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organized with EBU Network Technology Management Committee (NMC)

"A Hitchhiker's Guide to… Networks"
Your panic-free guide to future networks

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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 speakers' presentations, which are available on the CD-ROM distributed at the isse of the seminar to the participants.

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The slides number (in brackets) refer to the slides of the corresponding presentation.
To help "decode" the **abbreviations and acronyms**[1] used in the presentations' slides or in this report, a list is provided at the end of this report.
Web links are provided in the report or in the list of abbreviations for further reading.

Many thanks to all the speakers and session chairmen who revised the draft.

The Networks 2005 report is still available on the FTP site: ftp://uptraining:ft4train@ftp.ebu.ch and on the EBU site: http://www.ebu.ch/CMSimages/en/NMC2005report_FINAL_tcm6-40551.pdf

[1] About 210!

Introduction

Rhys LEWIS Chairman of EBU Network Technology Management Committee

"Why has the interest and the need in network technology increased so much over the past years?" – because we live in an Universe of:

- Telecom companies, Internet players, broadcasters, publishers merging or partnering
- Users connecting, interconnecting, exchanging (blogs, podcasts, tasks experimentation with services…)
- Users generating content on the networks
- "Broadcasters" having more and more to 'feed' people with on-demand material via networks, rather than with broadcasting programmes via transmitters; the BBC iMP (integrated Media Player, or iPlayer) to be launched late-2006 (slides 7-12).

The resulting key issues are: establishing standards, formats, defining quality of service - giving access to accurate metadata to be able to find the content itself and especially identifying material - making sure the content is secure, managing the rights, controlling systems…while being aware of non-technical aspects (e.g. legal), of new business models and opportunities (e.g. pictures from the public sold to broadcasters through a 'broker' or through a push-button on the mobile phone!), of the necessary control of quality and authentication.

In this context the role of the EBU-NMC (Network technology management Committee) through its various project groups (slides 17-27) is to:

- Interpret network technologies and their impact for EBU members, by: understanding the strategic and technical impact of new developments (mainly contribution networks), supporting and standardising new uses, educating and informing.
- Advise on Eurovision & Euroradio networks and operations: on technology and technology-related service issues, and by identifying and evaluating new technology opportunities and solutions.

1 File Transfer

File transfer is becoming a more and more important tool for content exchange - both inside a broadcaster's premise and between broadcasters. Being able to use non-real-time networks for content exchange (even in faster than real-time if needed!) can offer additional flexibility and cost savings when compared to "traditional" real-time circuits. But to really achieve an improvement in workflow and costs, the complete chain of content exchange via file transfer has to be defined very carefully and must take into consideration both the risks and the advantages of new technologies.

1.1 WAN acceleration

Matthias HAMMER, IRT – Broadcast Networks and Servers, Germany

The transfer of huge amount of data by the broadcaster, the worldwide contribution and distribution networks, the time-critical news material, the necessary reliability of the data delivery, implies for Wide Area Networks (WAN) to have three performing OSI communication layers:

- Layer 2 (Data Link) offers now 'unlimited' bandwidth through (NG-)SDH[2], RPR, DTM[3], ATM;
- Layer 3 (Network) is successful and powerful with IP;
- Layer 4 (Transport) using the TCP (Transmission Control Protocol) has to be improved.

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[2] See 2005 Networks report § 1.2.1.1

[3] See 2005 Networks report § 1.2.1.2

Therefore the Institut für Rundfunktechnik in Munich (IRT) and the NHK carried out tests of three TCP versions to find out what was the maximum throughput rate against the delay (5 - 30 ms), the bit-error ratio BER (up to 10^{-5}) and the receive buffer sizes (64 kB to 1 MB). The results were mostly influenced by the size of the receive buffer (slide 5) and varied for the different products by different BER (slide 8).

The following acceleration solutions can be considered according to one's own situation:

- Changes on the software level:
  - Not always possible for most off-the-shelf software
  - Transfer via parallel TCP-sessions
  - Changing the transport protocol, e.g. new TCP-type protocol, UDT (UDP-based data transfer)
  - Optimisation of the Operating System
- Changes in the infrastructure:
  - With the insertion of acceleration "Proxy" hardware (some test results will be published by the EBU FT-AVC Group)
  - Peer-to-Peer decentralised communication[4]

1.2 RSR audio file ingest system

Gérard SAUDAN, Technical project manager, Radio Suisse Romande, Switzerland

"Redline" is the system which allows the RSR radio digital production system based on Dalet[5] to ingest more than 1000 sound files per week from: Flashcard recorders, Pyramix[6] or ProTools[7] audio workstations, ripped CD tracks, EBU concerts[8], abroad correspondent feeds (slide 4), via LAN, WAN, FTP or HTTP.
The system is integrated in the RSR IT architecture through one Redline server in the 'DeMilitarised Zone' to ingest FTP or HTTP files, and one other Redline server in the inside IT network to directly ingest internal sources files (slide 5) and acquire the external files through the firewall. Associated with each sound file are metadata in a XML form (slide 6).

The formats are converted from MP2, MP3, AAC, FLAC[9], Linear…into the Broadcast Wave Format BWF MPEG-1 Audio Layer II (256 kbit/s stereo 48 kHz). Since at the start 20 to 30 % of the files were not fully correct, an automatic detection and repairing function is inserted into the workflow, using file repair tools like 'Tidy' or 'VBR Fix'.
The system components used are open source software, Dalet professional transcoder (to produce fully compliant BWF files) and transfer & archive agents.

The main advantages are:

- Easy to use (no super user needed) with simple interfaces (slides 12-15)
- Transfer from any PC (facilitate the homework!) and through all Web connections (Web cafes, Hotels, 'hot spot'…)
- Independent from the production system (XML format for the metadata)

Only some problems with the upload bandwith for large files.

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[4] KOZAMERNIK (F.) – *EBU Seminar report – From P2P to Broadcasting.* April 2006, EBU Technical Review. http://www.ebu.ch/en/technical/trev/trev_306-p2p.pdf

[5] http://www.dalet.com/radiosuite.html

[6] http://www.merging.com/2002/html/pyramix.htm

[7] http://www.avid.com/products/audio/

[8] See 2005 Networks report § 1.4.1

[9] http://flac.sourceforge.net

1.3 The BBC Production Gateway

Neill ANGIER + Richard ATHERTON and Peter BRIGHTWELL, BBC, UK

BBC is trialling file-based delivery between 6 post-production houses and the BBC(slide 5). The capacity of the network links between the different sites is of 7Mbit/s (ADSL), or 100 Mbit/s, or 1 Gbit/s.

It uses some functionalities of an independent MDP (Media Dispatch Protocol) Agent implementation provided by Siemens Business Services. The 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&D[10] and the Pro-MPEG Media Dispatch Group[11] at IBC 2005, there is an open source reference Beta implementation available[12]. It works as a simple middleware (slide 13): a 'Dispach 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.

The ongoing operational trial focuses on several workflows:

- Selected rushes transferred from the Post House, the Edit preparation taking place at the BBC (slide 8)
- Assets+EDL transferred from the BBC to the Post House where the finishing takes place (slide 9)
- Broadcast quality assets retrieved from the BBC Archive and transferred to the Post House (slide 10)
- Finished assets delivered from the Post House to the BBC or to Red Bee (formerly BBC Broadcast) for Quality Control and Playout (slide 11)

The evolution of the Production Gateway could include:

- More MDP functionalities: multiples files in a single transaction, "pull" mode, security measures, pause/resume or abort transfers, completion message.
- More than 2 organisations involved? with a peer-to-peer architecture? What about then security and trust?
- A Services-Oriented Architecture, SOA. This is a set of services (the Media Production Gateway being one of these) talking through an interoperability layer (slide 16). At present many of these services are implemented within vendors' proprietary applications, and Portals are also beginning to appear as preferred ways of delivering solutions and services.

2 Network management and control

The requirement of network administrators to manage network performance, find and solve network problems, and plan for network growth within media production and broadcast organizations has never been stronger.

This session explored the use of the Simple Network Management Protocol (SNMP), although originally developed for IT network components, is well suited for use with other media elements such as transmitters or production equipment.

[10] http://www.bbc.co.uk/rd/projects/mdg/index.shtml

[11] http://www.pro-mpeg.org/publicdocs/mdg.html

[12] http://sourceforge.net/projects/mediadispatch

2.1 SNMP Primer

Peter STEVENS, BBC, UK

Short for ***S**imple **N**etwork **M**anagement **P**rotocol,* SNMP is a set of protocols for monitoring and managing complex networks and attached devices. The first versions of SNMP were developed in the early 80s within the Internet community (RFC1157[13]). SNMP becomes the de facto control protocol of devices on the Internet. It typically uses UDP over an IP network, but is completely network agnostic. It works on many transport layers of many different networks and is quite flexible. The history of SNMP has seen several contenders, versions and extensions (slides 3+4, 10-14).

SNMP works by sending messages, called *protocol data units (PDUs)*, to different parts of a network. SNMP-compliant devices, called SNMP*agents,* store data about themselves in *Management Information Bases* (MIBs) and return this data to the SNMP requesters (slide 5+14). The agent collects data from the device that it manages, and is the interface between the manager and the individual device. Typically the agent block will sit in the device to be managed. But one may have a separate SNMP agent in a stand-alone PC and connect it to a legacy kit not supporting SNMP.

The **MIB** is effectively the centre of the protocol:
The MIB is organised in a tree structure and every object in this tree is uniquely identified with an object identifier (slide 7). At the 'enterprise (1)' level, any enterprise can have its own object ID. Anything beneath this , for example, the 'BBC (2333) level' is entirely up to the BBC how to define the object IDs, so that through these unique object IDs one can control the end kit.
The MIB is a collection of objects. For each object a value is associated with. Setting this value to a particular instance causes the unit to do something. One can find out what the configuration of the unit is by getting or retrieving these values. The SNMP manager queries the objects through the agent software - and that is how it finds out what's going on within the network.

There are some basic **operations** within SNMP (slide 9):

- GET request, to find out configuration details of the controlled device by retrieving a value.
- GETNEXT for looking at tables of information. Within the structure one can arrange the information in a logical table, so this will let the manager step through and find out what it's going on. GETBULK for retrieving multiple values.
- SET for modifying the value of an object
- GET RESPONSE message, used by the agent to reply to the manager.
- TRAP, enabling an agent to notify the management station of significant events by way of an unsolicited SNMP message, for example in case of failure. INFORM is similar to TRAP.

The goal of the EBU N/CNCS group is to take one step further and design a common standard, based on SNMP, to control and monitor many different types of equipment used in the broadcasting field.

2.2 SNMP implementation examples

2.2.1 Monitoring and controlling a transmitter

Andreas METZ, IRT, Germany

Since November 2003, the IRT has been developing with the German public broadcasters' network ARD and Systems-International (TSI), and with 4 transmitters manufacturers (slides 14+18), a Transmitter Control MIB, as a **Telecontrol** Interface for the management of Broadcast transmitters allowing:

- Transmitter monitoring (failure of channels, services, components)
- Primary fault clearance (equivalent network, cut-off)
- Network configuration

[13] http://www.ietf.org

- Fault clearance "initiation"
- Information from the service provider

It is not a replacement of the vendor management products such as service interface, maintenance tools, delivering measurement data.

The specifications of the future standard (late-2006, if all problems are solved before), that were worked out in the IEC Project Team PT 62379 (slide 19-23), will concern:

- DVB-T, DAB, FM/UKW, DRM (possibly) transmitters
- For each transmitter type the following categories are defined (valid at the moment for DVB-T, DAB, FM/UKW): Single transmitter, Dual drive, active reserve, passive reserve, N+1 configuration (slide 16)

2.2.2 Remote controlling a Newscast!

John GLIMBERG, Senior Systems Engineer, SVT, Sweden

This live (and successful) demonstration of the remote controlling of a newscast in Sundsvall (Sweden), over the Internet, took place from Geneva and displayed over satellite and TCP/IP for viewing purpose (slide 4). Different operations were shown:

- Searching news item on the "Falklands" in the Stockholm Central Archive (on a data tape library) – Photo 1-, retrieving one extract on Mrs Thatcher and inserting it in the rundown of the regional Sundsvall station (Photo 2). The video file of the 1982 news item was copied and played on the show within minutes.
- Dragging a news item "Valar" – Photo 3- from the Stockholm rundown into the Sundsvall one (Photo 4). The video file was immediately copied 400 km to Sundsvall and played on the show.
- Switching from one camera to another one during the newscast (Photo 5), or controlling any other equipment (Photo 6).
- Revising, modifying the rundown order.
-
- This "Easy Control" system is implemented in 10 stations around Sweden (slide 5), supported from Stockolm around the clock by only 5 people.
-

2.2.3 Controlling a 'radio station in a box'

Luke SLUMAN, BBC R&D, UK

This is a BBC project that deals with the replacement in Brodcasting House of the entire traditional live audio structure with a network technology based on ATM and AES 47. This is where the SNMP solution (§ 2.1) comes in to control the end kit, a “BBC radio station in a box” (slide 3). There is one of these boxes for each radio network and one per output channel (FM, DAB, D-Sat).
The first part of the common control protocol defines a framework for blocks of functionality that make up an item of equipment. A table is used (slide 4 - bottom left) to map block numbers to the place in the MIB where the relevant functionality is defined. These blocks are referenced by an Object Identifier (OID) in the table.

The advantage of the block structure is that standardisation of blocks may happen independently from the framework of the common control protocol. There will be a core of block definitions that get standardised with the common control protocol but, in addition, other bodies may have some standard block sets. For example, there could be some special EBU blocks specific to European broadcasting or may be a broadcaster such as the BBC could have their own blocks to suit their particular operation. In addition, this structure can be used by manufacturers to provide functionality unique to them.
The different blocks and the corresponding MIBs are detailed in the slides 5-8.

As well as the block listing, there is an input table for each block (slide 4 - bottom right). This shows where each input to that block comes from – i.e. which of the previous blocks are connected to the current block.

The demonstration used an example unit - the ‘978’ Transmission Stream Manager (TSM) developed by dCS Ltd of Cambridge, England, and an interface with set commands (slide 9). It showed the audio loss detection and the switching to an audio clip store.

Status page broadcasts (slide 10) are designed to stop many people from requesting the same information about the status of a unit. A display (slide 11) provides a summary of 62 Transmission Stream Managers. The Siemens’ Colledia Control system for the TSMs (slides 13 to 17) has been chosen for BBC Broadcasting House.

3 Network Solutions

The session described real-world applications: a high-capacity metropolitan fiber network, the use of Internet Protocol for audio to mitigate the potential loss of ISDN circuits, and the implications for networks of the move towards High Definition.

3.1 VRT's Coarse Wavelength-Division Multiplex (CWDM) Network

Bruno LAUKENS, Project Manager, VRT, Belgium

In 2003 and 2004 three fibre optic rings were installed in Brussels (slides 21+22) to interconnect European buildings (Parliament, Council, Commission) - Belgian Government, Federal and Flemish Parliament buildings – the International Press Centre, Broadcaster's stations or offices (VRT, EBU-CNCT, ORF, WDR…).
This network uses the Coarse Wavelength Division Multiplexing (CWDM), which in the "windows" of the laser spectrum (slide 17) with 2 x 8 different laser wavelengths creates 16 channels of a capacity between 100 Mbit/s and 2,5 Gbit/s each (slide 18). This technique is cheaper than the Dense WDM, which allows 40 x 2,5-10 Gbit/s channels (slides 15+16) but requires stable, power-consuming and expensive lasers. With the appropriate interfaces one can transmit SDI/ASI, HD-SDI, Ethernet 100Base-T or Gigabit, PDH, SDH, IP, over 50 km (slide 19). The CWDM equipment is from Network Electronics ASA company (Norway)[14]

3.2 Sending Audio over IP

Peter STEVENS, BBC, UK

BBC local radio stations were wanting to share live programme material over the BBC IP network during the evening periods using audio over IP codecs (APT WorldNet Tokyo at that time), but the quality was not as expected. Furthermore, it will probably get harder, slower and more expensive to use ISDN circuits as time goes on, although it guarantees the quality of service. For these reasons the BBC R&D Lab started to conduct tests (slide 5).with various codecs (STL-IP[15], Pronto[16], APT[17], Mayah[18], Digigram[19], Papatsco[20]…slide 7) and simulating different network parameters (with expensive solutions such as Shunra and Ixia, and others that are free, generally based on Linux, such as ns2, Netem, etc.).

The results of the tests (slides 9-12) and the demo showed that:

- the rate of latency change (slide 10) is as important as the latency value itself (0 to 70 ms, in this example)

[14] http://eng.625-net.ru/content/2005_01/fiberoptic7.htm
[15] http://www.stl-ip.com/
[16] http://www.prodys.net
[17] http://www.aptx.com
[18] http://www.mayah.com
[19] http://www.digigram.com
[20] http://www.patapsco.co.uk

- an increased receive buffer size of 100ms (slide 11) applies apparent improvement, but with the disadvantage of adding delay, which might not be acceptable under the operational conditions, such a two way conversations.

Testing is essential to ensure that what the manufacturers say about their products is true and meets the broadcasters needs.– in a cost effective and reliable way.
There are many improvements on the way within the audio over IP field, such as the inclusion of:

- More robust transfers with channel coding/FEC
- Error detection, correction and concealment
- Higher bandwidths, allowing for PCM stereo 5.1
- Managed bandwidth in networks at lower costs
- Signalling – dialling/DNS?/SIP? And other possible methods?
- Man to machine interface suitable for non-engineers

3.3 Contribution networks for HD

Markus BERG, Head of Broadcast Networks & Servers department, IRT, Germany

The network requirements concerning real-time transmissions for broadcast networks (slides 4+5) are in principle the same for HD as for SD, with the exception of the bandwidth requirements: 1,5 Gbit/s from HD-SDI and later 3Gbit/s or more. For storage, the needed capacities will also rise (for example: 1TB of storage for a 90-min film in uncompressed HDTV). Now, the question is: for HD networked production and HD contribution and primary distribution do we need:

- New networks ? Not necessarily - the existing LAN (Gigabit Ethernet, Fibre Channel – slide 15) and WAN technologies (ATM/SDH, DWDM, IP/MPLS, DTM, RPR – slide 17) have mostly at least the required bandwidth. Timing constraints due to possible synchronisation problems still have to be evaluated.

  But existing networks must be enhanced:
  - To allow LANs and WANS to cope with the rising traffic (for example to transport several uncompressed HDTV streams at the same time), to control the increasing data volume with prioritization concepts, to meet all the timing/synchronisation requirements.
  - There are some new network technologies especially in the WAN which may ease the transport of HD: like for example NG-SDH[21], Optical Routing. But these technologies first need to be validated against the broadcasters requirements.
- Network adapters? These adapters have the tasks of adaptation of the A/V signal to the network layer, of timing (clock recovery…), of error detection and correction (FEC, sequence numbering…), and of signalling. HDTV network adapters have already been announced/deployed for various WAN technologies (slide 22) by different manufacturers (slide 23).

As a conclusion we can say that todays network technologies are ready to transport HD, but they must be properly implemented and managed to guarantee the level of Quality of Service, that broadcasters need for their applications.

4 Contribution technology / satellite networking

4.1 DVB-S2 Primer… and IP services by satellite

Alberto MORELLO, Director RAI Research, Technology Innovation Centre, RAI, Italy

The DVB-S2[22] is the second generation of the DVB-S standard for satellite broadcasting, point-to-point

[21] See 2005 Networks report § 1.2.1.1

[22] MORELLO (A.) and MIGNONE (V.), *DVB-S2 – ready for lift off*. October 2004, EBU Technical Review.
http://www.ebu.ch/en/technical/trev/trev_300-morello.pdf

interactive applications and professional transmission systems (DSNG, Internet trunking, cable feeds…).

Its 25 to 35 % bit-rate capacity gain (compared to DVB-S) is based on:

- Efficient channel codes for error detection and correction (LDPC codes concatenated with BCH), with a variety of code rates available : 1/4 (1 useful bit for 4 transmitted bits), 1/3, 2/5, 1/2 (for DVB-S), 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10
- Four possible modulation codes, with increasing channel efficiency (slide 28): QPSK (2 bit/s/Hz), 8PSK (3 bit/s/Hz), 16APSK (4 bit/s/Hz), 32APSK (5 bit/s/Hz). Compared to QAM, the APSK modulation schemes allow an easier compensation of transponder non-linearities.
- Three possible spectrum shapes, with a filter roll-off of: 0,35 – 0,25 – 0,20

This coding flexibility is especially used with the two following operational modes:

- VCM: variable coding and modulation. VCM allows to allocate a different modulation scheme and error correction level to each of the data streams of the same carrier.
- ACM: adaptive coding and modulation (slides 13-15). ACM allows to dynamically change the demodulation scheme and the error protection level for each data frame. When combined with a feedback mechanism from each receiving terminal, this last feature is particularly interesting for bandwidth optimization in an interactive network. The transmission parameters can be then optimized for each terminal, and weather influences, such as rain fades, can easily and safely be compensated.

The other major difference and advantage when compared to DVB-S are the ability to combine different input data streams into one carrier: MPEG Transport Stream format, generic format (e.g. IP…),

Fast-Internet services (slides 17-19) can be carried using DVB-S2 ACM, with IP over generic streams (slide 29) or over MPEG-TS (slide 30). On a Ka-Band satellite transponder (with nation-wide spot-beam coverage) this service may become economically competitive with ADSL, especially in wide countries without a full terrestrial infrastructure (slide 22).

DVB-S2 can also be used for mobile television in hybrid satellite-terrestrial networks (slides 24-25 + 33). Specifications for mobility will be published late-2006.

4.2 France 3 Migration of DSNG operations to DVB-S2

Alain DANRE, France 3, France

In order to feed its 24 regional newscasts twice a day, France 3, the French regional public broacasting network, has 15 manually operated DSNG vans and 5 with automated transmission (+ 3-4 early-2007).
In order to save money, France 3, by leasing a permanent 18 MHz channel capacity on the Atlantic Bird 2 satellite, wants to migrate to DVB-S2 and by doing so to use:

- either 5 x 3,6 MHz slots (instead of the actual 3 x 6 MHz slots) - sufficient to ensure the return on investement,
- or leased 4,5 MHz occasional slots.

For the control of the automated DSNG vans a multi-customer VSAT service is used (up to 2 Mbit/s, but less than 300 kbit/s for France 3).

- The questions still to be answered are:
- What are the optimum operational parameters: filter roll-of (0,20? 0,25?), latency (40 ms) and frame structure (16 kbit versus 64 kbit?)
- Interoperability with other broadcasters (5 % of the transmissions)?
- What is the best combination of parameters (8PSK or 16APSK, FEC 5/6 or ¾, reduced bit-rate…)?
  Real performance figures from the manufacturers are expected…!
- VCM (depending on a good level of interoperability) or ACM (but when?) mode?
- MPEG-4 AVC? (yes for the bandwidth saving, but codec performance and cost?)

4.3 Broadcasting networks for the Winter Olympic Games

Vincenzo SARDELLA, Engineer, RAI, Italy

The 2006 Winter Olympic Games have been an opportunity for RAI to launch experimental HDTV and Mobile-TV transmissions, and DTT hierarchical modulation.

The transport networks in the overall architecture (slide 5) included following technologies:
- Optical fiber for ASI signals from the RAI Production Centre to the International Broadcasting Centre IBC and to the RAI Research Centre CRIT (slide 10)
- SDH radio link + ATM from the RAI Research Centre to the main Broacastingsite (Eremo)
- Satellite from the IBC to the DTT modulator and transmitter (slide 11)
- OFDM to feed DTT repeaters

The HDTV video signals were encoded in MPEG-4/AVC 14,5 Mbit/s (Tandberg) and audio in Dolby AC3.
For DVB-H, the TV channels were encoded in H.263 (video at 250 kbit/s) and the radio channels in AAC format at 64 kbit/s.
For DTT, the hierarchical modulation used QPSK (with 1/2 code rate) in 64 QAM (with 3/4 code rate) with a constellation proportion ratio of α=2, OFDM symbol guard interval of 1/8 and 8k carriers.

5 Security

5.1 The impact of outsourcing and partnering on IT security

Andy LEIGH, Head of Information Security Stategy, BBC, UK

The facts about IT (in)security:
- TCP/IP is insecure[23]
- As a result, most organizations, over the last decade, have built themselves into a "**walled citadel model**" when using TCP/IP communications to other networks (including the Internet). They use firewalls to interface with these networks (like armoured gates) and prevent any other non-firewalled IP-to-IP communications (like a strong, stone wall). Consequently all traffic only goes in and out of the guarded gate.
- Corporations, businesses, home users hide behind the armoured gateway of their firewalls because of:
  - The very real existence of targeted or automated network attacks.
  - Poor LAN-centric protocols (file-server systems used " chatty" protocols, operating Systems assume they are on a disconnected isolated LAN). This is because they developed as solutions on disconnected building and office LANs before the concept of IP-based Intranets and company connections to the Internet.
  - Many systems just assume whoever is on the network is trusted.
  - Many applications and Operating Systems are badly written with back-doors and flaws. New flaws are being discovered daily and new OS versions introduce new flaws. Most commercial software is not very strong.
  - Lack of public (IP version 4) addresses available on the Internet. Firewall-centric Network Address Translation and "Private" IP addresses allow companies to have multiple internal IP addresses and only a few genuine public Internet addresses.
  - An extra advantage is to reduce operational costs by having a single point to monitor (look for attacks) and patch.

[23] See 2005 Networks report § 3.2

- But the security perimeters are disappearing = "**de-perimeterization**" = "… and the walls came tumbling down" (slides 8-10):
  - o Some inside people are outside: staff working from home, in hotels and cafes; outsourcing: services - equipment and people that used to be inside "trusted" are now outside "untrusted".
  - o Some outside people are inside: partners; outsourced personnel; systems dialing the supplier if there is a fault and requiring the supplier to login to fix.

The **Jericho Forum** / Open Group[24], founded in January 2004, is an "international circle of about 50 IT customer and vendor organizations dedicated to the development of open standards to enable secure and boundaryless information flows across organisations". It issued, in April 2006, **11 commandments** which define both the areas and the principles that must be observed when planning for a "de-perimeterised" future. The commandments should serve as a benchmark by which concepts, solutions, standards and systems can be assessed and measured (slides 12-23):

Fundamentals

1. The scope and level of protection must be specific and appropriate to the asset at risk.
2. Security mechanisms must be pervasive, simple, scalable & easy to manage (there is no single solution or vendor for security problems).
3. Assume context at your peril.

Surviving in a hostile world

4. Devices and applications must communicate using open, secure protocols.
5. All devices (IT, Production, Broadcast) must be capable of maintaining their security policy on an untrusted network.

The need for trust

6. All people, processes, technology must have declared and transparent levels of trust for any transaction to take place.
7. Mutual trust assurance levels must be determinable.

Identity, Management and Federation

8. Authentication, authorisation and accountability must interoperate / exchange outside of your locus / area of control. All transactions must be authenticated.

Access to data

9. Access to data should be controlled by security attributes of the data itself (e.g. in the Metadata).
10. Data privacy (and security of any asset of sufficiently high value) requires a segregation of duties/privileges.
11. By default, data must be appropriately secured when stored, in transit and in use.

5.2 The military approach to IT security… versus Broadcast

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Military IT equipment and networks have to be:

- Robust (rough handling; operation in extreme environments)
- Interoperable (new equipment must operate with old; equipment must operate with allies' equipment)
- Integrated in complex systems
- Resilient and continue to operate under attack; resilience can be built into IT systems hosts and/or network nodes
- Reliable (should work first time; should guarantee to do their task)
- Protected by encryption (any message transmitted or stored cannot be accessed/modified by an enemy) and 'lure' (false/idle data may be sent to prevent traffic analysis)
- Updated and re-accredited during their life

Data disposal must be available through system's life, and data is a more important issue than equipment in case of emergency distruction.

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24 http://www.opengroup.org/jericho/ or https://www.opengroup.org/jericho/index.tpl

Military versus Broadcast Information Security

Information Security = CIA	Military	Broadcast
Confidentiality You don't want your enemy to eavesdrop on your communications or read your files if they capture your equipment	- Intentions - Capabilities	- Information sources
Integrity When you send an instruction, you expect it to be received exactly as you sent it, not garbled	- Intelligence must be reported correctly - Orders must be disseminated without corruption	- Must report facts correctly in order to maintain credibility and trust of listeners/viewers
Availability You need to be able to use your systems as and when you need to, you don't want them knocked out just as you start an offensive	- To be able to report intelligence when it occurs - To be able to issue orders when required	- To file stories when the journalist wants/needs to - To transmit programmes on schedule - To distribute on-line content on demand from user

Abbreviations and acronyms

Note: Some terms may be specific to a speaker or/and his organization

Session.Lecture-Slide		
4.3	**a.g.l.**	Above ground level (field strength)
4.3	**A/V**	Audio/Video, Audiovisual
1.2	**AAC**	Advanced Audio Coding
5.1-6	**ACL**	Access Control List
4.2	**ACM**	Adaptative Coding and Modulation
2.3-23	**ADSL**	Asymmetrical Digital Subscriber Line
2.4	**AES**	Audio Engineering Society
2.4	**ALD**	Audio Loss Detector
1.3	**API**	Application Programming Interface
4.1	**APSK**	Amplitude Phase Shift keying (DVB-S2)
3.1	**ASI**	Asynchronous Serial Interface (DVB)
2.1	**ASN**	Abstract Syntax Notation
1.1	**ATM**	Asynchronous Transfer Mode
	AVC	Advanced Video Coding (MPEG-4)
4.1-10	**AWGN**	Added White Gaussian Noise
4.1-30	**BB**	BaseBand
4.1-8	**BCH**	Bose, Ray-Chaudhuri, Hocquenghem code (DVB-S2)
1.1	**BER**	Bit Error Ratio
1.1	**BIC TCP**	Binary Increased Congestion control - TCP
	BISS-E	Basic Interoperable Scrambling System with Encrypted keys
		http://www.ebu.ch/CMSimages/en/tec_doc_t3292_tcm6-10493.pdf
4.1-18	**Buff.**	Buffer
4.3	**BW**	Bandwidth
1.2	**BWF**	Broadcast Wave Format
4.1-16	**C**	Satellite frequency band (3,7 – 6,425 GHz)
4.1	**C/N**	Carrier-to-Noise ratio
4.3	**CA**	Conditional Access
	CMIP	Common Management Information Protocol
2.1-3	**CMOT**	Common Management Information and Protocols over TCP/IP
3.3	**CN**	Corporate Network
3.1	**CNCT**	Centre National de Coordination Technique (EBU)
	CPU	Central Processing Unit
4.3-3+6	**CRIT**	Centro Ricerche e Innovazione Tecnologica (RAI)
	CWDM	Coarse/Dense Wave Division Multiplex(ing)
3.1	**CWDM**	Coarse Wavelength Division Multiplex(ing)
1.2	**DAB**	Digital Audio Broadcasting
1.1	**DataTAG**	Intercontinental Grid tesbed project for advanced networking
4.1	**DEM**	Demodulator
1.2	**DMZ**	DeMilitarised Zone
5.1	**DRM**	Digital Rights Management
2.2	**DRM-DI**	Digital Radio Mondiale - Distribution Interface
4.3	**DS-3**	Digital Signal - level 3 container (45 Mbit/s - PDH)
2.4	**D-Sat**	Digital Satellite
5.1	**DSL**	Digital Subscriber Line

4.2	**DSNG**	Digital Satellite News Gathering
5.2	**DSSO**	Defence Security Standards Organisation (UK)
1.1	**DTM**	Dynamic synchronous Transfer Mode
	DTTB	Digital Terrestrial Television Broadcasting
4.1-4	**DTV**	Digital TeleVision
	DVB	Digital Video Broadcasting
4.3	**DVB-H**	DVB - Handheld
	DVB-IP	Specifications for the carriage of Internet Protocol traffic on DVB channels
	DVB-RCS	DVB with Return Channel via Satellite
	DVB-S	DVB - Satellite
	DVB-S2	DVB – Satellite 2nd Generation
	DVB-T	DVB - Terrestrial
3.1	**DWDM**	Dense Wavelength Division Multiplex(ing)
1.3	**EDL**	Edit Decision List
3.1-19	**EO**	Electrical-Optical
4.3	**ERP**	Effective Radiated Power
2.3-17	**ESA**	European Space Agency
4.3	**ESG**	Electronic Services Guide
3.1	**Eth.**	Ethernet
3.1	**ETSI**	European Telecommunications Standards Institute
	FEC	Forward Error Correction
3.1-22	**FiNE**	Fiber Network Eurovision (EBU)
		http://www.netinsight.net/pdf/040823_Casestudy_EBU_2.pdf
1.2	**FLAC**	Free Lossless Audio Codec
	FM	Frequency Modulation
	FO	Fibre Optics
1.1	**FT-AVC**	File Transfer technologies for Audio Visual Content (EBU Working Group)
1.1	**FTP**	File Transfer Protocol (Internet)
	GB	Gigabyte
1.1-12	**GbE, GE**	Gigabit Ethernet
4.3-19	**GPRS**	General Packet Radio Service
4.1-18	**GSE**	Generic Stream Encapsulation (DVB-S2 & IPv6)
4.1-19	**GTW**	Gateway
	HD(TV)	High-Definition (Television)
3.3	**HD-SDI**	High Definition SDI (1,5 Gbit/s)
2.1	**HEMS**	High-level Entity Management System
1.1	**HSTCP**	High Speed TCP
	HTTP	HyperText Transfer Protocol
1.3	**HTTPS**	HTTP using a version of SSL or of TLS
1.1	**HW, H/W**	Hardware
4.3	**IBC**	International Broadcasting Centre
	ID	Identifier, identification
	IEC	International Electrotechnical Commission
3.3	**IEEE**	Institute of Electrical and Electronics Engineers
2.2	**IETF**	Internet Engineering Task Force
1.1-10	**IF**	Interface
	IP	Internet Protocol
	IPTV	Internet Protocol Television
4.2	**IRD**	Integrated Receiver- Decoder
1.1	**IRT**	Institut für Rundfunktechnik (Germany)

	ISDN	Integrated Services Digital Network
	ISO	International Organization for Standardization
	ISOG (WBU-)	International Satellite Operations Group of the WBU http://www.nabanet.com/wbuArea/members/ISOG.html
	ISP	Internet Service Provider
1.1	**IST**	Information Society Technologies (European Programmet)
	IT	Information Technology ('informatique')
	ITU	International Telecommunication Union
4.1	**Ka**	Satellite frequency band (20 - 30 GHz)
4.1	**Ku**	Satellite frequency band (10,7 - 18 GHz)
	LAN	Local Area Network
1.1	**LFN**	Long Fat Networks!
4.1-8+30	**LPDC**	Low-Density Parity-Check codes (DVB-S2)
2.1	**MAC**	Message Authentication Code
1.1	**MDG**	Media Dispatch Group (Pro-MPEG)
1.3	**MDP**	Media Dispatch Protocol
2.1	**MIB**	Management Information Base (SNMP)
4.3	**MOD**	Modulator
5.2	**MoD**	Ministry of Defence
1.2	**MP2**	MPEG-1 Audio Layer II
1.2	**MP3**	MPEG-1 Audio Layer III
	MPE	Multiprotocol Encapsulation
	MPEG	Moving Picture Experts Group
3.3	**MPLS**	Multi-Protocol Label Switching
4.3	**MUX**	Multiplexer
3.2	**N/ACIP**	Audio Contribution over IP (EBU Project Group)
	N/ACT	Advanced Contribution Technology (EBU Project Group)
2.1	**N/CNCS**	Common Network Control Strategy (EBU Working Group)
	N/FT-AVC	File Transfer technologies for Audio Visual Content (EBU Working Group)
	N/HD-NET	High Definition on NETworks (EBU Working Group)
	N/SECURITY	Network Interconnectioin SECURITY (EBU Working Group)
	N/WAN	Use of Wide Area Network for the carriage of audiovisual content(EBU Working Group)
5.1	**NAT**	Network Address Translation
1.1	**NG-SDH**	Next Generation - SDH
5.1	**NIC**	Network Interface Card
3.3	**NLE**	Non-Linear Editing
	NMC	Network technology Management Committee (EBU) http://www.ebu.ch/en/technical/organisation/nmc/index.php
3.3-17	**MPLS**	Multiprotocol Label Switching
4.3-11	**ODFM**	Orthogonal Frequency Division Multiplex(ing)
3.1-13	**OE**	Optical-Electrical
2.1	**OID**	Object Identifier
4.3	**ORX**	Optical Receiver
	OS	Operating System
	OSI	Open Systems Interconnection
3.3-17	**OTN**	Optical Transport Network
4.3	**OTX**	Optical Transmitter
1.1	**P2P**	Peer-to-Peer
3.1	**PDH**	Plesiochronous Digital Hierarchy
2.1	**PDU**	Protocol Data Unit

1.3	**PG**	Production Gateway (BBC)
1.3	**PH**	Postproduction House
4.3	**PID**	Packet Identifier
5.2	**PKI**	Public-Key Infrastructure
4.1-30	**PL**	Physical Layer
	Prep.	Preparation
4.3-18	**Prot.**	Protection level
4.3	**PSI**	Programme Specific Information (MPEG-2 System)
4.1-5	**PSTN**	Public Switched Telephone Network
2.2-19	**PT**	Project Team
4.3	**QAM**	Quadrature Amplitude Modulation
3.2-5	**QoS**	Quality of service
4.2	**QPSK**	Quadrature Phase Shift Keying (DVB-S / -S2)
1.1	**RB**	Receive Buffer
	RCS	Return Channel per Satellite (DVB)
1.1	**RFC**	Request For Comments (IETF)
2.1	**RMON**	Remote Monitoring
1.1 + 3.3-17	**RPR**	Resilient Packet Ring
4.1-10	**Rs**	Symbol bit-rate
1.1	**RTT**	Round Trip (delay) Time
4.1-10	**Ru**	Useful bit-rate
3.2	**RX**	Receiver
4.2	**SCPC**	Single Channel Per Carrier
	SD(TV)	Standard Definition (Television)
3.1	**SDH**	Synchronous Digital Hierarchy
	SDI	Serial Digital Interface (270 Mbit/s)
	SDSL	Symmetric Digital Subscriber Line
	SFN	Single Frequency Network
	SFTP	SSH (Secure Shell) FTP
2.1	**SGMP**	Simple Gateway Management Protocol
4.3	**SI**	Service Information (DVB)
4.1-21	**S-ISP**	Satellite – Internet Service Provider
4.1-22	**SLA**	Service Level Agreement
2.1	**SMI**	Structure of Management Information
1.3	**SMTP**	Simple Mail Transfer Protocol
21	**SNMP**	Simple Network Management Protocol
5.1	**SOA**	Service Oriented Architecture
3.3	**SONET**	Synchronous Optical Network (SDH / U.S.A.)
	SSL	Secure Socket Layer
4.1-24	**SSP**	Satellite broadcast Services to Portables
4.3	**STB**	Set-top box
	STM-16	Synchronous Transport Module Level 16 (2,5 Gbit/s)
	STM-64	Synchronous Transport Module Level 64 (10 Gbit/s)
	TB	Terabyte
2.2	**TC-MIB**	Transmitter Control MIB
	TCP	Transmission Control Protocol (Internet)
3.1	**TDM**	Time Division Multiplex(ing)
	TLS	Transport Layer Security
	TM-GBS	Technical Module - Generic Data Broadcasting & Service Information Protocols (DVB)
4.3-2	**TOBO**	Torino Olympic Broadcasting Organisation

	TS	Transport Stream (MPEG-2)
2.4-9	**TSM**	Transmission Stream Manager
3.2-5	**TTL**	Time to Live
	TX	Transmitter
1.1	**UDP**	User Datagram Protocol (Internet)
1.1	**UDT**	UDP-based Data Transfer
1.3	**UGC**	User Generated Content
4.3	**UHF**	Ultra High Frequency
3.1-19	**Upg.**	Upgraded
2.1	**USM**	User-based Security Model
5.2-9	**UUC**	Unix to Unix Copy
2.1	**VACM**	View-based Access Control Model
1.2	**VBR**	Variable Bit Rate
	VC-1	Ex - Windows Media Video Codec, now SMPTE 421M-2006
4.2	**VCM**	Variable Coding and Modulation (DVB-S2)
4.3	**VHF**	Very High Frequency
3.3 p.6	**VoIP**	Voice over IP
4.2	**VSAT**	Very Small Aperture Terminal
	WAN	Wide Area Network
	WBU	World Broadcasting Unions http://www.nabanet.com/wbuArea/members/about.asp
3.1	**WDM**	Wavelength Division Multiplex(ing)
	WiFi	Wireless Fidelity
	WiMAX	Worldwide Interoperability for Microwave Access
1.1 p.5	**WS**	Window size
	XML	eXtensible Mark-up Language