Distributing the Eurovision Song Contest with Dolby Atmos Audio

Dolf Schinkel

On 18, 20 and 22 May, KPN distributed the live Eurovision Song Contest 2021 with Dolby Atmos sound in a project with NPO Innovation and the Dutch ESC2021 organisation.
KPN has an interactive TV platform with over 2 million users. About 25% of the users have a set-top box capable of decoding HEVC, which supports Dolby Atmos in pass-through mode. And it can downmix to 5.1 or 2.0 when a device is attached that doesn't support Dolby Atmos. The older set-top boxes are AVC-based; these support neither MPEG HEVC nor Dolby Atmos.
We positioned the broadcast as a technical trial. The original broadcast was distributed on the main "NPO1" public broadcast channel, while the Atmos trial was accessible on a separate event channel.

In this paper, I will give some insights into this innovative audio-visual project.

"Just add the extra audio"

It might seem easy to add an extra audio distribution channel when your country hosts the Eurovision Song Contest, but we ran into many obstacles starting this project: rights, responsibilities and an inflexible broadcast architecture made this much harder than we anticipated.

The regular NPO1 broadcast of the European Song Contest (ESC) was already designed and being built when we decided to add an Atmos signal.
A simplified version the original setup is shown in figure 1. In this set up the components not relevant for the event channel are left out.

The TV signal is produced by the ESC 2021 organization for the EBU and sent to all the Eurovision countries, Israel and Australia, over satellite.
For the Netherlands, the signal is received in Hilversum by the broadcast organization AVROTROS that produces the local program. The feed was a satellite feed, that was replaced with a fibre feed during the project. AVROTROS adds titles and a live commentary from the venue.

The signal is then provided to NPO, the public Broadcaster, which adds logo's and extras such as Teletext and subtitles. The NPO1 channel is distributed to users by KPN and other TV distributors in the Netherlands.
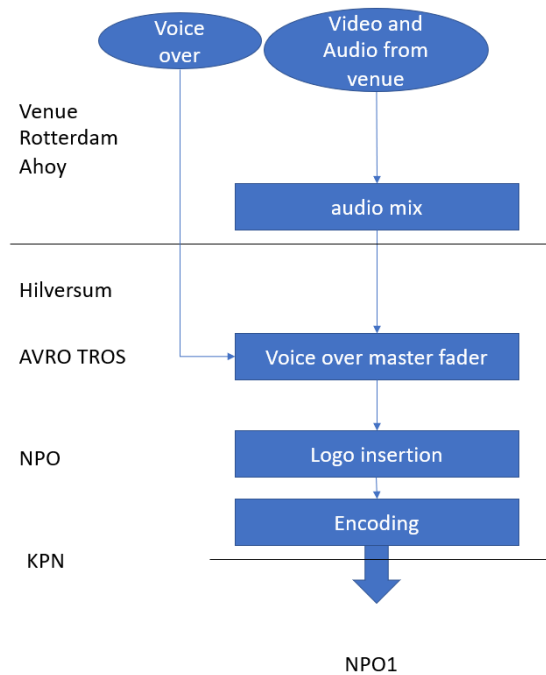
*Figure 1 - simplified diagram for the NPO1 channel during the event.*

And this is how we did it.

To create the immersive audio, we placed extra microphones and an additional mixing console in the venue.

NEP supplied their newly built audio truck, the "NEP MusicOne", which was manned by audio technicians from both NEP and United.
The TV signal and commentary was fed back from Hilversum to this truck.
All audio coming from the stage was merged with the extra microphones and the commentary to create the discrete audio tracks for the Dolby Atmos mix.
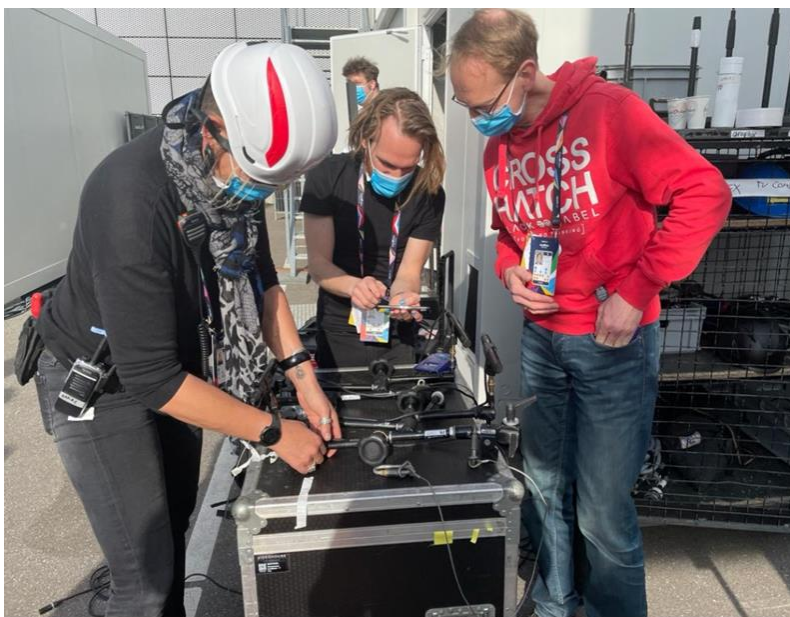
Preparation of the 4 overhead microphones in a Hamasaki mini square configuration (photo by NEPinternational)

The incoming audio feeds were delayed to compensate for the Rotterdam-to-Hilversum satellite and fibre roundtrip delays.

In the NEP MusicOne truck, two audio technicians mixed the immersive audio in a 5.1.4 format and were able to have in realtime the 5.1 and stereo downmixes from the Atmos (thanks to the Dolby DP590 unit). The original stereo audio was passed through.
The combined 5.1.4 + stereo signal was fed over a fibre connection in HD SDI with discrete audio to NEP live centre in Hilversum.
NEP provided a playout with Dolby Atmos sound to fill the gaps in programming between the Eurovision transmissions. The choice was not to use a test pattern, but a Dolby Atmos test sequence, allowing people at home to test their home equipment before the show starts.

From NEP in Hilversum, the signal was sent to KPN's Hilversum-in HD SDI, with discrete audio. It was then encoded using an Ateme HEVC encoder that included a Dolby Atmos encoder.
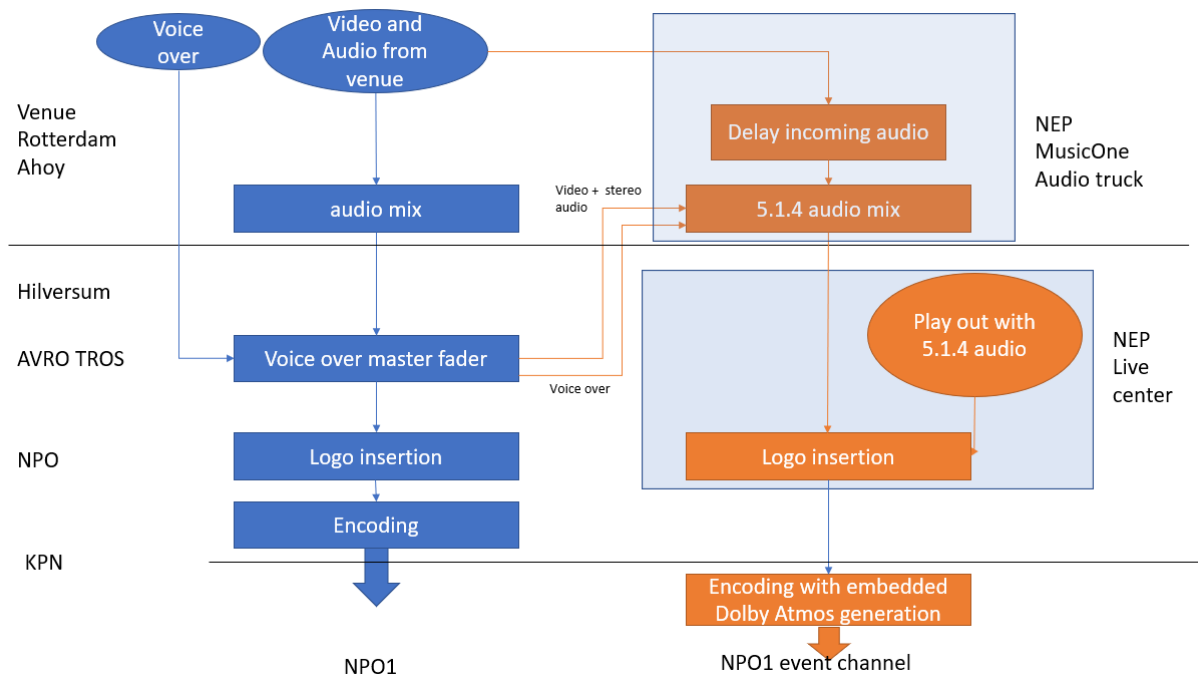Figure 2 illustrates how the Dolby Atmos tv channel is produced.

Figure 2 Simplified diagram for the Dolby Atmos NPO1 event channel

Channel-based versus object-based audio

The minimal preparation time for this forced us to make it as straightforward as possible.
Dolby Atmos supports both channel-based and object-based audio and we had to make a choice how to do it. As the KPN set-top box does not support AC4 yet, the audio was put in an E-AC3 container (Dolby Digital + Atmos.
By design, all Doby Atmos encoders support the addition of a voice-over to the signal. More than one voice-over can be added, and the metadata controls these objects.
In an ideal situation, the metadata for this is generated in the audio mix. For this project we had no hands-on experience with this specific Dolby Atmos metadata. And there was no time to test this out, as we only had one full day to do the complete sound set up.

Lack of experience, combined with the requirement of AVROTROS and NPO that the program would be delivered with the commentary voice-over, we decided to make this as robust as possible and mix the voice-over into the 5.1.4 audio.

For his project, we only had a single voice-over, in situations where there is more than one voice-over (Multilanguage) the Dolby Atmos object-based solution is the more logical choice.
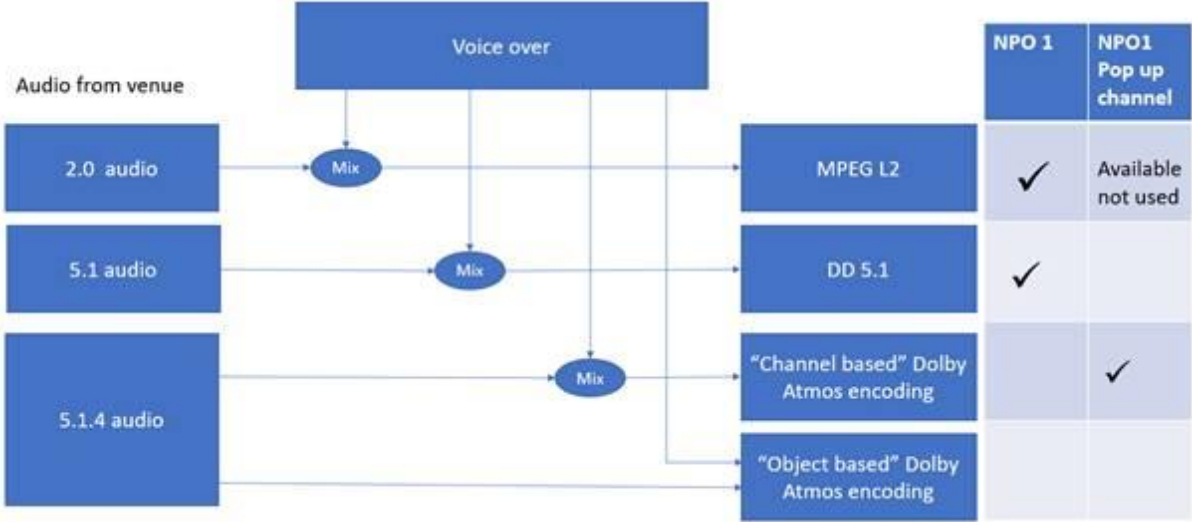
In figure 3, the chosen configuration is shown.

Figure 3 channel-based versus object-based solutions

"Hello Europe"

The audio technicians were briefed by Dolby, sharing the insights of past (live) events broadcast with Atmos like, e.g., Premier League matches in the UK.

The Eurovision Song Contest has rehearsals and a separate jury show for each program. This means there was some time to test. And having an audience was relevant, the sound of the audience was a relevant component of the overall sound. The jury show, which is not publicly broadcasted, but has an audience, was fed back to the MusicOne using a VPN connection.

Experts from KPN and NEP listened in at homes (given protected access to the test signals) to give feedback on how the sound was coming through in the living room. Our quality testing was done on the day before the first live show.

From earlier Dolby Atmos projects, the advice was to give more rear and top speaker signal than the spatial audio producers would expect when listening in the NEP MusicOne. This is because a typical living room has different acoustic dampening characteristics. The expert listeners confirmed that these adjustments were necessary.

Also, during this rehearsal, we had to measure the delay and compensate for it, to maintain lip-sync. It took a few minutes during this first attempt, but over the three broadcast days this delay proved to be constant, and we calibrated it about 25 minutes before every broadcast.

After the trial day on Monday, we were ready to transfer the NPO1 event channel to the half-million set-top boxes in the KPN interactive TV network, waiting for the famous opening line: "Hello Europe."

Customer feedback and learnings.

To gather feedback, KPN opened a thread on the public KPN forum (KPN.com/forum). On the forum customers could react and ask questions.

With the help of partners in the project, we provided Atmos soundbars to the two moderators of the forum to help them with their task.

The forum was a structured way of presenting the extra information needed by our customers to start using Dolby Atmos.
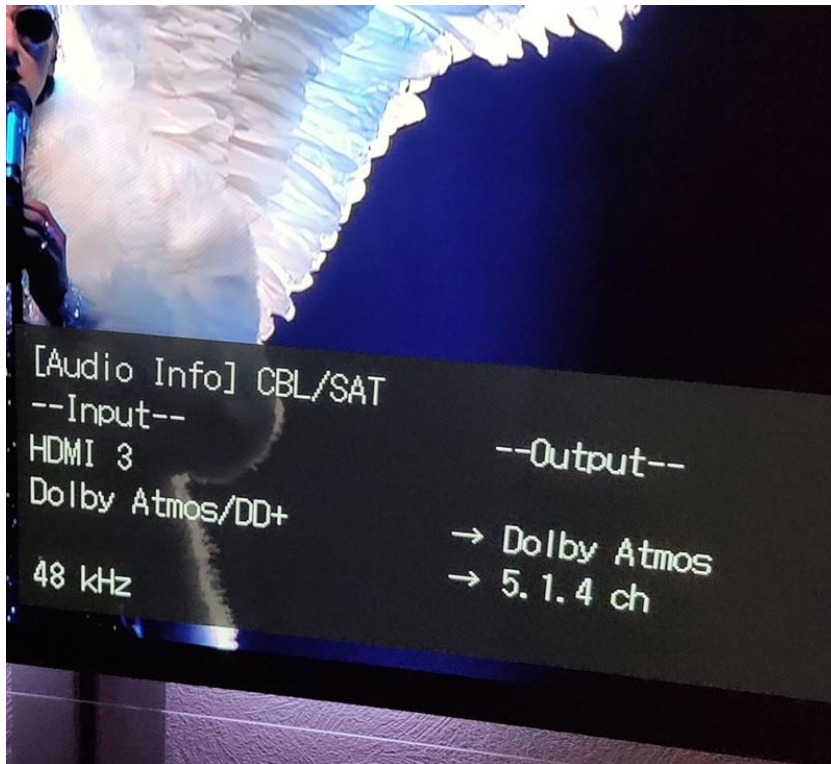
A screenshot from an end user shared on kpn.com/forum showing his receiver setting on the TV screen

Reactions of customers were on average more than positive. The sound quality was considered to be very good.
People found it helpful that there was a test sequence with Dolby Atmos playing when there no live event.

Downmix in the set-top box to Dolby Digital 5.1 was perceived as providing a better quality than the standard 5.1 audio (subscribers could compare by zapping between the signals).
A general reaction was: "this sound so good, give us more!".
Some practical problems that customers had with lip sync, could be solved with guidance from the KPN Forum (e.g. try this solution)

For operational control and management of TV distribution automatic silence detection is used by KPN. During the tests phase we had an interruption on some of the discrete audio signals leaving the truck. Resulting in missing audio in some of the rear loudspeakers in the living room.
Because we did not have automated monitoring and silence detection, It took us more time than usual to discover and resolve the issue. To solve this we made someone responsible to monitor the signal for distribution.

The learning on the sound level of the overhead speakers in living rooms, "make them louder than you think is necessary", was confirmed in this project.

Thank you
This project was a cooperation between NPO innovation, AVROTROS, ESC2021, Dolby, Ateme, NEP, United, Samsung Benelux, LG Benelux, TP Vision and VodafoneZiggo and KPN. The goal was to test

the entire chain from production to the living room for Dolby Atmos immersive audio. This was a success and I would like to thank everybody for their participation.

This paper is meant to help people implementing immersive sound. The user feedback is publicly accessible in the KPN Forum (KPN.com/forum, in Dutch language).