Overview of the components of the common innovation platform based on a first operational implementation

Overzicht van de verschillende componenten van het gemeenschappelijk innovatieplatform op basis van een eerste operationele implementatie

BOM-VLAANDEREN
WP6: Demonstrator – ontwikkeling van een gemeenschappelijk innovatieplatform
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2 Introduction

This is the first deliverable of work package 6 (Demonstator – common innovation platform). This deliverable will describe the setup and its results created during the first three quarters of the BOM-VL project.

Chapter 3 will describe the setup in detail. During this setup and testing by multiple partners, problems finding a common fileformat (MXF with the right audio and video tracks) arose and were solved. This is described in chapter 4. Mapping the metadata to a common hierarchical model will be studied in work package 3, but in the meantime temporary solutions were found for the demonstrator. These will be described in chapter 5. Chapter 6 describes the results of the demonstrator up till now.
3 Demonstrator setup

The first step in work package 6 was setting up an ingest platform and storage environment to make it possible gaining experience with large scale digitalization and storage. In a second phase this platform can then be used as innovation platform for feedback from the other work packages.

3.1 Ingest platforms

Figure 1 shows the current implementation of the demonstrator platform. Two partners of the project (Videohouse and VRT) offer the necessary hardware and accompanying software for an automatic digitizing process. IBBT iLab.t offers the necessary servers and storage for storing the archived material. Comsof offers licenses for using their media asset management software for the demonstrator. (the budget for purchasing those systems is outside the BOM-VL budget)

Sony Flexicarts are used as robots for putting the video tapes in VTRs (video tape recorder). They can contain up to 60 smaller tapes or 30 large tapes. Before, they were typically used by broadcasters for playout, now they can be perfectly used to automate digitizing processes for archiving.

VTRs come in different flavours depending on the type of tape: Beta SX, Beta SP, Digibeta, IMX, … or a combination. The VTRs are connected to Vizrt videoservers through an SDI (serial digital interface) connection. These Vizrt videoservers can convert two SDI inputs per server into MXF files with DV or IMX as video codec. After creation of the MXF file, it is moved to local network attached storage (of about 5TB) where the file remains until quality control has been performed by a human being. The size of this storage is related to the number of days (e.g. weekend) one can wait with quality control. After this quality control, the MXF file together with its metadata in XML is pushed to the IBBT archive via FTP.

This complete process is controlled by Vivesta’s MediaFlow software.

When the files and metadata arrive in Gent (in IBBT’s iLab.t lab environment), they are stored on temporary storage before they are further processed. This makes it possible to disconnect the rest of the system, e.g. for maintenance. The rest of the system is driven by MediaDRAIN, the media asset management software of Comsof, also partner in the project. The high resolution files are sent to LTO4 tapes in a Spectralogic T950 tape robot and a low resolution version and keyframes are created by the transcoding farm. These are stored on online disk storage for fast consultation. The metadata is stored in an SQL database.

Besides this, an e-VTR is also present in Gent, which is owned by VRT Medialab, but can be used now and then for the project, for smaller ingests/demos. IBBT owns also an XDCAM player which can be used to ingest files from XDCAM disks.

The ingest platform at the VRT is used for VRT content only, while the platform at Videohouse is used for ingesting the content of all other BOM-VL partners.
Figure 1: Demonstrator setup
3.2 Network connectivity

For transferring the files from the ingest platform at Videohouse and VRT to IBBT, a dedicated 1 Gb/s VPN (virtual private network) is set up over Belnet (the Belgian national research network) between VRT, Videohouse and IBBT iLab.t.
3.3 Workflow

3.3.1 VRT ingest platform
VRT has two proprietary databases with metadata (KPS and Basisplus). KPS contains more technical information about the tapes (type, timecodes, audiotracks, …) while Basisplus has more content oriented metadata (detailed descriptions, item information, …).

Vivesta MediaFlow queries those two databases and if a tape occurs in a flexicart, looks up the tape ID and retrieves the necessary metadata information. This metadata is then put in an XML. Special cases (e.g. no records found or multiple records found for a tape) have to be solved by an operator or archivist.

3.3.2 Videohouse ingest platform
The Videohouse ingest platform is used for digitizing tapes of all other partners and as such, a more generic workflow had to be developed to process the metadata.

![Diagram](image)

**Figure 3: Processing metadata/tape barcodes before ingest**

Figure 3 shows the process and tools used for preparing tapes and metadata before entering them in the flexicart. This can be used for all metadata delivered in XML format. The XML preprocessor is broadcaster specific.

The XML which is fed to Vivesta MediaFlow looks as follows (details depend on metadata which is present or not):

```xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<MDAI_XML_TYPE name="BOM_SBS_XML" version="1.0">
  <export>
    <mob>
      <fulltape>preplay</fulltape>
      <tapeid>20061226</tapeid>
      <tapeformat>DBR</tapeformat>
      <bitrate>IMX50_A4_24</bitrate>
      <clientid>SBS</clientid>
      <title>SBS The Block</title>
      <description>Het vijfde Koppel heft … </description>
    </mob>
    <metadata>
      <PROGRAMMEGROUP>
        <CURRENT_TITLE>The Block</CURRENT_TITLE>
      </PROGRAMMEGROUP>
      <PROGRAMME>
        <ORIGINAL TITLE>Aflevering 4: Game Over</ORIGINAL TITLE>
        <CURRENT_TITLE>Aflevering 4: Game Over</CURRENT_TITLE>
        <CURRENT_SUBTITLE />
        <EPISODE_NUMBER>4</EPISODE_NUMBER>
        <DESCRIPTION>…. </DESCRIPTION>
      </PROGRAMME>
      <MEDIAOBJECT>
        <TITLE>ID, or 'broadcast'</TITLE>
      </MEDIAOBJECT>
    </metadata>
  </export>
</MDAI_XML_TYPE>
```

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Of course, if such an XML can be exported from the metadata database of the broadcaster, the preprocessor is not needed.

### 3.3.3 Quality control

Quality control at both ingest platforms is done by an operator. By default the operator checks begin/middle/end of the generated MXF file (playing it at high resolution and full bandwidth with an Opencube MXF player integrated in Vivesta MediaFlow) for visual and auditive quality. The operator can then ‘accept’ the file or reject it. More detailed quality control (e.g. watching the complete video) is possible but costs a lot more time. Automatic control (e.g. by Tektronix Cerify or comparable devices) is also possible, but not implemented in this demonstrator.

### 3.4 MediaDRAIN Media asset management

MediaDRAIN is used in the BOM-VL demonstrator as media asset management system. As Comsof is also partner in the project, it makes it possible to have feedback of the research (e.g. of the metadata, search methods) getting back implemented in MediaDRAIN.

The following figures show some screenshots of MediaDRAIN with the BOM-VL content.
3.4.1 Security model

For the BOM-VL project, it was agreed that the partners of the project have access to each others low resolution content, but not to the high res content. Of course it is also not possible to change each others metadata.

This could be solved by the standard MediaDRAIN security model as follows:

- There are 4 entities known in MediaDRAIN:
  - Nodes (media object, programme, programme group)
  - Organisations (VMMa, VRT, …)
  - User groups
  - Users

- Rights:
As such, we can create the model as depicted in Figure 5. Within each partner, user groups are defined (e.g. archivists which can do everything including changing or deleting content, operators which can read/search through the archive and export high res files). And then there is also a ‘visitors’ user group, which contains all users of all other partners. These can only read/search/browse through the content of the other partners.

![Figure 5: BOM-VL demonstrator security model](image)

## 4 MXF files

### 4.1 Introduction

MXF is a container format (see also WP3, State of the Art) and because of its support for a large range of codecs and wrap formats, MXF files can differ relatively much from each other. It appears that commercial applications (editors, playout systems) typically only support a couple of formats, and not all. A first difference is e.g. the operational pattern: OP1A (all video and audio tracks in 1 file) or OP-ATOM (the video and audio tracks in separate files).

A great amount of effort went into confining the range of MXF file types to be used in the project. As it was impractical to choose a single MXF/codec file type, a.o. because not all content needs the same archive quality (e.g. because of the original tape quality or content), which saves storage space and money. Compare e.g. DV25 (25Mb/s) with IMX 50 (50Mb/s), this means a factor 2 difference. Both are of course broadcast quality formats, the former typically used for news, the latter typically for other programs.

Even though the essence coding and some aspects of the MXF file format differ between the MXF file types, a large set of similarities exist, which results in a range of simple and easy to manipulate MXF files.

### 4.2 Tests

Because of the compatibility problems that were seen by multiple partners in their own environment, test files were generated and tested by multiple partners.

#### 4.2.1 Test files

Generated by the ingest platform (Vizrt videoserver):

- DV25_________VHO00000A62.mxf: DV25 - 4 audio tracks 16 bit
- DV25_________VHO00000A62_opencube.mxf: same as previous after Opencube XFconverter processing to XDCAM format
- IMX30A416B____VHO00000A5C.mxf: IMX 30 4 audio tracks 16 bit
- IMX30A416B____VHO00000A5C_opencube.mxf: same as previous after Opencube XFconverter processing to XDCAM format
- IMX30A420B____VHO00000A5D.mxf: IMX 30 4 audio tracks 20 bit
- IMX30A424B____VHO00000A5E.mxf: IMX 30 4 audio tracks 24 bit
• IMX30A816B___VHO00000A5F.mxf: IMX 30 8 audio tracks 16 bit
• IMX30A816B___VHO00000A5F_opencube.mxf: same as previous after Opencube XFconvertor processing to XDCAM format
• IMX30A820B___VHO00000A60.mxf: IMX 30 8 audio tracks 20 bit
• IMX30A824B___VHO00000A61.mxf: IMX 30 8 audio tracks 24 bit
• IMX50A416B___VHO00000A70.mxf: IMX 50 4 audio tracks 16 bit
• IMX50A416B___VHO00000A70_opencube.mxf: same as previous after Opencube XFconvertor processing to XDCAM format
• IMX50A420B___VHO00000A71.mxf: IMX 50 4 audio tracks 20 bit
• IMX50A424B___VHO00000A72.mxf: IMX 50 4 audio tracks 24 bit
• IMX50A816B___VHO00000A73.mxf: IMX 50 8 audio tracks 16 bit
• IMX50A816B___VHO00000A73_opencube.mxf: same as previous after Opencube XFconvertor processing to XDCAM format
• IMX50A824B___VHO00000A75.mxf: IMX 50 8 audio tracks 24 bit

Other files:
• XDCAM_DV_C0003.MXF: original from XDCAM camera (DV25)
• XDCAM_IMX30_C0001.MXF: original from XDCAM camera (IMX30)
• XDCAM_IMX50_C0005.MXF: original from XDCAM camera (IMX50)
• Evttr_IMX50.mxf: original from Sony E-VTR IMX50

### 4.2.2 Technical description of test files

All tested MXF files belong to the same Operational Pattern 1a category, which means they contain a single Material and a single File Package, which both have the same duration. The Essence Container, in all MXF files, is part of the header partition and this header partition is followed by an empty footer partition (see Figure 6 for an example file structure). Also, all files have a frame wrapped Essence Container and all picture and sound elements in this container have a constant size. This directly results in a simple Index Table, which is present in the header partition of each MXF file. At byte level we see that all Partition Packs define a KAG size of 512 bytes, which theoretically results in an increased I/O performance.

When looking at a more detailed level at the essence we see that the Video Sampling Rate of all video essence is 25 frames per second (which also equals the Edit Rate of all tracks in the MXF files). Similarly the Audio Sampling Rate of all audio essence is 48000 samples per second.
4.3 The individual MXF files

Despite the wide range of similarities between the MXF files there do exist a few differences. In the following pages six different MXF file types will pass under the magnifying glass.

4.3.1 Ardendo OP1a SMPTE D-10 (vizrt videoserver)

The first MXF file (type) we consider is a D-10 IMX 50 MXF file, generated by the Ardendo ardftp application (version 2.2.13).

The file consists of a single video and a single audio track. The video essence is encoded using a D-10 MPEG-2 422P@ML, 50Mbps, 625/50-I codec. It has a 720x576 resolution and an aspect ratio of 4/3.

The audio essence is packed into the AES3 audio format and consists of eight 24-bit channels (of which four are silent channels)

We used the IRT MXF Analyser light\(^1\) application to check all MXF files for errors. For the current file type a single error was encountered:

"UMIDs: The dictionary version number is 0x01, but the material type 0x0d is not a SMPTE 330M-2000 value"

which in principle should not produce any problems when handling these MXF files as these UMIDS are solely used to provide a unique identification to the Material and File package.

\(^1\) http://ftp.irt.de/IRT/mxf/index.php
4.3.2 Ardendo OP1a DV-DIF Video & AES-BWF Audio (vizrt videoserver)

The second MXF file (type) we consider is a multi-track MXF file, again generated by the Ardendo ardftp application (version 2.2.13).

It consists of a single video track and four audio tracks. The video essence is encoded as IEC DV video, compressed to 25Mbps, 625/50-I. It has a 720x576 resolution and an aspect ratio of 4/3. The audio essence elements are packed into the AES-BWF audio format and each consist of a single 16-bit channel.

The IRT Analyzer light application uncovered the same error as with the previous analyzed MXF file:

“UMIDs: The dictionary version number is 0x01, but the material type 0x0d is not a SMPTE 330M-2000 value”

4.3.3 SONY eVTR OP1a SMPTE D-10

The next MXF file (type) is generated by a SONY eVTR (application version 1.00) and has a similar file format as the first MXF file, described earlier in this section.

The file consists of a single video and a single audio track. The video essence is encoded using a D-10 MPEG-2 422P@ML, 50Mbps, 625/50-I codec. It has a 720x576 resolution and an aspect ratio of 4/3. The audio essence is packed into the AES3 audio format and consists of eight 24-bit channels (of which four are silent channels)

The IRT MXF Analyser light application however uncovered a new error:

“Invalid timecode. Drop frame is not defined for 25 frames per second timecode.”

When taking a closer look at the metadata we see that for the considered file the drop field flag in the Timecode Components has a value of 255 (and not 0 or 1 as expected).

4.3.4 SONY XDCAM OP1a DV-DIF Video & AES-BWF Audio

The next three files are generated using a SONY XDCAM, or more specifically by the SONY Opt application (version 1.40). The first MXF file of these three is very similar to the second MXF file described in this section.

However, the file not only consists of a single video track and four audio tracks, but also contains a data track. The video essence is encoded as IEC DV video, compressed to 25Mbps, 625/50-I. It has a 720x576 resolution and an aspect ratio of 16/9. The audio essence elements are packed into the AES-BWF audio format and each consist of a single 16-bit channel. The MXF file contains no further information on the data track.

The header partition also contains a chunk of XML data, which contains descriptive metadata on the MXF file. An example of part of such data can be seen in figure 2.
Figure 7: Data track of an XDCAM MXF file

Again, the IRT MXF Analyser light application uncovers errors:

"The correct number of elements for property "EssenceContainers" is 3 and not 2 as encoded in the file."

"Missing element "UL data track" in batch "EssenceContainers" when comparing against the Essence Container Labels found in the Descriptors of Top Level Source Packages of this file."

Both errors relate to the same problem, that no information is provided on the data track present in the file.

4.3.5 SONY XDCAM OP1a SMPTE D-10 (imx30)

The next MXF file (type) consists of a single video and a single audio track. The video essence is encoded using a D-10 MPEG-2 422P@ML, 30Mbps, 625/50-I codec. It has a 720x576 resolution and an aspect ratio of 16/9. The audio essence is packed into the AES3 audio format and consists of eight 16-bit channels.

As with the previous file, the header partition also contains a chunk of XML data.

The IRT MXF Analyser light application found no errors.

4.3.6 SONY XDCAM OP1a SMPTE D-10 (imx50)

This last MXF file (type) is almost identical to the previous described file (type); only here the video essence is encoded using a D-10 MPEG-2 422P@ML, 50Mbps, 625/50-I codec.

4.4 Conclusions on MXF files

It appears that the MXF files under test are very comparable and analysis (by standard tools and manual inspection) doesn’t show big problems. However, some files (e.g. with 20 bit audio tracks) are not working on some platforms.
As a conclusion of this deep analysis, it seems that some options are not supported (e.g. 20 bits audio) on some platforms which is then listed in the feature list, or that some platforms have bugs which make that they cannot read certain files because of certain MXF header fields they expect or something.

As a rule of thumb, a specific file interchange between two platforms should be tested! However, mostly these are some small things that can be adapted by the vendors. And by rewrapping/changing the MXF header, the content tracks are not changed, so no quality is lost.

As such, the following three formats generated by the vizrt videoservers are accepted for the demonstrator:

- DV25 – MXF-GC AES-BWF 16bits audio, 4 channels
- D10 – IMX-30 – 16 bits audio, AES-8ch (4 in use)
- D10 – IMX-50 – 24 bits audio, AES-8ch (4 in use)

5 Metadata

If we restrict the tapes to those accepted by the flexicart and VTRs (BetaSP, BetaSX, Digibeta), then this digitalization is now straightforward (exotic formats or content which needs restauration however will be more complex). Processing the metadata and developing a mapping however has to be done for each partner separately.

Because of this complexity a specific WP3-WP6 workshop will be organized about this metadata and we prefer to write a separate document after this workshop about this metadata.

Up till now, everything is mapped to an enhanced P/META model as we mostly dealt with broadcaster metadata.

This looks as follows:

```xml
<PMeta xmlns="http://www.ebu.ch/P_META" xmlns:erd="http://www.ebu.ch/P_META/ExternalReferenceData" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="P_META1_1_SimplifiedBaseProfile1_2.xsd">
  <s_AVAILABLE_MATERIAL_ITEMISED_LIST element_name="AVAILABLE_MATERIAL_ITEMISED_LIST" element_id="S72">
  </s_AVAILABLE_MATERIAL_ITEMISED_LIST>
  <SET_DATA_VALIDITY_TIMESTAMP element_name="SET_DATA_VALIDITY_TIMESTAMP" element_id="S46">
    <SET_DATA_VALIDITY_DATE element_name="SET_DATA_VALIDITY_DATE" element_id="A367">2008-10-31</SET_DATA_VALIDITY_DATE>
    <TIME_GMT_OFFSET_COUNT element_name="TIME_GMT_OFFSET_COUNT" element_id="A221">+60</TIME_GMT_OFFSET_COUNT>
  </SET_DATA_VALIDITY_TIMESTAMP>
  <PMETA_VERSION_NUMBER element_name="PMETA_VERSION_NUMBER" element_id="A423">1.1</PMETA_VERSION_NUMBER>
  <ORGANISATION_DETAILS element_name="ORGANISATION_DETAILS" element_id="S14">
    <ORG_NAME element_name="ORG_NAME" element_id="A83">VRT</ORG_NAME>
  </ORGANISATION_DETAILS>
  <PROGRAMME_INFORMATION>
    <PROGRAMME_GROUP>
      <PGR_IDENTIFICATION element_name="PGR_IDENTIFICATION" element_id="S44">
        <IDENTIFIER element_name="IDENTIFIER" element_id="S32">
          <IDENTIFIER_DETAIL>
            <IDENTIFIER_TYPE_CODE element_name="IDENTIFIER_TYPE_CODE" element_id="A150">V215</IDENTIFIER_TYPE_CODE>
            <IDENTIFIER_NUMBER element_name="IDENTIFIER_NUMBER" element_id="A105">7b280113f0914f68a5fbf9f74b1f7e54cbaba9017d3c4632ba4d7f77c493d047</IDENTIFIER_NUMBER>
          </IDENTIFIER_DETAIL>
        </IDENTIFIER>
      </PGR_IDENTIFICATION>
      <PROGRAMME_GROUP_TITLE_HISTORY element_name="PROGRAMME_GROUP_TITLE_HISTORY" element_id="S48">
        <ORIGINAL_PGR_TITLE>
          <PGR_TITLE element_name="PGR_TITLE" element_id="A99">PLANKENKOORTS</PGR_TITLE>
        </ORIGINAL_PGR_TITLE>
        <CURRENT_PGR_TITLE>
          <PGR_TITLE element_name="PGR_TITLE" element_id="A99">PLANKENKOORTS</PGR_TITLE>
        </CURRENT_PGR_TITLE>
      </PROGRAMME_GROUP_TITLE_HISTORY>
      <PGR_DESCRIPTION element_name="PGR_DESCRIPTION" element_id="S43">
        <PGR_SYNOPSIS_DESCRIPTION element_name="PGR_SYNOPSIS_DESCRIPTION" element_id="A98">PLANKENKOORTS</PGR_SYNOPSIS_DESCRIPTION>
        <SUBTITLE_FLAG element_name="SUBTITLE_FLAG" element_id="A176">0</SUBTITLE_FLAG>
      </PGR_DESCRIPTION>
    </PROGRAMME_GROUP>
    <PROGRAMME>
      <PROGRAMME_IDENTIFICATION element_name="PROGRAMME_IDENTIFICATION" element_id="S38">
        <IDENTIFIER element_name="IDENTIFIER" element_id="S32">
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          <PROGRAMME_TITLE element_name="PROGRAMME_TITLE" element_id="A110">19990821 JAZZ MIDDELHEIM TOOTS & MIDDELHEIM</PROGRAMME_TITLE>
        </ORIGINAL_PROGRAMME_TITLE>
        <CURRENT_PROGRAMME_TITLE>
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2 This is an sich not restricted to MXF files. In e.g. the telecom World (xDSLforum), it is common practice to organise ‘Plugfests’ where all vendors come with equipment to connect to each other and test. For MXF files, they can be even easily transferred over Internet.
6 Demonstrator prototype experience

6.1 Ingest capacity

At the moment of writing (end of September 2008), about 120 LTO4 tapes are in use, meaning that about 100TB has been archived, or about 5500 hours of video content.

The ingest platform at VRT was fully operational at the end of March, while the platform at Videohouse was fully operational in May, but could only start at full speed in June because of the test cases with the MXF files.

The VRT platform ingested till now at about 1400-1500 hours per month (with 2 flexicarts and 4 VTRs), while the videohouse platform ingests at about 700-800 hours per month (with 1 flexicart and 2 VTRs, but mostly full tape ingest).
These MXF files could be processed by 2 transcoding servers and 1 LTO4 drive at IBBT.

### 6.2 Network bandwidth

As we are dealing with large files (15-50GB), this poses huge stress on all server, storage and network components.

We saw the following problems:

- Belnet had troubles with a particular switch in Gent which dropped its ARP table now and then. This resulted in connection loss between the sites but was solved when they put, faster than planned, the new network in place.
- With only 1 FTP connection the bandwidth from VRT to IBBT was only 500Mb/s maximum. Multiple connections can use the full bandwidth. This problem is not present with transfers from videohouse, and probably caused by a firewall configuration at VRT.
- The temporary NAS storage has a lot of traffic: potentially 4 streams from the 2 videoservers (2x 1Gb/s), a transfer to IBBT (1Gb/s) and quality control (MXF streams of 25-50Mb/s). As such, the transfers from VRT to Gent are restricted to 100Mb/s during day hours when operators have to quality control. See also the figure below of transfer speeds during day.

![IBBT VRT VRT 2 Traffic](image.png)

### 6.3 Various problems

- Some tapes have multiple timecodes on it, e.g. because of reusing an old tape. As such, Vivesta MediaFlow has been adapted to search for a stable timecode (without interruptions) during a couple of seconds
- LTO4 tape delivery. This is very strange, but an order of 100 tapes has been done at the end of July and by now they have not been delivered. The vendor (although not a small one) speaks about manufacturing delays. This should be kept in mind to not slow down ingest possibilities.

### 7 Conclusions on first implementation of the demonstrator

During this development and implementation of the ingest platforms and archiving setup a lot of smaller (smaller hardware/network problems) and bigger (MXF file type, metadata mapping) problems were solved resulting in a successful implementation now containing about 5500 hours of video. Scalability of this platform is okay and the platform is built out of different modules, as such making that an interruption of one module does not cause the other to stop.

As such the digitising platform is now stable and can run at about 150-200 hours of tape ingest per week per flexicart with 2 VTRs. However, mapping and extracting all metadata of all the proprietary databases is a lot of work, and can not be shortened or speed up really. However, it should only be done once per partner or per database.

Besides this metadata mapping, one should also watch out for delivery problems with e.g. LTO tapes and with possible incompatibilities with MXF files on some platforms.