useful to establish a bit-transparent data channel to carry MCA programmes within the existing MPEG-2 multiplexes. Such an approach would permit any MCA coding system to be used immediately on the Eurovision Network, for test purposes.

5. 2048 kbit/s.
6. Extensive listening and performance tests are detailed in Document 6D/38-E, Document 6Q/40-E submitted to ITU-R on 10 September 2001.
7. Dolby E is introducing exactly a 1-frame delay for encoding and exactly a 1-frame delay for decoding the signal, and the coded audio frame boundaries are aligned to the video frame boundaries.
8. See **http://www.dolby.com/professional/pro_audio_engineering/services_dolbye.html**
9. This is given in Appendix 1 to Annex 1 of ITU-R BS.1548-1.

Franc Kozamernik graduated from the Faculty of Electrotechnical Engineering, University of Ljubljana, Slovenia, in 1972.

He started his professional career as an R&D engineer at Radio-Television Slovenia. Since 1985, he has been with the EBU Technical Department and has been involved in a variety of engineering activities covering satellite broadcasting, frequency spectrum planning, digital audio broadcasting, audio source coding and the RF aspects of various audio and video broadcasting system developments, such as Digital Video Broadcasting (DVB) and Digital Audio Broadcasting (DAB).

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In 1991 Mr Benovsky joined the EBU Technical Centre in Brussels where he worked in the network planning section, becoming experienced in organizing the technical facilities for major sport events such as the Olympic Games and World Championships via both terrestrial and satellite networks. He currently works for Eurovision Technical Services as a satellite engineer responsible for the Eurovision satellite network.

The test was a useful opportunity to gather some experiences from the participating Members. There are some outstanding MCA matters that need to be resolved. The most pressing issue is to reach an agreement among the Members concerning the allocation of audio channels associated with a television programme. It would be sensible to assign channels 1 and 2 to the stereo signal, and channels 3 and 4 to the multichannel compressed audio.

Furthermore, it would be useful for radio and TV tests and regular transmissions to carry a time code in order to facilitate any error detection and system verification. The SMPTE time code can be carried as metadata along with the programme throughout the broadcast chain.

An agreed set of metadata could carry a number of important system parameters including those intended for the network operator to configure the MCA system as well as those intended for the end consumer set-top box. The so-called “professional” metadata would describe the format of the MCA bitstream and the system configuration. The so-called “consumer” metadata would help the receiver to configure the MCA channels received and control the dynamic range, dialogue levels, etc.

Subsequent MCA test transmissions should involve both video and stereo/MCA sound, so it is possible to check the overall synchronization of audio and video signals (particularly important for lip-sync).

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10. The complete list of persons who helped during this trial is far too long to include here.

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