INSIGHT FROM EBU TECHNICAL

ISSUE 12 • JUNE 2012

tech-i

Hacking Digital Radio

Plus WRC-12: WHAT NEXT FOR DTT? • EBUCORE • INTRODUCING MPEG-DASH
FREE & OPEN SOURCE MEDIA SOFTWARE *...and much more*

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EBU TECHNICAL
MEDIA TECHNOLOGY & INNOVATION

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BE FIRST TO AIR

News and sports contribution is one of the most complex and demanding environments in the broadcast market. Guaranteed performance, interoperability, reliability and readiness for any application or scenario is of paramount importance.

However, contribution architectures are rapidly changing, and although satellite networks have been the mainstay for contribution applications, modern fiber networks continue to expand providing operators the option to use high bandwidth fixed links as an alternative.

These options for connectivity and corresponding bandwidth differences create additional choices in video compression technologies; MPEG-2, MPEG-4 AVC and JPEG 2000 which are now all valid alternatives. Having choice is a great enabler, but for broadcasters, system operators and contractors, these choices of connectivity and technology are leading to multiple device investments to ensure compatibility with any scenario and reduce risk of lost revenue.

As the pioneer in contribution solutions, Ericsson is resolving this challenge with its new range of contribution platforms. The new AVP3000 Voyager is already supporting multiple compression technologies, MPEG-2, MPEG-4 AVC and JPEG 2000 in both SD and HD for both satellite and IP transmissions. Ericsson's RX8200 Receiver is now ready to fully compliment the AVP3000 Voyager by supporting the same choices of compression and transmission technologies.

Recently selected by the EBU for its MPEG-4 AVC refresh project, Ericsson's RX8200 Advanced Modular Receiver is fast becoming the de-facto standard for contribution applications throughout the world.

For more information, please visit
www.ericsson.com/television

ERICSSON

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Issue 12 • June 2012

Cover Story: Our cover features a Hybrid Radio voting application using RadioDNS. It was developed during the RadioHack workshops that took place at the EBU during Radio Week in February. See page 7.

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Sustaining or disrupting technology?

Lieven Vermaele
EBU Director of Technology & Development

Some developments bring about immediate changes to our business, while others change things over the longer term. Those that change the short to medium term can be characterized as reactive or tactical, and are often done to maintain market share or enhance a value proposition in an existing market.

Such evolutions are driven by 'sustaining' technology innovations – technologies that improve the performance, price point, quality or value to the consumer. Examples may include DVB-T2, HDTV, Hybrid TV, etc. Implementing them makes good sense for a media organization because they maintain the existing business model and are predictable in terms of impact.

But some evolutions are less visible and can have an even greater impact in the long term. It is crucial to recognize them as part of a strategic move to build new market share in markets yet to emerge, and to create new value propositions. These evolutions are driven by 'disruptive' technology innovations.

We can see that broadband and IP systems will be everywhere; on-demand media is on the rise; app-driven models are gaining acceptance; HTML5 and Adaptive Streaming improve the interoperability of media on the internet; etc. These technologies can create a new medium and a new experience. Media organizations should never ignore these evolutions, but should actively understand what (and how) media products will be built and consumed in the future. Because it is harder to predict what will generate new markets and revenue, it is difficult for management to value and approve these projects on traditional terms. However these projects are essential because the (media) world will change. The timeline is unclear but the impact can come faster than we think.

Sustaining technology innovations are important for maintaining and maximising profit/share in existing markets. But media organizations should not ignore disruptive technologies and should start to build and prepare their future products and business. With appropriate organization, both can be coped with.

So, by their very nature, disruptive technology innovations are harder to predict. But we can still try! In asking where some of the trends might lead us, I propose the following three predictions.

IP in the home, the office and the car will be key. We will no longer require different set-top boxes or specific devices for difference screens. Indoor reception or redistribution of broadcast signals will be replaced by IP and we will have screens and devices that 'talk' with each other. In this scenario there may be a place for broadcasting via a media server (perhaps as part of a TV set or as a future router/set-top box) that will be able to seamlessly integrate broadcast signals received from outdoors and fixed broadband.

The zapper with number buttons we know today can be thrown away. The experience of watching TV channels won't change overnight, but in future it will start from selection on a personal device. From their smartphone or tablet people will select a live channel, on-demand content or even an App (where the live and on-demand elements are integrated). Thus the TV becomes a display and less a media receiving device. We have video in a full screen browser: and you can watch the selected programme on any kind of visual device and transfer the experience seamlessly between devices.

This leads to my third prediction, where the concept of a TV channel changes or disappears to be replaced by an App. What if one of today's newspaper or children's game Apps were to add live or on-demand programming within the App? This would give us the opportunity to watch TV via these 'brands'. Paying a few euro per monthly subscription for an App will be much cheaper than a cable subscription for hundreds of channels, of which I really only watch a few.

It's time for the EBU and our Members to develop a new vision for the future of media. We plan to start that process at June's Technical and General Assemblies.

WORKPLAN

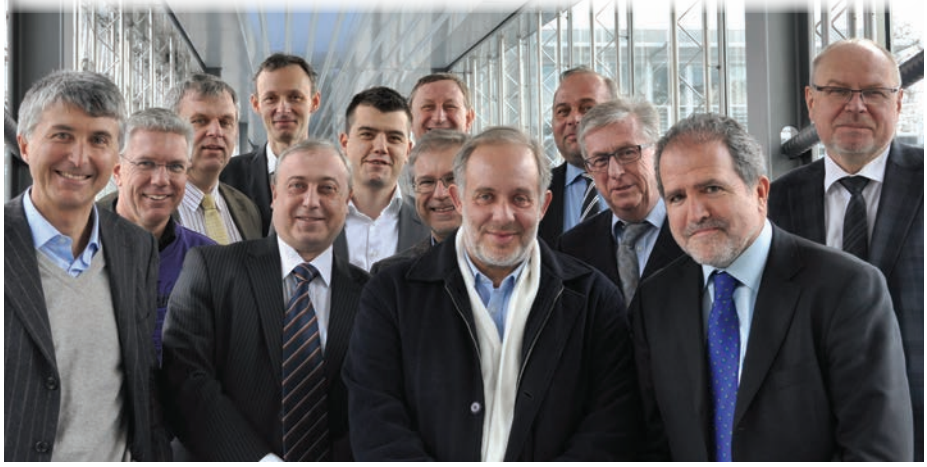
A PLAN COMES TOGETHER

The work done by our Strategic Programmes (SPs) over the last year has been driven by the 2011-2012 Workplan, developed by the Technical Committee in conjunction with staff in the Technology & Development Department. In February of this year we began the process of developing its successor.

The **2012-2013 Workplan**, due to be approved in May by the Technical Committee and later endorsed at the Technical Assembly, is based on inputs from the Chairs and Vice-Chairs of the SPs and Project Groups. The Technical Liaison Officers were also given an opportunity to review and comment on the document, to ensure that it adequately reflects the needs of the EBU membership. This planning process helps to ensure that the EBU's technical work remains relevant and is carried out according to well-defined, time-bound objectives.

TECHNICAL COMMITTEE

Elections for the Technical Committee 2012-2014 will take place during the Technical Assembly in Zagreb (7-8 June). We are grateful to the outgoing committee for their contribution over the last two years. Left to right: Alberto Morello (Chairman), Egon Verharen, Klaus Illgner-Fehns (1st Vice-Chairman), Petr Vitek, Igor Orlov, Lieven Vermale (Director EBU Technology & Development), Andy Bower, Thomas Saner, Carlos Gomes, Kazimir Bacic, Arild Hellgren (2nd Vice-Chairman), Pere Vila Fumas, Jorma Laiho. Not pictured: Yves le Bras.



BROADTHINKING 2012

BROADBAND DEBATES

For two days at the end of March the talk in Geneva was all of Content Delivery Networks, video streaming, multiscreen apps and policy related subjects like net neutrality. The annual EBU BroadThinking seminar is very much at the cutting edge of new services offered by broadcasters exploring the possibilities opened up by internet-connected TVs and mobile devices.

It was clear from the amount of discussion that followed all of the sessions at BroadThinking 2012 that this is an area where best practices are still in formation. One lively debate concerned whether the emphasis should be on Quality of Service, via a managed end-to-end network, or rather on ensuring Quality of Experience while using the open internet as best effort network. There was broad agreement that the current state of the internet is not suited to large scale high quality networks – but delegates also heard presentations that pointed to how these issues could be resolved in future.

Elsewhere in this issue of tech-i you can find an article on the new MPEG-DASH adaptive streaming specification (page 6).

BroadThinking 2013 will take place on 27-28 March. The presentations delivered at BroadThinking 2012 are available on the EBU TECHNICAL website: http://tech.ebu.ch/broadthinking2012

DISCUSSION PANEL AT BROADTHINKING 2012 – FROM LEFT TO RIGHT: STEF VAN DER ZIEL (JET-STREAM BV), THOMAS STOCKHAMMER (QUALCOMM), YANNICK LE LOUÉDEC (ORANGE LABS), JARI AHOLA (VTT), DAVIDE MILANESIO (RAI).

Video Library

The EBU TECHNICAL video collection is growing, including event reports, introductions to technical topics, webinar recordings, and presentations from our seminars and events. Visit: http://tech.ebu.ch/videos

PRODUCTION TECHNOLOGY SEMINAR 2012

ROBERTO POMARI (RSI), KEYNOTE SPEAKER AT PTS 2012

DIGITAL RADIO SUMMIT 2012

SUMMING UP THE SUMMIT

At the heart of the EBU's Radio Week is the Digital Radio Summit. With most of the key technical and standardization bodies for digital radio meeting in Geneva that week, the Summit is naturally an opportunity for open and wide-ranging discussion. In addition to the usual updates from the aforementioned standards bodies, one of the main themes this year was looking to some of the 'latecomers' to digital radio. A keynote from Joël Ronez of Radio France, and a later presentation on French community radio provided some insight into the direction the digital debate is taking in that country. Delegates also heard from Germany, the Netherlands and Denmark, three countries where the future looks bright for DAB-based digital radio.

The Summit also provided a chance to look at some of the latest technology developments for radio. There were progress reports on the possibilities presented by visual radio and radio "tagging", as well as a look at the latest moves towards enabling a mass market for digital radio in cars. Also in the technology domain, earlier that same week the RadioHack workshops brought together software developers, integrators, and engineers from broadcasters, service providers, network operators and manufacturers for some hands-on hacking. (See full report on page 7.)

The **Digital Radio Summit 2013** will take place on 13 February. Videos of the presentations from this year's Digital Radio Summit are available to EBU Members on the website: http://tech.ebu.ch/digital-radio-summit12

(LEFT TO RIGHT) JØRN JENSEN (WORLDDMB), NICK PIGGOTT (RADIODNS), RUXANDRA OBREJA (DRM), ANDY GIEFER (IMDA), AT THE DIGITAL RADIO SUMMIT 2012.

TALKING TRANSITION

Print deadlines meant that we couldn't report fully on this year's EBU Production Technology Seminar (31 Jan – 2 Feb) in the March edition of tech-i. It's still worth noting now, nonetheless, that it was a hugely successful event, with almost 120 participants gathering in Geneva for three days of presentations around the theme of Production@transition. In his final wrap-up of the event, the EBU's Dr Hans Hoffmann said that it had been "an important event for EBU Members facing difficult decisions regarding their next investment cycles".

Almost all sessions returned to the same overarching theme: the need to adapt to increasingly complex production environments. Whether in the areas of digital workflows, codecs or metadata, it was evident that the transition to file-based, IP-based systems presents numerous challenges. Speakers reported on key work being done by the EBU, SMPTE and in other domains to meet these challenges. The task of measurement in one form or another – of displays, cameras, audio, and with respect to Quality Control – was another area in which delegates took away lots of information and advice on how best to make the most of the technologies available and still in development.

PTS 2013 will take place from 29-31 January. Videos of the presentations delivered at PTS 2012 can be accessed online by EBU Members: http://tech.ebu.ch/pts2012

Technical Assembly 2012
7-8 JUNE, ZAGREB

TA2012 is hosted by HRT, Croatia's national public broadcaster. The programme includes a number of interactive discussion sessions, presentations on technology topics of strategic importance, and elections for the 2012-2014 Technical Committee.

http://tech.ebu.ch/ta2012

MDN Workshop
20 JUNE, GENEVA

The Metadata Developer Network (MDN) workshop is a unique opportunity offered to metadata experts and developers to participate in hands-on demonstrations exploring new dimensions of information management.

http://tech.ebu.ch/metadata12

Network Technology Seminar 2012
26-27 JUNE, GENEVA

The Media & IT Rendezvous. NTS is aimed at broadcast engineers dealing with specialized and IT infrastructure as well as IT network and storage specialists who deal with broadcast media content.

http://tech.ebu.ch/nts2012

Libre Software Meeting
7-12 JULY, GENEVA

An open platform for Open Software users, developers and stakeholders. The EBU, as a supporting partner for the event, has developed a series of sessions on media, radio, television and professional graphics.

http://tech.ebu.ch/opensource2012

IBC 2012
6-11 SEPTEMBER, AMSTERDAM

As usual the EBU will be present at Europe's largest broadcast media convention. Along with demos and presentations on the EBU booth (10.F20), a conference session on Saturday afternoon will provide advice on how to "Prepare Today, Prosper Tomorrow".

http://tech.ebu.ch/ibc2012

Looking further ahead...

Forecast 2012
14-15 November

Production Technology Seminar 2013
29-31 January

Digital Radio Summit 2013
13 February

BroadThinking 2013
27-28 March

Let's DASH!

WITH THE COMPLETION OF THE MPEG-DASH STANDARD, THE INDUSTRY IS PROVIDED WITH AN ENABLER STANDARD FOR MASSIVELY SCALABLE DISTRIBUTION OF HIGH-QUALITY STREAMING VIDEO OVER THE OPEN INTERNET. QUALCOMM'S **THOMAS STOCKHAMMER** EXPLAINS.

In the last century, access to video delivered over networks was almost exclusively dominated by scheduled consumption on dedicated devices – broadcasters distributed premium content at a specific time to TV sets. Broadband internet, both fixed and mobile, as well as highly capable devices such as smartphones and tablets have changed video consumption patterns dramatically in recent years. Video is now consumed on-demand on a multiplicity of devices according to the schedule of the user.

Recent studies conclude that mobile data traffic will grow by a factor of 26 between 2011 and 2016 and that by 2016 video traffic will account for at least two-thirds of the total. The popularity of video also leads to dramatic data needs on the fixed internet. In North America, real-time entertainment traffic (excluding p2p video) today contributes more than 50% of the downstream traffic at peak periods, with notably 30% from Netflix and 11% from YouTube.

HTTP DELIVERS

The astonishing thing is that these data needs are not driven by traditional broadcast, IP multicast or managed walled-garden services, but by over-the-top video providers. One of the cornerstones of this success is the use of HTTP as the delivery protocol. HTTP enables reach, universal access, connectivity to any device, fixed-mobile convergence, reliability, robustness, and the reuse of existing delivery infrastructure for scalable distribution.

One of the few downsides of HTTP-based delivery is the lack of bitrate guarantees. This can be addressed by enabling the video client to dynamically switch between different quality/bitrate versions of the same content and therefore to adapt to changing network conditions. The provider offers the same media content in different versions and the client can itself select and switch to the appropriate version to ensure continuous playback. Figure 1 shows a typical distribution architecture for dynamic adaptive streaming over HTTP. HTTP-based Content Delivery Networks (CDNs) have been proven to provide an easy, cost-efficient and scalable means for large-scale video streaming services.

SETTING A STANDARD

MPEG has taken the lead on defining a unified format for enabling Dynamic Adaptive Streaming over HTTP (DASH). MPEG-DASH was ratified in 2011 and published as a standard (ISO/IEC 23009-1) in April 2012. It is an evolution of existing proprietary technologies that also addresses new requirements and use cases. DASH enables convergence by addressing mobile, wireless and fixed access networks, different devices such as smartphones, tablets, PCs, laptops, gaming consoles and televisions, as well as different content sources such as on-demand providers, broadcasters, or user-generated content offerings.

The standard defines two basic formats: the Media Presentation Description (MPD) uses XML to provide a manifest of the available content, its various alternatives, their URL addresses, and other characteristics; and Segments, which contain the actual media streams in the form of chunks, in single or multiple files. In the context of part 1 of MPEG-DASH the focus is on media formats based on the ISO base media file format and the MPEG-2 transport stream.

With these basic formats MPEG-DASH provides for a very wide range of use cases and features, including support for server and client-side component synchronization and for efficient trick modes, as well as simple splicing and (targeted) ad insertion and session metrics. DASH can support multiple Digital Rights Management systems, content metadata, and support for advanced codecs including 3D video and multi-channel audio.

TOWARDS DEPLOYMENT

With the completion of the standard the focus has shifted towards deployment and commercialization of DASH. In this context MPEG will later this year publish Conformance Software and Implementation Guidelines and continues to work on client implementations and optimizations. This is especially relevant for a stable and consistent user experience under varying network conditions. On the distribution side, coming optimizations include DASH for CDNs – to improve efficiency, scalability and user experience – along with integration into mobile networks and transition between unicast and multicast distribution.

The creation of the DASH Promotors' Group (http://dashpg.org) will help to address interoperability and promotional activities. The EBU is among the 50 major industry players that make up this group. Support is also provided for other standards planning to include MPEG-DASH to enable over-the-top video, including HbbTV, DLNA, the Open IPTV Forum and 3GPP. Furthermore, the W3C consortium is considering extensions to the HTML5 video tag that would aid the integration of DASH into web browsers.

The significant efforts currently under way to deploy DASH in a wide range of contexts raise the expectation that MPEG-DASH will become *the* format for dynamic adaptive streaming over HTTP.

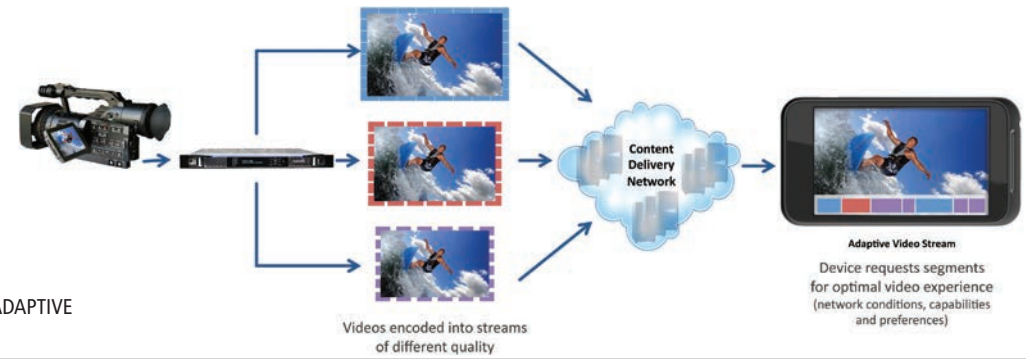
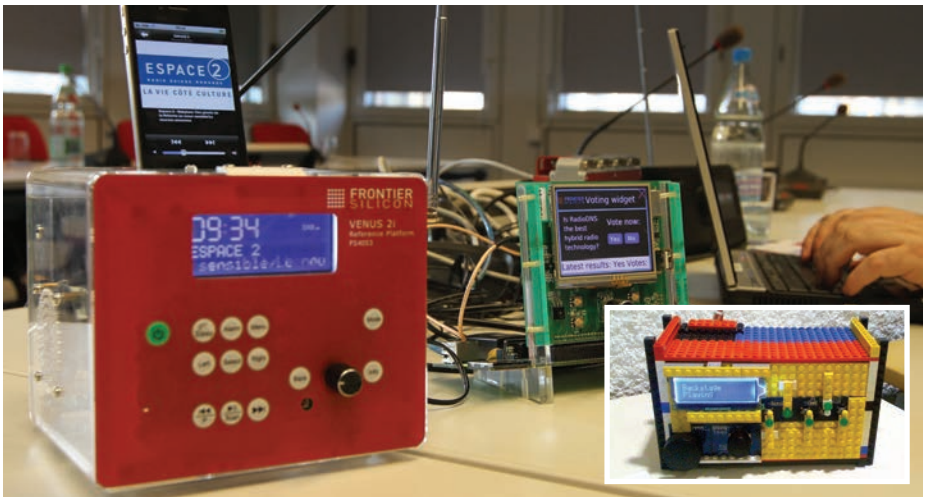


FIGURE 1: ARCHITECTURE FOR ADAPTIVE STREAMING OVER HTTP



RADIODNS VOTING APPLICATION BASED ON A RECEIVER CHIP FROM FRONTIER SILICON; INSET: LEGO DAB RADIO BUILT USING MXLAB'S DIGITAL RADIO KIT

THE EBU'S **MATHIAS COINCHON** EXPLAINS WHY HACKERS DESERVE A MORE POSITIVE REPUTATION, PARTICULARLY AS THEY PUSH THE BOUNDARIES OF HYBRID RADIO TECHNOLOGY.

Hackers at Digital Radio Week

Don't worry – this has nothing to do with criminal activities! Despite a misuse of the word in the press, the correct definition of a hacker is a person who builds, rebuilds, modifies, or creates software or electronic hardware, either to make it better and faster, to give it added features, or to make it do something it was never intended to do.

So RadioHack 2012 (13-14 February) was organized as a creative event for developers and engineers from broadcasters and industry, as well as for students. It was for anyone interested in tweaking or modifying software, playing with prototypes, and innovating to open new possibilities for radio. Many EBU events concentrate on strategy and theory, with PowerPoint presentations dominating, but this was really a hands-on event. Participants had an opportunity to make new contacts, exchange source code and experiences and, most of all, to experiment. In the context of the proliferation of tablets and multimedia devices, radio hackers can take advantage of the scalability of such devices to innovate. Hybrid radio applications using DAB/DAB+ and RadioDNS were at the centre of this event thanks to the active participation of BBC R&D, CRC, Global Radio labs, IDAG and EBU TECHNICAL.

HACKING HIGHLIGHTS

RadioTAG, demonstrated by BBC and Global Radio, is a hybrid radio application that enables a simple clicking action from the listeners on their receiver when something catches their attention on air. The "tag" thus created can be used to listen again, receive more information or to share on social networks. At RadioHack, open source tools and libraries to start using RadioTAG were shown.

Other hybrid applications explored by the hackers included RadioVIS for adding visual elements to broadcast radio and RadioEPG. The latter, in addition to delivering electronic programme guides, also enables transparent service following from broadcast to broadband, e.g. seamlessly moving from a DAB transmission to the same service on the internet if the broadcast signal is lost.

OPEN SOURCE TOOLS

EBU TECHNICAL has created a free experimental online service and an open source production platform for broadcasters who want to start making hybrid radio using RadioDNS. These tools were used by some at RadioHack to enable hybrid radio on their own networks.

CRC (Communications Research Centre Canada) hosted a complete workshop on their tools:

- mmbTools, the free open source DAB+ broadcast chain suite with a multiplexer, modulator and encoder;
- FM TwoO, an RDS library for the FM tuner in the Samsung Galaxy phone and a RadioDNS app;
- OpenMokast, the free/open DAB/DAB+ software receiver implementation.

A high power DAB+ transmission from the roof of EBU, covering the Geneva region was on air during the week, showing CRC mmbTools integrated in a real "DAB+-in-a-box" setup, enabling affordable digital radio for local/community radio. IDAG also brought some Enspert DAB+/DMB Android tablets with their Application Programming Interface. Participants were able to install and learn how to develop applications using the broadcast tuner.

A welcome last minute participant was Frontier Silicon, who brought a new possibility to display Scalable Vector Graphics (SVG) on their newest receiver chips, making it possible to send interactive images to receivers. One student, also working part time for a broadcast solution company, took the opportunity to create a voting application using SVG visuals for receivers with direct feedback to the music rotation system in the broadcast production system.

And finally, mxlab brought along their digital radio kit, successfully used for schools where children can build a radio themselves and create their own case, as with the Lego-based device pictured.

So, many contacts developed between broadcasters and also with industry, a lot of knowledge was exchanged and everyone left with new ideas and inspiration. We're now seeing more and more applications trialled by broadcasters. Now that the technology proofs-of-concept have been made, the next step is also to test real content and create use cases for the features demonstrated.

JOIN RADIOHACK

After the success of this first edition, we have created a RadioHack community under the umbrella of the Digital Radio Platforms (DRP) Strategic Programme. The community will be active mainly through an annual RadioHack event, with a mailing list and wiki used to share resources throughout the rest of the year. So don't hesitate to join if you are interested or contact us for more information. Resources can be found on: **http://tech.ebu.ch/radiohack**

DELEGATES AT WRC-12 IN GENEVA, FEBRUARY 2012. PHOTO: ITU / P.M. VIROT

Harmonizing the 700 MHz band?

FINDING A WAY FOR BROADCAST AND MOBILE SERVICES TO LIVE TOGETHER IN THE 700 MHZ BAND. **WALID SAMI** OF THE EBU SETS OUT OPTIONS.

The World Radiocommunication Conference WRC-12, held in Geneva from 23 January to 17 February 2012, decided to allocate on a co-primary basis the 700 MHz band (between 694 MHz and 790 MHz) in Region 1 to the Mobile service immediately after the next Conference scheduled in 2015. Furthermore, this band has been identified for use by the International Mobile Telecommunication (IMT) family of applications.

This decision was taken in response to the request made by African and Arab Administrations just before the Conference. Most of these Administrations cannot release the 800 MHz band (from 790 to 862 MHz, allocated by WRC-07) from existing services, because it is mostly used for governmental applications. Since the 700 MHz band is not yet used for digital broadcasting in the concerned countries, it provides a solution for them to introduce IMT applications in the UHF band in a reasonably short timeframe.

However, the situation in Europe is completely different. The 800 MHz band was released from broadcasting after the WRC-07 decision and several policy and regulatory measures were taken in Europe to harmonize and promote its use for 4G systems with an accelerated pace. The released broadcasting frequencies were reallocated in the remaining UHF band below 790 MHz. Considerable standardization and regulatory work has been carried out to cope with this new situation. This included managing interference in the DTT reception below 790 MHz, treatment of the consequences for cable TV services which continue using the 800 MHz band, and reallocation of Program Making and Special Events (PMSE) services from the 800 MHz band to the remaining band.

The discussion in Europe on long term usage of the UHF band does in fact include the possible sharing of the band with other services, in what is called the "2nd digital dividend". The decision of WRC-12 will undoubtedly accelerate this debate in Europe and would force some Administrations, individually or within the CEPT framework, to make decisions earlier than expected. All stakeholders will therefore need to define relatively quickly their policy with regard to their future presence in the UHF band.

Whatever the decision will be, it is almost certain that the implementation of mobile services in the 700 MHz band will not be made at the same time in different parts of Region 1, namely Africa, Middle East and Europe. The large differences in the weight of terrestrial broadcasting among European countries will further complicate the situation in Europe. Most likely there will be a period of many years of sharing the band between different services before a harmonized use is achieved, if at all.

This timing issue will make it necessary to coordinate potential different uses of the 700 MHz band between neighbouring countries. This requires adequate and agreed technical tools and methods to help reach agreements between Administrations on operational conditions (separation distances, transmission characteristics, mitigation techniques, etc.) of the networks on both sides of a border. The role of the ITU in defining and approving such methods is crucial and the contribution of the broadcasting community to the definition of these methods is essential.

The EBU continues to contribute to the activities of ITU-R on these subjects in close cooperation with all stakeholders of terrestrial broadcasting in and outside Europe.

The road to WRC-15

THE EBU'S **ELENA PUIGREFAGUT** OUTLINES HOW THE BROADCAST COMMUNITY HAS STARTED THE CRUCIAL PREPARATIONS FOR THE NEXT WORLD RADIOCOMMUNICATION CONFERENCE IN 2015.

At WRC-12 decisions were made to set a course for a second digital dividend, as outlined in the article opposite by Walid Sami. Losing the use of the 700 MHz band – or more – would call into question the long term viability of terrestrial television broadcasting. The threat is very serious for the broadcasting community, so any preparations for WRC-15 cannot be envisaged without all stakeholders joining forces to develop the case for a vibrant and sustainable terrestrial television broadcasting platform.

The timetable to prepare for WRC-15 is very tight; the Conference Preparatory Meeting (CPM) last February agreed on the establishment of a Joint Task Group, JTG 4-5-6-7, to be responsible for the two relevant agenda items. For the 700 MHz band, spectrum and protection requirements for the broadcasting and mobile services need to be submitted before 31 December 2012 (agenda item 1.2). For additional frequency bands to be allocated to the mobile service, information needs to be submitted by 31 July 2013 (agenda item 1.1). And the work of the JTG 4-5-6-7 should be completed by the third quarter of 2014, leaving enough time for the report to be published before the second WRC-15 preparatory meeting in the first quarter of 2015.

SM WORKSHOP

As a first step, on 27 March 2012 the EBU Strategic Programme on Spectrum Management (SM) held a workshop titled "WRC-12: What next for DTT?". The complete terrestrial broadcasting chain was represented with more than 60 participants from 19 different European countries. Participants represented public service and private broadcasters, broadcast network operators, media policy regulators, equipment manufacturers and the Programme Making Special Events (PMSE) sector. There was a common understanding of the threats among all participants, who highlighted:

- that a Europe-wide view of spectrum requirements for DTT (including PMSE) would be valued, although there are different national situations (migration plans to more efficient technologies, number of services, type and extent of coverage, importance of regional and local services etc.) which also need to be addressed;
- that the technical conditions for protection of broadcasting services from interference from mobile services, and vice versa, need to be defined;
- that the broadcast community needs to lobby their national governments to define a long-term media policy that provides clarity and certainty for the broadcasting services.

ITU-R QUESTIONNAIRE

Addressing the most urgent task, the SM decided to create a task group to prepare and input on spectrum requirements for the broadcasting service. This task group has been actively contributing to the ITU-R WP6A preparation of a questionnaire to be sent to Administrations and sector members to collect their spectrum requirements for DTT. The questionnaire is expected to be sent by the ITU-R at the end of May 2012, with responses expected before 31 July.

At the WP6A meeting several administrations mentioned that they wouldn't be in a position to define their requirements by the deadline without contributions from broadcasters. It is therefore essential that broadcasters actively contribute at national level with their spectrum requirements. The EBU will also continue working on the matter through the task group. A further workshop may be organized by the SM group, allowing the broadcast community to jointly consider their responses to the questionnaire.

Coordination with sister broadcasting unions, (ASBU for Arab countries, AUB for Africa, ABU for Asia Pacific and NABA for the American continent), has also started through the World Broadcasting Unions Technical Committee.

The SM group has also considered the need to define spectrum requirements for PMSE services; this can be addressed via a specific question in the ITU-R questionnaire about other uses of the UHF band. The SM group will liaise with the Association of Professional Wireless Production Technologies (APWPT) on this topic.

PREPARATORY STUDIES

The SM project group on Sharing with Digital Broadcasting (SDB) has been preparing technical studies related to sharing and compatibility between broadcasting and mobile services and will continue to do so. Contributions are expected to be of key importance at next WP6A meeting, in October 2012, to agree on the methodology for making the compatibility calculations, a likely milestone for the work of the JTG 4-5-6-7.

> It is essential that broadcasters actively contribute at national level with their spectrum requirements.

These EBU groups will also contribute to the European preparations to be undertaken by the CEPT. A project team has been created under the Conference Preparatory Group (CPG), to deal with preparations for WRC-15 agenda items 1.1 and 1.2. The date of the first meeting will be decided by 15 May 2012.

The EBU has also discussed how lobbying for a sustainable terrestrial television broadcasting platform could be organized. The first step is to develop a position on a long term UHF spectrum approach. Once this has been defined, further actions to engage the support of the whole broadcast community will be considered. In the meantime, it remains essential that all members of the broadcast community lobby their national regulators regarding their spectrum requirements for broadcasting services. Remember, the first deadline is 31 July 2012!

HRT – Hrvatska Radiotelevizija

AN OVERVIEW OF THE PRODUCTION AND DELIVERY FACILITIES OF THE CROATIAN NATIONAL BROADCASTER HRT, THE HOST OF THIS YEAR'S EBU TECHNICAL ASSEMBLY. **BY KAZIMIR BACIC, HEAD OF TECHNICAL DEPARTMENT**

HRT is the only public service broadcaster in Croatia. It began life as Croatian Radio (HR) on 15 May 1926, with the television service, HTV, making its first appearance on the same date thirty years later. HTV began with only one news and production studio and a very limited distribution and broadcasting network. From the very beginning HRT has had its own distribution and transmission network, which since 2001 has been run by a standalone company OiV (Transmitters and Communications).

We now have seven TV and twenty radio studios at our headquarters in Zagreb. We have four TV OB vans, three SNGs and eight radio OB vans. HRT also has seven regional radio stations and five regional television centres in different parts of Croatia, with their technical equipment and staff being part of the central Zagreb organization. There are separate Technical Departments for HTV and HR.

HTV's Technical Department has five organizational units: TV Continuity, Production, Lighting, IT Production, and Maintenance. HRT also has a general IT Department and a Power Department.

HRT'S NEW DIGITAL PRODUCTION STUDIO; (INSET) FIRST TV STUDIO IN 1956; (BELOW LEFT) CNCT CONTROL ROOM AT HRT; (RIGHT) TV OB VAN.

GOING DIGITAL

Over the past twenty years or so we have been moving to a completely digital environment for production and, later, delivery. For radio the process started in 1994, and in 2004 we put in place an integrated system for acquisition, production and broadcasting - something that included a digitized archive for radio material. 2004 was also the year that HR fully equipped a new recording studio and put two digital radio OB vans into operation.

Today HR has three national radio services, eight regional, and our international radio service, Voice of Croatia, which is broadcast on MW and SW. We also have three dedicated internet radio services, alongside the broadcast services which are streamed online.

The digitization process for television began in 2002. Among its studios HTV now has two large digital production studios (900m^2 and 600m^2), two digital OB Vans and completely digitized acquisition, production and broadcasting in the News and Current Affairs Department. We installed the AVID nonlinear workflow engine, which integrated asset management, workflow automation and security control into a single system to deliver a business-wide solution. We are constantly upgrading this system, which has tools for searching, archiving, viewing, logging, automatic transcoding, dual-resolution encoding and intelligent tracking of multi-resolution files.

NONLINEAR WORKFLOW

With a click of the mouse users can choose high resolution when developing a trailer, the best available resolution for editing, DV to switch to a laptop computer, or a proxy copy in low resolution for review and easy installation on a desktop computer. While users are engaged in selecting the appropriate resolution, in the background the system performs a complete encoding and transcoding of media content. Upon completion of editing, it is possible to send contributions directly to the video server to broadcast, to the archives or to alternative locations to publish content, such as the web.

The ability to log and view media and to transcode media content into different file formats allows users to save valuable time in the production environment. The digitization of our main television archive remains at the planning stage.

MAJOR ACHIEVEMENTS

Analogue switch-off was achieved on 31 December 2010 and there are now two national DVB-T multiplexes operated by OiV. This has given HRT the opportunity to introduce two new thematic TV programmes; but this also brings challenges, both in technical and programming terms.

In recent years a number of technically difficult productions were successfully delivered. To mention only a few: the visit of President Bush to Zagreb in May 2008, the visit of the Pope to Croatia in May 2011 and the Ski World Cups (both men and women) in January 2012. The Ski World Cups will be presented again in January 2013.

Kazimir Bacic is **In the Spotlight** *on page 15*

Solving the Digital Radio Equation

THE EBU'S DAVID WOOD INVITES YOU TO WEIGH UP THE OPTIONS FOR DIGITAL RADIO.

Radio is priceless. It sets the rhythm of our lives and connects us to the world. In one form or another, it's going to be with us to the year infinity. But radio providers face choices that are complex. They need to decide whether to provide digital radio services (if they have not already done so), which technology to use, and what sound quality to aim for. In each case there are many elements to be weighed up. Given the evidence, what would be your 'heaviest' side of the scales?

In theory, the decision to 'go digital' with radio is a 'no-brainer'. The transition from analogue to digital is an inevitable step for everything electronic, like the transition from sail to steam or horse to car. We need to migrate to digital, to avoid it becoming irrelevant in the digital age, don't we? In practice, there is more to it.

In some countries, such as the UK, the addition of digital to analogue radio has been successful, and in Norway dates for switching off analogue radio have already been proposed. In other countries, such as Spain, digital radio has been tried unsuccessfully. India is witnessing an explosion of growth in analogue FM radio. Why has this apparently illogical situation occurred?

The first choice faced by the radio provider is how to persuade users to buy digital radios, and listen to them. Users have to be convinced that a digital radio is somehow better than an analogue radio. There has to be something more available than with analogue radio, and something that will warrant us changing the habits of a lifetime. This is not a simple challenge, and sometimes has been achieved and sometimes not. Until you get acclimatized to digital, you hear very little difference between FM and digital audio. There are vast numbers of FM stations available already, and any new stations are unlikely to provide dramatically new content. Few nations are planning to switch off analogue radio, so in most cases there is no compulsion to buy a digital radio.

The second step is to decide what technical system to use for digital radio. The main contenders in Europe are the DAB and DRM families. In the US, the main contender is the HD-radio system, and in Japan it is ISDB-Tn. Each has strengths. ISDB-Tn is a system with technology shared with digital television broadcasting. HD-radio and DRM+ can be an add-on for an FM radio transmission without needing a new allocation. DRM uses the AM bands. The DAB family, usually in the VHF Band III, can be the gateway to new entrant radio stations and provide large choice of stations. The systems also allow different degrees of multimedia to be added.

Add to the mix the challenge of how to get digital radios into all cars. You also need to be able to reach a price point for portable receivers that the public is willing to pay. The resurgence of FM in India has a lot to do with the inclusion of FM receivers (but not digital radio) in mobile phones, so the relationship of digital radio with the mobile phone has to be factored in. The relationship of broadcasting to internet (though less of a challenge for radio broadcasting than we thought it would be ten years ago) is also an element.

The third step is to decide what audio quality to provide with your digital radio services. This can be a trade-off in terms of content and audience time. On one side, the lower the bit rate you use, the more stations you can squeeze into the same overall bit rate (or bandwidth). Going down in bit rate can mean more choice for the listener, more station licence fees for the nation, and maybe more advertising revenue.

On the other side, using a newer compression system tends to reduce the bit rate needed for 'no impairments' for 'average' audio material, but less so for 'critical' audio material. Also, increasing the number of radio stations in a given market can have a downside for 'content quality' – it may be necessary to produce more programming without an increase in the overall budget or market size. Finally, people tend to listen for longer times, all other things being equal, with higher quality audio – so lower bit rates can mean shorter listening time.

Albert Camus pointed out that "life is the sum of all choices". Unless everyone makes the same choices, each life will be different. The same may apply to this complex area of digital radio. What do you think are the best choices?

A NEW INTERDISCIPLINARY STRATEGIC PROGRAMME WILL HELP EBU MEMBERS TO ACHIEVE THE COST REDUCTIONS AND EFFICIENCY GAINS THAT COME WITH A MORE INTEGRATED MEDIA ORGANIZATION.

Herbert Tillmann, BR - Bayerischer Rundfunk, IMPS Chairman; Hans Hoffmann, EBU Head of Media Fundmentals & Production, IMPS Coordinator

Integration is the name of the game

A crucial new Strategic Programme was given the seal of approval by the Technical Committee at its meeting during February 2012. The IMPS programme, standing for Integrated Media Production Strategies, addresses a very real and pressing set of challenges that EBU Members need to meet and overcome if they are to thrive in the years ahead.

Most broadcasters have now begun producing and distributing content for multiple platforms. These include linear television in SDTV and HDTV; non-linear and hybrid services such as catch-up TV; services to mobile devices; and so forth. The same applies to the radio services of broadcasters, and almost all broadcasters also have online portals of one kind or another.

MANAGING CHANGE

In the future EBU Members need to be able to provide content that matches the needs of these different platforms simultaneously, in better quality, and with higher production efficiency, in order to meet the changing media demands of consumers. In addition to greater integration of production services and new workflows, significant change is required at organizational, operational, and user levels. The way organizations are structured must change; the habits of users and the tools they use must change; and, of course; new production technologies must be introduced. But in many cases it's the management of all of this change in a broadcasting organization that's the big hurdle.

The adaptation towards fully integrated production can be categorized in three phases:

PHASE 1 – MEDIA PRODUCTION ISLANDS: In this case a broadcaster with a TV and/or Radio department has established a separate department for Online services, and there is little cross-departmental integration. There are only a few commonalities with, for example, at best a few common technical infrastructures used to access joint databases and Content Management Systems (CMS).

PHASE 2 – INTEGRATED MEDIA PRODUCTION: Here we have broadcasters with an integrated technology infrastructure but still with separate production islands in terms of organizational structure (i.e. separate departments and staff responsibilities in the domains of TV, Radio and Online). A common infrastructure allows each department to access all content, usually realized through non-linear IT and file-based production systems and CMS.

In this phase broadcasters have to address technical challenges related to interoperability in file-based production, Media Information Management, and media storage and archives. It is usually the potential cost benefits that move a broadcaster in Phase 2 towards Phase 3.

PHASE 3 – FULLY INTEGRATED MEDIA PRODUCTION: Here the broadcaster has a fully integrated Content Management platform (as in Phase 2), but has also achieved a high level of organizational integration, having undertaken structural and strategic adaptation.

In Phase 3 creative staff perform functions for all three media types (TV, Radio, Online). Integrated Content Management and organizational structures allow staff to access all content and to produce output formats for the various distribution forms automatically. In addition archives are an integrated part of the production environment. Such broadcasters have a high demand for technical solutions that allow a multi-vendor infrastructure, and therefore open systems and interoperability are key.

AND SO...IMPS!

IMPS is taking an interdisciplinary approach, as reflected in the collaboration between the EBU Technical Committee, the News Technology Committee and EBU TRAINING.

In the first place, recognizing that EBU Members are at different phases of integration, IMPS will offer a platform to share experiences and facilitate learning, via thematic site visits to the premises of Members with advanced media integration, e.g. Radio-Bremen, YLE, RTBF, BBC, etc.

Participants can learn about the benefits and costs of an integrated approach; how 'change management' was handled; the technical solutions applied and the operational issues identified; and the training needs of users.

Another important element will be identifying operational issues that arise when creating content for TV, Radio and Online from a single working environment. These could be issues related to the CMS, media repositories, or the potential of SOA (Service Oriented Architecture) and FIMS (Framework for Interoperable Media Services) based approaches. Other issues to be addressed are rights information and handling and identifying barriers to accessing media information.

Finally, IMPS will develop a common approach for EBU Members to industry in this area. Requirements will be defined and communicated to industry by agreeing on a high level reference chain and developing best practice guidelines.

UP & RUNNING

As IMPS is addressing matters that are urgent for EBU Members, an aggressive timescale is needed. Several site visits to Members will take place between June and November 2012, with a final seminar on 10-11 December in Geneva. Best practice guidelines and requirements discussions with industry are scheduled for autumn 2012. EBU Members can join the group here: **http://tech.ebu.ch/imps** For more information contact Hans Hoffmann: hoffmann@ebu.ch

EBUCore: the Dublin Core for media

EBUCORE IS THE EBU'S FLAGSHIP SPECIFICATION FOR METADATA. **JEAN-PIERRE EVAIN** EXPLAINS THE BACKGROUND AND LOOKS AT SOME IMPLEMENTATIONS

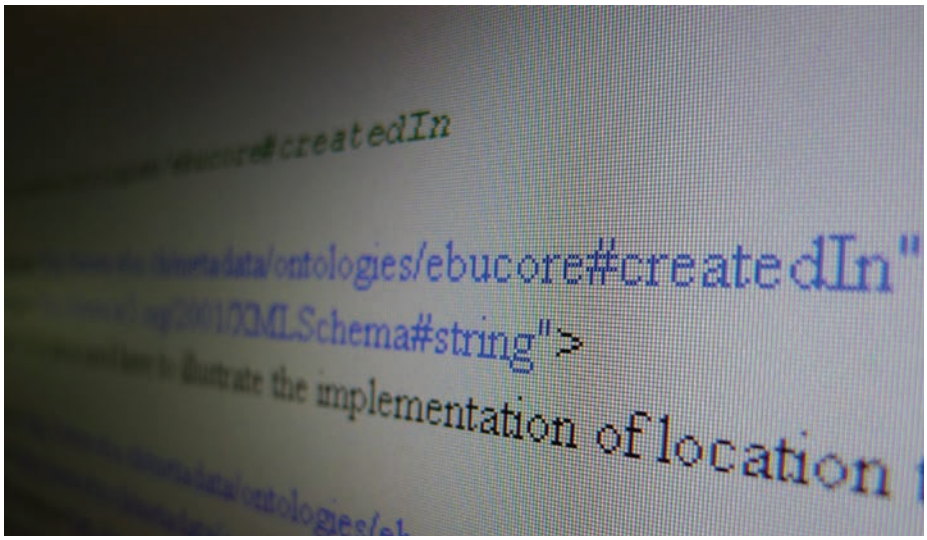
EBUCore was first published in 2000. It was originally a set of definitions for audio archives, applied to the Dublin Core, , which is itself a generic set of descriptive terminology that can be applied to any content. XML was then in its infancy but its use would grow dramatically, demanding more structured information to describe audiovisual content. Since then, other semantic languages have greatly influenced the way this information is modelled. EBUCore followed this evolution to become what it is today: the Dublin Core for media, a framework that can be used to describe just about any media content imaginable.

EBUCore is the fruit of well-defined requirements and an understanding of user and developer habits. User friendliness, flexibility, adaptability and scalability are more important than richness and comprehensiveness allied to impossible compliance rules. The richer the metadata, the higher the likelihood that implementers will reinvent their own. History is full of such examples. The golden rule for EBUCore was and remains "keep it simple and tailor it for media".

EBUCore covers 90% of users' needs and its use is no longer restricted to audio or archives. Based on the simple and flexible EBU Class Conceptual Data Model (CCDM), EBUCore's ontology (categories and structure), which is expressed in RDF/OWL (Resource Description Framework/Web Ontology Language), can be used right through to the delivery of content to the end user. It responds to the need for more effective querying. It also paves the way for effective metadata enrichment using Linked Open Data (LOD).

EBUCore was designed to be a metadata specification for "users with different needs" and duly serves this goal. Delegates at the EBU's Production Technology Seminar last January heard a wealth of evidence pointing to the key role that EBUCore is now playing. Several speakers explained how they have deliberately chosen and benefited from EBUCore.

The EBU-AMWA FIMS project (wiki.amwa.tv/ebu), creating a vendor-neutral specification to interconnect production equipment, has adopted EBUCore. The FIMS 1.0 specification uses EBUCore as its core descriptive and technical metadata. FIMS is a vital project for the future of file-based production and feedback received from participants has influenced the most recent version of EBUCore. Early adopters of FIMS, such as Bloomberg, are using this metadata.



The UK's Digital Production Partnership (DPP), which recently published its new specification for file-based programme delivery, is mapping its metadata to EBUCore and TV-Anytime. (TV-Anytime was co-founded by the EBU, who chaired the metadata activities and now actively maintains the specification on behalf of ETSI).

The work on EBUCore and EBU's CCDM greatly influenced the development of W3C Ontology for Media Resources , and vice versa. MA-ONT, as it is known, is a subset of the EBUCore ontology and the RDF/OWL representation rules are common to both. This work is also being used to propose extensions to the schema.org in order to describe TV and radio programmes and associated services and schedules.

EBUCore is also used as the solution for metadata aggregation in EUScreen (www.euscreen.eu), the European audiovisual archives portal and now a key contributor to Europeana, the European digital library. Two forms of EBUCore are used in this context, the EBUCore XML metadata schema and also the EBUCore RDF ontology.

Other on-going or planned activities using EBUCore include:

- EBUCore will be listed as a formal metadata type by the SMPTE. The EBU is arranging for software to be available to embed EBUCore metadata in languages such as XML or JSON.
- The NoTube project (www.notube.tv) has combined egtaMeta (an EBU specification extending the EBUCore for the exchange of commercials) and TV-Anytime to develop innovative solutions in targeting advertising.
- EBUCore is also used in combination with MPEG-7 in the VISION Cloud project (www.visioncloud.eu) exploring technologies for storage in the cloud. The EBU is directly involved in the definition and promotion of the new MPEG-7 AVDP profile.
- Singapore's national broadcaster, MediaCorp, has implemented and adapted EBUCore/SMMCore into its internal company metadata framework.
- The EBU is engaged with several broadcasters for the adaptation of EBUCore in different contexts such as a common metadata format for file exchange.

The above is just a small selection of developments. For example, EBUCore is also republished by the Audio Engineering Society (AES) as AES60, and is available in XML, SMPTE KLV, JSON and RDF/OWL.

Watch this space as the EBU will soon publish a user-friendly EBUCore mapping tool on its website.

Free For All (including the media)

THE OPEN SOURCE SOFTWARE COMMUNITY WILL GATHER IN GENEVA FROM 7-12 JULY FOR LSM 2012. THE EBU IS PRODUCING CONFERENCE SESSIONS ON FREE AND OPEN SOFTWARE IN MEDIA.

Product incompatibilities and vendor lock-in are some of the biggest hurdles we encounter every day. Sometimes these are due to mediocre design and engineering, but more often they are the result of conscious decisions to limit a product's capabilities. Vendors hope to make money by forcing the user to take a specific path. There is nothing new about this and it may be simply the way the marketplace works. However, proponents of a different model seem to be gaining ground.

For many years now we have grown accustomed to the use of free(ly adaptable) software on the Internet. Think of Linux, Apache, Mediawiki, etc. These products evolve rapidly thanks to their open nature and of course the efforts of active developer communities. For the user their quality, ubiquitous use (interoperability) and zero price tag are the main attractors. Is there any sign of similar solutions for our professional needs? That was the question we asked back in 2007, when the EBU organised a two-day Open Source Seminar dedicated to solutions for the audio-visual industry. This year we will do the same, but we have made it part of the much larger Libre Software Meeting (LSM) in Geneva – the city of many free-thinkers. What will be there to see?

The EBU-organised part takes place on Tuesday 10 and Wednesday 11 July. It is a two-day seminar with over 20 presentations and a handful of workshops on open source tools to help production and distribution of content. Topics covered include the development of open hardware (including an open camera!), cloud storage, graphics, video editing, audio editing, hybrid radio, radio play-out, 3D animation, MXF low-latency streaming, SIP audio contribution/ intercoms, interactive TV, IPTV, OTT streaming, and open radio tools. A number of EBU Members will present their experiences with free software. Here are a few examples.

TUX THE LINUX PENGUIN VISITED THE EBU FOR THE OPEN SOURCE SOFTWARE WORKSHOP IN 2007

ONE WEEK OF FREEDOM

The 13th edition of Libre Software Meeting (LSM) takes place from 7-12 July in Geneva and covers free software for all sorts of applications: office, health, security, politics, education, research, software development, internet, operating systems, system administration, etc. There will be demos, workshops and free beer too! **http://2012.rmll.info/en/**

CLOUD STORAGE (BBC, UK)

BBC's David Butler will introduce OpenStack, which is a collaborative software project designed to create freely available code, badly needed standards, and common ground for the benefit of both cloud providers and cloud users. His presentation will outline why the media industry is interested in virtualization and cloud, the components of OpenStack and a brief description on what is needed to create a private cloud using the OpenStack software.

NEWS MANAGEMENT (RAI, ITALY)

For RAI, Dr. Maurizio Montagnuol will show how the RAI Hyper Media News aggregation system helps managing news streams from different media sources using the Apache OpenNLP library for text analysis. News topics are contextualized within automatically extracted information and indexed using the Apache Solr engine. This makes unified search

and browse services available to any web user. Additional resources, such as the broadcaster's archive, can be accessed as well.

24/7 GRAPHICS & VIDEO PLAY-OUT (SVT, SWEDEN)
The Swedish public broadcaster has created a professional broadcast quality graphics and video solution, combining free and open source software and cheap hardware. Motion graphics designer Jonas Hummelstrand (SVT) will explain how the software works and how it forms an integral part of everything from news shows, channel branding, and game shows to special events, such as election coverage. Additionally a CasparCG workshop will be given by Robert Nagy (Redpatch).

INTERNET TV DISTRIBUTION CHAIN (VRT, BELGIUM)
VRT of Belgium has built a complete chain for distributing audiovisual material over the public internet, which combines tools for encoding (ffmpeg, x264 and MP4box) with solutions for distribution (Apache and mod_smoothstreaming). The whole workflow is glued together with some bash scripts and automake-magic. The result is an easy-to-use toolkit, which serves the three most popular videoformats (Adobe, Apple and Microsoft) from a single disc-format.

The complete programme of the EBU sessions can be found at: http://tech.ebu.ch/opensource2012
For more information, you can also contact: coinchon@ebu.ch

WHAT IS 'FREE'?

There is quite some confusion about the words 'free' and 'open', when applied to software. For 'libre software' proponents, the meaning comes down to 'free to use as you like', not necessarily 'free' in the sense that you cannot charge for it. Similarly what is called 'open' may not be free to use or adapt, it simply means you can 'look under the hood' to understand what is going on. Open software may still require a paid licence and prohibit you from making any changes.

Kazimir Bacic HRT

IN EACH ISSUE OF TECH-I WE INVITE A MEMBER OF THE EBU TECHNICAL COMMITTEE TO TELL US A LITTLE MORE ABOUT THEMSELVES. THE TECHNICAL COMMITTEE CONSISTS OF 13 PEOPLE WHO ARE ELECTED TO REPRESENT THE INTERESTS OF THE EBU MEMBERS AS A WHOLE. ELECTIONS FOR THE 2012-2014 TERM WILL TAKE PLACE IN JUNE AT THE TECHNICAL ASSEMBLY IN ZAGREB.

WHAT ARE YOUR CURRENT RESPONSIBILITIES AT HRT?
I am responsible for technology development and operations in TV production as the head of a technical department which has about 950 employees. Our team includes engineers, technicians, cameramen, editors, and maintenance staff.

WHAT DO YOU CONSIDER AS YOUR FINEST PROFESSIONAL ACHIEVEMENT TO DATE?
I have been either the Project Manager or Head of many projects such as "File-based News Production", the planning and installation of our two large digital production studios, our CNCT Digital project, and the digitization of continuity and play-out at HRT. In the realm of production I'm particularly proud of the technically very demanding coverage of the Papal visits to Croatia (4 times) and the FIS Ski World Cups in January each year since 2005.

WHY DID YOU STEP FORWARD AS A CANDIDATE FOR THE EBU TECHNICAL COMMITTEE?
I have worked at HRT for 28 years, first as a Broadcast Engineer in the TV studios, CNCT (the national technical coordination centre) and continuity, and for the last 10 years as the Technical Director. HRT had been the EBU technical centre for JRT (the former Yugoslav Radio Television) since 1967. So, from the very start of my HRT life I was collaborating with EBU Operations, and I realised the importance of good collaboration between the EBU and its Members. This was my main reason to participate more in the EBU's technical development from the Members' side.

WHAT, FOR YOU, ARE THE MOST IMPORTANT CHALLENGES FACING EBU MEMBERS TODAY?
I see the main challenges for public service broadcasters as the coordination and harmonization of their activities in the transition to an all-digital and file-based environment. It is also important to continue to develop the EBU Contribution Network.

TELL US ABOUT SOME OF YOUR INTERESTS AWAY FROM THE WORKPLACE.
I like to ski and to sail. I also enjoy travelling and exploring other countries. I have big family with four children and we spend a lot of our free time together.

EBU NETWORK TECHNOLOGY SEMINAR 2012

26-27 June 2012 / Geneva

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In collaboration with SMPTE

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