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Report

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2006 Production Technology seminar report

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Introduction

This report is intended to serve as a reminder of the presentations for those who came to the seminar, or as an introduction for those unable to be there. So, please **feel free to** forward this report to your colleagues!

It is not a transcription of the lectures, but a summary of the main elements of the sessions. For more details, the reader of this report should refer to the updated speakers' presentations, which are available on the following FTP site in the folder "2006 Production technology seminar updated pres"

via browser: <ftp://uptraining:ft4train@ftp.ebu.ch>

or on the server: <[ftp.ebu.ch](ftp://ftp.ebu.ch)>

login : uptraining

password : ft4train (case sensitive)

The slides number (in brackets) refer to the slides of the corresponding presentation.

To help "decode" the (too) numerous¹ abbreviations and acronyms used in the presentations' slides or in this report, a list is provided at the end of this report. Explanation of some terms, provided by the speakers, may complete the definition.

Web links are provided in the report or in the list of abbreviations for further reading.

Many thanks to all the speakers and session chair(wo)men who revised the draft, and to RTBF colleagues for their remarks.

1 Data modelling and metadata

Data modelling has been around for a couple of decades in many industries, to exchange information between systems, to integrate systems. As modern broadcast facilities are composed of many interconnected IT components, the modelling of these systems and the data they work with is as important as the 'wiring diagrams' of traditional facilities. It is important to have common definition of the data exchanged, the same naming and description. But it is difficult to model a facility. Moreover, is there enough commonality between broadcasters to have generic reference models?

1.1 VRT data model

Luk Overmeire, VRT, Belgium – and the work of Maarten Verwaest, with contributions of Bart Cornille

A data model is a building block of a complete enterprise architecture (slide 3). At VRT a 4-layer model was first devised to represent the different dimensions of the making of a programme (slide 9):

- 1) **Enterprise Control**², with the Enterprise Resource Planning (ERP) system SAP, with the MRPII model, maintaining the logistic and financial information;
- 2) **Product Engineering**, with the descriptive information of 'creative processes' (scene descriptions, scenarios, shooting scripts ...);
- 3) **Production**, with the technical information concerning the digital production steps (from ingest over editing - assembly to playout) and the handling of the Essence itself and of the metadata;
- 4) **Technological platform** with the physical file.

Parallel to this 4-layer representation, there are 3 levels of abstraction (slides 14 to 17):

¹ About 300!

² The SMEF BBC model, which has been a big source of inspiration for the VRT model, has reinvented the top layer, whereas VRT has adopted what MRPII and APICS vocabulary already offers.

- the **Conceptual Level** (slide 15) with "Business Objects": 'Material Object' (layer 1), 'Archive Object' + 'Editorial Object' + 'Publication Event' (layer 2), 'Media Object' + 'Media Instances' (layer 3), and at last 'Audio/video File' (layer 4);
- the **Semantical Level** (slide 16) which details from a functional perspective the relations between the 'Business Objects' (red) and their descriptors (green);
- the **Logical Level** (slide 17), the most detailed one, with the entities connected to the different objects. the Data Dictionary lists the different attributes related to these entities (866 altogether).

This theoretical and complex **reference model** plays a major role:

- in new important projects, which will use a subset of 'Business Objects' and information items (slide 21);
- in integrating different applications - for example:
 - to extend the data model of the Central Media Asset Management (MAM) system (Ardome³), with some extra needed attributes, and for the exchange of metadata between this Central MAM and the local MAM of Video Workcenters (slide 22);
 - for the exchange of programme-related information between the ERP system 'SAP' and the schedule management system "Whats'On"⁴ (slide 23) ; this implies that Whats'On and SAP have to be able to produce/exchange XML documents that contain P/META tags.

1.2 The DR Metadata Standard

Ole Hybaek, DR (Danish Broadcasting Corporation)

The goal was to establish a common view of all media centric metadata inside DR, with a limited set of attributes (200-250), and by maintaining a conceptual (immaterial) and a logical (leading to physical implementation) model. The DR Metadata standard⁵ is under the responsibility of:

- the Media Archive, in charge of the semantics (e.g. description, examples) of the Data Dictionary,
- and the Technology Department, responsible for the data descriptions (e.g. data format, relations) in the Data Dictionary, the Entities-Relations diagrams, the specification of a logical scheme for integration, the reports and the information on the Web, the validation and the publishing of new versions, the system development and the integrations.

This metadata standard is now used in the DR central Media Archive, the DR Interactive Learning site for schools, the Web Content Management System (CMS), the Rights Management System, ...It also helps to develop integration schemes, for example, to define a System-to-System (S2S) scheme to exchange a 'running order' and items between the Dalet+⁶ MAM system and the DR Integration Platform (slides 7 to 17). The DR Technology team first defines a mapping scheme, and then Dalet must do the actual mapping to integrate the DR data model. This implies a shared knowledge with the vendor of the information architecture, open and generalised APIs, and the respect of a 'standard' system.

The tool used to develop the model and the mapping is QualiWare⁷, similar but more simple to customise than System Architect⁸

1.3 Metadata & EBU contribution

Jean-Pierre Evain, EBU Technical Department

³ <http://www.ardendo.com/?page=products&subpage=ardome>

⁴ <http://www.mediagenix.com/product/product.htm>

⁵ <http://www.dr.dk/omdr/index.asp?appflag=force&aid=517>

⁶ <http://www.dalet.com/index.html>

⁷ <http://www.qualiware.com>

⁸ <http://www.telelogic.com/corp/products/systemarchitect/index.cfm>

The first mission of EBU is to **share information** through its metadata activities (P/MAG, ...) with new pages and links on the EBU Web site (Spring 2006)⁹.

The second mission is to '**connect islands**' (slide 5):

- In the Business-to-Business domain, by transforming the P/META specifications into several specialised specifications for Programme exchange, News exchange, Satellite (ISOG) exchange, Archive exchange ...taking also into account existing classification schemes (ESCORT, TV Anytime, PBCore¹⁰...);
- In the Business-to-Consumers domain, by promoting TV Anytime¹¹, now ETSI 102822 series (January 2006).
- In the Digital Rights Management field, by continuing to work on it ...

The issue is to agree on common information and its representation. De facto, common representation formats allow for different representations of the same information.

2 Digital news production

In recent years many broadcasters have been through some difficult times to introduce digital tapeless production, in particular in the realm of news. Therefore EBU International Training, as part of a cross-disciplinary project on Digital Newsroom, has since March 2002 organised visits in 10 member organisations and 2 seminars. This allowed IT and Broadcast engineers, journalists, heads of News departments of about 20 broadcasters to see digital newsrooms implementations, to share experiences, and to create an exchange network.

2.1 HRT newsroom digitisation experience

Tena Perisin, HRT (Hrvatska Radiotelevizija), Croatia

Between September 2001 and July 2005, it took time and energy for a small team of HRT to implement a Digital Newsroom. The key success factors of this project were:

- Starting from the journalists' needs.
- Thinking in terms of new workflow and not new broadcasting equipment.
- Joining the EBU interdisciplinary visits and seminars, meeting and discussing with other broadcasters, looking for 'best practices'.
- Seeking advice for writing the call for tender, not as a set of technical specifications, but as a description of a digital workflow.
- Training the production team members, with the vendor experts and in-house 'super-users'

The solution implemented is an integrated Avid newsroom system (slides 11 to 25), but with still a lot to be done: creating new jobs (media manager), new competences (rough editing for journalists), 'pushing' people to change ...

2.2 The ZDF case

Carsten Urban, ZDF

The ZDF Digital News implementation is characterized by its integration in a **global Digital Production** architecture and its '**Workgroups**' organisation, with the following guidelines:

- Different "Workgroups" do not necessarily have to be identical - a typical News Workgroup has other needs than a typical Post Production Workgroup -(e.g. with Avid Unity); but the structure must allow material exchange between the workgroups, where needed (slide 6).

⁹ <http://www.ebu.ch/en/technical/metadata/specifications/index.php>

¹⁰ <http://www.utah.edu/cpbmetadata/>

¹¹ <http://www.tv-anytime.org/>

- Identify horizontal and vertical functional relationships.
- Keep it simple! In order to identify necessary relations, look for a structure which allows to start with a global view and then go step by step into details.
- Have one „Ingest-Workgroup“ for the whole facility - potentially everyone wants to access incoming material
- Integrate one platform for all Graphics elements.
- Integrate the Digital Archive

But **new challenges** arise. The "unlimited" enlargement of the system (increase of the capacity, of the number of clients) is critical, because:

- The more things have to be integrated, the longer it takes.
- The technical development to consolidate products and systems, and to make them ready for operation needs a lot of energy.
- One large Production system for all facilities increases the dependency on this system.
- Workflow and production process changes have to be deeply discussed with all the people involved, and have to be slowly and 'softly' implemented.
- It is not only a technical problem, it is also an organisational challenge of the overall production process, and a shift in the company culture.
- Create a structure which can develop and integrate further investments.

2.3 BBC vision of the future

Chrichton Limbert, Head of Production Modernisation, BBC News, UK

The vision starts with a 3-stage architecture (slides 4+5):

- The '**Mediaport**', with an "arrival board", collecting all news items arriving as files from outside.
- The '**MediaPool**' where media material is looked at
- The '**Factory**' producing, assembling and formatting for the different distribution platforms

Multiple layers and platforms is another part of the vision. Broadcasters cannot have a new production team every time a new consumer device is brought out. They have to keep every single element as separate as possible all along the production process (slide 7), so that when the stream gets to a device just the bits that are needed for that device get used (slide 8). BBC News is **thinking of considering** the gallery not as a final master mixing point but as a preview point. What leaves the gallery is clean audio/video and data, and for each service one graphics box glues the relevant bits together and does a specific rendering according to a template.

This leads to new production principles:

- Quality – world class journalism and production values across ALL platforms and services
- Speed – fast and efficient delivery with a minimum of low value interventions
- Distinctiveness – supported when recognised in audiences research
- Equality – breaking stories go to the first available audiences
- Collaboration – temporary cross-media teams to cover major events
- Simplicity – more staff flexibility aided by integrated systems and processes
- •24hours / 7 days – continuous news

And what will journalists do?

- Receive alerts of events, wires, process flows etc.
- Search (copying wires, media, information from all sources - professional or individual) and Browse media assets (keyframes) and information
- Create Assets ="Items" (text, headlines,...) for publication across any platform
- Create Associations within and between platforms and fill templates for publication or broadcast = "Built"

- Publish automatically across multiple platforms in multiple “qualities” and only render the layers and elements at point of publication

3 Exchange technologies

Networks and networking are the essential tools whereby parts of a production, or stages of post-production can be done multi-site where resources and economics dictate. To play a full role in this scenario networks must be able to transport content with high transparency using universal standardised formats and protocols.

3.1 SuperPOP

Puiu Dolea, Network Development and Administration Engineer, Eurovision Operations, EBU

SuperPOP is the name of the **Eurovision Mediacache Server** (EuMC). It is a new video file server, to be installed during the spring and the summer 2006 in EBU member organisations. The Record and Edit functions are centrally controlled by the EBU Geneva HUB. The Playout and the File Transfer are locally controlled by the user (slides 10 and 15).

-The video content is “ingested” (recorded) in the SuperPOP -mainly- as a **MPEG-2 Long GOP Transport Stream** (TS), directly from satellite, without being decoded to uncompressed format. Then, each item is automatically edited (to define clean start and end points of the item) and presented as a file to the user. Eurovision controls directly, via satellite, the start/stop/rough-edit/transfer/availability commands. The file can then be played out (as video SDI) or transferred (as a file, to a local video editor) to other video systems.

-A second possible “ingestion” method is (direct) **file transfer** (e.g. over fibre).

The files ingested contain the Essence and the metadata (XML text both in English and French). MXF wrapping will be available for file transfer.

3.2 Media Dispatch

Peter Brightwell, BBC research & Development, UK

The Media Dispatch Protocol (MDP) is an open protocol to enable secure and automated delivery of large media files and their metadata between production organisations according to an agreed standard. Launched by BBC R&D¹² and the Pro-MPEG Media Dispatch Group¹³ at IBC 2005, there is an open source reference Beta implementation available¹⁴.

It works as a simple middleware: a 'Dispatch Agent' provides Applications with a set of services for delivery, while hiding the implementation details. Agents negotiate and coordinate the details of the delivery. They do this by exchanging XML documents called 'Manifests', which contain information about the files, protocols, URLs, deadlines, etc.

MDP supports the use of different transfer protocols (e.g. HTTP, FTP), the 'chunked' transfer of large media files, the pause-and-resume of transfers, and the detection of failed or stalled links with automatic resume. It supports secure delivery (e.g. HTTPS, SFTP), with server and client certificates, and integrity checking.

Technical trials have been carried out in the London area, and MDP forms part of the BBC's Production Gateway project. This is trialling file-based delivery between 6 post-production organizations and the BBC; it uses an independent MDP Agent implementation provided by Siemens Business Services.

¹² <http://www.bbc.co.uk/rd/projects/mdg/index.shtml>

¹³ <http://www.pro-mpeg.org/publicdocs/mdg.html>

¹⁴ <http://sourceforge.net/projects/mediadispatch>

4 MXF interoperability and constraints

The MXF is an interchange format for Essence and associated Metadata, proposed by the Pro-MPEG Forum and recommended by EBU. But it is a very new standard (publishing by SMPTE started in 2004, and still being extended), and a very complex toolbox (6 specifications documents for a basic implementation, 10 Operational Patterns ...¹⁵). Is MXF too difficult to handle? Now the hype-phase has moved into real-world implementations. Practical constraints and interoperability issues are emerging. How well do current systems 'talk MXF' and what is still to be solved?

4.1 EBU implementation and interoperability tests

Dr. Ingo Höntsch, IRT, Germany

In order to test the standards conformance of MXF files, the conformance and performance of MXF encoders and of MXF decoders, the IRT in Munich invited 31 manufacturers to participate – 12 of which came to a preparatory meeting in June 2005 and finally 9 submitted 11 products to the tests.

- In these products were implemented: MXF OP1a or OP Atom as operational patterns, D10, DV-DIF, MPEG-ES as Essence containers, eventually with PCM audio.
- Encoder
 - A small number of products produces 100% compliant simple files
 - A small number of products has major invalidating errors
- Decoder
 - All products can import and play simple MXF files and the Essence of files that have user metadata
 - Some products can import and display user metadata (DMS-1), and **some lose user metadata on import!**
 - No product can support all MXF options with its increasing complexity of parameters¹⁶
- Audio
 - All products supported at least 2 PCM channels, many 4, some up to 8
 - The audio-video delay of most products is below 3 ms
 - Some products contain the same audio Essence twice (PCM and DV-DIF), but signal **it** only once.
- Time Code: MXF offering a number of different ways to transport the Time Code, there is a great variation in the implementation.

The complete test reports will soon be published (on *irt.de*).

If the MXF implementations are ready for system integration, especially for the interchange of Essence, but attention must be paid to the production metadata interchange.

4.2 Experiences

Dr Henk den Bok, NOB Cross media facilities, Netherlands

MXF (OP1a) is used in the Digital Facility of NOB, and to import Essence (D10-30 or D10-50) and metadata coming from separate Production companies, and to export them to the Digital Archive company (slide 3). For content exchange, MXF has completely replaced the tape in the digital broadcast facility, and SDI feeds in some cases. The system has passed the final testing phase and will go on-line this spring. As a spin-off, several trends can already be discerned:

- several broadcasters are working hard to connect their digital production system to the NOB digital broadcast system through MXF file uploads
- several commercial broadcasters have set up similar systems (although on a smaller scale)
- several production companies are tuning into the MXF standard as well
- several parties (both commercial and the Netherlands Institute for Sound and Vision) are taking

¹⁵ http://www.irt.de/IRT/home/indexmxf_e.htm Status of the MXF Standards documents

¹⁶ See "Repository of Golden Files" <http://www.irt.de>

up a structural digitalization of their archive material and are developing attractive deployment strategies.

- in short, Hilversum is buzzing with MXF

However, this euphoria did not come into being without some serious headaches:

- MXF continues to be a novel technology requiring continuous attention in terms of operability. The need for compliancy test tools is stressed
- The move to file-based operations closes an era of working with broadcast equipment and associated workflows. Now more than ever we find ourselves in a situation that our business has been taken over by (almost) pure ICT systems. These new technology bring about their own specific problems in terms of operational and technical support, version management, test environments and migration policies.
- Last but not least, people start to realize that their job function has fundamentally changed and in some cases may be at risk in the (near) future. This realization brings about a host of typically human responses that must be dealt with using careful people and change management.

Gordon Castle, Senior Technology Fellow, CNN, U.S.A.

The initial plan at **CNN** was to integrate all systems and locations (Atlanta, London, Latin America) in its Integrated Production Environment (slide 8) using a single MXF specification (Long GOP MPEG-2 / OP1a). 2 projects were mentioned - one at CNN which was an Integrated Production Environment (IPE), and another at Turner which integrates Atlanta, London and Latin America playout facilities on a single content specification (MXF). The CNN project is concentrated on Atlanta and New-York and will extend to the other CNN bureaus in the future. But the MXF implementation is behind schedule, because of:

- Confusion due to the vendors' level of understanding and interpretation of MXF, and to the lack of defined and implemented models with proven integration.
- Inconsistent vendors support
- Slipping project timelines: the vendor development and testing, as well as the integration, has taken much longer than originally planned in every project

What is needed is a wider and more consistent support of MXF, vendor-neutral compliance tests, convergence around fewer application specification (e.g. for HD MXF integration), and development and support of OP2 and OP3 (to support handling of multiple audio tracks and custom editing for certain markets and channels).

Nevertheless, the structures and principles of MXF have accelerated vendor integration discussions and focused work; 'MXF-aware' tape storage (Quantum SDLT 600A) is proving to work efficiently, and CNN will buy MXF file-based cameras when changing cameras.

5 HD production technology and constraints

5.1.1 HD Tutorial: principal technologies

Massimo Visca, RAI, Italy; presented by Mario Stroppiana

This overview is a reminder of:

- The plethora of HD formats and parameters
- In acquisition:
 - The role of the optical system (depth of field, tight mechanical tolerances ...)
 - The luma and chroma subsampling and the compression used in camcorders
- The proposals of new codecs in production: JPEG2000¹⁷, H.264 Studio Profile, BBC Mezzanine¹⁸,

¹⁷ <http://www.jpeg.org/jpeg2000/>

¹⁸ <http://www.bbc.co.uk/rd/pubs/whp/whp-pdf-files/WHP119.pdf>

(SMPTE VC-2), Avid DNxHD¹⁹ (SMPTE VC-3)

- The lack of a reference display

5.1.2 HD chains and the risks of quality losses

Reinhard Knör, IRT, Germany

The IRT analysed the cascading in SDTV production chains from acquisition through transmission and its impact on picture quality presented to the audience. In particular, the dissemination of modern flat panels in the domestic domain has been considered, thus evaluating the delivered pictures on both CRT's and flat panel displays.. It was found that:

- With the increasing size of modern flat panel displays, the impairments (artefacts) become clearly visible and contribute heavily to picture quality degradation. In addition this quality suffers from internal 'rescaler' and 'de-interlacer' being part of those displays.
- Logically, low quality profiles that have been established by considering moderate size CRT's only, may no longer be adequate as part of the chain. However, still good results can be achieved - even with longer production chains - if high level profiles (high bit-rates) are used in the production areas concerned.

First experiences and outlook concerning future HDTV chains:

- The changes between compression formats for post-production are less critical than with SD, as long as there is sufficient bit-rate available.
- The interlace-to-progressive conversion is very critical, the lines up-conversion is critical, and the combination of conversion processes multiply the risk of quality losses.
- Due to the many formats and options, the selection of the right tools becomes more complicated than ever with SD
- The careful design of the overall chain remains the main insurance for quality, but a complete evaluation still has to be done.

5.1.3 EBU work

Per Boehler, NRK, Norway

P/HDTP (High Definition in Television Production)

- The attempt in autumn 2005 to have the 720p50 format adopted by the ITU-R failed (the SMPTE standard for 720p/50 can be used instead), and some manufacturers are still reluctant to provide 720p50 equipment.
- Several manufacturers have migration plans towards 1920x1080p50/60 cameras but with varying time scales.
- A very large amount of work is needed to test and evaluate all combinations of scanning and compressions, and a wider variety of suitable test sequences is necessary.
- Start preparing and making HD productions NOW ...and make mistakes!!²⁰

Jörn Tuxen, DR, Denmark

B/TQE (Television Quality Evolution) – This Working Group, now dismantled, has produced on flat panel displays a number of Informative papers (I34, I35, I39) and **Technical** documents (especially Tech. 3299 and Tech. 3307)²¹ on flat panel displays.

(+) The TQE group finally persuaded manufacturers in February 2005 to make agile equipment, thereby obtaining freedom of choice for Broadcasters in Europe.

¹⁹ <http://www.avid.com/dnxhd/index.asp>

²⁰ "The early bird may catch the worm, but it is the second mouse that gets the cheese"!

²¹ <http://www.ebu.ch/en/technical/publications/index.php>

(+) LCD-TFT, PDP, DLP flatpanels and projectors are on the market and new technologies are emerging (OLED, SED, LCOS, DMD).

(-) A reference flat panel display is not yet available, but a SED flat panel could be a good candidate.

Reiner Schäfer, IRT, Germany

B/HDC (HD Codecs) – This new Working Group will

- Communicate with manufacturers of H.264 equipment and encourage them to encode EBU HD test material²²
- Find the amount of impact on picture quality by professional conversion between the EBU recommended HD formats
- Perform tests under scientific conditions
- Consider quality in context of the whole digital chain to consumer (e.g. including professional format converters)
- Monitor the evolution of consumer flatpanel displays and HD receivers

6 HD experiences

Peter Biber, SRG/SF DRS, Switzerland

The "killer driver" will be the FIFA 2006 World Cup ...

... but the presentation of the preparation of the FIFA 2006 **World Cup** by the Swiss team, and of the further migration path to HD, could unfortunately not take place, because of a "technical" problem in the conference room!

Helge Semb, NRK, Norway

A few points extracted from the very detailed presentation document of a **cameraman's experience with HDV**:

(++) Such a small and inexpensive camera provides "amazing" pictures on a first impression

(+) Involvement and insight shooting are allowed by this lightweight camera

(-) Artefacts: tendency to blurr small details (especially with moving shots); colour changes in extreme areas according to light reflection

(-) Inferior (compressed) sound quality

Thomas Repp, Director, Bayerische Akademie für Fernsehen, Germany

This also very detailed presentation of **HDTV shooting in High Quality production**, analyses the migration of classical cinematic tools from film to HDTV and gives practical tips and hints for this migration (choice of lenses, back focus, l vs. P, light, blacks/whites, contrast, focus, movement, details ...). This director of photography's point of view was illustrated by a short film "Die Augenfalle".

Philippe Jacot, EBU, Head of Coproduction Unit, EBU Television Department

The making of the "Henri Dunant, Red on the Cross" film in HD, showed:

(+) Good still shots, good track in/out, low light is perfect

(-) Difficult lateral dolly shots

(-) Cable 'mess' is back (steadycam, multi-camera with sound synchronization)

(+) Not as expensive as feared at first (immediate preview means time gains), but necessity to reorganize the workflow to keep the budget.

(+) The 5.1 sound quality is very important, at low additional costs

Necessity to work with Cinema professionals ... and to train video & film professionals to work with HD

²² http://www.ebu.ch/en/technical/hdtv/test_sequences.php

Hans Hoffmann, Senior engineer, EBU Technical Department

HD Demonstrations

- Using a split screen on a HD Vutrix²³ professional LCD display (1920x1080) and a MPEG-4 AVC / H.264 non real-time software encoder/decoder at **6 – 8 – 13 Mbit/s**. Test sequences in 1280x720p/50 and 1920x1080/i/25 HDTV formats: "Start of a cross-country race" ...look at the clouds, the grass, the runners ...! 720p was clearly better than 1080/i and only the 13 Mbit/s bit-rate was satisfactory.
- Using a **5.1 surround sound** with a hockey on ice match sequence. Impressive for the ears!

Andy Qusted, BBC, UK

Concerning the **costs in HD Production**:

- The cost parity of HD equipment and SD equipment (will these still be available?) is expected in 2008-2010.
- If you want 100% HD go tape-free.
- All new building have to include HD planning and provision to migrate to HD; current building, studio and OB 'refreshes' will accommodate HD as the de facto standard.
- Prioritise the migration to HD production according to Genres: drama films / long running series / large or (inter)nationally important events (concerts, sports competitions, 'historical') / film-based acquisition to stay active in 5-10 years / programmes with high sound production values / programmes with a high value to archive.
- Use the right format for the rights programmes : HDCAM SR, D20, Genesis, Viper: high incremental cost / HD D5, HDCAM: medium-low incremental cost / HDV: cost neutral (compared to DV production) / DVCRPO100: lower cost than SD (Digi. Beta.).

Training in HD

- HD affects everyone, so train everyone ... starting with the production management.
- Do not underestimate the cultural issues HD will cause, especially to Directors of Photography, Directors, front of camera talent ... + Design, Post-Production, Sound craft...
- Share knowledge and lessons learnt around HD production techniques²⁴

7 HD vendors' perspectives panel (session 7)

Stefan Hofmann (Panasonic), John Ive (Sony), Al Kovalick (Avid), Semir Nouri (JVC) Klaus Weber (Thomson Grass Valley)

Avid: The DNxHD compression format is in the process of being standardised by SMPTE as VC-3 (VC-1 = Microsoft, VC-2 = BBC Mezzanine); supporting 115 - 220 Mbit/s for 1920x1080i 24/25/50/60 and 60-220 Mbit/s for 720p 24/60+50...; planning for 1080p 50 and 60; 6-generation transparency.

JVC: supports the tape (HDV); committed to progressive, because displays and projectors (e.g. HD D-ILA technology) can handle it better; smooth transition for consumers with the Hybrid DVD disk (with separate SD-DVD + HD-DVD layers).

Panasonic: will continue to support tape as well as IT (P2) products, SD and HD switchable products lines; 720p50 and 1080i-50(25), interlace and progressive, several compression/quality levels.

Sony: "HD is the next generation of SD"; the consumers and the manufacturers will set the agenda for

²³ <http://www.vutrix.com/>

²⁴ BBC HD: 'The High Definition Guide' http://www.bbc.co.uk/guidelines/delivering_quality/pdf/tv/HDBookv01_00.pdf

HD in many ways. Set a "drop date" for SD switch off and work towards it; don't wait until your viewers have moved away to alternative HD entertainment options! Broadcasters increasingly thinking of themselves as publishers offering an integrated package. 1080p is a future high-end production format and not short term! Additional problems on the horizon for colour gamuts between sources and displays.

Thomson Grass Valley: to keep the production costs lower, producing 720p and 1080i+p switchable; Infinity camcorder and recorder with integration into a News system.

Q1: What will be the **price evolution** curve of HD equipment compared to SD equipment?

A1 - (Sony): the HD equipment price is presently 15%-20% above SD. In less than 5 years with a lot of R&D and new chips the HD price = present SD price. And you get an improved SD output with an HDTV source.

(TGV): The HD equipment (e.g. camera) price is equivalent today to the SD price 5 years ago! In absolute value the price premium will get lower and lower.

(Avid): the value of simultaneous SD+HD equipment (e.g. editor) is more than HD-only plus SD-only!

(Panasonic): a present SD investment cannot be justified on medium/long-term and even on short-term! Our target is to come out this year, with a new product line with the same pricing for SD and HD.

Q2: We start to buy 720p or 1080i, and in 5 years you buy 1080p? So you **buy HD twice!**

A2 : 1080p will be possibly only applied to the higher end production and getting enthusiastic on the new technology does not provide the budget! It will take some time to develop (e.g. interfaces ...) and to be able to propose a reasonable pricing: at least 7 years (which is about the lifetime of a camcorder).

(CNN) It is not a matter of replacing but of augmenting a system. We will not need to produce everything in 1080p but only, for example, for high-end sports events. Anyway the distribution channels don't yet exist and the consumers will not pay the double bandwidth and for a minimal differential quality on most of the programmes.

The same dilemma exists on the consumer equipment level: not available or not switchable formats.

8 Multichannel audio production

Television is Radio with pictures. High Definition television is an aurally immersive soundscape with better quality pictures. Multichannel audio can now be accommodated in most delivery environments – satellite, DTT, Internet and shortly in DAB, DRM and even in (standard) MP3 players. Multichannel audio production is a must for the competitive programme maker. Surround sound is of fantastic value – sound = emotion!

8.1 New audio standards

Lars Jonsson, Technical Strategist, Swedish Radio Corporate Development

- Along with HD video in Set-Top Boxes and in HD DVD / Blu-ray Discs:
 - Dolby Digital Plus (DD+)²⁵ with a wider range of bit rates; the decoder plays Dolby Digital bitstreams.
 - Dolby TrueHD²⁶, with extension to MLP (Meridian Lossless Packing) codec, up to 14 channels and 18 Mbit/s, adds metadata capabilities, supports 192 kHz sampling rate and 24-bit.
 - DTS-HD²⁷
- Various low-bitrate formats in stereo and multichannel for radio/TV, PCs and handheld devices:
 - DAB Surround²⁸ (will become a new MPEG-standard in the autumn of 2006)

²⁵ http://www.dolby.com/consumer/technology/dolby_digital_plus.html http://www.dolby.com/resources/tech_library/index.cfm

²⁶ <http://www.dolby.com/consumer/technology/trueHD.html> http://www.dolby.com/resources/tech_library/index.cfm

²⁷ <http://www.dtsonline.com/consumer/dtshd.php>

- HE-AAC²⁹ (with optional transcoding to DTS)
- The brand new *Audio Lossless Coding*, ALS (ISO 14496-3 MPEG-4 Audio, 3rd edition, Amendment 2)

To avoid the cascading artefacts, with very often 3 or 5 stages of low-bit rate coding reached, stay on (or go back to) Linear PCM, and for high-end programming consider using the IEEE 754 floating point 32-bit representation.

The current EBU Workgroups on audio coding: P/AGA, B/AIM, B/MCAT. A new EBU Multichannel audio file format MBWF/RF64 has been defined³⁰

8.2 Practical 5.1 for HD

Mike Felton, Freelance, UK

This case study details how surround sound was added to a long-running music programme on BBC2 (*Later with Jools*), when the production moved to HD. The programme formula comprises 4 bands (1 on each side of the studio) and 1 or 2 solo acts all playing live, and the recording happens in a single continuous take. The stereo sound mix is achieved live. The video post-production phase is mainly for trimming interviews to time and camera shot substitution from isolated video tapes.

A hard disk multi-track is used with some sub-group stems (2 stereo Band + 2 Stereo Vocal + 1 stereo Reverb + 8 mono Individual Audience mics + Host personal mic + "Extras" track – solos etc.). For surround sound the sub stems are distributed: Main Vocal in Centre (with slight divergence) / Instruments and Backing Vocals, stereo across L-R / Reverbs, stereo across L-R and Ls-Rs / Audience mapped all around (the 4 audience blocks - one in each studio corner - being mixed according to the band direction – slides 18 - 27).). The music mix is ready made from the addition of the sub-group stems from the live recording. The audio post-production phase is mainly audio background noise 'cleaning up' and blemish removal to match the higher production values expected by the HD market. No Low-Frequency Effects (LFE) channel is used, because it was developed for cinema (disaster movies explosions, etc.) and is not necessary in this context³¹.

The quality chain (Mic-Desk-Disk) is 24-bit linear.

The tracks 1-5 (L,R,C,Ls,Rs) are encoded into Dolby E³², and with the tracks 7-8 (Stereo) are transferred to the HDCAM tape.

9 Storage management and new technologies

The TV programme production was for decades using (D)VTRs and is now moving to IT-based production scenarios.

9.1 Storage as an integrating layer for Broadcast and IT

Hans-Peter Christmann, Siemens Business Services, Germany

This 'tutorial-like' presentation provides:

- A review of the storage-server architecture concepts: DAS, NAS, SAN; with sub-systems and mirroring; online and nearline storage, short-term and long-term storage (slides 5-9).
- A comparison of media parameters for primary / secondary / archive storage (slide 17).
- A comparison of 'low-cost' disk and tape library storage (slides 15+16)
- A list of storage requirements for Broadcast (slide 4)

²⁸ <http://www.iis.fraunhofer.de/amm/techinf/dabsurround/index.html>

²⁹ http://www.ebu.ch/en/technical/trev/trev_305-moser.pdf

³⁰ http://www.ebu.ch/CMSimages/en/tec_doc_t3306-2006_tcm6-42570.pdf

³¹ http://www.dolby.com/assets/pdf/tech_library/38_LFE.pdf

³² http://www.dolby.com/professional/pro_audio_engineering/solutions_dolbye.html

- Some final recommendations (slide 19)

9.2 A new approach to Digital News Archiving³³

Nicolas Hans, Product Strategy Director, Dalet, France

Moving to a tapeless environment one might expect a 40% reduction in the time used (for ingest + shot listing and logging + dubbing and storage) and a 60 % reduction (for searching + recovering + reconciliation) – (slides 12+19).

To take advantage now of IT-based storage, with the magnetic disks cost divided by 2 every 12 months (cheaper than video tape), on-line files are the primary content carriers. One has to build a unified content catalogue. To provide an unified view of available assets irrelevant of where there are stored, the challenge is to collect and manage metadata at every step of the workflow (slides 33+31).

9.3 Holographic data storage

The holographic data storage looks like it will be becoming THE storage solution of the future. Holographic recording is optical data storage but in a 3-dimensional format³⁴

Art Rancis, Vice President, InPhase Technologies, U.S.A.

InPhase Technologies³⁵, a spin-off of Lucent Technologies' Bell Labs, has developed a 130 mm holographic disk (*Tapestry*) which stores, using blue laser beams, hundreds of 1,4 Mbit data pages (slide 4) in a single location on the disk (slide 5)³⁶, before shifting the disk to the next location. In October 2005 it demonstrated with Turner Broadcasting the first play-out-to-air use of a 300 GB disk at a 160 Mbit/s data rate. The aim is to reach by 2009 a 1,6 TByte capacity with a 120MByte/s data rate. The archive life is expected to be more than 50 years, but it may actually be more than 100 years. The product will undergo NIST archive life tests in the Spring of 2006.

Besides the capacity and the data rate, the operational advantages are:

- Sequential Write, Random Reads
- Easy emulation of DVD-R, CD-R, optical WORM (OSTA-UDF format) and tape.
- Numerous interfaces: SCSI Ultra 80 or 160, Fibre Channel, SATA, IEEE 1394, USB2, SAS, ATAPI, GigaEthernet (FTP), SD, Compact Flash.
- Optical encryption to prevent piracy and content theft.
- Media (Hitachi Maxell) cost: \$ 0,20 / GB, which translates into a media cartridge price of around \$150.
- Drive cost: \$ 15k

InPhase will be announcing it's OEM drive and media resellers during 2006 at both NAB and IBC trade shows. These OEMs will be distributing and supporting various InPhase based products for the broadcast, post production, and film markets.

³³ <http://www.dalet.com/docs/wp/A%20new%20approach%20to%20digital%20news%20archiving.pdf>

³⁴ <http://www.nxtbook.com/fx/books/rms/TechnologyReview-InPhase/> (MIT Technology Review)

See also: http://www.optware.co.jp/english/what_040823.htm (*Holographic Versatile Disk* - Japan)

³⁵ <http://www.inphase-tech.com/index.html>

³⁶ <http://www.inphase-tech.com/technology/index.html> http://www.inphase-tech.com/media/inphase_promo.mov

Abbreviations and acronyms

A/V	Audio/Video, Audiovisual
AAC	Advanced Audio Coding
AAF	Advanced Authoring Format
ALS	Audio Losless Coding
API	Application Programming Interface
APICS	American Society for Production and Inventory Control http://www.apics.org/default.htm
ASI	Asynchronous Serial Interface (DVB)
ATAPI	ATA (Advanced Technology Attachment) Packet Interface
AVC	Advanced Video Coding (MPEG-4 Part 10 = ITU-T H.264)
B/AIM	Audio in Multimedia (EBU Project Group)
B/HDC	High-Definition Codecs (EBU Project Group)
B/MASQE	Multichannel Audio System and Quality Evaluation (EBU Project Group)
B/MCAT	Multichannel Audio Technology (EBU Project Group)
B/TQE	Television Quality Evolution(EBU Project Group, dissolved)
B2B, BtoB	Business-to-Business
BD	Blu-ray Disc
BEXT	Broadcast audio EXTension to the basic WAVE format
BF	Back Focus
BIS	Broadcast Integration Service. The SGI (Silicon Graphics Inc.) name for the functional layer of the DRAMS*
BV	Backing Vocals (as opposed to Main Vocal)
BWF	Broadcast Wave Format
C	Centre
CBMS	Convergence of Broadcast and Mobile Systems (An ongoing joint work between DVB Forum, WorldDAB and 3GPP)
CCD	Charge Coupled Device
CEO	Chief Executive Officer
CES	Consumer Electronics Show (U.S.A.)
CGI	Common Gateway Interface
CIFS	Common Internet File System
CMS	Content Management System
CRT	Cathode Ray Tube
CRT	Cathode Ray Tube
D97	The Need for Format-Agile HD Equipmentsupporting the 720p/50 image format – 2nd edition (EBU)
D-ILA	Digital Direct Drive Image Light Amplifier (JVC projector)
D/A	Digital-to-Analog conversion
DAB	Digital Audio Broadcasting
DAB	Digital Audio Broadcasting
DAS	Direct Attached Storage
DB	DataBase
DC	Dublin Core http://dublincore.org/
DCT	Discrete Cosine Transform
DD+	Dolby Digital 'Plus'
DIF	Digital Interface Format (DV)
DIT	Digital Imaging Technician
DLP	Digital Light Processing (projector)
DMAM	Digital Media Asset Management
DMB	Digital Multimedia Broadcasting (A standard adopted by WorldDAB for transmission of Multimedia over DAB. In use in Korea.)
DMD	Digital Micromirror Device (display)

DMF	Digital Media Factory (VRT)
DMS	Descriptive Metadata Scheme (MXF)
DMZ	DeMilitarised Zone
DNxHD	High Definition encoding (Avid) http://www.avid.com/resources/whitepapers/DNxHDWP3.pdf?featureID=882&marketID=
DP, DoP	Director of Photography
DPA/X/S/M	Digital Production Actualities/Magazines/Sports/Mobile (ZDF)
DRAMS	DR (Danish Broadcasting Corporation) Asset Management System
DRIL	DR (Danish Broadcasting Corporation) Interactive Learning. It's a community for schools in Denmark where DR publishes multimedia information. The issues are history, politics and culture and the site includes definition of tasks and questions.
DRIP	DR (Danish Broadcasting Corporation) Integration Platform
DRM	Digital Rights Management
DRM	Digital Radio Mondiale
DSC270	Digital Serial Component 270 Mbit/s (SDI, ITU-R BT.301)
DTS-HD	Digital Theater Systems - HD
DUT	Device Under Test
DV	Digital Video cassette recorder format
DVB S/C/T	Digital Video Broadcasting (Satellite/Cable/Terrestrial)
DVTR	Digital VTR
ebXML	Electronic Business using eXtensible Markup Language http://www.ebxml.org/
EDL	Edit Decision List
e.g.	'exempli gratia' = for example
EIP	Enterprise Integration Platform (CNN)
EMC	Eurovision MediaCache server (EBU)
EPG	Electronic Programme Guide
ER	Entities - Relations. An Entity is more or less the same as a SET in P/META. A relation between entities describes the context and gives life to the model. The model may describe either an 'objective reality' or a specific perspective or view of the objective reality. The DR (Danish Broadcasting Corp.) metadata standard intends to describe the objective reality, the runningorder+item interchange schema describes a specific view of the objective reality.
ERP	Enterprise Resource Planning
ES	Elementary Stream (MPEG-2)
ESCORT	EBU System of Classification Of RTv programmes http://www.ebu.ch/CMSImages/en/tec_EBU_escort2-4_tcm6-11889.pdf
ETSI	European Telecommunications Standards Institute http://www.etsi.org/services_products/freestandard/home.htm
EuMC	European Mediache Server (SuperPOP)
EVN	Eurovision News Exchange http://www.eurovision.net/news/exchanges.php
e-VTR	Sony MPEG IMX VTR + network card and MXF interface option
FC	Fibre Channel
FiNE	Fiber Network Eurovision (EBU) http://www.netinsight.net/pdf/040823_Casestudy_EBU_2.pdf
FS	Full Scale
FTP	File Transfer Protocol (Internet)
FULL (copy service)	Full Copy means Size and Content according the original Data (Siemens)
GbE, GigE	Gigabit Ethernet
GOP	Group Of Pictures (MPEG-2)
GPI	General Purpose Interface
HD(TV)	High-Definition (Television)
HDMI	High Definition Multimedia Interface http://www.hdmi.org/
HDS	Holographic Data Storage
HD-SDI	High Definition - SDI

HDV	High-Definition DV format
HE-AAC	High Efficiency – AAC http://www.ebu.ch/en/technical/trev/trev_305-moser.pdf
Hi-Res.	High Resolution
HSM	Hierarchical Storage Management
HTTP	HyperText Transfer Protocol
HTTPS	HTTP using a version of the Secure Socket Layer (SSL) or Transport Layer Security (TLS) protocols
HYBNET	Hybrides Breitbandübertragungsnetz = Hybrid Broadband Transfer Network = a high-performing fiber infrastructure (SDH) of the ARD in Germany, which connects the regional broadcast stations (BR, SWR, HR, SR, WDR, NDR, RB, MDR, RBB) together.
I	Interlaced
I34-2002	The potential impact of flat panel displays on broadcast delivery of television (EBU Technical Information) http://www.ebu.ch/CMSImages/en/tec_text_i34-2002_tcm6-4783.pdf
I35-2003	Further Considerations on the Impact of Flat Panel Home Displays on the Broadcasting Chain – 1 st edition (EBU Technical Information) http://www.ebu.ch/CMSImages/en/tec_text_i35-2003_tcm6-10879.pdf
I39-2004	Maximising the Quality of Conventional Quality Television in the Flat Panel Environment - 1 st edition (EBU Technical Information) http://www.ebu.ch/CMSImages/en/tec_text_i39-2004_tcm6-10500.pdf
ICT	Information and Communication Technology
ID	Identifier, identification
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
IFA	Internationale FunkAusstellung (Berlin)
ILM	Information Life Management
IOPS	Input/Output Per Second
IP	Internet Protocol
IPDC	IP DataCasting
IPE	Integrated Production Environment (CNN)
IPsec	IP Security
IPTC	International Press Telecommunications Council http://www.iptc.org/pages/index.php
IPTV	Television via Internet Protocol
IRD	Integrated Receiver-Decoder (-> STB)
IRT	Institut für Rundfunktechnik (Germany)
ISAN	International Standard Audiovisual Number
iSCSI	Internet SCSI
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
'ISO'	ISOLated
ISOG (WBU-)	International Satellite Operations Group http://www.nabanet.com/wbuArea/members/ISOG.html
IT	Information Technology (<i>Informatics</i>)
ITU-R	International Telecommunication Union – radiocommunication sector
L / Ls	Left / Left surround
LAMP	Linux, Apache, MySQL, PHP / Perl / or Python - more generally it means a Open Source Software 'bundle' of operating system, web server, database and programming language. http://www.onlamp.com/pub/a/onlamp/2001/01/25/lamp.html http://en.wikipedia.org/wiki/LAMP_%28software_bundle%29
LAN	Local Area Network
L-Band	0.39 to 1.55 GHz
LCD	Liquid Crystal Display
LCOS	Liquid Crystal On Silicon (display)
LFE	Low Frequency Effects
LSDI	Large Screen Display Imagery
LTC	Longitudinal Time Code
LTO	Linear Tape Open (IBM, HP, Seagate)

LUN-masking	Assigning Logical Units to the different hosts. Each host has only access to LUNs visible for him. This visibility is managed by the storage System (Siemens)
MAID	Massive Array of Inactive Disks (disks farm)
MAM	Media Asset Management
MBMS	Multimedia Broadcast Multicast Service
MBWF	Multichannel BWF (-> Tech. 3306)
MDP	Media Dispatch Protocol
METS	Metadata Encoding and Transmission Standard http://www.loc.gov/standards/mets/
mgt	Management
MIB	Management Information Base http://www.snmpplink.org/
ML	Main Level (MPEG-2)
MLE	Non-Linear Editing
MIB	Management Information Base
MOB	Media Object
MOC	Media Operations Center (CNN)
MOG	Media Object Group
MOS	Media Object Server http://www.mosprotocol.com/
MOS	Media Object Server
MPEG	Moving Picture Experts Group
MPS	Media Production Suite (IBM media management application at CNN)
MRPII	Manufacturing Resource Planning 2
MS server	Microsoft server
MTF	Modulation Transfer Function
MXF	Material eXchange Format
NAS	Network Attached Storage
NAS	Network Attached Storage
NCS	Newsroom Computer System
ND-Filter	Neutral Density Filter, often used in a Matte-Box in front of the lens. "Wedge" or "attenuated" filters have different densities from top to bottom, allowing to reduce contrasts in the image.
NDMP	Network Data Management Protocol
NES	News Exchange Set http://www.ebu.ch/en/technical/metadata/specifications/notes_on_nes.php
NFS	Network File System
NIST	National Institute of Standards and Technology (U.S.A.)
NRCS	NewsRoom Computer System
NTBR	Non-Tape Based Recorder
OAIS	Open Archival Information System (ISO 14721:2003)
OB	Outside Broadcasting
OEM	Original equipment Manufacturer
OL	The OL system is an instance of the DR (Danish Broadcasting Corporation) media archive and ingest facilities deployed on a transportable server system.
OLED	Organic Light Emitting Diode (display)
OLTP	On-Line Transaction Processing
OP	Operational Pattern (MXF)
OSTA	Optical Storage Technology Association http://www.osta.org/
P	Progressive
P/AGA	Advisory Group on Audio (EBU) http://www.ebu.ch/en/technical/projects/pmc/index.php
P/AGTR	Advisory Group on Television Recording (EBU Project Group, in "hibernation")
P/CP	Common Processes in TV Production (EBU Project Group)
P/DISPLAY	Use of non-CRT displays in production environment (new EBU Project Group)

P/HDTP	High Television in Television Production (EBU Project Group)
P/HDV	Use of HDV format for acquisition (new EBU Project Group)
P/MAS	Monitoring of Access Services (EBU Project Group)
P/NAP	Networking in Audio Production (EBU Project Group)
P/TVFILE	Use of FILE formats for TeleVision production (EBU Project Group)
P+S Adaptor	The P+S company in Munich has designed a unique adaptor: the HDV camera is filming not directly through the lens, but through a rotating matte. A PL-mount lens, designed for 35mm Cameras in front of the matte is projecting its image to the matte - with the effect of having the same depth of field as in professional 35mm film.
PB	Public Broadcasting/Broadcasters
PBCore	Public Broadcasting Metadata Dictionary Project http://www.utah.edu/cpbmetadata/
PCM	Pulse Code Modulation
PDA	Personal Digital Assistant
PDP	Plasma Display Panel
PMC	Production technology Committee (EBU Technical Department)
PNN	Permanent News Network
Pod	Local playback center at CNN
POP	Point of presence
PPV	Pay-Per-View
PSB	Public Service Broadcasting
PsF	Progressive segmented Frame
PVR	Personal Video Recorder
QC	Quality Control
QW	Architecture tool used by DR (Danish Broadcasting Corporation)
R / Rs	Right / Right surround
R&D	Research & Development
R112-2004	EBU statement on HDTV standards http://www.ebu.ch/CMSimages/en/tec_text_r112-2004_tcm6-16462.pdf
R115-2005	Future High Definition Television Systems: The need to develop television production equipment for a progressively scanned image format of 1920 horizontal by 1080 vertical resolution at 50 and 60 Hz frame rates. http://www.ebu.ch/CMSimages/en/tec_text_r115-2005_tcm6-37869.pdf
RFP	Request For Proposal
RfSMux	Rundfunk Service Multiplexer = Broadcast Service Multiplexer (Codec that provides different profiles for access to the HYBNET)
RGBA	Red, Green, Blue, Alpha channel
RIFF	Resource Interchange File Format
RSVP	Resource Reservation Protocol (Internet)
RTF	Rich Text Format
Rx	Receiver
S/PDIF	Sony/Philips Digital Interface
S2S	System-to-System
SAN	Storage Area Network
SAN	Storage Area Network
SAP	Systems Analysis and Program development (Germany)
SAS	Serial attached SCSI
SATA	Serial ATA (Advanced Technology Attachment)
SCSI	Small Computer System Interface
SD	Secure Digital card
SD(TV)	Standard Definition (Television)
SD(TV)	Standard-Definition (Television)
SDI	Serial Digital Interface
SDI	Serial Digital Interface (270 Mbit/s)
SDLT	Super Digital Linear Tape (Quantum)
SDTI	Serial Data Transport Interface

SED	Surface conduction electron Emitter Display
SFTP	SSH (Secure Shell) FTP
SHA	Secure Hash Algorithm
SMEF	Standard Media Exchange Format (BBC)
SMPTE	Society of Motion Picture and Television Engineers
SNAP copy service	SNAPshot means all changes done since the definition of the snapshot, The content of the snapshot consists of the unchanged original data and of the changes since the definition of the snapshot (Siemens)
SNG	Satellite News Gathering
SNMP	Simple Network Management Protocol http://www.snmplink.org/
SNR	Signal-to-Noise Ratio
SOAP	Simple Object Access Protocol http://www.w3.org/TR/soap/
SPOP	SuperPOP
SQL	Structured Query Language
SQL / MySQL	Structured Query Language / http://dev.mysql.com/
SSL	Secure Socket layer
STB	Set-top box (-> IRD)
SVOD	Subscription VOD
TC	Time Code
TCP	Transmission Control Protocol (Internet)
Tech. 3293-2001	EBU core metadata set for Radio archives http://www.ebu.ch/CMSImages/en/tec_doc_t3293_tcm6-10494.pdf
Tech. 3295-2005 (P/META)	EBU Metadata Exchange Scheme http://www.ebu.ch/CMSImages/en/tec_doc_t3295_v0102_tcm6-40957.pdf
Tech. 3298-2004	An EBU 'route-map' to high definition (HD) http://www.ebu.ch/CMSImages/en/tec_doc_t3298_tcm6-17109.pdf
Tech. 3299-2004	High Definition (HD) Image Formats for Television Production http://www.ebu.ch/CMSImages/en/tec_doc_t3299_tcm6-23327.pdf
Tech. 3301-2005	Metadata for non-tape based camcorders (EBU) http://www.ebu.ch/CMSImages/en/tec_doc_t3301_v1-2005_tcm6-40955.pdf
Tech. 3306-2006	Multichannel File Format, MBWF http://www.ebu.ch/CMSImages/en/tec_text_r111-2004_tcm6-12769.pdf?display=EN
Tech. 3307-2006	Service requirements for free-to-air High Definition television receivers
Tech. 3309-2005	Evaluations of Cascaded Audio Codecs (EBU) http://www.ebu.ch/CMSImages/en/tec_doc_t3309-2005_tcm6-41405.pdf http://www.ebu.ch/en/technical/trev/trev_304-cascading.pdf
Tech. 3312-2006	Bitrate for HD distribution via DTT
TFT	Thin Film Transistor (LCD)
'Tks'	Tracks
TLS	Transport Layer Security
TS	Transport Stream (MPEG-2)
TVA	TV-Anytime http://www.tv-anytime.org/
Tx	Transmitter
UDDI	Uversal Description, Discovery and Integration protocol http://www.uddi.org/about.html
UDF	Universal Disk Format
UDP	User Datagram Protocol (Internet)
UI	User Interface
UMID	Unique Material IDentifier
UML	Unified Modelling Language
UMTS	Universal Mobile Telecommunications System
URI	Uniform Resource Identifier (Internet)

URL	Uniform Resource Locator
USB	Universal Serial Bus
USID	Unique Source Identifier (OriginatorReference field of BWF)
VAR	Value Added Reseller/Retailer
VBI	Vertical Blanking Interval
VBR	Variable Bit Rate
VC-1	SMPTE code for the Microsoft Video Codec
VC-2	SMPTE code for the BBC's Mezzanine Video Codec
VC-3	SMPTE code for the Avid DNxHDt Video Codec
VDCP	Video Disk Control Protocol
ver.	Version
VESA	Video Electronics Standards Association
VITC	Vertical Interval Time Code
VJ material	Video Journalist material captured using domestic style DV camcorders
VLAN	Virtual LAN
VO	Voice Over
'VOC'	Vocals
VOD	Video On Demand
VPN	Virtual Private Network
VT(R)	Video Tape (Recorder)
w.r.t.	With reference to
WAN	Wide Area Network
WAVE	WAVEform audio file format (Microsoft)
WB server	Warner Bros server (CNN)
WBU	World Broadcasting Unions http://www.nabanet.com/wbuArea/members/about.asp
WDSL	Web Services Description Language http://www.w3.org/TR/wsd/
WoC	Work Center
WORM	Write Once Read Many
XML	eXtensible Mark-up Language