

# tech-1



## Positive outcome for broadcasting at WRC-23

Plus

- Loudness for cinematic content
- NRK embraces high dynamic range
- SVT's Adde Granberg targets Production 2.0

and more...

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**Cover story:** The EBU brought a strong team and strong messages to the recent ITU World Radiocommunication Conference 2023 (WRC-23). Our cover photo shows Doreen Bogdan-Martin, ITU Secretary-General, during the opening ceremony at the Dubai World Trade Centre. On pages 10 and 11 we report on the successful outcomes for broadcasters, in particular the decision to retain the lower UHF band for broadcasting until at least 2031. (Photo: ITU/D. Woldu).

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# Embracing the AI opportunity for the good of society

**Antonio Arcidiacono**, Director of Technology & Innovation, EBU

The way our community chooses to use and engage with AI-based applications will dictate whether public service media (PSM) remain a – or even be *the* – trusted source of content, from news to education or sport. A reaction based only on passive defence and/or throwing up legal barriers against AI-based applications would help to limit potential negative impacts on PSM, but we should also be aiming to use these technologies to enhance PSM's essential guiding role in society.

The exponential growth of AI-based applications, after so many years bubbling under, is paving the way for a new industrial revolution that goes well beyond the software-centric evolution of the first internet generations. And this revolution is intrinsically connected with basic human nature when it comes to dialogue, learning and the development of common cultures.

AI now presents itself as a kind of 'augmented self', extending the cognitive and functional abilities of the individual. Enhancing human capabilities in this way can allow for more effective collaboration between human and artificial intelligences. It seems likely that conversational engines will outflank and progressively replace applications and websites, with these new AI-powered 'individuals' becoming our daily counterparts. Would this world be again dominated by (new or old) big players?

This conversational evolution will also stimulate the emergence of small and medium sized companies creating the LLM (large language model) based assistants that will appear everywhere, from cars to mobile phones, watches and wearables. All these conversational agents need raw material to build upon and a new offer will materialize to



Antonio Arcidiacono

feed them. Direct traffic to websites will progressively fall, and the mediation of those conversational agents will probably become the new way of being relevant for the wider public.

Should PSM be frightened by such a trend? Big companies and private investors are putting massive amounts of money into developing this new world; it is only by combining the forces of medium-sized and small players that we can have a fighting chance to defend our culture and quality of life. We need to privilege all the native human advantages, combining the physical and digital worlds, leveraging technologies to stay in the lead, building our future together.

## **MEDIA LITERACY**

Citizens, starting from the new generations, need to have diverse sources of information and to learn how to interpret the biased perspectives pushed to them. In this accelerating environment it is more important than ever that citizens have means of tracing sources and assessing their trustworthiness.

Media and AI literacy is

becoming more important every day. It should be applied at the 'age of curiosity' for children from 7 to 11 years old, developing their ability to understand the underlying mechanisms and then analyse and criticize ideas. Parents, too, should be indirectly involved in this educational exercise, de facto accelerating two entire generations at the same time.

Sources of information can often be biased by some agendas to the detriment of other groups of people. The truth should be the result of a critical analysis by each citizen and each citizen should be given a multiplicity of diverse sources of information.

Kai Gniffke, Director-General of SWR and the General Intendant for ARD, recently underlined the urgent need to invest in education bringing "journalism and technology together and demonstrating a certain *Technikfröhlichkeit\**."

*"I would like SWR to strengthen people's media skills even more. Our goal should be for every pupil in Rhineland-Palatinate and Baden-Württemberg to come into contact with an SWR media literacy project during their school career. After all, we must not leave young people to the non-transparent algorithms of foreign tech companies alone."*

It is only by leveraging these technologies to the advantage of citizens and young generations – from strong education to diverse and trusted information – that we will grow a new cultural environment that can endure and avoid surrendering to the dominant forces of big companies or the distortion induced by perverse market players.

\* Technological happiness

## Calling innovators: time to submit nominations for the 2024 EBU Technology & Innovation Awards



### Nominations are now open for the EBU Technology & Innovation Award 2024 and the Young Technology Talent Award.

Both will be presented during the EBU Technical Assembly in Naples on 13 and 14 June.

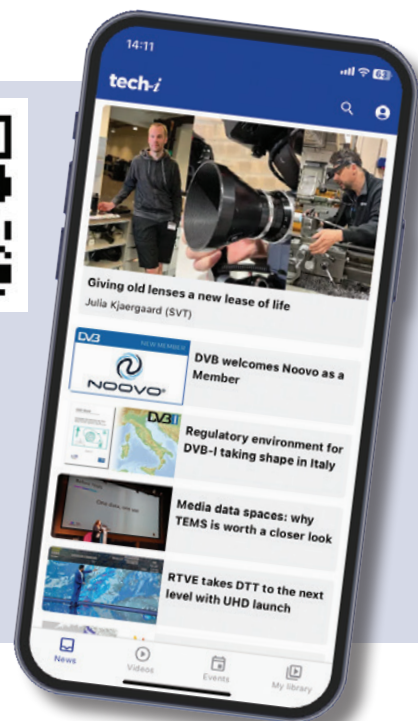
First presented in 2016, the EBU Technology & Innovation Award recognizes, encourages and supports outstanding technical solutions developed by Member organizations. Winning teams and organizations benefit from a significantly raised profile within the broadcasting community, with press and online coverage through the EBU, the option to have a presence on the EBU's stand at IBC in Amsterdam later in the year, and often speaking opportunities. Every member of the winning team also receives a certificate.

2022 saw the introduction of a category focused specifically on those just starting out in their careers. The Young Technology Talent award focuses on the technology talent pipeline, whether at student level, if linked to a university or institution, or for those starting their career at an EBU Member organization. The prize is about bringing novelty that can be showcased through demonstrations, prototypes, proofs of concept, trials or similar – and, of course, which is relevant to the media industry. The award is also an opportunity to highlight the importance of graduate level work in media technology.

*For more information on how to submit nominations for these awards, visit <https://tech.ebu.ch/awards>.*

### tech-i in your pocket – tap into our app

The tech-i app is now available for both iOS and Android devices, putting the latest developments on media technology at your fingertips. All users can access news and views from EBU Technology & Innovation, 5G-MAG and the DVB Project. Logging in with a (free) EBU account additionally provides access to the video library. EBU Members can see all videos, while non-Members will see public videos and those of events they have participated in. Automatically generated subtitles are available in eight languages – Arabic, English, French, German, Italian, Polish, Spanish and Turkish – and videos can be downloaded for offline viewing. Download tech-i today from the app store on your mobile device. Visit: <https://tech-i.ch/download.html>



# Quality conversations and valuable insights at PTS 2024



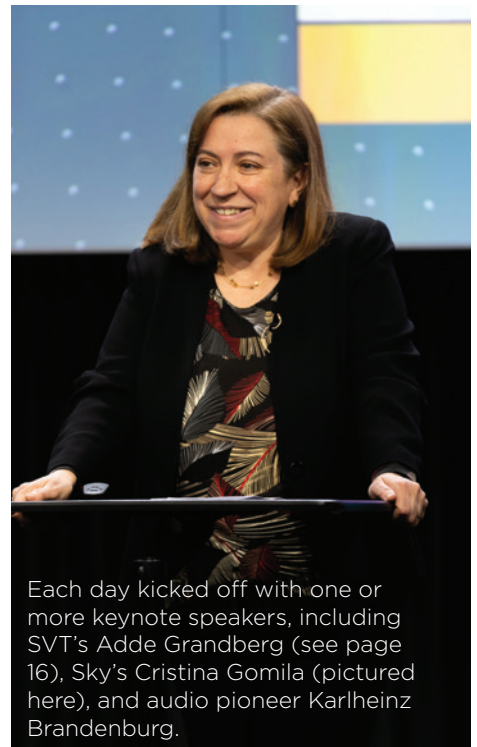
The EBU Production Technology Seminar was back to its very best for the 2024 edition, with 160 attendees travelling to Geneva for the event and a further 50 following it online. The videos and slides are now available to EBU Members via the website and the tech-i app.

There was a very wide range of speakers drawn from EBU Members, other media organizations – such as NHK, with Hirofumi Morioka pictured above during his presentation on volumetric capture – and industry vendors.

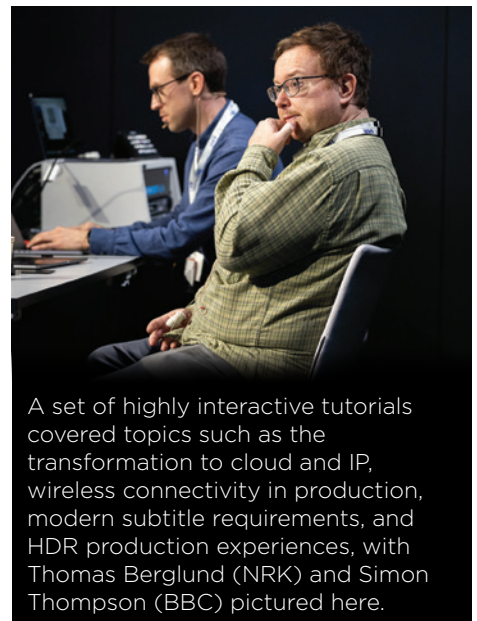
Pictured below is one of the many panel sessions at PTS 2024, this one focused on transformative technologies, with moderator Hans Hoffmann (EBU) talking to tech leaders Stefan Kollinger (ORF), Willem Roskam (NPO) and Dominique Hoffmann (WDR) – Annsofi Eriksson (SR) joined via video link.



MaryKos Photography



Each day kicked off with one or more keynote speakers, including SVT's Adde Grandberg (see page 16), Sky's Cristina Gomila (pictured here), and audio pioneer Karlheinz Brandenburg.



A set of highly interactive tutorials covered topics such as the transformation to cloud and IP, wireless connectivity in production, modern subtitle requirements, and HDR production experiences, with Thomas Berglund (NRK) and Simon Thompson (BBC) pictured here.

## OUR NEXT EVENTS

### Data Technology Seminar 2024

Join us at EBU HQ in Geneva, 12-14 March, for DataTech 2024, the EBU's annual flagship event for practitioners in data and AI for media.

<https://tech.ebu.ch/events/dts2024>

### Sustainability Summit 2024

An online event for all things broadcast sustainability. Join on 16 April for insights in areas such as production and technology.

<https://tech.ebu.ch/events/sustainability2024>

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### HORIZONS 2024

The flagship EBU event on media distribution, product and platform technology, combining a stimulating conference programme with supercharged networking and discussions, in Geneva on 21-22 May.

<https://tech.ebu.ch/events/horizons2024>

### Network Technology Seminar

A flagship industry event focused on the latest developments in media production infrastructures, networks, and cloud technologies, taking place in Geneva on 18-19 June. <https://tech.ebu.ch/events/dts2024>

# Warmest of reactions to AI-generated subtitles at VRT

**Klaas Baert**, innovation project lead at VRT, describes how the Belgian broadcaster used the EBU's EuroVOX transcription and translation tools to deliver subtitles on a live production.

*De Warmste Week* – or The Warmest Week – is an annual charity event that sees the delivery of more than six days of uninterrupted live radio and television. With a view to spreading the warmth as widely as possible, for the March 2024 edition VRT leveraged AI-based tools to provide live subtitles, taking advantage of the EBU's EuroVOX toolbox. The system is not yet perfect, but this experiment allowed VRT to take a further step towards 100% accessibility.

Viewers were able to follow *De Warmste Week* live from start to finish with subtitles via the web version of VRT MAX. AI-generated subtitling is not new – it's been around for a while on platforms like YouTube. But that didn't make this project any less challenging.

First of all, when it comes to Flemish Dutch, a minority language in a global context, the state of the art compared to English language models lags a bit behind. Second, doing it live, without any delay, creates an extra challenge. And finally we ran the experiment inside an already complex live television and radio production.

Despite all these challenges, we chose to proceed with the test because we want to be ready when this form of AI makes a complete breakthrough. If you wait until the system is completely finetuned, you will lag behind.

The technical challenges and the short integration period forced us to make certain choices, such as the fact that the subtitles did not run across the entire screen width. Viewers had to become accustomed to this unfamiliar way in which the subtitles were presented. We also realized that the AI was not yet



Subtitles were automatically generated over the live content

“The system is not yet perfect, but this experiment allowed VRT to take a further step towards 100% accessibility.”

completely accurate, especially when the speech of a given person was indistinct, leading to the appearance of errors in the live subtitling every now and again.

## USER OPINIONS

Knowing that these problems existed, we took this opportunity not only to test the technology but also to ask the end users what they thought of the quality. So, on VRT MAX a survey link was made available next to the live stream of *De Warmste Week*. The survey was completed by 1,200 viewers.

Overall, 85% of the respondents found the quality of the captions “acceptable” to “good”. For 15% they were “not good enough”. When asked for the reason for this rating, most of them answered that it was because of usability issues. These are issues that can be fixed through engineering, such as how the

captions run across the screen, rather than the quality of the speech-to-text AI.

Overall, the survey delivered a score with which you can confidently continue to build a solution in production.

Nevertheless, there are some points to address before launching this in a live production environment. We need to find a solution that is optimized for digital streaming as well as linear television. One of the shortcuts we took was using a typical broadcast protocol to encode the subtitles to the video stream, which gave us a line limit of 37 characters. And this protocol is not usable for our live streams that are digital-only, like Facebook Live.

Nevertheless, the experiment was very successful and helped a lot in understanding how to work with the technology as well as for measuring the user acceptance rate of AI captions.

# Putting data at the heart of successful PSM strategies

There is a growing realization that sound data architectures are essential to serving modern media audiences. We asked three of those active in the area to describe how (meta)data is handled where they work.



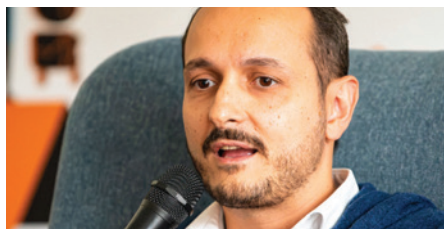
**Jürgen Grupp,  
Information  
Architect, SWR**

My role involves advising projects on semantical and technical aspects. The

first step is always about finding a common language and a common view of the business. The quality of communication is decisive for the quality of the solutions we find. By having the right terms and definitions in place, we avoid expensive detours and inappropriate solutions. Sound information architecture is the stable and flexible infrastructure of any digital business process.

Most people in the organization value data as indispensable for their daily work. We have identified the need for building a strategy and coordinating the various initiatives. A data board has been established, bringing together business and technology views from across the organization. The board will prioritize, direct and initiate projects to create business value.

As chair of the Editorial Committee for EBUCorePlus, the semantic information model developed and maintained by the EBU, I see great benefit in bringing Members together and defining a common semantic model. This will speed up system integration, reduce vendor lock-in for your own organization and, in the long run, foster data and metadata exchange between Member organizations.



**Samuel Profumo, Chief Data  
Officer, RTBF**

I oversee the development and implementation of public service algorithms, ensuring they adhere to our core values of ethics, transparency and alignment with our public mission. My role also involves developing advanced audience analytics, ensuring the precise management and organization of metadata, and leading the process of automatic content enrichment to enhance the value and relevance of our media offerings.

RTBF's strategic vision RTBF27 sees data as a fundamental pillar, aiming to "bridge the gap between citizens living in a personalized world". Our recent shift towards comprehensive metadata management, epitomized by the development of a unified content management portal, marks a significant step in this direction. The industrialization of automatic metadata extraction processes through AI is also a key driver in our transformation. Now engaging with most of our audience through registered profiles on our digital platforms, we have a robust foundation for personalizing and enriching their experience.

The wealth and quality of our trusted content provide fertile ground for joint innovation at EBU level. Pooling and leveraging our data can spearhead the development of new AI tools, facilitating the work of our editorial teams and enhancing

the audience experience. The idea of creating shared data platforms and establishing standardized protocols for data management and privacy is particularly promising.

**Jeremy Tarling, Head of Content  
Metadata, BBC**



I am responsible for the development, coverage and quality of content metadata for BBC's digital product portfolio, including iPlayer, Sounds and BBC's various websites and apps including News, Sport, Bitesize (education) and children's content.

As a 100-year-old broadcaster, BBC has many established ways of working based around linear television and radio production. A key part of our long journey (the first BBC website went live in December 1997) towards a truly "digital-first" BBC is our focus on data-driven decision making, from programme commissioning through to the audience experience of our digital products. Rich content metadata descriptions of programmes and other digital content, combined with audience consumption data, helps us to build a more personal BBC, using machine learning and AI to drive algorithmic experiences of a BBC that feels more like it is 'for me'.

The EBU has been instrumental in the development and governance of technical standards that are a constant reference in our digital transformation. Participation in the EBU's data workstreams has been very helpful for knowledge sharing and common problem solving – for example in the Metadata and AI group that covers metadata standards like EBUCorePlus together with challenges like AI benchmarking and automatic metadata generation.

# Finding the right loudness formula for cinematic content

**Florian Camerer** (ORF), chair of the EBU's working group on loudness, PLOUD, writes about the difficult birth of the group's tenth publication, and why it was well worth the wait.

Yes, the loudness gang is still alive and kicking! Admittedly, the kicking happened in dark studios and home offices, but nevertheless... After what seems like an eternity (it has been more than four years, actually) we published *Loudness normalization for cinematic content* in November 2023, yet another milestone of the intrepid audio knights.

## MOVIE DIALOGUE

Why did it take so long to get this document off the ground? One reason is that there are loud movies and there are soft movies – imagine a high-paced action film vs. a romance with mainly soft dialogue. Normalizing both film examples to the same Programme Loudness (PL) level will result in a considerable difference in their dialogue levels.

Another reason is that this form of programming (movies, television series, radio drama, etc.) is often characterized by a large difference between the level of dialogue (speech, voice) and the average loudness of the whole programme. In some extreme cases this difference can be 15 LU (Loudness Units) or more! If such a film is normalized with PL to  $-23$  LUFS\*, the dialogue would sit way lower, potentially motivating the listener to operate the remote control frequently to adjust the playback level.

For (mostly commercial) broadcasters that have advertising breaks in between movies, the level of speech can exhibit large jumps, despite the fact that both programmes were made in accordance with the EBU's Loudness Recommendation R 128! Figure 1 illustrates this potential problem.

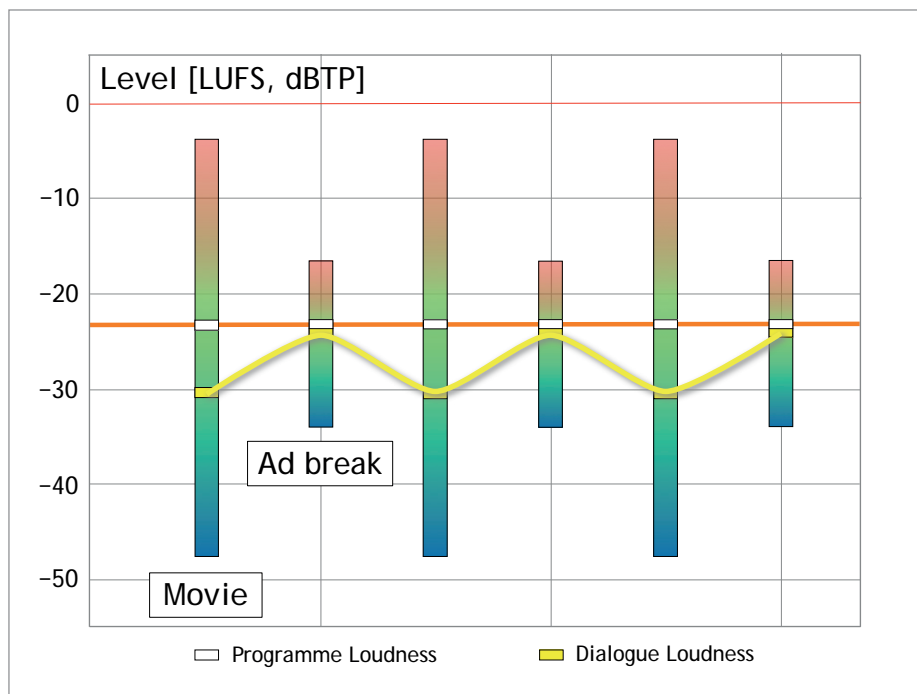


Figure 1: Jumps in dialogue loudness levels between a movie and an advertising break

## WORK BEGINS

One of the core members of the EBU's PLOUD working group, Richard van Everdingen, had done extensive work on this topic, consulting for the SBS broadcaster in the Netherlands. During that work, he co-developed a dynamics-processing algorithm for cinematic content, based on the difference between the dialogue and the PL level. When the work on a supplement to R 128 was started in 2019, this difference stood again at the centre of attention.

Eventually, the parameter was called Loudness-to-Dialogue Ratio or LDR. Evaluation and potential subsequent processing of cinematic content would be dependent on LDR.

The author of the current article produced draft after draft, but due to different

approaches to the subject at hand between the core people working on the supplement, it was unfortunately not possible to find consensus on the exact wording. So, the author decided to bite the bullet and in 2023 conducted an extensive analysis of 44 German dubbed movies that had two important features: they were all normalized with PL to  $-23$  LUFS and they were already dynamically treated to better fit the majority of playback situations for the audience of ORF. (Two experienced engineers of the Austrian public broadcaster had performed the processing).

After several months of work, and with later help from Richard van Everdingen and another PLOUD core member, Thomas Lund, consensus was found. Hallelujah!



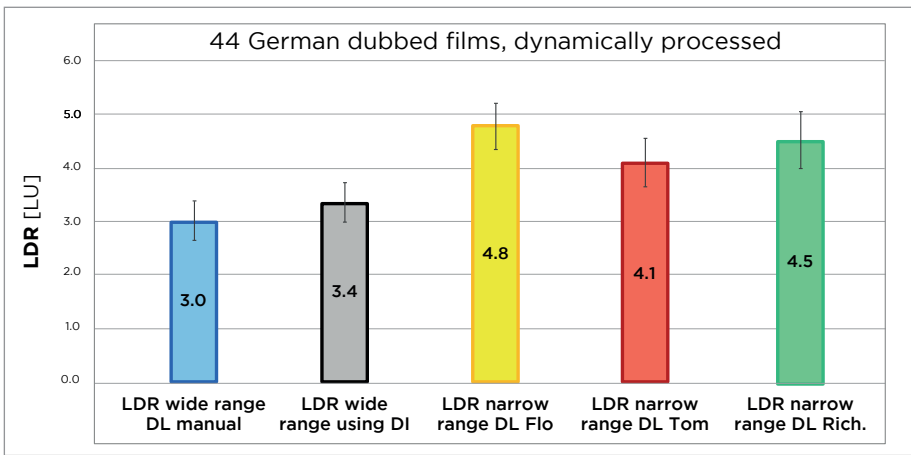


Figure 2: Average Loudness-to-Dialogue Ratio (LDR) of 44 dynamically processed films – three different extraction methods for the dialogue, with the third performed separately by Florian Camerer, Thomas Lund and Richard van Everdingen.

“PLOUD’s tenth document took longer than any of its predecessors – but we feel it was worth the effort. In the end, it is the task of the individual broadcaster to choose the most appropriate method to treat and normalize cinematic content.”

### THREE METHODS

Figure 2 shows the average LDR for three different methods to isolate dialogue: manually (all dialogue parts, or “wide range” DL), automatically (with Dolby’s Dialogue Intelligence algorithm), and again manually (only normal speech or “narrow range” DL, without shouting or whispering). The latter was performed by all three of us (Florian, Thomas, Richard).

For almost all analysed films, LDR lies below 5 LU. Consequently, this value was used as the upper limit above which dynamic processing is

recommended. If LDR is below 5 LU, no processing is needed. The 5-LU limit is not carved in stone, as the data pool was not a mix of different broadcasters’ processed films. But we feel it is an excellent starting point, also fully in line with what Richard had been doing in his extensive work for SBS.

Supplement 4 to EBU R 128 now contains clear guidance on how to decide on potential dynamic processing for cinematic content using LDR. It also offers two distinct methods for the subsequent normalization: the established mantra of

normalizing Programme Loudness to the target level of  $-23$  LUFS; and normalizing Dialogue Loudness *up to the target level* of  $-23$  LUFS.

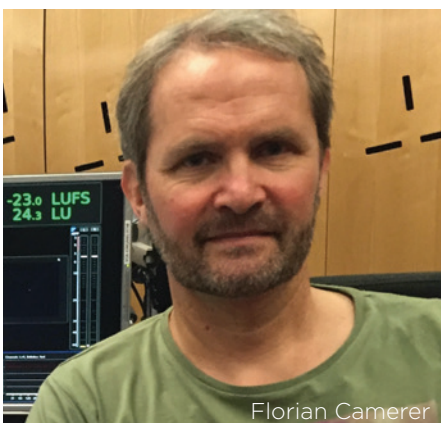
The latter effectively is “anchor-based” normalization and has been an option from the beginning of (PLOUD) time. The reader is advised to check § 9.4 of the heavily updated Tech 3343 (“Production Guidelines”) for a detailed description of the genesis as well as the practical consequences of this supplement. A clear decision hierarchy is presented, giving guidance on how to manoeuvre in this field.

PLOUD’s tenth document took longer than any of its predecessors – but we feel it was worth the effort. In the end, it is the task of the individual broadcaster to choose the most appropriate method to treat and normalize cinematic content. EBU R 128 supplement 4 and Tech 3343 provide all the necessary information.

Find the documents below at: <https://tech.ebu.ch/publications>

- EBU R 128 s4 – Loudness normalization for cinematic content
- EBU Tech 3343 – Guidelines for Production of Programmes in accordance with EBU R 128

\* LUFS stands for Loudness Units relative to Full Scale. It is a standard loudness measurement unit for media content.  $-23$  LUFS is the recommended targeted level to which audio should be normalized according to EBU R 128



# Mission accomplished: excellent outcome for broadcasting at WRC-23

The EBU brought a strong team and strong messages to the recent ITU World Radiocommunication Conference 2023. **Elena Puigrefagut**, **Walid Sami** and **Darko Ratkaj** report on the successful outcomes.

The most significant result of WRC-23 for EBU Members, related to agenda item 1.5, is that Broadcasting remains the only Primary service, with regional scope, in the table of allocation for ITU Region 1\* in the UHF band 470–694 MHz. The proposal of CEPT (46 European regulatory bodies) to add a Secondary Mobile allocation in the table and that of ASMG (22 Arab States regulators) to add a Primary Mobile allocation in the band 614–694 MHz in the table were not agreed.

The CEPT request was, however, partially satisfied through a new country footnote that allocates the band 470–694 MHz to Mobile on a Secondary basis, with conditions, in all CEPT countries except Italy and Spain.

The ASMG request was partially satisfied through a new country footnote that allocates the band 614–694 MHz to Mobile on a Primary basis, with identification to International Mobile Telecommunications (IMT) and with conditions, in 11 Arab countries.

Individual requests from a relatively small number of



Doreen Bogdan-Martin, Secretary-General of the International Telecommunication Union during the opening ceremony of WRC-23 at the Dubai World Trade Centre (Photo: ITU/D. Woldu)

Sub-Saharan African countries, some of them being also part of ASMG, for Primary Mobile allocations were not satisfied. Instead, a new country footnote was added, which allocates the band 614–694 MHz to Mobile on a Secondary basis with conditions in eight African countries.

## CONDITIONS ATTACHED

The important thing in these country-based allocations are the conditions associated with them. The secondary allocation doesn't give the right for protection from primary services in neighbouring countries. In practice, this allows countries with existing or planned DTT

services to continue operating their networks without any additional constraints even if one or more of their neighbours opted for the Secondary Mobile allocation.

The Primary Mobile allocation for 11 Arab countries is also subject to several conditions, the most impactful being that the Mobile service that would use this allocation cannot claim protection from the existing and future broadcasting stations in neighbouring countries operating in accordance with the ITU's GEO6 plan. This makes the allocation in practice secondary.

In addition to the certainty ensured by this WRC-23

## Positive outcome for PMSE, though subject to national decisions

The outcome of WRC-23 for the services ancillary to broadcasting and to content production, namely PMSE (Programme Making and Special Events) was good in many aspects and subject to questions in some others.

On one side, the conference recognized the special status of PMSE by retaining a country-based Secondary Mobile allocation dedicated to these applications. This allocation concerns 88 countries that have been using the UHF band 470–694 MHz for PMSE, through effective sharing with DTT, for several decades.

On the other side, the new country-based

allocations to the Mobile service are intended for Mobile allocations other than PMSE. This automatically reduces the amount of spectrum available for PMSE applications. The biggest reduction of spectrum for PMSE will be in countries that plan to introduce cellular mobile networks in parts of the band. In the other countries, the impact on spectrum availability for PMSE will depend on the policy of the regulators in terms of priority between different applications of the Mobile service, all of them having the same regulatory status.

## Other results from WRC-23

WRC-23 also considered various proposals to add new allocations to the Mobile service, or to elevate existing ones, for use by IMT applications. The most relevant were in the C-band, around 3.6–3.8 GHz, historically used for satellite downlink, and at around 7 GHz, historically used for satellite uplink. In all cases where a change to the Mobile allocation was made, it was associated with measures to protect the Fixed Satellite Service in the countries that still use it, which is in line with the EBU position.

Other agenda items concerned the use of high altitude IMT base stations in the 700 and 800 MHz bands. Here also, suitable measures were adopted to protect broadcasting services where used. A similar outcome was noted for a new allocation to an Earth exploration satellite service in VHF band I, at around 45 MHz.

Another good result for broadcasters was the withdrawal of an agenda item that targeted using IMT technologies to provide high-speed internet access for fixed premises by operating in any frequency band allocated to the fixed and fixed satellite services. This represented a potential threat to the bands used for direct-to-home reception from satellite. However, the Radiocommunication Assembly RA-23, which met the week before WRC-23, decided to task the ITU-R study groups with examining this subject before considering any change to the Radio Regulations, which is in line with the EBU position.

decision for the continuation of DTT services in the concerned countries, those countries interested in introducing new terrestrial broadcasting technologies, like 5G Broadcast, can rely on a solid allocation of spectrum to Broadcasting, until at least 2031.

### **EIGHT YEARS**

This date of 2031 is related to the decision of the Conference to include an agenda item on the UHF band at WRC-31. This item calls for review of spectrum use and of the needs of applications of broadcasting and mobile services and for the consideration of possible regulatory actions in the frequency band 470–694 MHz, or parts thereof.

The period until 2031 therefore provides an opportunity for broadcasters and regulators in countries using terrestrial broadcasting networks in the UHF band to prove that terrestrial broadcasting remains important beyond 2031.

### **PREPARING FOR WRC-27**

WRC-27 will be a ‘Satellite’ conference as most of the agenda items decided at WRC-

23 for the next conference WRC-27 concern services that use satellite, with a widely confirmed interest in non-geostationary satellite systems. Several frequency bands concerned by WRC-27 agenda items are either used for distribution of EBU Members’ content or for wireless equipment used to produce this content.

The EBU workshop “WRC-23 – outcomes, evaluation, and preparing for WRC-27”, held on 29 January 2024, helped to identify the relevant agenda items for EBU Members, to assign priorities and to define actions for the various EBU groups.

## WRC-23 explained

The World Radiocommunication Conference 2023 was held in Dubai from 20 November to 15 December under the invitation of the United Arab Emirates. The conference was attended by more than 3,900 people from 163 member states and 217 input contributions were received.

The agenda of WRC-23 was defined at WRC-19 (see issue 34 of *tech-i*, March 2020) and included a crucial item for the future of EBU Members’ distribution and contribution services, agenda item 1.5 concerning the UHF frequency band. With this and other agenda items, the general aim of WRC-23 was to revise the Radio Regulations that govern the worldwide use of spectrum.

## How the EBU prepared for Dubai

The EBU and its Members had been preparing for WRC-23 since as far back as WRC-15, and more intensively since WRC-19. This preparation included continuous participation and contribution to Regional Regulators’ Associations meetings and to relevant ITU working groups. The EBU’s competence in the fields of technical sharing studies and studies related to broadcasting spectrum use and needs was recognized. Preparations also included coordination with our sister unions, ASBU for the Arab states and AUB for the African states.

The EBU coordinated the actions of the global broadcasting community and worked closely with the broadcast network operators and the PMSE community. The EBU and BNE (Broadcast Network Europe) operated a joint booth at WRC-23 with demonstrations of 5G Broadcast and DVB-I. The EBU was present throughout the entire conference and worked with administrations from Europe, Africa and Arab countries to influence the decisions.

\* ITU Region 1 comprises Europe, Africa, the Commonwealth of Independent States, Mongolia, and the Middle East west of the Persian Gulf, including Iraq.

# How NRK took the initiative on HDR production and distribution

**Odd Erling Høgberg** describes how he and his colleagues at Norway's NRK put HDR production workflows in place, while also building enthusiasm for the new format across the organization.

In December last year, NRK reached a milestone with the enabling of high dynamic range (HDR) in our OTT service NRK TV. The occasion was our new high-profile Christmas show for children and families called *Snøfall 2*.

The journey commenced in 2016 when my boss at the time returned from a visit to a camera manufacturer, armed with photos of HDR-filled presentations. He tasked me with unravelling the potential of HDR and its implications for NRK.

The next couple of years were marked by theoretical exploration. We started to educate first ourselves, then our colleagues, on the topics of UHDTV. I searched for HDR know-how through many channels – my primary source was the EBU's Beyond HD working group, later the Video Systems group. Meetings and discussions with colleagues in these groups provided us with knowledge and insight, and the EBU HDR workshops in 2019 (Oslo) and 2022 (Baden-Baden) moved us significantly closer to the target.

## FIRST EFFORTS

In 2018, we initiated our first HDR production. It demanded several publishing and distribution hacks to get it aired on our OTT platform in January 2020. The need for a systematic approach emerged, leading to the formation of a task force with representatives from the post-production, publishing, and distribution teams. Besides the sheer necessity of it, a bonus that came with this interdisciplinary collaboration was that it bridged some gaps between production and distribution teams. As a result, they now have a better understanding of the various challenges that exist within our



A blind-test rig in the main staff cafeteria helped to spread awareness and interest

workflows.

The establishment of an HDR test lab facilitated comparisons of different technical qualities of video clips, providing insights into how different components of a video signal affect the perceived image quality. The lab also played a pivotal role in distribution tests when we evaluated the quality with which each app and platform was playing back.

At this point, the push for UHDTV mainly came from within the technology department, and this meant we would struggle to get funding for wider adoption. We escalated our efforts towards the programme departments, as they were important for a wider adoption of this HDR initiative across the organization.

To spread awareness and interest, we created a blind-test rig presenting two technical versions of the same clip, with which our colleagues could vote for the clip they subjectively liked the best. We showed comparisons between HD and UHD, SDR and HDR, and combinations of these.

The blind test produced a lot of results that aligned well with our own findings, that *contrast* is the key component for a higher visual experience. Further studies also showed us that in most cases both dynamic and temporal

resolution separately mean more for a perceived sharper image than spatial resolution.

## IMPROVED SDR TOO

In 2022, we started recording the first productions planned for HDR mastering, and a growing curiosity for HDR live emerged, accelerated by the Baden-Baden workshop. An added value of producing live HDR is that your SDR (standard dynamic range) version also gains higher quality. This should not be underestimated; in my opinion this alone makes it worthwhile to produce live content in HDR. Currently HDR is restricted to our video-on-demand content – we will start HDR live trials this year.

Before our launch on 1 December, we performed distribution trials on several platforms. To assist our viewers with their HDR experience we created a HDR section in our NRK TV help pages, and a 30-second teaser was made available on NRK TV, showing whether the TV system in use is HDR capable or not.

With our newly established publishing and mastering workflows for HDR, we now find ourselves in a favourable position where creativity, not technology, sets the limits.

# Lessons learned from building your own live broadcast encoder

**Fredrik Widlund** describes why and how Sweden's SVT built its own live broadcast encoder, adopting a philosophy of using open, shared building blocks.

SVT challenged the status quo ten years ago in tasking a team to build, in-house, a peering platform for online content delivery rather than buying a service. This brave effort turned out to be very valuable from a strategic business perspective. We built a technology stack that required minimal operational effort, saved money, and basically just worked.

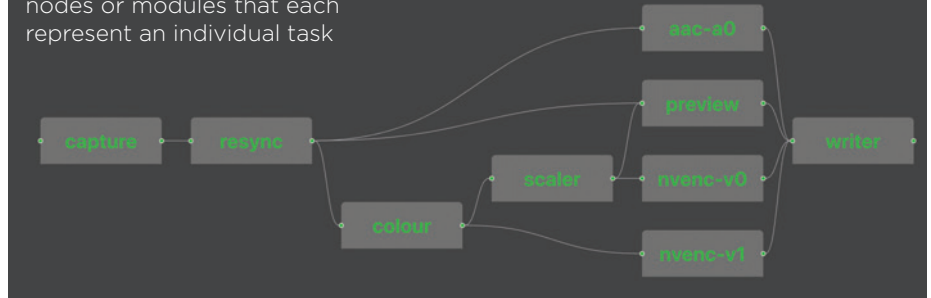
Five years later, the same team was faced with deciding the future of our live encoding platform. Despite having placed our trust in a leading vendor, we were far from happy: output quality was not good enough, and while the solution was expensive both to scale out and support, we kept having to fix bugs and solve reliability issues ourselves. We had patched the core of the solution to the point of removing the original product completely.

We began by researching a range of different solutions, both professional products and off-the-shelf components, software- and hardware-based. The conclusion was that hardware-accelerated encoding is needed when it comes to scaling out real-time streams, and that the GPU market is outpacing professional products. Based on this insight, we made the decision to build.

So, what are the primary design goals of a live broadcast encoder?

**Quality** – representing information as efficiently as possible is the obvious task of an encoder. For a live encoder, processing information in real time is more challenging than for an on-demand platform that can batch process in multiple passes long before publishing the content. By replacing the older platform, we were able to

The encoder's functionality can be represented as a graph of decoupled nodes or modules that each represent an individual task



double the framerate and take huge leaps in improving the visual quality, without increasing bandwidth or changing codecs. At the same time, we raised the bar when it comes to enabling UHD content.

**Reliability** – a broadcaster stream is typically active 24/7. This means that the streams can never go offline. From a business perspective, availability is often the primary concern. This also means that the failure of core hardware components, guaranteed to happen at some point, must be considered. We built an encoding platform with redundant active/active paths in frame-perfect sync. We can thus handle maintenance and failures without interrupting streams or impacting user experience.

**Performance** – a real-time encoder must handle very large information flows without interruptions. A single temporary bottleneck somewhere in the dataflow will disrupt the entire stream and likely cause buffering for all the viewers. To achieve cost-efficiency we need to scale up as well as scale out, meaning a single node should ideally be able to handle multiple stream ladders without creating noise and jitter in the system. To optimize performance, we pass information solely by reference,

using shared memory, and process using GPU and SIMD (single instruction, multiple data) accelerated algorithms.

**Maintainability/extensibility** – to avoid large codebases and increasing technical debt we built a generic low-level, real-time dataflow framework, which is available as open source. What this means is that the functionality of the encoder as a whole can be represented as a graph of decoupled nodes or modules that each represent an individual task such as capturing SDI input, transforming colour space, scaling resolution, or encoding a frame of video for a specific bitrate. The nodes are then connected to each other resulting in a complete encoder flow. Adding and changing core functionality becomes as simple as building, adding, and connecting nodes in this configuration.

This platform has been running all our live streams for several years now. We are currently looking at our options when it comes to switching the to the upcoming generation of GPU encoding engines. In the end we managed to get to where we wanted, and to create clear business value from building. Again, with a solution that requires minimal operation effort and just works.

# Tools and test materials for Next Generation Audio

Those working with object-based audio, whether for greater immersion or improved accessibility, can lean on an ever-expanding range of open-source tools, writes BBC's **Dave Marston**.

The EAR Production Suite is a free, open-source software suite to enable authoring and editing of ADM (Audio Definition Model) media in the REAPER digital audio workstation. It began as a collaborative project between IRT and BBC under the EBU and continues to be developed and maintained by BBC R&D.

We released v1.0 of the software last year and intend to release v1.1 in the coming months. This new version will include much-requested features like support for up to 128 channels and wider compatibility for importing ADM generated by third-party tools, as well as some minor bug fixes and performance improvements.

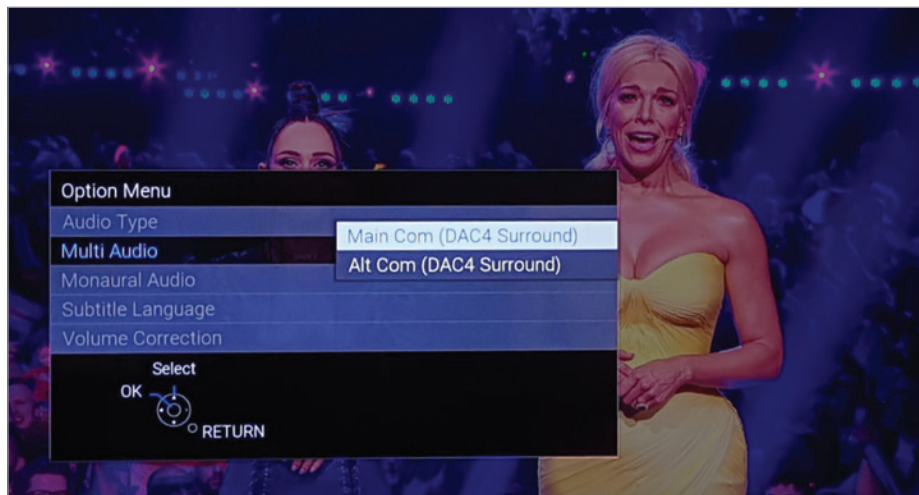
Download the software from: <https://ear-production-suite.ebu.io>

## EAR ADM TOOLBOX

In the course of our ADM work we have developed lots of small tools and library functions that can be used to manipulate and analyse ADM files in specific ways. This works fine for development, but these tools are spread across multiple repositories and do not necessarily work well together.

The EBU ADM Toolbox (EAT) aims to solve this problem, being a set of tools for processing ADM files. It contains a framework for building processing graphs that operate on audio and ADM data, a set of ADM-related processes that sit within this framework, and a tool that builds and runs processing graphs based on a configuration file.

For example, one configuration file provided in the EAT conforms an ADM file to the emission profile. This specifies 19 processes chained together, incorporating a BW64 file reader and writer, and many processes that make small changes to the ADM metadata. The functionality of these processes can be adjusted



BBC R&D tested S-ADM during the Eurovision Song Contest 2023

by modifying the configuration file, and can be combined together with other processes to implement completely different workflows.

The toolbox is still currently command-line only, but we're planning to develop a simple graphical user interface to make it easier to use.

## ADM C++ LIBRARY

libadm is an open-source C++ library for parsing, manipulating and writing ADM XML metadata (specified in ITU-R BS.2076). It was created by IRT and released by the EBU to facilitate the development of software using the ADM. The library is currently maintained by BBC R&D, and for its next release, we are preparing to add support for S-ADM (Serial ADM) metadata (ITU-R BS.2125) to complement the existing support for file-based ADM.

S-ADM support enables live workflows in addition to the offline production afforded by file-based metadata. The update also improves performance for both file-based ADM and S-ADM, particularly when manipulating large documents.

libadm is available on GitHub at <https://github.com/ebu/libadm/>

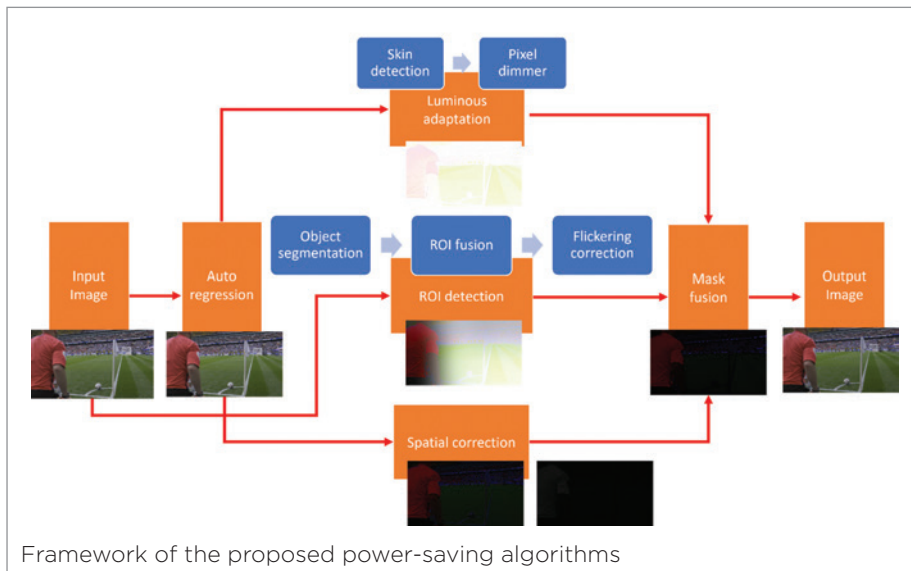
## LIVE TEST OF S-ADM

At the Eurovision Song Contest in May 2023, BBC R&D, alongside L-Acoustics and Dolby, trialled a live end-to-end chain of Next Generation Audio using S-ADM. L-Acoustics' L-ISA Controller tool generated ADM-OSC (Open Sound Control) messages to enable live 3D positioning of audio objects. A BBC tool generated an S-ADM stream, controlled from the ADM-OSC messages, and delivered it over a SMPTE ST 2116 transport alongside the audio. The tool 'squeezed' the stream to match the capabilities of a Dolby AC-4 encoder. Dolby also provided consumer devices that could decode the AC-4 stream to demonstrate live NGA payout.

As part of the trial, many hours of audio stems and video were recorded. This recorded material can facilitate future tests that simulate the live set-up. From this captured material excerpts have been generated for demonstration purposes. The work following on from the trial includes further development of S-ADM tools and transport, improvements to ADM-OSC, and a better understanding of the challenges of live production for NGA.

# Content-dependent power-saving models for HDR displays

Experimental findings have demonstrated that targeted adjustments to HDR video signals can reduce the power consumption of display devices with minimal impact on viewers, writes **Gosala Kulupana** (BBC R&D).



High dynamic range (HDR) technology provides a large range of luminance values and consequently elevates the perceived quality in video content. At the same time, HDR content consumes a large amount of power when displayed on compatible devices. We have analysed the power consumption of the display across different HDR content and a few different HDR TV sets and proposed Just Noticeable Difference (JND) based algorithms to reduce the power consumption with a minimal impact on the user perception.

The flow chart above illustrates the architecture of the proposed algorithms. An autoregression model is first employed for each pixel to calculate two components: orderly components (the ones that are predictable from the surrounding), and disorderly components (the ones that are not predictable from the surrounding). The orderly components generally correspond to low-frequency



parts of the image and hence are more sensitive to human eyes than the disorderly components. They are later used as inputs to compute several visual masks that are later applied on video frames.

Display power consumption and image luma values have a monotonic relationship, which means as one variable goes up or down, the other variable goes in the same direction. Therefore, the above derived orderly components are used to compute the deduction in luma values corresponding to one JND (i.e., the first visual mask). In essence, they represent the maximum power savings attainable in the HDR displays for the smallest perceptible quality difference. During this process,

we make sure that human skin tones are not affected, as the eye is very sensitive to skin tone (i.e., pixels that correspond to human skin tones are not modified).

A region-of-interest-based mask is also applied, to keep the objects within images minimally impacted and consequently deliver most of the power savings from background regions within images. A pre-trained model is deployed for this task.

Finally, a spatial correction mask is employed to preserve the edges of the objects, as the human eye is also sensitive to variations along object boundaries. A series of gradient, gaussian and box filters are used here to detect the edges and subsequently compute spatial correction masks.

Fifteen video sequences in three categories were tested to evaluate the performance of the proposed methods: sports, drama and nature. All were in UHD Hybrid-Log Gamma (HLG) HDR. Three HDR TV sets were used during the experiments (LG-C1 OLED TV, LG-C2 OLED TV and Sony Bravia 65" ZD9 LCD TV). For the LG sets, "Filmmaker" and "Standard" modes were used, whereas for the Sony TV, "Cinema Home" and "Standard" modes were used.

The experimental findings confirm that power consumption in display devices is highly dependent on the type of content they display (e.g., bright videos consume more power). Furthermore, the "Standard" mode in OLED TVs with extra processing of video images is linked to ~30% higher power consumption than the equivalent "Filmmaker" mode. Importantly, by employing the proposed power saving algorithms, the power consumption can be reduced up to 18% in certain scenarios. Further work will be conducted on embedding chrominance information and conducting formal subjective studies.

*Jayasingam Adhuran also contributed to the work described here.*

# Getting closer to viewers: production will be distribution

CTO of Sweden's SVT, **Adde Granberg**, says the biggest change for television production in future is that it will be driven by viewers. This article is based on his keynote address to the EBU Production Technology Seminar 2024.

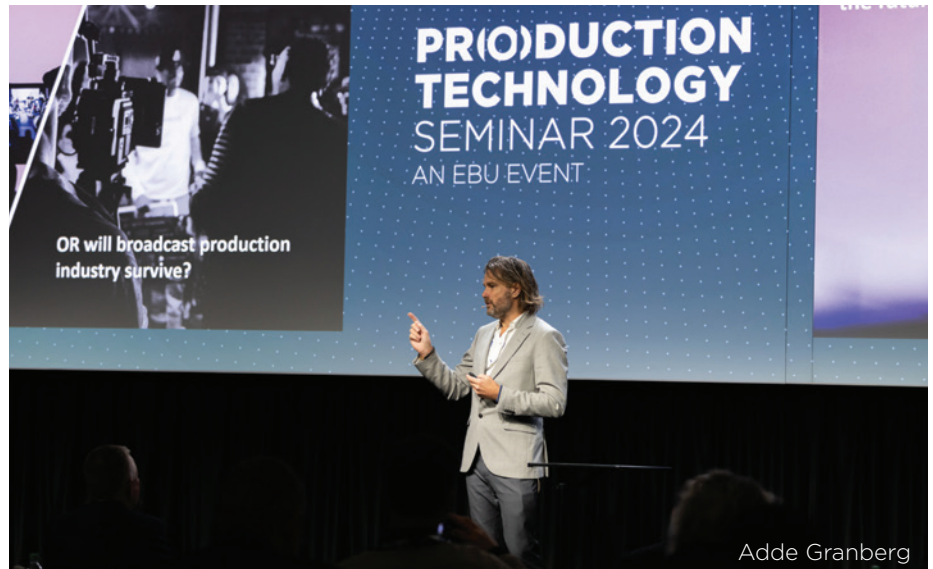
We should use technology to do production, not the other way around. The truth is, however, that television production has always been driven more by technology than by content.

Today, with our existing production processes, we are distantly removed from our viewers. We still go to conventions in Las Vegas and buy expensive equipment with excellent IP-based protocols that can handle uncompressed 4K video. The vendors are delighted with this, as it means not only are we buying expensive production equipment, but we're also buying expensive network equipment that needs to be replaced every three years. (It still works, but nobody will support it!) So, we've changed the cable and we're still far from our viewers.

The digitalization that is coming to the production industry will put production really close to the consumer. From my perspective, it will be a distribution business, not a production business. At SVT, I'm starting to implement a "Production 2.0" glass-to-glass strategy – production will be distribution.

We need to focus on what the audience would like to have and in what kind of quality, not what the production would like to have. Today, despite all the high-quality, uncompressed, high-bandwidth protocols we use in production, in getting the content back from our OB trucks or through our distribution networks, we're compressing it all down to seven megabits. We've been doing this for decades and we're still doing it.

So, we think about the cloud, and we have debates around whether it should be on my premises or someone else's



Adde Granberg

premises or wherever. But in the end, it's just a data centre. The television centre will no longer be a technical facility – it will be a facility for people who would like to create some kind of content with some kind of user interface.

We need to remove this notion of having a fixed quality, as we are used to having, from ingest to the cloud, to distribution. We need to ask ourselves what kind of quality we should have at the point of distribution and try to have that persist through the chain from the camera. And we need persistent metadata too, from camera to end user.

When producing in future, we will not use the actual data, the actual content – instead we will work with pictures in a low-latency, good quality workflow. So, the host can see the pictures and you can buffer the quality. For the first time in production history, you can now pay and get better quality: if you want to have high quality from the camera to the audience, you can buy connectivity. If you don't need to have live transmission, you can use a buffering quality and release it later on.

## THINKING GLASS-TO-GLASS

Right now we have departments for ingest, studios, postproduction, availability services, all with their own ideas around quality. Instead, all of us need to align to a video stream, from glass to glass. And all our teams need to adopt that mindset, that way of being organized, with metadata flowing from end to end, aided by AI of course. Metadata will also flow back from the viewers and feed into our programming decisions.

We need to challenge the way we're thinking, the way we're structured, and really embrace this future with enthusiasm, especially when we are in a legacy industry. And if we're going to gain from AI and digitalization, we need to reconstruct the IT architectures and we need to get some new talents into our industry, pushing us forward.

*EBU Members can view Adde Granberg's PTS 2024 keynote on at <https://tech.ebu.ch/pts2024> or via the tech-i app*



# Content is king, but distribution is queen

Founded in 2021, the CDN Alliance is on a mission to enhance the CDN Industry and work closely with the broadcasting industry to improve delivery of streaming video, writes its chair

## Mark de Jong.

Did you know that the CDN industry has existed for more than 25 years? The first CDN (content delivery network) was founded in 1996, called Digital Island, and the current market leader Akamai started in 1998.

Nowadays, CDNs are responsible for the vast majority of all internet traffic globally of which more than 70% is streaming video. Without CDNs, the internet as we know it today, and with that all the services that use streaming video, would not work. It is expected that the total volume of data traffic will continue to grow exponentially for the foreseeable future and that the proportion taken up by streaming video will grow as well.

The CDN industry, however, is very complex, with a wide variety of players, technologies, services, innovations, and relationships, across the domains of delivery, security and edge that are an integral to the activities of every content provider that wants to distribute their video content over the internet. Yet, the CDN sector offered few insights, was not approachable as an industry, and barely cooperated in solving challenges the sector as a whole was facing.

These were a few of the reasons for the CDN Alliance to start late 2021, to become an independent non-profit organization that wants to connect, support, and represent the global CDN industry and CDN community (which is its mission, in fact). Now two years old, the CDN Alliance as an industry forum is well recognized within both the CDN industry as well as



Mark de Jong is chair of the CDN Alliance

the broadcasting industry. It executes a variety of activities such as working groups, networking events and platforms, and webinars while working on a variety of projects across the domains of business, technology, and policies in relation to CDNs and content delivery.

### WHY COOPERATION IS KEY

With an increasing amount of content distribution for broadcasters being streaming video, more cooperation is needed between the broadcasting and CDN industries. Content is king, but distribution is queen.

Specifically for the broadcast industry, the CDN Alliance has several activities to support further cooperation. During this year's IBC, the biggest broadcasting exhibition in the world, once again in September in Amsterdam, we will hold the third edition of the CDN Alliance

Connect event, with 500+ people attending. It is the biggest networking event at IBC, bridging broadcast and CDN.

The CDN Alliance also has three working groups that are important for broadcast, such as the Dictionary Working Group with a focus on standardizing on terms used in relation to CDN, the Low Latency Working Group building an independent overview of everything on low-latency streaming, and the Traffic Radar Working Group that is building a framework for information

exchange on peak traffic expectations across content providers, CDNs and internet connectivity providers to minimize impact on peak traffic. And there are more working groups in the pipeline.

We are also contributing to the EBU recommendation EBU R 159, titled "Procurement of Interoperable Content Delivery Networks", and are involved in the EU Fair Share Debate, which focuses on potential EU legislation regarding data traffic charges from internet connectivity providers towards CDNs, which would in turn impact costs for broadcasters and the whole CDN ecosystem.

The CDN Alliance works closely with organizations like the EBU, the SVTA, and Greening of Streaming to further bolster cooperation that is important for the broadcasting industry. Cooperation is key and of benefit to both the broadcasting industry and CDN industry. Remember: content is king, but distribution is queen.

# Back to the future: SVOD platforms adopt linear broadcast strategies

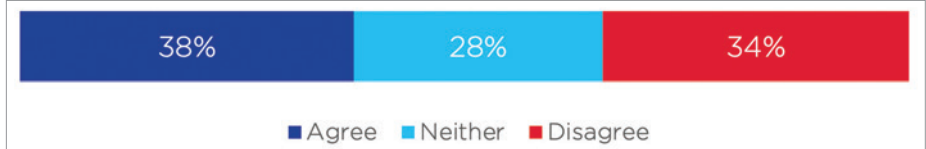
In their drive for profitability, SVOD services are returning to the strategies that made broadcast television successful, writes **Will Davies** of the EBU Media Intelligence Service.

When streaming video-on-demand (SVOD) services such as Netflix first emerged almost 20 years ago, they were an antidote to many of the constraints of traditional television and were welcomed by consumers. The ability to access a large library of content at any time, for a monthly subscription that could be cancelled at any moment, proved highly attractive to consumers.

However, after years of focusing on subscriber growth, streaming services are now under pressure to deliver a profit, and many have returned to some of the models that made broadcast and pay-TV successful for so long.

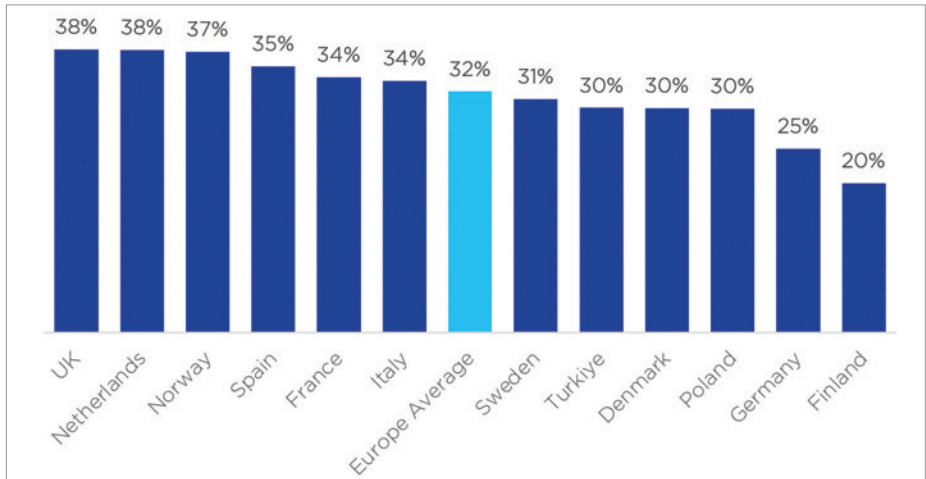
Firstly, SVOD services have started to introduce advertising tiers to their platforms. The viewing experience mirrors the one established in broadcast television, with commercial breaks scheduled evenly throughout the duration of the content. Furthermore, with an average of 38% of European consumers declaring that they would be willing to see ads if their subscription price came down, the rationale to launch an ad tier becomes clear (Fig. 1).

A model that streaming services rejected but are now returning to is the windowing and licensing of content. The US studios decided that having exclusive content on their flagship SVOD services was necessary to attract subscribers, even if it meant foregoing a significant amount of revenue that would have come from licensing their content to other broadcasters and media platforms. As they seek to make their streaming divisions profitable, the US studio giants are becoming more open to having their content available on competing SVOD services, with Disney, Comcast and Warner Bros. Discovery all now licensing



**Fig 1: I would be willing to see some/more adverts if it made the price of a video-on-demand service I already have, or am planning to subscribe to, cheaper.**

Source: EBU MIS based on Ampere Analysis Consumer, Q3 2023. Average of 12 European markets (Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Poland, Spain, Sweden, Turkiye, UK). Based on a nationally representative, online sample of 18- to 64-year-olds in each market.



**Fig 2: % respondents who feel overwhelmed by the number of streaming services**

Source: EBU MIS based on Ampere Analysis Consumer, Q3 2023. Based on a nationally representative, online sample of 18- to 64-year-olds in each market

content to Netflix.

SVOD services initially built their strategy around offering consumers the greatest choice of when, where, and how to watch content, and part of this strategy meant releasing all episodes of a series on the same day. However, streaming services such as Netflix, Prime Video and Disney+ have started to return to traditional scheduling models for some of their new series. These may be weekly episode releases, similar to the scheduling structure of broadcast television, or they may be a hybrid model with series broken into blocks and released over several months.

With the proliferation of different SVOD services and streaming platforms, viewers are becoming overwhelmed and

suffering from ‘subscriber fatigue’ (Fig. 2). To combat this, SVOD services are now entering into partnerships with pay-TV and telco operators to bundle their services with the linear television channel packages. Omdia estimates that by 2028, 25% of global SVOD subscriptions will be part of an operator bundle. Factoring in potential price increases for SVOD services, consumers may find the streaming landscape of the future does not look so different to the broadcast model that it sought to replace.

*The above insights are drawn from the recently published EBU Media Intelligence Service “SVOD landscape” report. Select “Research” when visiting: <https://ebu.ch/publications>*

**IN THE SPOTLIGHT****Tatjana Mladenovic**

LEAD DATA MANAGER  
AT THE BBC ARCHIVES  
TECHNOLOGY & SYSTEMS  
DEPARTMENT

**WHAT ARE YOUR CURRENT RESPONSIBILITIES?**

I am involved in all aspects of data management and high-level design of models and processes in BBC Archives Technology & Systems. I am also responsible for the quality and usability of our data. Our team has recently started building a new data platform that will enable us to not only manage our existing data efficiently, but to also take advantage of the latest developments in AI and machine learning (ML) to improve and enrich it. In large and complex organizations with a long history, like the BBC, managing archives data can be very challenging, but our efforts pay off through the content we surface to producers and audiences, preserving our cultural heritage at the same time.

**WHAT DO YOU CONSIDER AS YOUR FINEST ACHIEVEMENT SO FAR IN YOUR CAREER?**

I started working with media metadata over 20 years ago at Amazon.co.uk, before joining the BBC, and I have been very fortunate to have worked on many exciting projects. I am particularly proud of the work I have done for the BBC in the past few years on the automation of data processes and data consolidation. However, I expect that my finest achievement will be the current Archives project of building a modern cloud-based data platform. You can learn more about the data strategy driving this project at the EBU Data Technology Seminar in March 2024.



Tatjana Mladenovic is co-chair of the EBU Smart Media Production Strategic Programme and chair of its project group on AI and Metadata

**WHAT ARE YOUR PREDICTIONS FOR MEDIA TECHNOLOGY IN THE FUTURE?**

I specialize in data and, in this area, we have seen rapid developments in AI and ML, which provide opportunities for the automation and improvement of data processes on a scale never seen before. They also create new challenges that are particularly important for public service organizations. As co-chair of the EBU Smart Media Production Strategic Programme and chair of the AI and Metadata activities, I see that the ethics, legal and trust challenges are well understood and that there is great interest and effort in solving them at PSM organizations. I expect that the rate and scale of AI and ML innovations will continue, and as the challenges are addressed, we will see increasing adoption of AI and ML in media organizations, reducing costs and providing exciting new features.

**WHAT, FOR YOU, ARE THE BIGGEST CHALLENGES FOR EBU MEMBERS TODAY?**

Most EBU Members need

to reduce their costs and make their processes more efficient. At the same time, we need to compete with an ever-growing number of commercial production and streaming services. Young generations have different media consumption habits and are not attracted to traditional services, so we need to innovate and adapt. Developments in AI and ML have great potential but require great care in how they are implemented. All these challenges affect each of the EBU's Members, and through the EBU, we can support each other and work together at solving them.

**TELL US ABOUT SOME OF YOUR INTERESTS AWAY FROM THE WORKPLACE.**

I enjoy cycling and hiking and I'm looking forward to spring bringing some nice weather. I sing in and help run a local choir and I'm looking forward to our next performance of Fauré's Requiem. After a long day, my favourite way of relaxing is listening to music, reading a book or a trip to the cinema.

Join us and the industry's leading experts for technology updates, strategic insights and real-world use cases, plus demonstrations and networking.



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