

tech-1

Setting the pace for online platforms

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Cover story: Antonio Arcidiacono argues opposite that accelerating media innovation is crucial for Europe to strengthen its digital sovereignty. One key element of that is competing with the global video streaming giants. In this issue of tech-i, we present three examples of public service media fighting back to remain competitive locally in the global marketplace. See pages 8, 9 and 10.

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Media innovation and Europe's digital sovereignty

Antonio Arcidiacono

Director of Technology & Innovation, EBU



These are fascinating and challenging times: attractive content cannot reach an interested audience if it is not supported by innovative infrastructures and related technologies. Technology and innovation are thus the basis of all successful new media products.

Since taking up this position, I have come back again and again to the same message: *it is only by joining forces that we will be able to remain relevant in the very competitive media market.* This includes public and private broadcasters and the European media industry as a whole. And we certainly need more collective effort to accelerate European media innovation.

Actions speak louder than words, however, so allow me to mention just two of the projects I'm pleased to have set in motion over the past 12 months.

The October launch of the 5G Media Action Group – 5G-MAG – will help to put Europe at the centre of the 5G conversation when it comes to media-related applications. Representing the interests of the media industry in the area of 5G, this new global organization offers a “convergent voice” that was previously missing.

In a different domain, the EuroVOX project has been building momentum over the past year. The aim is to create an open European platform for language management and accessibility, an open platform using AI-based speech-to-text-to-speech algorithms to make any content available to any citizen in their native language (see page 7).

These are only two examples of several developments aimed at reinforcing the leadership role of the European media industry.

Policymakers want to make Europe fit for the digital age and they certainly agree that media play a central role in this process, contributing to creating inclusive and cohesive societies, promoting fundamental democratic values, and helping to develop the skills necessary for informed citizenship. For the latter, digital and media literacy play a key role in empowering citizens and combatting information disorder, including disinformation. Providing Europeans with innovative and creative instruments should be a priority. New generations should be helped to develop the ability to communicate more effectively using those instruments, equipping them to better understand and interrogate the avalanche of information they are exposed to.

However, Europe's media and creative industries are operating in an increasingly global and competitive marketplace and the digital age has changed the speed of innovation.

Media innovation therefore must be accelerated by putting a stronger focus on the sector in Horizon Europe and other relevant programmes. This support must be proportional at least to the importance of media in Europe and the related GDP it generates. More support is needed to adapt cutting-edge technologies for innovative media services, for example in the fields of AI and data, cloud-based platforms, immersive experiences, language management and accessibility, as well as recommendation and personalization services.

Accelerating media innovation is crucial if Europe wants to strengthen its digital sovereignty!



Launching the global 5G Media Action Group

5G-MAG, the 5G Media Action Group, is a newly formed association designed to give the media industry a voice in the 5G debate. The EBU hosted the association's first General Assembly on 16 October 2019, when 39 member organizations approved the statutes and internal rules and elected a steering board of 21 representatives. Antonio Arcidiacono, EBU Director of Technology & Innovation, was elected as chair of the steering board.

"We are proud to announce that

5G-MAG is now officially active and starting to globally represent the common voice of the media community", he said. "5G-MAG aims to translate the standardization work of engineers in 3GPP, DVB and the EBU into operational services that are of value in media production and distribution."

Since being announced at IBC2019 in Amsterdam, 5G-MAG has gained the support of stakeholders from across the media value chain, including media organizations, broadcast and mobile network operators,

manufacturers and regulators.

The EBU has been instrumental in the creation of 5G-MAG in line with its role to foster the development and deployment of technologies of strategic importance to the media industry.

5G-MAG has initiated work on the various topics identified at the General Assembly. Those who are interested in shaping 5G deployments for the benefit of the media industry – and the billions of consumers it serves – are invited to join the association.

Visit www.5g-mag.com or contact info@5g-mag.com.

WRC-19 REVIEW WORKSHOP

OUTCOME OF WRC-19 AND PLANNING FOR WRC-23

21 JANUARY 2019

Taking stock after Sharm el-Sheikh

This one-day workshop, by invitation only, will bring together the broadcast community to review the outcome of WRC-19, to identify common actions between the different stakeholders and to define an associated road map of activities, up to and beyond WRC-23.

Please ensure your organization is represented.

See tech.ebu.ch/wrc19workshop or contact ecoffey@ebu.ch.



Live IP vendors step up to the JT-NM Tested challenge

The EBU, through its involvement in the Joint Task Force on Networked Media (JT-NM), has been following the development of standards for Live IP production since the very start, *writes levgen Kostiukevych*. The JT-NM Tested programme was initiated earlier this year as a means of getting a snapshot of the current state of product implementations for the key standards. It's all about improving the implementations and driving the industry forward. With the publication of the "EBU Pyramid" (EBU Tech 3371 "Minimum user requirements to build and manage an IP-based media facility"), we felt that the technology was mature enough to be publicly tested, with the results published.

JT-NM Tested is not a certification programme. It is rather a snapshot in time of how vendor equipment conforms to key parts of SMPTE and other standards, providing prospective purchasers and users with a reference as they undertake equipment evaluation and qualification.

Following a first run ahead of NAB 2019, another gathering of vendors and testers took place at Riedel Communications in Wuppertal, Germany, ahead of IBC2019. A total of 32 vendors participated. There were two test plans against which the products were assessed: one was for SMPTE ST 2110 and the other for JT-NM TR-1001-1 (covering some

of the NMOS standards and some IT protocols). **These two JT-NM Tested Catalogs, detailing both the tests that were undertaken and the results of those tests, are available for download from: jt-nm.org/jt-nm_tested**

In general, the success rate at the Wuppertal event was much better than the previous event. Vendors have recognized the value of JT-NM Tested and also accepted the introduction of mandatory self-pre-testing for this second run. However, challenges remain. It was notable that not all products were submitted for the NMOS/TR-1001 testing. We had been expecting a higher level of adoption. On the plus side, PTP and network stability were excellent, proving that the robustness and stability of the implementations was increasing.

The findings from this second JT-NM Tested event will be fed back to the relevant standards bodies. The scope of the programme will be expanded further for future events, with the cybersecurity tests, which were undertaken on a trial basis in Wuppertal, being formally integrated. There will also be more workflow-oriented testing and the inclusion of further NMOS specifications.

We are grateful to Andrew Bonney (BBC) and Willem Vermost (EBU/VRT) for their valuable contributions to JT-NM Tested.

Six valuable takeaways from the Media Cybersecurity Seminar (tech.ebu.ch/mcs2019)

1. Shift Left!

The idea of Shift Left security is to move security considerations to the far left of the development timeline, rather than only thinking about them at the end.

2. Crowdsource your vulnerability assessment!

Implementing a Responsible Vulnerability Disclosure policy, possibly coupled with a "bug bounty" programme, will give ethical hackers a way to help you without the threat of being prosecuted. See EBU R 161.

3. Take on the pirates!

Content piracy is harming business, even for free-to-air broadcasters (see page 11). Concerted action is needed for both legal and technology-based solutions, including more widespread adoption of the EBU-led BISS-CA protocol.

4. You need a SOC!

Every media company needs a Security Operations Centre, in-sourced or outsourced, to monitor and detect suspicious activities within its facilities and networks.

5. Company culture must catch up!

Security is still often seen as a separate topic but it should be a minimum requirement for projects, equipment purchases and more. Tailor-made guidelines like EBU R 143 and EBU R 148 can provide a head start.

6. Know your suppliers!

Liability in the case of a cyberattack can extend also to your suppliers and their suppliers. A wide and deep supply chain map is required and you might want to consider cyber insurance.

More services, more participants and more implementations: PEACH is growing

The EBU collaborative project delivering a recommendation and personalization solution is going from strength to strength, writes PEACH developer **Yury Brukau**.

Another year of intense developments for PEACH has seen the addition of the user preferences service and a GDPR manager. There is also now an improved platform for data scientists and a data collection library for mobile (both iOS and Android) – and we migrated the operations to Amazon Web Services.

Four EBU Members have implemented PEACH and are actively contributing to its development. There is ongoing interest from other broadcasters, and we are conducting several trials (e.g. TG4, LRT). Get in touch: peach.ebu.io

PEACH @ VRT

After a successful trial of PEACH in the VRT NU web portal last year, the first use case was delivered by the end of summer, providing user-based content recommendations on the portal's home page. We will continue working together to adjust the algorithm and prepare other applications of PEACH, such as programme or news recommendations in other VRT products.

VRT participates in the Content Personalization Network (CPN) project funded by the EU Horizon 2020 programme. The project is focused on news personalization. There are interesting opportunities for knowledge exchange between PEACH and CPN and we are looking forward to seeing what we will be able to do together.

PEACH @ SVERIGES RADIO

Since joining PEACH at the end of 2018, SR has been steadily gaining knowledge and control over its recommendation offering. The Swedish



broadcaster started by porting recommendation products that were already in production. This went smoothly and the quality of the recommendations from PEACH was at least on a par with the old system.

SR has improved the workflow for developers who use the PEACH data science platform and improved both the data collection and overall performance of calculating and serving recommendations. Several A/B tests have been conducted to learn what offerings the audience prefers. The quality of the recommendations has been improved through user-individualized filtering of recommendation lists.

SR has been able to reduce

the complexity and costs of data collection by moving to services provided by PEACH. The team is now working on their first news recommendation service targeting editors. The algorithms are now literally in the hands of SR's own development team: they can themselves explore, experiment and learn how to build products uniquely suited to SR.

PEACH @ RTS

In Switzerland, integration between the RTS Play application and PEACH was improved over the course of 2019 so that there is now a consistent user experience in the Play application on different platforms (web, iOS, Android), for content recommendations, continuous playback and personalization. RTS can measure the impact of recommendations on overall content consumption.

A new RTS Info mobile app was released in September, providing users with personalized news feeds with audio and video content. Together with a new UI and separate audio and video feeds, it brings personalization to users' news feeds using services provided by PEACH.

PEACH @ BR

The earliest implementer, BR continues using PEACH for the personal recommendation page in the BR Mediathek. One of the next things on the roadmap is updating its mobile apps to use the data collection library provided by PEACH and to improve evaluation of the recommendation algorithms. The PEACH team visited BR in November to discuss future use cases and evolutions of PEACH in BR products.

New standards and tools for reliable NGA workflows

Next Generation Audio is now closer to the mainstream thanks to some significant steps forward over the past year, explains IRT's **Michael Weitnauer**.

At an ITU meeting last March, we finally achieved one of IRT's main audio objectives of recent years: the standardization of an open renderer for Next Generation Audio (NGA). It was a meeting of the study group for international standards in programme production and quality assessment. The renderer standard agreed is a crucial element for a reliable NGA workflow and will make sure that the sound engineer can monitor the signals in the same way as the audience. That may sound trivial but was indeed not guaranteed until recently, owing to a fragmented market situation.

This renderer is a complete interpretation of the Audio Definition Model (ADM) Format, specified in Recommendation ITU-R BS.2076 and very much based on the EBU ADM Renderer – EAR (EBU Tech 3388), our joint project with BBC, b<>com and France Télévisions, within an EBU working group. The EAR renderer specification was published in March 2018 and, precisely one year later, the ITU-R Working Party 6C agreed on the new recommendation BS.2127-0 “Audio Definition Model renderer for advanced sound systems”.

Even though this new standard is very much based on EBU Tech 3388, the ITU-R recommendation is a joint effort of multiple broadcasters and manufacturers. To make sure that the renderer is compatible with all currently available NGA technologies and systems (e.g. AC-4, MPEG-H or DTS:X), we worked together with industry partners like Dolby, Fraunhofer IIS and Xperi.



Screenshot of the EAR Production Suite

OPEN SOURCE TOOLS

This is a great achievement but our efforts to engage and push ADM and the ITU ADM Renderer for a truly open and independent NGA workflow didn't stop there. We also implemented these standards in open source software libraries (such as libadm, libbw64 and libear), which will simplify the integration of the ADM workflow in production tools, foster wide support and guarantee smooth interoperability. Moreover, we teamed up once again with our BBC R&D audio colleagues for an exciting new project where all these developments come together: the EAR Production Suite.

The EAR Production Suite is a set of VST® plugins for digital audio workstations (DAWs) that enable sound engineers to produce and author content using the ADM format; and to monitor it for any ITU-R BS.2051 loudspeaker configuration using the ITU ADM Renderer.

It will enable professionals to import and export ADM files, compliant to the EBU ADM Production profile (EBU Tech

3392). Apart from using it for productions, we envisage the EAR Production Suite as a role model for further ADM implementations to harmonize ADM workflows and functionality.

This joint development has already implemented most basic features. These include the import of ADM files, the explosion of object-based content to Reaper tracks, groups and automation curves, the editing of audio objects in each track, and the rendering of different loudspeaker configurations for monitoring. This early version was successfully demonstrated to several interested visitors at the EBU booth during IBC2019, where we received valuable feedback.

The EAR Production Suite will be published as an open source project on GitHub, in addition to freely available release builds. There are still a few open issues, such as the export of ADM files and advanced ADM programme authoring, but we expect the release to be available during or before Q1 2020.

EuroVOX: tackling the language barrier with machine-based translation

For public service broadcasters, increasing the reach of their content is of prime importance. A group of EBU Members are collaborating on a tool that will tackle one crucial barrier, explains **Ben Poor**.

The EBU's EuroVOX Project aims to be an open toolkit for transcription and translation, allowing citizens easy access to media content in their native language.

With a rich tapestry of spoken languages across Europe, there is a greater need to involve all citizens in the cultural fabric of society, helped by access to public service content, regardless of the user's native language.

LEVERAGE AI & ML

The rise of artificial intelligence and machine learning, providing tools for automated transcription and translation, has the potential to provide a solution. This is partly driven by the GAFAM (Google, Amazon, Facebook, Apple, Microsoft) companies that have invested billions of dollars in creating their own language services, as well as acquiring specialist companies. There are smaller companies that also provide services (e.g. Speechmatics), along with research institutes and universities (perhaps specializing in specific languages).

Having equal and open access to a wide range of these services, either from the big vendors or smaller institutes is one of the

goals of the EuroVOX Project.

Being an open toolkit means having a unified and openly standardized API (application programming interface) on top of language tools from a wide range of vendors: large, medium and small. This gives content producers the opportunity to perform a single integration with their production workflows and tools, and then use EuroVOX to access a much wider range of language tools than is available with any single provider.

This also means that, through continuous automated benchmarking, as well as the collation of human feedback, the "right" vendor can be selected when performing a transcription, translation or other task. This would be decided on a range of objectives: cost, speed, accuracy, etc.

EI-TRADUCTOR

EuroVOX is currently under development through the collaboration of a group of EBU Members, each with their own requirements. One of the first steps was to create a pilot tool to fulfil a specific use case: EI-Traductor is a web tool for news producers to take audiovisual content from one language and

translate it into another.

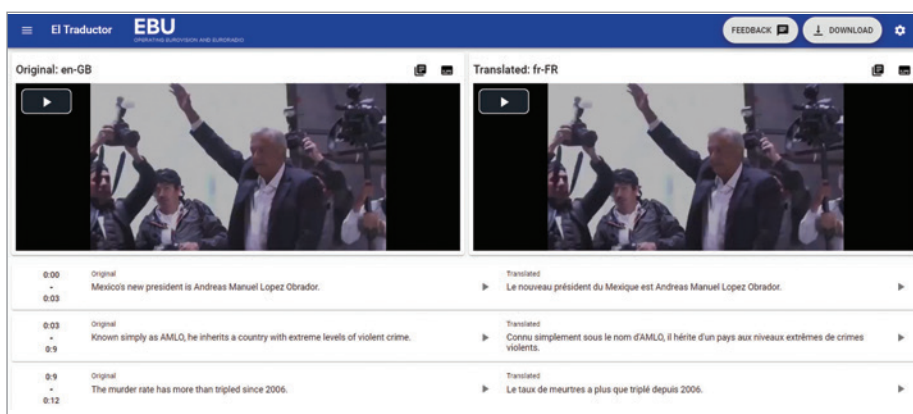
To do this, the original video is ingested and transcribed from its original language, after which it is presented on the interface as a series of timestamped sentences. These sentences are then translated to the target language and spoken using a synthetic voice. The original audio of the video is then ducked (reduced in volume to 30%) while the voice is overlaid. The end result is that the spoken elements of the video are automatically re-voiced into a new language.

Currently, the accuracy of such transcriptions and translations is not 100% and so the tool emphasizes its assistive mode. It allows a human editor to view the results and easily make any final amendments. Once the video is complete, it can be downloaded for publishing on social platforms, with subtitles and transcripts in both the original and target languages.

EI-Traductor demonstrates the potential of EuroVOX and is now being trialled in Member newsrooms to get real user feedback from editors and journalists.

The next steps for the larger project are to extend the functionality of the production API layer (including adding more language vendors to increase the range of languages supported), as well as widening the group of Members involved.

Get more out of your available resources by joining EuroVOX and benefiting from a much larger team dedicated to producing a system of immediate value to you. Contact poor@ebu.ch or visit tech.ebu.ch/eurovox



Screenshot of EI-Traductor

A smart use for HbbTV in Sweden

Anders Hebert is Product Owner for SVT Play on TV platforms. He describes here how the broadcaster has ensured its on-demand platform is prominently positioned in Swedish living rooms.

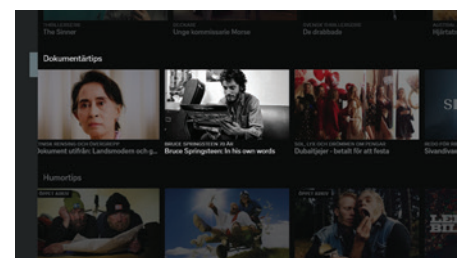
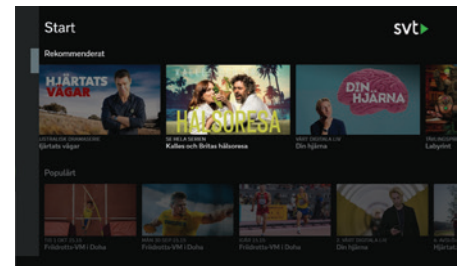
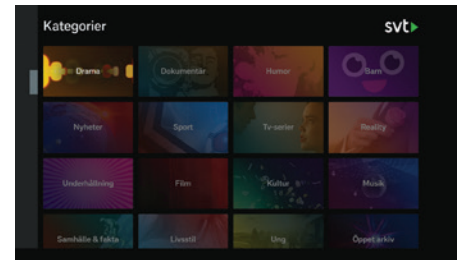
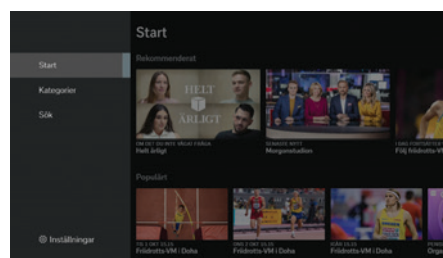
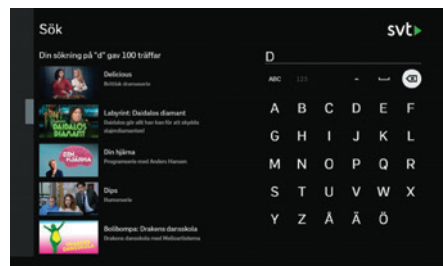
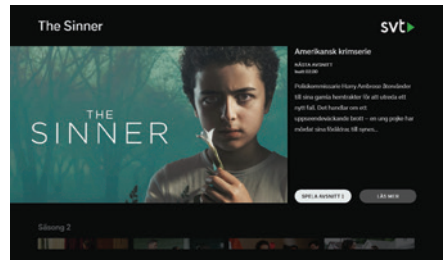
With our VOD service SVT Play, we have always wanted to meet the audience where they are. In 2006, we brought an on-demand mindset to the Swedish population with our desktop web service. A few years later an adaptive, mobile-first-inspired SVT Play website was launched to put our video content in the hands of Swedish commuters.

As the smart TV audience started to grow, we wanted to bring television back into the living room, this time using on-demand video. Both the users and the TV manufacturers were asking us to build apps for their specific devices, but with the limited resources of a public service media organization we'd never be able to develop and maintain native apps for each platform.

So, we turned to HbbTV. Just about every TV manufacturer is listed on the HbbTV member list so we approached them early about using the HbbTV standard to publish smart TV apps. Communicating our plans to the manufacturers was important to give them time to adjust their stores and devices as required to support the initiative.

MODERN TOOLS

We decided to use version 1.5 of the HbbTV standard, to reach as many devices as possible while still using a modern streaming format for video. Although version 1.5 uses older web technologies such as CE-HTML and EcmaScript 3, our in-house development team have set up a modern development environment where they're using current HTML5 tools like TypeScript and React. They're working like any modern web developer, giving us a lot of flexibility to test different ideas and improvements. With usability testing of prototypes



and early iterations, we can easily improve our solutions and we're pushing code into production at least weekly. The deployment workflow automatically transpiles the modern HTML5-based code to the older web standards of HbbTV 1.5 making the service compatible with even 5-year-old TVs.

When publishing an app on a new platform, we upload an application to the manufacturer app store. However, there's no actual code in these apps; they just hold the URL to our HbbTV service and some basic metadata. To the user, it's like any other smart TV app, but for us there's a huge difference: that single HbbTV service has the market penetration of tens of native apps.

Between this HbbTV service and an Android TV app, SVT Play covers almost every smart TV device sold in Sweden, as well as a lot of cable and satellite set-top

boxes. The HbbTV-based app is used on, for example, Samsung, Panasonic and LG, for the latter on devices ranging as far back as 2014.

NEXT TO NETFLIX

SVT has chosen to publish this HbbTV service as a smart TV app and not a channel-bound service. The reason for this is that our users are familiar with other VOD apps like Netflix and HBO, and they expect SVT Play to be found in the same space. This also gives us brand exposure when users are launching, for example, Netflix and they see our logo on the next icon. We are investigating channel-bound services too, but we don't have any plans to use them for SVT Play. Our users are already familiar with VOD apps so any channel-bound HbbTV initiative would be focused on improving the broadcast experience.

Yle Areena - bigger than Netflix

Kari Haakana, Head of Services at Yle, puts the success of the Areena streaming platform down to a combination of several factors. In general, it's about making the right choices.

Yle, the Finnish national broadcaster, has been able to beat Netflix, at least if you believe a study from AudienceProject. According to the AudienceProject Insights 2019 report, Finland is the only country of those covered (the others being the US, UK, Germany, Denmark, Sweden and Norway) where the public broadcaster's video-on-demand service is more popular than the American streaming behemoth. How has this achievement been possible?

First of all, we started early. We launched Areena, our video and audio streaming service, as early as 2007, the same year as BBC iPlayer and only two years after YouTube first appeared. Since then we have been putting lots of work and resources into our service. Currently, practically all of Yle's video and audio content is available in Areena, both live and on demand.

It has taken a lot of effort to ensure we have quality content for Areena. Most of the content on the platform is still the same as on the broadcast services, but we are steadily increasing the amount of online-only content, especially audio podcasts and

the live video service. We also pay very close attention to the analytics, to see what sort of content works, when it works and how it works.

PRODUCT DEVELOPMENT

We also put considerable effort into developing the technology that drives the service. We don't have *projects* with Areena. We consider it to be a product, not unlike Google search or Spotify, and you can't develop a meaningful product with a string of projects. We have dedicated teams that combine people from Yle and selected companies to develop Areena with small iterations and continuous testing.

We also believe that having video and audio services in a single application is beneficial for both. We can cross-promote content more easily and we avoid the need to create the same kinds of feature for two different products.

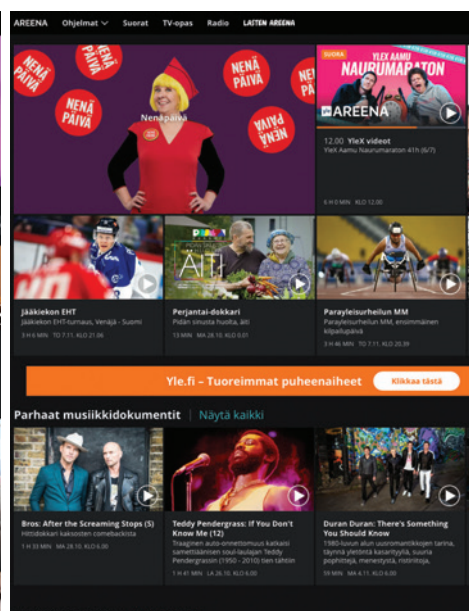
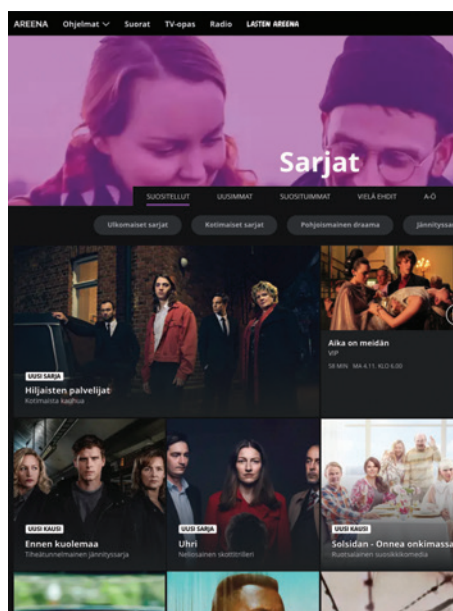
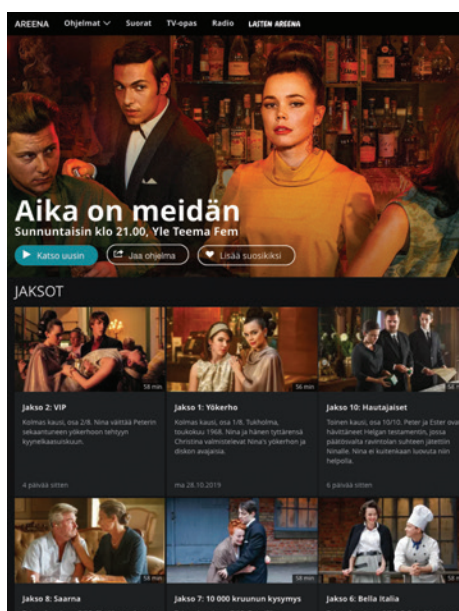
Timing is essential with product development in a fast-moving technological environment. We try to spot changes in the usage patterns and, at least until now, we have succeeded. We created our own mobile applications for Areena ten years ago. Within a

couple of years, the stream starts on mobile surpassed stream starts on traditional computers. Now our mobile applications have been installed on more than two million devices and are being used by approximately a million different mobile devices weekly.

GROWTH ON SMART TVS

We also launched our first smart TV application back in 2013. Currently 25% of our stream starts happen in smart TV applications, 25% in browsers and 50% in mobile applications. The number of different smart TV devices using our service has already surpassed the number of tablets and continues to grow by approximately 100% year-on-year.

The next platforms for Areena are car entertainment systems and voice-controlled environments like Google Assistant. We are also experimenting with audience commenting for live shows, different recommendation solutions and a fully personalized user experience. Beating Netflix is going to be harder each year, but it's still possible, if we continue making the right choices.



Relaunching RaiPlay for a new era

The Italian public broadcaster Rai has rebranded, re-engineered and reinvigorated its on-demand player RaiPlay. Taking care of product development at Rai Digital, **Gianluca Visalli** provides this overview.

The renewal of Rai's public service charter in 2018 marked the beginning of a new era for the company. The contract with the government specifically mandates Rai to expand its multimedia platforms, looking beyond traditional linear broadcasting. One concrete outcome of this has been the November 2019 relaunch of RaiPlay.

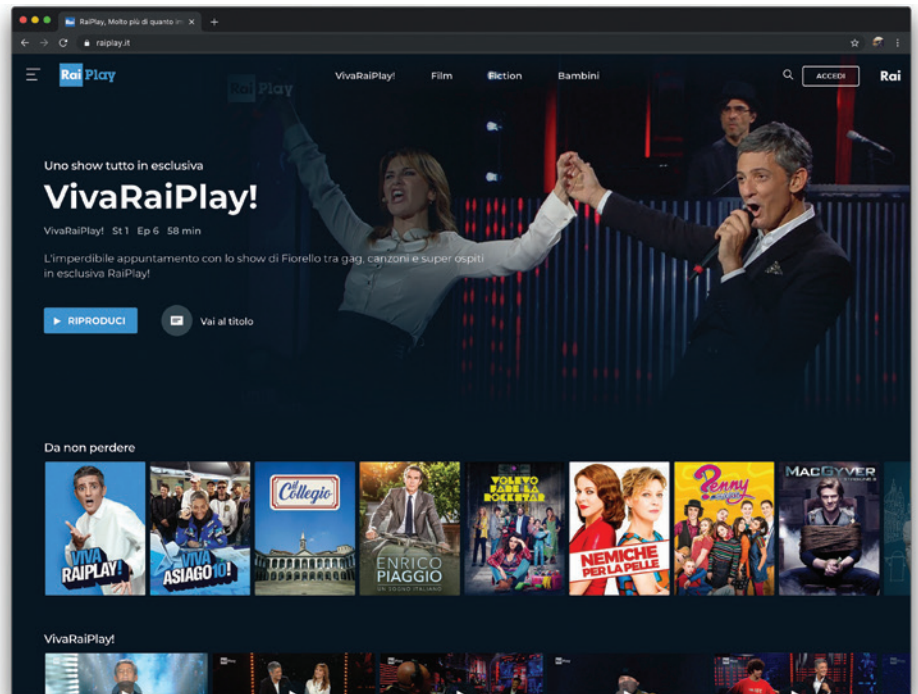
STRONG STARTING POINT

First launched in September 2016, RaiPlay had built a good market position even before its relaunch. The strategy for this first phase had been to establish an OTT (over the top) platform in the market as a means of distributing existing content. This positioned Rai as a market leader in terms of digital distribution.

A data strategy was also added during this period. While users could freely watch the linear services via RaiPlay, to access the catalogue on demand registration was mandatory. This enabled the collection of basic demographic information, such as age and gender, alongside consumption data. This provided the basis for a recommendation system introduced in 2018.

As of September 2019, RaiPlay had 12.5 million registered users and racked up 488 million video views in the first nine months of the year. This marked a 75% increase on the same period in 2018, so the trend was clearly upwards. Nevertheless, in the face of increasing competition from global video-on-demand platforms, and in line with Rai's 2019-2021 business plan, a complete redesign of the player was undertaken.

The aim is to ensure that wherever audiences are moving away from Rai's linear broadcast services and onto OTT platforms,



they include RaiPlay within their media menu. This applies to mature audiences as much as to younger people (who may not even have Rai's linear channels within their current scope of consumption).

NATIVE DIGITAL CONTENT

The relaunched platform continues to offer simulcast of the linear channels alongside a catch-up service and the catalogue of all programmes that have previously aired. What is new is the focus on native content, whether produced specifically for RaiPlay or acquired for the platform. The main challenge in terms of product design has been to integrate all of these different kinds of service in a way that's easy to browse and still fulfils our public service remit of also giving prominence to content that might be less popular or commercial.

The placement of content on the new RaiPlay is no longer done with reference to the schedules of the existing linear

channels. Instead a completely independent offer has been created, whereby the RaiPlay team has a full editorial remit with the aim of creating a wide native offering across different genres: movies, (Italian) fiction, international TV series, kids, documentaries, music and theatre, and archives.

A complete re-engineering has aligned the player with the latest trends and expectations with regard to the graphical interface, the overall user experience, the search engine, algorithms, etc. The user experience is now consistent across all of the player integrations, of which there are five: Android TV, iOS, HbbTV and the dedicated apps for Samsung and LG smart TVs. A more basic app continues to serve MHP receivers, which have a shrinking but still significant presence in the Italian market.

On the RaiPlay app for smartphones and tablets, the user can download content for viewing in offline mode. This offers full mobility and reduced consumption of data traffic.

Free-to-air does not mean free

Television piracy is a flourishing business, writes **Diane Hamer**, Head of Content and Brand Protection at BBC Studios. The emergence of bespoke illegal “expat” channel subscription services poses perhaps the most direct challenge to the BBC’s global commercial activity.

No longer solely the preserve of teenagers in their bedrooms, much television piracy is now conducted on a highly organized, commercial scale by sophisticated networks of illegal operators and may be linked to other criminal activities. Better broadband speeds enable high definition pirated content to be streamed directly to viewers – via set-top boxes, smart TVs, tablets and smartphones – anywhere in the world at any time.

ILLEGAL SUBSCRIPTION SERVICES

Like the legitimate media industry from which it steals, the pirate television economy serves a range of audience demands, from live sports to Hollywood films and television box sets on demand, to national linear channels streamed live and on a catch-up basis. It is hard to quantify how many illegal “expat” channel streaming subscription services currently operate globally and the numbers change all the time, as law enforcement or civil actions shut some down and others emerge.

A concerning feature of the higher end illegal “expat” services is how legitimate they look, an impression enhanced by well-designed websites selling branded set-top boxes, the availability of customer support lines, the use of mainstream payment providers, and their reassuringly expensive subscription fees. (I have seen services offering subscriptions of USD 380 per year.)

Many of these illegal services also make claims (often found in genuine looking Terms of Service or FAQs) designed to reassure customers of their legality. One common claim is that the service is legal as long as the customer has a UK television licence. (This is wrong: a television licence is

not tied to the UK domicile of the licence fee payer; it does not legitimize or clear the rights for the distribution of BBC public service channels to customers around the world.) Another is that the service is permitted under the EU Audiovisual Media Services Directive (wrong again: the AVMSD governs how content is regulated in the EU, but it does not permit the distribution of copyright-protected works without the consent or compensation of the broadcaster or copyright owner). Nevertheless, such claims are often sufficient to reassure the customer that they are buying a genuine service (and not, as is often the case, handing over credit card details to organized crime groups) and to muddy the waters for law enforcement.

FREE TO REDISTRIBUTE?

A consistent, but inaccurate, theme underpinning many of these illegal services is that content that is broadcast free-to-air, such as on the BBC’s linear UK public service channels, is free for the taking. This is apparent from the number of

operators boldly promoting the availability of BBC, ITV and other UK free-to-air channels on their service. Because UK viewers do not pay for this content at the point of consumption, these services operate on the presumption that no one is hurt when it distributed to a global audience without the permission of the rights owner.

High quality content is very expensive to produce, and the BBC supplements the income it derives from UK licence fee payers by the activities of its commercial subsidiary, BBC Studios, which invests in content production in exchange for global distribution rights, including with PSM partners. This is a virtuous circle that helps fund high quality content for UK licence fee payers and enables the BBC to meet global demand through the international distribution of programmes and services, with due remuneration of contributors and underlying right holders. But unless the industry steps up its efforts to tackle this wide-scale piracy, this virtuous circle is at risk of being breached.

The image shows a promotional graphic for a 'Supreme Package' subscription. At the top, it says 'Supreme Package' in white text on a blue background. Below that, the price is listed as '\$38.00/monthly' in blue, with '\$380.00/yearly' in smaller grey text underneath. A claim of '107 Channels - Great Value!' is displayed in blue. The main part of the graphic is a grid of 107 small channel logos, including BBC One, BBC Two, BBC Three, BBC Four, BBC News, 4, 5, Challenge, Create Great TV, Dave, E4, ITV, ITV2, ITV3, ITV4, and many others. At the bottom, there is a line of text: 'Includes all of Standard, Premium, Ultimate package channels + all of your favorite UK free-view channels including these above plus many more! Also includes 100 live radio stations. All packages come with Full 30 day PVR go back in time features, including 100 live UK Radio Stations.'

Well-designed websites for the higher end services give the impression of legitimacy.

Reducing the delay for live content over Multi-CDN

The EBU's **Hemini Mehta** describes how low latency was achieved over the Eurovision FLOW Multi-CDN setup for a successful IBC2019 demonstration.

Have you ever watched football online and heard your neighbours with a normal broadcast service cheer at least 30 seconds before you could see the score? As more and more viewers are watching live events online, and in some cases are paying to watch them, these long delays – or latencies – irritate them. Therefore, latency is a key factor for the video streaming experience. The Eurovision FLOW Low Latency demo at IBC2019 utilized DASH (Dynamic Adaptive Streaming over HTTP) with a low latency mode based on CMAF (Common Media Application Format), delivered through the FLOW Multi-CDN setup.

Latency is the difference in time between the frame being encoded and when it is displayed to the viewer. Low latency HLS and DASH enable faster delivery to the end user, by specifying short video segments, for example. CMAF is used to unify the behaviour of LL-HLS and LL-DASH throughout the delivery chain, from packaging to playout. CDNs need to optimize the CMAF pass-through by not allowing the caches to store the content packages.

Achieving low latency comes with issues. In the current system, the end user benefits from the use of pre-buffered content, which ensures that they have a better viewing experience

regardless of any difficult network conditions that may arise. Therefore, reducing the pre-buffered content has a risk of causing a poor end user experience.

Many content providers stream their services using Adaptive Bitrate (ABR). This also improves the end user experience by using the best stream over their available bandwidth capacity and checking it regularly to continue to give the user the best stream they can view. When the player requests the stream chunks, a check is done on the bandwidth and the right chunks are served at the optimal bitrate. Therefore, the added complexity of low latency can also introduce issues.

Low latency increases the number of requests for the chunks and so this is also an increased overhead.

To have low latency, as we have said, there must be some compromises and the following areas need to be balanced:

- User size and geographic distribution
- Encoding formats and device/player compatibility
- Video resolution and complexity

That said, many people already benefit from low latency on a daily basis, e.g. with video conferencing and other video calling services. The challenge is to perfect it for live broadcast events.

THE IBC2019 DEMO

The demo focused on keeping the latency below three seconds for the full delivery chain.

Encoding profile

MPEG-DASH adaptation set configured with:
Video: H.264 avc1.640029, 1 Mbps, 1280x720@30fps
Audio: AAC mp4a.40.2, 192 kbps, 48,000 Hz
Video segment size: 1 second

Origin

The origin was provided by System73. It was optimized for delivering content in streaming mode (as soon as it is produced), taking advantage of HTTP Chunked Transfer Encoding, keeping connections alive and HTTP/2 session performance. The encoder and packager implemented the CMAF specification with tight timing synchronization following MPEG-DASH requirements to guarantee timed delivery.

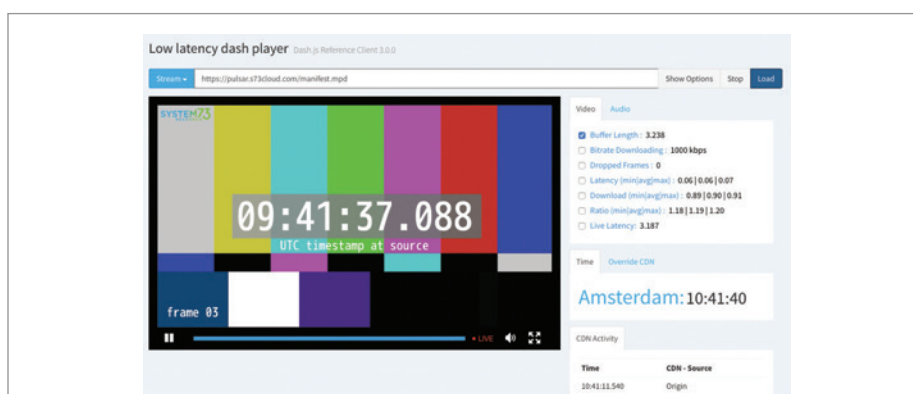
CDN setup

Both CDNs used in this demo, CenturyLink and StackPath, changed the behaviour from their caches to pass through CMAF content without storing it, to enable delays that are almost as low as the package length.

The demo used the DASH-IF reference player with built-in time and CDN-switching reference, as well as manual override for the purpose demonstrating CDN-switching during IBC.

Demo partners

Centurylink, Stackpath, System73, Warpcache



Mastering digital transformation at Norway's TV 2

A project to entirely renew its content handling systems represents a huge step forward for Norway's TV 2 and an inspiration for the wider industry, says **Hege Marie Kallestad**.

Our GPO – Greenfield Payout – project has been transformational for TV 2. To take just one example, with our previous workflow the partly manual checking of 1,000 hours of content, using different systems for linear and OTT, had an estimated delivery time of eight months' work from five full-time staff. In the new system, the same amount of content takes 14 days with three people.

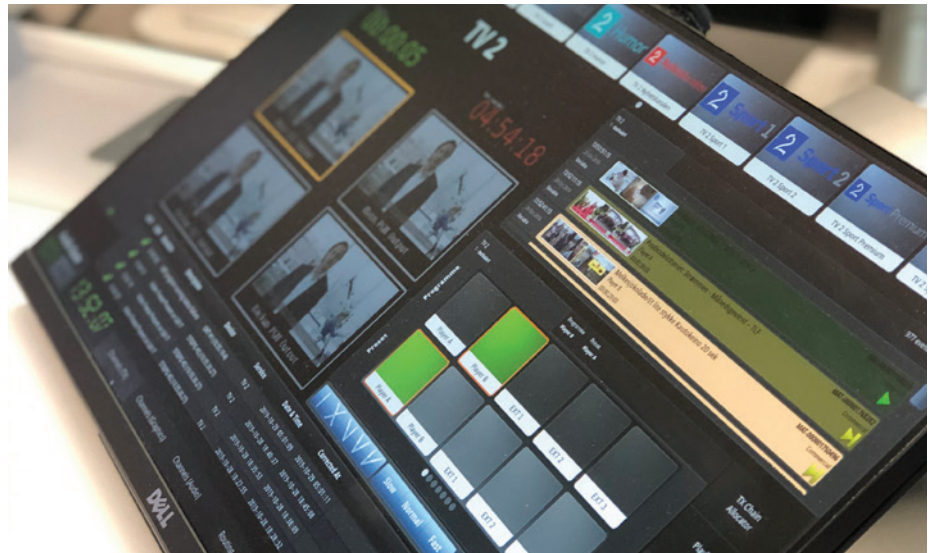
We have integrated all the workflows for linear and non-linear in all operational functions: from planning and content delivery to playout and publishing, both for technology and organizationally. We're now running nine linear broadcast channels and another 35 online only channels from one playout control room.

BIGGEST EVER PROJECT

This project started out as a traditional IT project, but after four years it has become the biggest transformation project TV 2 has ever completed, where the objective is to totally renew our content handling. It is a digital transformation project with focus on building and using new technology, but also transforming workflows and changing the way we do our daily work.

Our business goals were opex cost reduction of 30%, faster publishing, and easier scaling, modification and replacement of systems. We also wanted to combine and reduce several roles in the organization, remove duplicated workflows and build digital competence with increased skills. The project has made it possible for us to prepare for extremely fast turnaround and publishing to all platforms.

We have transformed the content handling value chain, from the top of the chain with metadata related to contracts



and rights, to sales and planning management, including content delivery and publishing on all platforms. We also had innovations like one of the world's first IP-based playouts. It's all connected and transparent for all platforms.

We developed our own Enterprise Service Bus, with product-specific adapters, supporting the integration between all systems. This gives us the possibility for flexible technology shifts in future and easier scaling. Everything is based on the use of a global ID structure. With our technology strategy in the core, there is no direct integration between systems, even between planning and playout. And for the first time in our history, we now have access to all data in real time.

MODERN WORKFLOWS

We've had huge efficiency gains. We achieved the targeted 30% reduction in opex and expect further reductions in future. However, the real value is in the access to data and analysis, increased time to market, fast turnaround time and combined rights management for OTT and linear, based on upstream

thinking. When a file has delayed delivery, the content service operator can simply turn around to the publishing desk and have them change the publishing time for OTT, and the CXM team can address the change directly to our consumers. No more calls or mails. A modern way of working.

This project has been all about learning, but also about unlearning old habits. It's about balancing the new and the old side by side. It's about organization and structure, culture and humans. It has been exhausting and demanding, but in the end, we finally got there.

Nobody knows for sure what will become the future business models in our industry, but with this project TV 2 is now positioned to meet those unknown needs of tomorrow. One of the most important learning points from a digital transformation is that it never really ends. And remember, technology is just an enabler – the main focus must be on people.

The TV 2 Greenfield Payout project was shortlisted for the 2019 EBU Technology & Innovation Award.

See: tech.ebu.ch/award

Loudness: the next generation

The relative calm around loudness normalization, achieved largely thanks to an EBU recommendation, has been destabilized by the rise of streaming services. ORF's **Florian Camerer** chairs the EBU group that's working on an extension of R 128.

The main focus these days regarding the deployment of loudness normalization is online streaming. This comes in different forms, like OTT (over-the-top) television or video and audio streaming services.

While the broadcast television community has united around a loudness normalization target level of -23 LUFS, largely due to the success of EBU R 128, the situation in the streaming world is much less clear. With the likes of Apple, YouTube and Spotify each implementing their own louder target levels of anywhere from -18 to -12 LUFS, it is understandable that a broadcaster would see level "competition" with the latter services as an argument for deviating from the established norm of -23 LUFS.

LEVELLING CHAOS

There is a longer story to tell about the evolution of loudness normalization targets among streaming services. Decisions taken by the aforementioned companies kicked off a new race, with a clear and present danger for a different flavour of levelling chaos. Our colleagues in the AES (Audio Engineering Society) are getting to grips with the situation

via new guidelines for audio streaming that seem to be veering towards a target of -18 LUFS ± 2 LU.

A broadcaster may not care about any level competition from other services. In this case the available content can be streamed unchanged which, of course, is the easiest solution.

Nevertheless, the landscape for audio levels is changing and broadcasters need guidance. A forthcoming revision of the CENELEC European standard for earphone levels in mobile devices (or PMPs, personal music players) will allow higher output levels, thus making a target loudness level of -23 LUFS very feasible. We also see more and more streaming services adopting loudness normalization by default, at a reasonably low target level, as well as devices adapting the loudness target level intelligently within themselves.

NEW SUPPLEMENT

The EBU project group for loudness, PLOUD, is currently working on supplement 2 to EBU R 128, addressing the issue of loudness for streaming. Any deviation from the "holy grail" of -23 LUFS is likely to be

temporary. Broadcasters can expect the publication of this streaming supplement in Q1 of 2020, relying on the same short and sweet guidance as the core recommendation R 128 provides. Figure 1 illustrates a preliminary example of the two main ways to stream legacy R 128-compliant content.

If a broadcaster is of the opinion that it absolutely must be on a par with music or video streaming services, then a level change towards -18 LUFS ± 2 LU may be looked at. The consequence of this approach is the necessary processing stage to prepare the R 128-compliant content to a higher target level (including appropriate high quality true-peak limiting). This may be performed by an appropriate dynamics processor during actual live streaming operations, thus keeping the "single inventory" strategy. For on-demand streaming, such dynamic treatment would have to be performed beforehand. In the future, level adaptations should be executed within the playback device, with knowledge of the device properties as well as the listening environment.

See: tech.ebu.ch/loudness

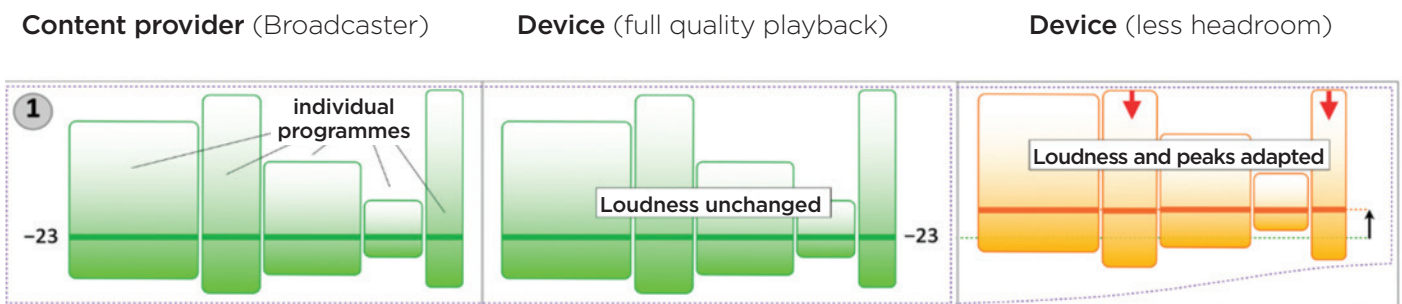


Figure 1: Normalization schemes for a stream at -23 LUFS. When the device is used in a situation with sufficiently high playback gain and headroom as well as low background noise, the loudness level is unchanged. However, the loudness level is adapted when there is limited playback gain and headroom and/or higher background noise; high-quality true-peak limiting is performed where needed (see the two red arrows).

MediaRoad: two years later, what has it achieved?

This European-funded project was tasked with giving a boost to innovation in Europe's media sector. BBC's **Judy Parnall**, who was on the MediaRoad project team, takes stock of what has been achieved.

Over the two years of the MediaRoad project, each of its constituent hubs – Sandbox, Policy and Network – has achieved a huge amount and all have exceeded their original aims. The project was established in 2017 under the EU's Horizon 2020 programme. Coordinated by the EBU, its aim was to support the transformation of the European media sector by building an ecosystem for innovation.

MediaRoad brought together a broad network of media stakeholders. They included diverse media associations, public service media organizations, commercial radio

MEDIAROAD IN NUMBERS

18 media innovation accelerators powered up by MediaRoad's Sandbox Hub
2 policy vision papers
20 thematic conferences and workshops
10 SkillBytes podcasts about digital transformation and the skills and competences of media professionals
50 stakeholders officially joined the network

broadcasters, media workers' organizations, academic research institutes and innovation centres, independent producers, and SMEs.

The objective was to boost

innovation across the European media sector and reawaken a "start-up" mentality in the sector. The project aimed to bring innovative concepts to fruition and market deployment while also helping to shape future media policy and contribute to the digital transformation.

The resources from all three hubs remain available on the MediaRoad website (www.mediaroad.eu). The Sandbox hub has planned its next phase and will be developing further with additional innovation models. The MediaRoad network will live on through LinkedIn, for future collaboration and sharing of developments.

SANDBOX HUB

The goal was to establish a series of Sandbox incubators that would work with start-ups to pitch, test and scale their innovations and to form a network to share case studies and learnings.

While the initial target was to build a network of four Sandboxes, by the end of the project, new or existing Sandboxes from 17 media organizations and two from non-media organizations had joined the hub. They are now exchanging best practice and contacts, including potential collaborators and innovation events. Several projects are emerging from these Sandboxes. The project has also published toolkits for establishing and running Sandboxes and guidelines on innovation and IPR exploitation.

At IBC2019, the Sandbox hub presented awards for the best projects to receive the Sandbox Quality Label. The top award went to Newsbridge for its Newsbridge idX project with France Télévisions. The runner-up was On-Hertz, for its radio-studio-on-a-tablet project with VRT. In addition, France Télévisions was recognized for generating the most projects to attain the Quality Label.

NETWORK HUB

The Network hub aimed to foster a network of researchers, broadcasters, production companies and others to encourage and share innovation. This was done through newsletters and events.

The events focused on diverse topics including robo-journalism; media innovation in the age of AI, social media and fake news; and post-convergence radio. The network also produced a series of podcasts called MediaRoad SkillBytes to explore what the transformation of the media technology environment means for professional journeys with regard to jobs, skills, recruitment and training.

POLICY HUB

The focus of the Policy hub was the development of a long-term policy vision for the whole radio and AV sector – including broadcasters, technology companies, social media providers, production companies, journalists and research institutes.

Two major vision documents on future and emerging technologies for the media sector were published to a wide audience. In addition, the hub provided consolidated responses to seven EU consultation calls and published eight quarterly newsletters and blogs along with several presentations and workshops.

MediaRoad received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 761412.

Content and technology: two sides of the same coin?

David Wood explores whether the technology that is used to deliver content is having an increasing impact on the creation of that content and what this means for the creators.



“But will there be, in the years ahead, forces that will change the process of content creation itself? Could technology and content eventually become, to an extent, sides of the same coin?”

We know about the revolution taking place as programme production migrates to technology based on IP, Internet Protocol. Content providers will be able to meet the needs of changing and multiple content forms. It will mean greater flexibility and perhaps, eventually, lower costs in programme making.

But will there be, in the years ahead, forces that will change the process of content creation itself? Could technology and content eventually become, to an extent, sides of the same coin? To be successful in future, will broadcasters and broadband providers need not only to win on content ideas but on technology too? The answer is probably yes.

TECHNOLOGY INFLUENCING CONTENT

There are many areas where technology influences or shapes media content. One is that the public face of the content provider can change from a channel button on the remote control to an app on a smart TV – and the skill with which that app is created will influence how little or how much content is watched.

But if there is a change in content making, a major impetus will be the growth in delivery via internet, whether OTT, web or hybrid services. Pretty much all content is, or eventually becomes, available via internet; and that usually allows the content provider to know which terminal is using their content at any moment.

The characteristics and feedback possibilities of internet delivery are becoming ever more used. Learning the habits of users makes it possible to offer the user recommendations about what he or she may want to watch, bearing in mind their interests. The PEACH system developed by several EBU Members

is an example. (See page 5.)

Not only can content providers learn what the user's habits were in the past, they can know what the users are doing at any moment, and thus in principle could adjust the content to maximize the number of users.

All of this can be said to constitute the use of big data.

SKILLS FOR PROGRAMME-MAKING

Bearing all this in mind, we may be moving on from a world where programme makers have required skills in two main areas: the first is creativity and imagination – the process known as ideation. The second involves interwoven abilities related to knowledge and experience.

Such abilities will always be necessary, but in future we may need to add to the list the skill to harvest and make use of big data.

Knowledge derived from big data could help decisions on the content itself as well as on which delivery platform the use of the content will be optimized. Can we even dream of a world where a media narrative can be adjusted in real time using big data?

Ideas like these have recently prompted the epithet “content is technology – technology is content”.

This might not be Voltaire's “best of all possible worlds” for media. Maybe it could be argued that content should challenge the user, offering something not experienced before. If we rely too much on big data, yes, we may end up with the popular, but will it be largely formulaic?

On the other hand, remember that most consumer commodities use far more sophisticated marketing tools than the media world has ever done, and maybe this silent revolution cannot be avoided. Perhaps it is the natural course of media evolution.

Taking DASH from specification to real business

In this series we profile organizations with which the EBU collaborates on technology-related matters. **Thomas Stockhammer** introduces the DASH Industry Forum.

The DASH Industry Forum (DASH-IF) was founded in 2012 to promote and catalyze the adoption of MPEG-DASH and help transition it from a specification into a real business. Since then, the organization has published several versions of its Interoperability Guidelines and other supporting material for the support of interoperable DASH-based streaming services for media streaming over the internet.

With more than 80 members, DASH-IF represents a large footprint of the ecosystem, including service providers, content delivery network operators and broadcasters, as well as technology providers in different domains, to connect the dots in an otherwise fragmented world of internet streaming services. DASH-IF also serves as the point of contact for other standards organizations when introducing new distribution means. As an example, DASH-IF regularly exchanges information with ATSC, DVB, EBU, HbbTV, 3GPP, CTA WAVE, MPEG, ETSI and the Ultra HD Forum in order to support their efforts for improved streaming services over the internet.

All work in DASH-IF is supported by publicly accessible test, reference and conformance tools. These include, for example, a reference DASH client (recently used for EBU demonstrations at IBC2019, see page 12) and a conformance checker that can be used to check if your service conforms to the DASH standards.

New DASH-IF implementation guidelines are on course for publication in early 2020. These will include the specification of protocol interfaces for live ingest/egress of media content, to be used between linear ABR



encoders, packagers, origins, and CDNs. Also included are sections related to low latency, targeted ad insertion, events and timed metadata, and updates to address the latest developments in DRM-protected media distribution.

While many consider that DASH is done, it seems that we are only at the starting point. Over the last several years, DASH has been established as the only openly standardized streaming distribution format and has, hence, received many inputs, stemming from different ecosystems. Ongoing work will include: the introduction of the Common Media Application Format (CMAF) serving as the convergence between DASH segment formats and other more proprietary systems; the role of DASH in television distribution (ATSC 3.0, DVB-I, SCTE, etc.); the development of new video codecs (VVC, EVC, AV1, etc.) and formats (HDR, 8K, VR); and, of course, the continuous and

growing interest in the mobile domain with the advance of 5G.

DASH-IF supports a multitude of promotional efforts, contributing to events such as the Media Web Symposium, EBU BroadThinking, DVB World and the Mile High Video workshop or organizing its own workshops. DASH-IF is also active in supporting the research community, and regularly issues academic awards and challenges.

Last, but not least, DASH-IF is well-known for its flagship social events, one at NAB in April, and one at IBC in September. Several hundreds of subject matter experts and friends gather to meet for a beer, a snack, some home-grown music and a lot of good networking. There are more than a few experts who come to IBC/NAB only because of the DASH-IF networking party!

You can find information on how to join this lively group and support its efforts by visiting: www.dashif.org

Planting seeds in Spotify's walled garden

Music streaming platforms are morphing into full audio platforms, forcing public broadcasters to decide on a strategy to follow. **David Fernández Quijada**, Manager of the EBU Media Intelligence Service, reports on this emerging trend.

On 6 February 2019, the leading music streaming platform Spotify announced that from that day it was considering itself not just a music service but an audio platform. Since then, Spotify has acquired several podcast studios to produce its own original shows while opening its platform to any publisher. The result is a growth in podcast consumption on this platform (+39% quarter-over-quarter in Q3 2019) and imitation from competitors such as Deezer.

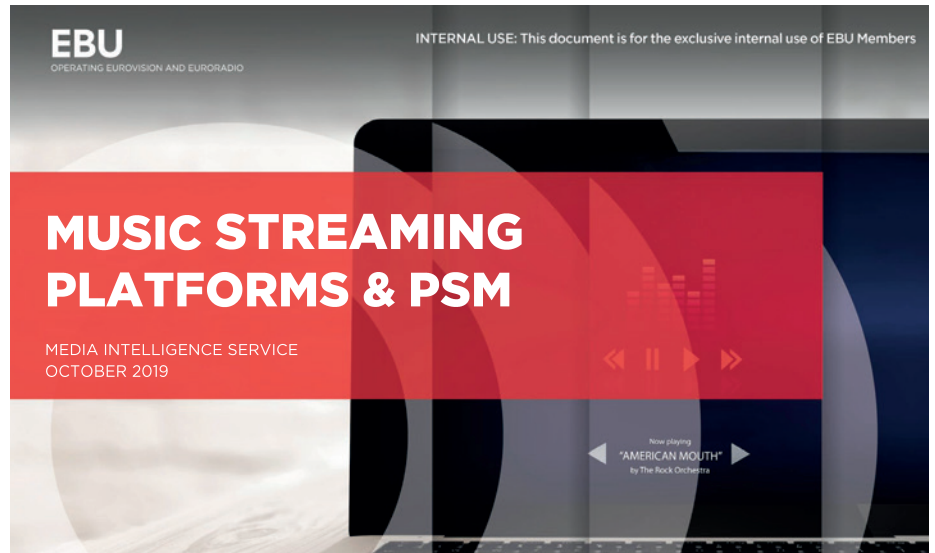
Another result is increased engagement from public service media in Europe, targeting Spotify's 248 million active users per month: 47 public broadcasters from 28 markets offer more than 2,800 shows on Spotify, including some television-only organizations.

On one hand, platforms like Spotify are seen as competitors for audiences; on the other, they are seen as a way to reach audiences that perhaps would never go to public radio-owned platforms. As a result, up to 11 public broadcasters have some kind of ongoing cooperation with Spotify.

These platforms also, of course, remain a magnet for music lovers, who in most cases are also radio listeners. That's why public broadcasters curate more than 2,600 playlists on Spotify, adding up to more than 170,000 music tracks.

This relationship with third-party platforms is not without problems: public broadcasters believe insufficient audience data is shared with them while complaining also about the (lack of) prominence of their services.

While these platforms are here to stay, identifying the areas in which public broadcasters



Public radio podcast offer on Spotify (Source: EBU based on Spotify)



Public radio playlists on Spotify (Source: EBU based on Spotify)

can use them to strengthen their public service mission and deliver more value to citizens remains a challenge for public media strategists.

EBU Members can access our recent report on music streaming platforms. Find it at: ebu.ch/mis-publications

Conference videos on demand

A selection of recent additions to our rich library of videos from EBU Technology & Innovation events, available to Members from: tech.ebu.ch/presentations

MANAGING CYBERSECURITY AT A LARGE MULTIMEDIA GROUP

Andreas Schneider (Tamedia)



Inspiration and advice on becoming an agile CISO

THE JT-NM TESTED PROGRAMME AT IBC2019

Willem Vermost & Ievgen Kostiukevych (EBU), Andrew Bonney (BBC)



A progress report on industry implementation of Live IP standards

TWO YEARS' EXPERIENCE WITH A MEDIA COMPANY SOC

David Garcia (France Télévisions)



Lessons learned from implementing a Security Operations Centre

CROWDSOURCED SECURITY: GET HACKED BEFORE YOU GET HACKED

Inti de Ceukelaire (intigriti)



An ethical hacker explains how you can help him to help you

AI, DATA AND PUBLIC SERVICE MEDIA

Bob van de Velde (NPO)



The new co-chair of the EBU AI & Data Initiative covered some key topics at IBC2019

5G PRODUCTION POSSIBILITIES

Ian Wagdin (BBC)



What does 5G technology promise for content production?

IN THE SPOTLIGHT

Anssi Komulainen CHIEF INNOVATION OFFICER, YLE

WHAT ARE YOUR CURRENT RESPONSIBILITIES AT YLE?

I am the head of Yle Beta, an incubator for future media at Yle, the Finnish Broadcasting Company. We experiment with new trends and emerging technology, and aim to identify the ones that have the potential to transform our industry and create new ways and forms for public service media. Yle Beta is my main tool in steering the innovation strategy of Yle.

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

My background is in content. I was the executive producer for *The Marshal of Finland*, a project in which we explored the flexibility of the stories we use to craft our national identity. We produced a film telling the story of a highly admired Finnish war marshal, in Kenya, with an African crew and an African screenwriter. The audience response to the film and the making-of documentary was controversial to say at the least. I feel that for a brief moment we really managed to mirror our society and truly make a difference.

WHAT ARE YOUR PREDICTIONS FOR MEDIA TECHNOLOGY IN THE FUTURE?

I believe that public service media will be all about data in the not so distant future. Data is the key to creating

personal and meaningful media experiences that enable us to stay relevant in the lives of our users and audiences. I believe that PSM values and the integrity that EBU Members have managed to maintain will be a great asset in future when our users trust us with very personal information about them. I feel that this relationship we have with our audiences will help us deliver the media services that matter the most, despite the enormous resources of our global competitors.

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

The biggest challenges for EBU Members today are the same things that have the potential to become our biggest assets: the complexity of working together with a multitude of very different languages and cultures. Not everyone needs to agree and not everyone needs to be part of everything but if we continue to find enough common ground with enough like-minded people, the cross-functional work culture we create will possess a great power to be leveraged in a myriad of ways.

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

I have a wife and two small boys. The children take care of our agenda outside work and make sure my life has never a dull moment. Whenever I get a chance, I enjoy exploring the world by travelling or having a nice conversation over a pint.



WRC-19 REVIEW WORKSHOP

OUTCOME OF WRC-19 AND
PLANNING FOR WRC-23

21 January,
EBU, Geneva

For EBU Members only

Register at
tech.ebu.ch/wrc19workshop

PRODUCTION TECHNOLOGY SEMINAR

AN EBU EVENT

28-30 January,
EBU, Geneva

Register at
tech.ebu.ch/pts2019

DIGITAL RADIO SUMMIT

AN EBU EVENT

12 February,
EBU, Geneva

Register at
tech.ebu.ch/drs2020

BROADTHINKING

AN EBU EVENT

WHERE BROADCAST
MEETS BROADBAND

24-25 March,
EBU Geneva

Register at [tech.ebu.ch/
broadthinking2020](http://tech.ebu.ch/broadthinking2020)