Wrapper Roundtable
March 9, 2006

These notes were prepared by Carl Fleischhauer with additions from Glenn Pearson and edited by Nan Rubin.

Summary

The Wrapper Roundtable was charged with the working premise of building an object that, roughly speaking, will serve the NDIIPP project *Preserving Digital Public Television,* as a submission information package (SIP) for the long term preservation of digital video, as that concept is expressed in the NASA OAIS reference model (ISO 14721:2003). Further, it was hoped that the PBS-directed solution might also serve some of the needs of the Library of Congress National Audio-Visual Conservation Center (NAVCC), currently under construction.

The meeting was organized by the *Preserving Digital Public Television* team (WNET, WGBH, PBS, NYU) with participation by the planning team for the Library of Congress NAVCC. Several guest experts were present, notable Oliver Morgan (specialist with MXF, technology provider to DOD and others), Brad Gilmer (specialist with AAF), Merrill Weiss (associated with SMPTE); also Glenn Pearson (has been analyzing Motion JPEG 2000) and Jerry McDonough (specialist with METS). *[Complete list attached.]*

In the working scenario used at the meeting, there were three illustrative stakeholders:

1. Program producer/content creator, i.e. television station WGBH;
2. Program distributor, i.e. PBS;
3. The Library of Congress, as a final content-preservation repository.

Using this scenario, the question was posed of how a program file might travel from production to broadcast and into a preservation environment, where the different needs of each stakeholder must be met. The discussion led to agreement on a general approach:

- The assumption moving forward from this group is that the wrapper will be AAF/MXF. Experts at this meeting clarified that these two specifications have always been related and appear now to be converging to some degree, in part through the SMPTE standards processes.

- An additional expectation is that both METS objects and PBCore metadata will be able to travel within the wrapper ("tunneling"). This will allow metadata elements that are not present in 'generic' AAF/MXF; the AAF specification has a procedure for adding extensions and this will very likely be used in the SIP design process.

The AAF/MXF model is structured to allow both metadata chunks as objects and/or to have the most important metadata in the header (or a header-equivalent, like a label on the outside) which is easy to read without unpacking the whole package (important for huge video files). And the procedure for developing AAF extensions offers a mechanism for having some of the elements in the header be the same as elements in the chunks.

Thus an archive could choose to grab elements from the header for automated descriptive cataloging, to extract metadata chunks stored as objects for use elsewhere, or to open the package, lift the elements and repackage it, e.g. with METS on the outside.
Within this scenario, of the three segments of workflow, only PBS has put its foot down and developed a specification for MXF, called the AS/PBS (Application Specification, more or less a "profile" of MXF for a specific use). With the new PBS interconnect system, they needed a new workflow based on non-real-time distribution. The AS/PBS applies to the specific format of programs sent from PBS to member stations for broadcast, as a de facto standard for the PBS system.

In important ways, the preservation SIP design will build upon this existing excellent foundation. The AS/PBS is a profile that defines the package of program content sent by PBS to its 355 member stations. However, AS/PBS includes some restrictions (e.g., 8-12 mbps data rate, long-GOP structure) that are intended to serve the particular needs of broadcast distribution and local playout. The preservation SIP might be a "superset" of AS/PBS that relaxed some of AS/PBS restrictions to make it suitable for preservation.

The representatives of the Library's NAVCC project encouraged the wrapper direction outlined above.

The group was also introduced to the existence of a wrapper concept developed by the Department of Defense for similar content, which reflects a similar approach to object creation, metadata capture, and related problems. Several meeting participants are connected to this project, so there was great interest raised by both the public television and NAVCC attendees in finding out more about it. Consequently, it was agreed to contact the relevant group at DoD to pursue more information.

The meeting also reinforced that all of this is a moving target. These standards and their various implementations are very much still evolving, and equipment manufacturers and software developers are being dragged along but not always willingly.

There was a high degree of consensus among attendees, and at the conclusion of the meeting, the group was enthusiastic about continuing to develop the wrapper together.

- Under direction of the NDIIPP Project, the project will produce a more formal requirements document to address the metadata needs of both PBS and of the Library of Congress.
- Not much original work needs to be done on the wrapper development. DOD has funded a wrapping toolset, and there are some open source tools (with AAF). The XML embedment needs more work. The project will set up a liaison with DOD.
- The METS & AAF interfaces need to be reconciled.
    - Assuring METS profile can be added as AAF extension
    - Mapping PODS (a working PBS database) to METS, consideration of PB-Core
    - Adding AS/PBS, PBS-Core as AAF extensions

    - Harmonizing PB-Core w/AAF, SMPTE RP210, etc
- Confirm who from each entity -- the Library of Congress, NAVCC, AAF, PBS, NDIIPP, METS, MXF, and related interests – will be able to work on each task.

The meeting made clear that by moving deliberately and publicly to take up the challenge of archiving/preservation systems early in the workflow, and presenting such requirements to the equipment manufacturers, public broadcasting is in the vanguard of setting parameters for digital preservation that other television producers and content providers are certain to follow.

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Running Notes from the *Wrapper Roundtable*

These notes were prepared by Carl Fleischhauer with additions from Glenn Pearson and Nan Rubin. While comprehensive, they are not a definitive transcript. A complete audio recording of the discussion is available.

Ken Devine: Outlined purposes of meeting. Noted that neither LC nor the first edition of NAVCC will be a preservation repository. There will be an LC repository in the future but this is not what we talk about today.

We also don't want to talk about what the preservation copy ought to be; there has a running debate about this. In our immediate public TV context, assume this: a 50 mbps MPEG file is going to be preserved; standard definition. This is the *contribution copy* of the finished program that producing stations will send to PBS for use in making the lower-res proxy (*distribution copy)* that is sent to the stations for actual broadcast. PBS will extract necessary metadata from the contribution copies.

In the scenario we want to focus on today, there are three stakeholders:

- Program Producers/Producing Stations (for instance, as represented by Dave MacCarn from WGBH)
- Distributors (PBS)
- Preservation repository (for instance, as represented today by NAVCC)

We want to talk about how do we bring program content into a wrapper, and how will this accommodate all three of our stakeholders?

Howard Besser: We are talking about final programs. What about the unfinished material, that the unit at the beginning of the chain needs to preserve?

Devine: Today, we want to deal with the ship that is leaving, we need to distribute finished programs in file form very soon. In this meeting we will set aside the important (future) need to discuss unfinished material.

Sam Gustman: For production, preservation, and access, there are zillions of solutions from different groups, from DOD, from corporate America, from Hollywood. You could picture a Venn diagram. There are also different solutions in the access area. I'll use AAF as the example. In our Shaoh oral history project, we want to keep production information (how the footage was produced).

But a Hollywood movie may not want to keep production information. DOD is using AAF, they want to keep the production metadata from production all the way through to preservation. I don't know about TV production, do you want to keep the production data? Is it less important in the TV production arena, or do you want the production information?

Devine: Mentions allied questions, format registry, etc. [Some of these have a theoretical quality just now.] Notes that MacCarn's problem is the real situation, with

manufacturers of equipment, especially for playout. But manufacturers of equipment don't care about preservation.

For this scenario, of the three segments of workflow, only PBS has put its foot down, and developed a specification for MXF, called the PBS-AS (Application Specification, more or less a "profile" of MXF for a specific use). Thomas Edwards of PBS (present at the meeting) is thanked. The PBS-AS applies to the specific form of programs sent from PBS to member stations for broadcast, as a de facto standard for the PBS system.

In this meeting, let's assume that we are going to create a superset of the MXF-PBS profile. We want METS to come into this, how can this play out? We talked to Jerry, make a METS document as a separate file that is shipped with the MXF file when it goes to PBS for distribution. Then that METS document ends up at NAVCC when the item arrives there.

We are asking, what is the best thing we can do? We need to get control of data in some way, we need to do something and move forward at this time. Our question is how to attach the preservation metadata, we need a placeholder where we can attach this data. We need a place where we can tell producers what to do, a specification.

Dave MacCarn: Let me clarify what is meant by the superset. PBS-AS applies to what goes into the generic container of MXF, we are talking about removing some of restrictions that are part of the specification. PBS-AS is aimed at the stations, it is a lower res file format for distribution: long GOP [group of pictures] at 8-12 mbps, [4:2:0?], which are appropriate limits for that specific purpose. But what we are talking about today, the superset, we may want to let other content be inserted in there, also be able to add METS data.

Tom Edwards: Let me say a couple of things about PBS-AS. PBS is moving to a file-based system. We needed to define a file that could be played at all stations, that is what is what drove the application specification. We see that MXF is in the process of adoption -- there are only 7 vendors who provide video-servers to PBS stations [video servers are or will be used at member stations], and they are beginning to adopt and implement MXF. We wanted a **distribution format** for our interconnect system, long GoP MPEG2 encoding.

We will also want a **contribution format** specification, for what comes from the producers to PBS. This will be I-frame only, less compressed, 50 mbps, with other details need to be worked up.

Jim Kutzner: Here's our context: PBS is a distribution company, 355 analog TV stations, moving to digital television (DTV). In the past, we have been doing real time distribution, this is well known and used for decades.

But with our new interconnect system, we are looking at a new workflow, this led to need for non-real-time distribution. Most new television workflows are non-real-time, we needed to get to that to save lots of money, but you get to disparity of files.

Gustman: I see an important metadata question, do you have to re-key? We all want to avoid the re-keying.

Devine: Well that topic is beyond our scope for today. There is re-keying that goes on, we could detail that out [at another time]. We are trying to reduce it.

Gustman: There are cost savings for oral histories [as in my Shoah project], if you can carry the metadata and wrapper through the whole process, without having to do any re-keying. Re-key is one of the villains in busting the budget.

Devine: Let me ask Jerry to talk about METS for a second, what is best way to get METS into our scenario? We see that when the content is at the repository, the need and uses for metadata shift.

Jerry McDonough: The big problem is rationalizing the production chain for the digital environment. Public TV is reliant on general TV standards, public TV will have to move in step with the larger community. METS does not have much to do with production, you don't need to produce METS data at the beginning of the production, you can make it at the end. As content moves through the process, you can have the metadata in KLV or XML. In terms of the OAIS model, it is the job of work of the ingest module to receive SIPs, and METS could be made there [or in a pre-ingest step].

Carl Fleischhauer: Ken, can we think about this meeting as being about defining an OAIS SIP? Of course, we all agree with Sam that we want to accrete metadata through the whole process, and inherit it at the end.

McDonough: [Says a few things about the SIP, notes that (video?) production tools may not be XML-ready.]

Gustman: AAF is a wrapper used in the production environment. I'd like to ask, "could we add something to AAF that helps with METS?" Can we introduce AAF to METS? (This motivated Brad Gilmer to lean over, shake hands with Jerry, and introduce himself.)

Devine: We should discuss the SIP, yes. But we want to gather the wagons and get into the details, and I am looking for special insights to Oliver, Brad, Jerry, and Merrill. We know we have several SMPTE members today, but we will think of Merrill as wearing the SMPTE hat today.

We will come back to the SIP, the vital question here. But first let's take a look at AAF.

Besser: Jerry and Ken, I'm not sure I heard what you said in the same way as some others. I agree that we may not need METS in the [production] chain but we do need the fields and data that later flows to METS, and these need to be specified in ways that will later roll into to the METS structure smoothly, we need control over terms, etc.

Devine: Yes, the data definition needs to be informed by METS.

McDonough: We want to separate the production and the archive, the archive's job is respond to what is being handed off. The archive may get KLV metadata, has to change it. This is what the OAIS model means by ingestion, taking the SIP and making an AIP out of it. We are asking what a SIP looks like, there is a question: when do we start making the SIP?

Devine: It is a given that there will be a need at some point to feed the info into the SIP, best time to capture the data is during production. We do need to define the data but we dare not define it so that it is too odious to the producers or they won't do it.

What are the mechanisms for supplying the data, that's a question.

Caroline Arms: I offer this observation: we know that metadata that you rely upon for distribution is indeed the reliable metadata. Some of the other metadata that we may wish for in the preservation archive may not be relied upon in production and thus may not be as reliable.

McDonough: Those in the archive will have to figure on receiving variable data.

Glenn Pearson: I will note that the MPEG-21 specification is in use by video outfits too. If we can generate METS, ought we not also generate MPEG-21?

McDonough: Let me note that METS and MPEG-21 are but structural specifications, they do not get into descriptive vocabulary, both are higher level languages for organizing metadata. They do not get into the fields/elements.

Pearson: Notes the existence of MPEG-7, which does feature descriptive specifications.

Oliver Morgan: We should remember that beyond preservation, there is access, discovery and distribution. We need to consider the different clients of the preserved material.

Devine: What goes into the SIP is at the core of what we are trying to figure out. We could discuss MPEG-21 vs METS for years, but we need to focus on what are we going to do in the very near term. There are other relevant issues, for example Dave's notion that info about the codec ought to be in the package. Yes, that is important but maybe we will get to that later.

Oliver: Currently I have the task with PBS-AS to add various metadata channels: descriptive, PB-Core, other technical metadata. We are now developing this for PBS. We don't want to just do things for the library and leave off the codec.

Gustman: Tell me about AAF vs. MXF.

Oliver There are two answers. They developed from different perspectives, but have converged as models. One answer is that they have the same data model, and can be seen as two peoples' view of the same thing. The second answer is that there are cheerleader squads from two different groups and this colors what is said. AAF came out of post-production, while MXF came from broadcast and transmission. Those of use working on the specification, we wanted guaranteed interoperability between the two. And today, the tools are more interoperable than in the past, but not fully.

Gustman: Are there things in AAF you want in MXF?

Oliver: In MXF, it is more difficult to tunnel thru. Tools for AAF post-production could be used to "tunnel" AAF production metadata through MXF to post-archive, but we need to continue to work with manufacturers about this.

Gustman: AAF lets you tunnel thru.

Oliver: You want to get everything in single container for preservation, to be sure you have it all. Then you want to be able to pick it apart to use it. The whole things is problem of bringing things together, move them, then use them.

Gustman: What can be done to inform AAF to improve?

Oliver: We don't need to go very far. We are about to tunnel thru to let PBCore into MXF, we could also tunnel thru for METS. [Additional remark referred to some kind of specification.]

Brad Gilmer (Executive Director, AAF Association).This may be achievable by working in the SMPTE environment. Thus, you could have "DMS-METS" tunneled through MXF. We are working in SMPTE to join these two specifications.

Edwards: I am not sure if all the metadata we need at PBS is in AAF. Some is not part of production, and needs to be married into the data. We have a web form for producers to provide the extra data that we need. Most important is Descriptive Metadata, which later can be the basis for web-based access and retrieval.

Gustman: MI3P is a b2b structure. It would be great if there was a formalized structure, back into the production environment, so that the data is there ("tunneled along"), so it is there when you need it.

Edwards: This is not a format issue, but rather a matter of the tools.

Gustman: About tunneling [which may bury data in the object], we do want the right parameters up front.

Oliver: Let me tell about DOD applications, from the MISB (Motion Imagery Standards Board).

[floor given to Gilmer]

Brad Gilmer: I see that a lot of you have been working on this for some time, it is an honor to participate, PBS is a national treasure.

I'll make some observations: there are a number of enlightened organizations who think about archiving as a beginning rather than an end of life process, that is good. In broadcast organizations, often archiving is what is left at the end, metadata is omitted, since it is costly to create. It is better to be thinking about archiving starting at the beginning of the production process, about doing the sorts of things you do at the beginning of the process, so the data for the archivist is there at the end.

Metadata accrues, it keeps being added as you go along the process path, and some will be more accurate than others. We need to enable a process that lets it accrue. AAF did start with post-production but it would be helpful to look at the capabilities that it has, beyond this limit.

Another thing to think about: "when is a program finished?" Producers may think that you freeze it at some point but with DVDs we see that multiple versions get created: the notion of a finished piece is changing.

The AAF board has recently taken the idea to standardize the specification AAF further within SMPTE. The core is the AAF object model, with a well-defined extension method now being standardized, which could be applied to METS data. This is vitally important for a couple of reasons. The AAF model has not been obvious to the casual observer. For an IT person, it is an object model. The object model has been standardized.

The model is extensible. If you wanted to extend the AAF object model to include PBCore or METS, you can extend according to the rules of the object model, you can put the rules into the object to explain the extension.

Should METS and PBCore data be stored within some wrapper; or in metadata of AAF file? Either could work. We need to distinguish "how to wrap" from "what should be wrapped". A question you face is this: is the PBCore or METS included in the object, or more [natively] in the AAF file? In the former, you get this wrapper, you look in, see there is a METS, you can get it out and read it. Or in the latter, you get the file, and bang, right there are the METS field, the data is right there. AAF doesn't care how it is done, you can do it either way. You can compare this to how the specification handles subtitling, it's the same way; there are two options.

The AAF association has no ax to grind, we are co-creator of MXF, we want to do what is best for users. When it comes to the SIP, we want a discussion about the method to wrap it. Then what is in it is a related discussion.

The purpose of the AAF association has evolved since 1999. It was at first a US/EU trade association, We started wanting the SDK, which was required, we spent a lot of time on the implementation. Now a requirement that implementation of new AAF features precede formal specification.

That work has been largely concluded, now we are moving to standardize it with SMPTE. The AAF association is now in an additional role, beyond the technical piece, but more a vehicle for representing the American slant on requirements for AAF/MXF.

BREAK

Gustman: About NAVCC planning, it is true that we have punted on the wrapper. NAVCC should be a repository of high-quality video and high-quality metadata. We will store essences and metadata in high quality form in the storage system, but we are not more specific about the packaging. The experience with the NBRS moving image collections is pertinent. SIPs came in, and a "wrapper hub" was created to be a "DIP-maker for other archives. So perhaps there needs to be a DIP-maker hub for the MXF-PBS wrapper.

The PBS material is just one type of SIP going into NAVCC. For analog video, they will digitize old tape formats, using the SAMMA robotic digitalization device, and this will put out Motion JPEG 2000 files. The image frames are wrapped in MXF or MJ2. This is how they can be stored in the archive, but exported to other formats (e.g., via the DIP-maker) as needed. For instance, they could be exposed through Project MIC [Moving Image Collection] meta-archive. On the audio side, NAVCC will make BWF from various DAWs that are in use.

When someone needs something, we will use MIC at the back end to output the metadata. We plan to use MIC (Moving Image Collections) tools (or tools similar to those in MIC) that can read in one format and read out in another. In OAIS terms, this is a DIP maker [for metadata]. [Dissemination Information Package is the content format used by a repository for a given user.]

There might be a PBS-AS MXF wrapper that comes out of the MIC or MIC-like system. We want to make this element the hub on the system back end. This is the best we can do because there is no agreement on what the preservation format is.

Devine: The output of SAMMA . . . Motion JPEG 2000, may or may not be MXF?

Gustman: The SAMMA startup, the first prototyping on behalf of the NAVCC, will be here on Capitol Hill in the media lab we have set up with the IT group. This will test the system. We expect to start in June. From Media Matters, the manufacturer, we are still hearing MXF stated as the wrapper they will produce.

McDonough: Let me explain what METS is. The structure is least common denominator for digital objects, for various media types. The specification focuses on what we call structural metadata, we wanted a fall back for multiple types of objects. It offers a structural framework. For the rest of the metadata--descriptive, administrative, and so on--we can pull together other types of data via extension schemas to the METS primary schema. It's "a stupid version of MXF."

MacCarn: I have a question for Brad and Oliver. As AAF and MXF come closer, and I see AAF in a standards process, will they end up being one thing? Will this be the outcome of the movement thru the standards process?

Gilmer: It depends. If you are looking at implementation, what can I buy, the tool you buy will use the subset of the thing for the part of the workflow you are in. From an overall system standpoint, we hope those system parts can talk to each other better.

Oliver: (rhetorically) Will they be one? The mission [of the standardization process] is develop a single framework to address different applications.

Weiss: They are both based on the well-defined SMPTE Universal Labels, and SMPTE is standardizing a bi-directional mapping between KLV and XML representations. [KLV is a binary format using nested key-length-value fields]. AAF and MXF can be thought of as different dialects of the same language.

Gilmer: The term dialect is OK.

I came from Turner broadcasting, where we spent millions on a project we had to kill. We tried to pull data silos together. About the names for things, you can call things whatever you want when you are only talking to yourself, but if you are going to exchange data, you need to map to different databases, and we know this is hard. There will be tools to aid interchange.

The driving concept is "one," to bring AAF and MXF together. We may never get there. Rationalizing multiple databases is a nightmare, to have people making artificial differences in naming to preserve market segment is bad. The objective is drive down costs by getting naming conventions and object model the same. We are not at one yet, but we are at a point, a number of enlightened manufacturers are seeing the users who want better interoperability. We think this has gotten to a number of manufacturers.

I don't have an ax to grind, I have a user requirement: cut production costs.

Weiss: There are difficulties. For instance, SMPTE is currently addressing whether contextual meaning should be given for SMPTE labels.

The questions I have, what are the requirements to apply METS, in an archival environment? It could be embedded in an MXF file but who is on top? Rather than having to have unpack the object, would it be better to have it exposed on the outside?

Do we need to think about an identification system? What if the work is never done, e.g. episodes and versions go on almost forever, or if creators keep working on it? There is an identifier system for audio-visual works, the number space is large enough to allow for versions. You may need to incorporate ISAN (International Standard Audiovisual Number) to tie in metadata and A/V content. [May also be V-ISAN for versions.] The ISAN is from the same people as ISBN [Bowker].

Devine: Let me pause here and summarize. Here's what I have heard:

- We are talking about the notion of an MXF based wrapper, with tunneling, and preservation metadata to be added at the time of creation.

- It could be either AAF or MXF; need to discuss the details, but the two may merge into one. But there are not 4 or 5 other contenders for a container at this moment.

- This gets us to the point of defining the SIP. It's better to agree on a SIP package format, even if imperfect, than to need manual ad-hoc of SIP data.

One important question is: how can we best imagine placing the preservation metadata? Inside, outside, or what? There may be role for MIC but there is a question of how it relates to MAVIS.

Given what we know, what is our best shot? Is it a METS document? How does that work? We have to make all of this up, there are no models to copy that are out there.

Let me ask about the MAVIS software that M/B/RS uses?

Dick Thaxter: Here's the context. The Library uses Voyager-based Integrated Library System (ILS), a major form of access to the items, the discovery system most people use: the LC catalog. Meanwhile, MAVIS is collection management system used by our division. It will be used for overall management of the video collection.

The records in the ILS [and MAVIS?] will link to the object [using "handle" identifiers], unless copyright considerations forbid that. Sam will be building another system for access and searching. ILS will allow the public to pull a subset of [presumably derivative] videos if permissions allow; maybe get only metadata otherwise.

Probably everything, such as SAMMA's digitalization quality reports, will be parked in the repository and could potentially be co-wrapped into MXF. MAVIS will eventually keep track of all digital objects (including, e.g., a scan of the label on a video case).

Fleischhauer: Traditional catalogs are surrogates for things on the shelf. Digital object metadata is a lot of production info, rather than cataloging info. NAVCC as conceived falls short of a true repository. LC's American Memory project likewise falls short: as a virtual repository, it's not so good for access and long-term preservation. Will there ever be a long term repository? It always seems to be 5 years away.

Thaxter: For generating catalog records, we can draw on experience with other media: Half of books are now in e-form, so we can generate catalog records from them. Also in the book world (but not for A/V), there's the ONIX (ONline Information exchange) system. For music, there is MUSE data for commercial recordings, to generate catalog records. Copyright info is another source.

Weiss: About the meta-metadata problem. When you build your catalog, you have an identifier, for example a title, then you can find the book. But how do identify the file? How to you get an equivalent, unequivocal mapping? We need identifiers to connect metadata and files.

Devine: I want the Library to tell us what metadata you want. We can invent a specification but we don't have any experience with your needs. In broadcasting, we need info on timing, things have to be frame accurate. But I'd like to know what you want in terms of metadata. LC should do own mapping (with frame accuracy). Wouldn't that suggests a translator process?

McDonough: They have to tell you what they want, but it would be helpful to understand the customer base, what people would use NAVCC. At LC, the data will serve two groups: the customers (end users) and those who run the archive (staff).

Fleischhauer: Regarding telling public TV about the metadata the Library needs, this may differ by category of metadata. For example, for descriptive metadata, LC may be competent to design a specification for IP metadata, but we won't be as good with video-technical metadata as real video engineers and SMPTE. And there's the third category: PREMIS (PREservation Metadata) stuff, metadata needed for long term for preservation in the OAIS representation. This is very emergent and I am not sure who is best. Perhaps Oliver's work with AAF suggests a reference point here.

Oliver: MXF can offer info on that last category.

Devine: Regarding NAVCC planning, I think it is the wrong idea to punt this question of wrappers. But now let's see who is in on this, what we are talking about today. We have promised to work this up at part of our NDIIPP project and we have a mechanism to test all this stuff. We have an opportunity to do something.

McDonough: Carl's third category is what is called the OAIS Representation Network. This will not come in with an SIP, but the SIP can point to this data.

Here's my off-the-cuff set of SIP metadata requirements:

- PBCore for the descriptive metadata [identifiers, includes ISAN]
- SMPTE RP210 for parametrics
- set of references to format specification
- With, very importantly, everything digitally signed (a requirement of PBCore).

Arms: We will want the ISAN, just as we get ISBN for books. We want all external data.

Oliver: The SMPTE universal label is in a registry [?]

Oliver: Now let me tell about my work with DOD. When faced with the need to define a storage wrapper, unlike what Sam describes happened earlier, DoD didn't punt... they wanted AAF. Now there's vast stored data, they measure storage in acres, not pedabytes. They use NITF (News Industry Text Format) as metadata for still frames. They tried to do the acres of libraries with AAF, where it covers stills and moving image (MPEG at different data rates) and also infra-red images. They tried to move acres of storage into a common format.

Gustman: In the course of NAVCC planning, we wanted to imitate DOD; the DOD systems could be applied at NAVCC. But we had too much negative feedback [either about using the DoD package; or defining the SIP], in M/B/RS and elsewhere in the library. It is worthwhile to consider an AAF environment, like the DoD project, where you can get MXF packages.

Oliver: There seems to be more interest in MXF, so a Library version should handle both AAF and MXF. Over the last couple of years, there has been a goal to interoperate with NATO, entailed KLV and the use of MXF (or AAF).

Regarding the auto-creation of catalog records, within DOD there is Discovery and Retrieval Data Model (for discovery), has to do with data from all different sensors, ingest into a common format, we added a meta-meta layer, about translating data.

Gustman and Scovill: Comments on the desirability of take-up of ideas from DOD.

Devine: Are you suggesting there is an existing toolset we can use, that is friendly to AAF and MXF?

Oliver: Just as we are in the process of writing AS/PBS for MXF, there is an AAF profile for Aerial Surveillance and Photogrammetry Applications (ASPA), a specification for which descriptive metadata schemes are defined, and mapping to catalog records. Today, the motion imagery is largely 6 mbps, changing rapidly to go both down and up

[for different applications], we see a move to H.264 at 2 mbps and 20 mbps for HD. Also a lot of interest in Motion JPEG 2000.

Gustman: There is enormous funding in DOD, if we adopt their approach and technology. They have attempted to do things that we have been talking about.

LUNCH

Devine: To recap, let's say we are going to do a superset of the AS/PBS for MXF, and tunnel in for PBCore. Question: what would be involved for implementation, say, to go to DOD, and ask them about adapting what they have? What do I now have to do? Let's say NAVCC wanted to take it up too? Where would you start? What do we do to get it?

Oliver: We have an agreement to produce a first trial system, we assume will be successful,
a couple of critical steps need to be taken. First, what is the first compression essence format? 50 mbps I-frame MPEG. Second, what are the requirements [use cases] of the metadata communities?
Collect together the different requirements that are going be placed on the metadata, categories of metadata, users, what they want to do.
I talked to Jerry, about integration into ILS, how do we relate that to the discovery systems in use for NAVCC. There will need to be tools to take the chunks of essence, to take chunks of PBCore, upon arrival.

All in all, there is not much that needs to be done that is original. DOD has funded a wrapping toolset thru the AAF association, so there are some open source tools (with AAF). More effort would be needed by MISB/DoD subcontractors working on XML embedment. Over the next few months, we'll be doing some wrapping of XML by DOD contractors.

Devine: Let me repeat back to you to be sure I understood. Here's our scenario: we have a file to move from PBS to NAVCC, it may or may not have METS in it. The steps to come up with an implementation include:

- identify the compression format
- come up with a comprehensive list of the clients for the metadata [and use cases?]
- come up a with a mapping with what you are going to accommodate in the model

Oliver: We have already been thru this in several iterations, we know how to do it. We could do this in one prototype iteration, then after that, we'd have a production system.

Devine: How long will this take? If money is no object?

Oliver: If resources are not issue, there is . . . . This feels like a six month project.

Gilmer: But that is after the profiles are written.

Oliver: The thing that always slows that down is when vendors become involved, new ones come in and then you slow down. It is good to prototype without using the approach within a product.

Gilmer: I would say that the project management side of me says that the part that needs work is the user requirements. Analysis, that is the hard part.

Oliver: Wrapping and unwrapping is like falling off a log. But figuring out who is interested in the metadata, getting agreement among the client groups, is tricky.

Edwards: Just FYI: a word about MPEG-2 and HiDef, at PBS we go thru about 1 terabyte per [day? month? year?], that is the level we go thru.

Pearson: There is also the back-end time to integrate the back end system into your cataloging system. Will both of the file types from PBS (50 mbps, 8 mbps) be provided to LC? This would mean that LC would not have to regenerate the lower-res files.

Gustman: That is not the current plan. NAVCC will keep audio derivatives online for access but not moving images. We plan to generate the video access copies on demand, so would not plan on getting both from PBS.

Pearson: Remember that the same metadata applies to both original and derivative.

Gustman: There is not a requirement for a low bitrate proxy at LC at this time.

Pearson: What is in the SIP is the start of the metadata, but scholars will come online and contribute their own metadata, be good to have a proxy online to support that.

Devine: This is a good topic but gets beyond the scope for today. NAVCC punted the wrapper and I am saying, OK, I'll take this up.

Nan Rubin: It is worth noting that we are designing a repository for Public TV that may be different from NAVCC or an LC archive.

Scovill: Regarding the decision not to maintain browse proxies of moving image content, this was economically driven. We want to be responsible to keep costs low and not to request more storage than is needed.

Arms: In terms of the SIP, you want it to be thing from which you can extract metadata; then this extract is compiled into a catalog [like the ILS].

McDonough: In a preservation repository, we will want provenance metadata, does that have to be added in the DOD system?

Oliver: Yes it is in there but DOD does not make extensive use of it.

Gilmer: We are now getting into requirements. It is worth saying that versioning is an issue, it would be good to get a tight requirement on versioning. At Turner, there were 17 different versions of *Gone with the Wind*; it got hard to pin down which one was needed in a particular instance.

Another concept about proxies [low res viewing copies]: the level of importance of the material may govern this. If it was really hot material, we'd keep proxies all the time; if not hot, less on hand.

Devine: On Howard's concern that, whatever wrapper we choose, we ought not strip things off. Is there a risk applications may strip things off?

Besser: Applications do this. I would make it a question for AAF and MXF, talk to vendors, guarantee that they are not doing this. If we are talking about metadata for preservation that enters the life cycle early, how do we reassure ourselves that it is not stripped out?

Devine: What exactly do we mean by tunneling? PBCore, it may do a lot, then there are common tools used at begin and end of prod cycle, to tunnel?

Oliver: *Tunnel* means not changed by the system. A server could be required to preserve all metadata that goes thru it. Regarding building a system that does this, the user community needs to fight back on that. You need a tight specification in your RFQ, and then you say, 'I'll verify with a testing product.' In the recent past, there has been a lot of manipulation of user requirement by the manufacturers and vendors. You can't be tied to a specific manufacturer.

Gilmer: Howard's question gets to different views of AAF. Some see it as an export/import model, but some see AAF technology as a system model, used separate from the tools, using the object model. Your purchase order requirements need to say that.

Edwards: AS-PBS is for a purpose, about play-able video. But the spec may not cover metadata.

Devine: With the 355 stations to purchase things, that is a lot of customers, enough to influence server makers or other manufacturers. It is a good place to get started.

Weiss: Be careful not to place inappropriate restraints on products in the marketplace -- your requirements may be on the system, not on the individual device.

Kutzner: This is about an extension of what we are doing; if metadata gets stripped out and this is well known, maybe it is OK. Part of the problem (in not having systems drop data) is that there is no single manufacturer that drives standards.

Edwards: AS-PBS is about what file servers need to be able to read. We need requirements on a device by device basis so manufacturers know what we need.

Devine: About the specification, we want to impose it on program producers. We want to proceed, can't wait for standards to fully develop. PBS took the lead in insisting that MXF support captioning. PBS often must drive this type of process because TV overall is Balkanized.

MacCarn: In NTSC, with closed captions on line 21, this the first line of video, if it had not been there it would never have been supported.

Besser: This reminds me of uncompressed JPEG. I recall problems with a "Mezell" project, in which all the vendors promised that they could handle to uncompressed JPEG; but when tested it was not really true. There needs to be vigilance, because they claimed capabilities that didn't exist in practice. It wasn't actually supported in software.

Gustman: You don't need 100% [of metadata?] to come from producers, archivists could do the rest. You could say that getting 70 percent of the metadata is better than what we have now.

Arms: I have been reading the specifications in the still-image community for PASS, now called Everplay. The spec is in three parts. One is the format part, and a separate one details what machines have to do.

Devine: Should we take up the DoD project? What would be the issues? I'd like to ask LC, if we were to take up a project, let's look at what the scope would be, and I'd like to know what would be the response level at LC.

Gustman: In the absence of politics in the institution, the DOD system would be where I would have started. I'd like to see this pushed with NAVCC participation. Can a working group solve the vendor issues? I don't know. Can we participate?

Scovill: This DOD thing is what we wanted to do in the beginning.

Thaxter: For analog video, we would be looking at Motion JPEG 2000, MXF wrapped. In general, there will likely be a lot of supported essence in MXF. About our use of Motion JPEG 2000, this is our decision for our own reformatting production. But for a lot of material that is born digital, we will not transcode.

Gustman: The original direction a year ago was that we would have an AAF wrapper around METS and MXF. Work in that direction stopped. Now we might get MXF-wrapped, PBCore.

Fleischhauer: Given particular born-digital object (from PBS), what are its characteristics? I think that LC would participate in metadata committees. We have some expertise in M/B/RS, some in NDMSO, some in OSI.

- Metadata to support discovery (Greg Lukow's group M/B/RS)
- Characteristics of digital stuff (Carl and OSI)
- Preservation/Management (who from LoC?)

Devine: The DOD thing looks good to me. There are parts and pieces to this, I'd like to scope something that can be done in a few months. I want to use the PBS move to non-real-time as the driver for this, rather than the NAVCC timeline. PBS's schedule is the most useful driver. What is the AS/PBS timeline?

Gustman: There is value in this for PBS, independent from NAVCC and the Library.

Kutzner: I can report that the Interconnection Replacement Office (IRO) at PBS is active, this is going forward. We're running the IRO to make it happen soon.

Gustman: For what you are talking about, Ken, we need to put some structure in place. Will need project management, workers, funding need to be sorted out.

Kutzner: Participants in NDIIPP are WGBH, WNET, & PBS. Remember that the PBS [interconnection replacement] project is paying for all of the Edge Servers at all the stations, to make sure it gets done. It is part of how we can get this to work. AS-PBS started for distribution formats, but we recognized that this idea should be pushed upstream for contribution formats and for the NYU connection to the NDIIPP project

Weiss: As the consultant to CPB on this, an aspect written into the requirements calls for program exchange between stations. It means a station-to-station program interchange apart from the programs that travel via PBS. Having metadata infrastructure in place will facilitate stations looking at each other's libraries to find programs.**,** even though it was not part of the initial project.

Gilmer: I'm worried about scope creep. Are we looking at system that DOD has, or part of the system? It is real important to be clear about what we are doing here. Is DoD code a piece of an overall system?

Oliver: About expectations . .. "this thing that DOD has." What have they got? DoD has proof of concept code and a set of lessons that can be repurposed to systems. It's not cut and dried. From the MISB group, the results of their work have flowed into open source software. This project has to define its goes-into and goes-outta and then proceed.

Gilmer: My vision is that you have systems that you can reach into, look into the archive. This is complicated, to come up with requirements, then look at systems see if they exist. Import-export is not a bad place to start, think of a phased project. With their extension system, you can add METS. But don't put in dark metadata. You don't know the effect of your action, e.g., editing that disturbs captioning. You are looking for reliability.

BREAK

Devine: Our intention is to look at MISB, to begin to figure out what is the appropriate requirements. This will signal that public TV is interested in this, to leverage the lessons they have learned, to build a SIP. What should be on the top of the list of requirements?

Gustman: We should say how far back from the archiving we go. Do we go back to production, is there a wrapper that stays with the object from the start?

McDonough: The SIP is a set of information and associated data that goes to the archive.

Gustman: Wouldn't it be AAF all the way the thru, one format from start to finish?.

Besser: What is important about the SIP is what is in there, rather than what it is in.

Pearson: Once it hits the preservation wall, is it frozen?

Gustman: The object in the archive may be added to later.

Devine: We need to incorporate PBCore.

Edwards: There is structural metadata in MXF.

Weiss: Let me work on a PowerPoint as we are talking, it is better than a white board, I'll send the file along after the meeting. [Weiss proceeded to do this; text is included at end of notes.]

MacCarn: Let me do a sidebar on registries. Who keeps the key to KLV licensing? That is a question for us.

Pearson: Should mgt information be in an SIP? I don't think so.

Oliver: [drew diagram on whiteboard of a content life cycle] I made this drawing to call attention to the fact that categories of metadata may or may not be on a given vector in the life cycle.

Gustman: About essences, will they all be wrapped the same way? The NAVCC plans say that we would reformat 50 mbps essences, and we would transcode, but not 8 mbps essences.

Gilmer: I'd like to propose some fundamental precepts, more or less at the at 50,000 feet level:

- AAF will be used as a top level wrapper format, includes MXF (servers only read MXF for playout)
- SMPTE essence descriptors will be used to describe the essence
- content than greater than > 50 mbps will be stored as JPEG 2000
- content at 50 mbps stored native
- content = 8 mbps stored in native form
- dark metadata is evil
- metadata cannot be disappear/stripped out
- AAF object model extension models will be used to accommodate
    - AS/PBS
    - PBCore
    - METS
- Someone will develop profiles will map to the AAF object model and identify missing parts for (a) distribution and (b) submission to archive

This kind of idea will also apply to Oliver's interface points in his diagram. We should see what is need at each interface/vector.

Oliver: What comes out of your AVID today? The AVID MEDIA manager, wants to export AAF or MXF, and it can do either one. I could construct all my [metadata?] as MXF, then import or export as AAF. In MXF, there may be extra bits of data in there that are not really MXF but there is no harm to them. Meanwhile, this model from Brad is a good match for the DOD approach, although their metadata type is their own.

Devine: The idea of using AAF/MXF as the top level wrapper, I see that there is consensus that this makes sense. This alone makes this meeting a success.

Now we need to work thru the metadata issues, which will be difficult. We need to refine PBCore. Now we need a requirements document about the metadata. One requirement is that all metadata must be retained.

Edwards: We have all been talking about PBCore as if it were in use already. But today, the metadata in use in public TV is PODS. PODS is the database for public TV, maintained by PBS but annotated by third parties. We are now going to creators and demanding frame-accurate data. This data drives all of the traffic systems at stations, and we need to figure out how that relates to where we are going.

Gilmer: What does archive software look like? What is on the market now, I am not clear about what is currently implemented. Be aware that AAF has produced open

source compliance and testing tools. These tools may be usable, if modified, to apply to validation of other types.

Possible roles of AAF Association:

- Provide open-source AAF tools, including testing for compliance;
- Can help marshal something through SMTPE.

Pearson: In the four-part categorization of metadata, part 3 (archive management…) is mostly part of the AIP, not SIP, so should be stored elsewhere. There may be some rights conveyed in SIP (maybe moved to category 1, intellectual…). Regarding Brad's precepts, probably all content should be stored in native digital-file form, dropping the distinction at 50 Mb/s.

Oliver [with diagram on white board]: Within a AAF wrapper, metadata like METS, PBCore, and PODSv4 could each be embedded as separate large items (like caption and audio are), and/or the individual metadata fields could (in total or selectively) be mapped to corresponding AAF fields, either existing fields or, using the extension mechanism, new fields. This is something for a working group to consider.

I am often disappointed with vendors. Here are a few things to be aware of:

1. Many vendors will only accept that one shape of bucket exists (e.g. MXF), and will argue that other shape buckets do not exist.
2. Vendors will not necessarily support AS/PBS [unless pushed].
3. There is interest (almost religion) in the ISO BMFF file format, used by MPEG and JPEG, so there will be a push for mapping [something] into that.

Joe Pawletko: About what we are doing at NYU. We use dSpace, an open source version of an institutional package and we are looking how to fit that into the OAIS model:

Accept SIP
populate OPAC
provide streaming content, e.g., access & discovery;
permit format migration.

We are leveraging METS as the container. Things we need to do, to fit into METS model:

Descriptive metadata : MARC-XML
Technical metadata: Video metadata/audio metadata
Rights metadata being looked at

For the extension schema for video, we are using the LC video metadata schema that Carl cooked up in the prototyping project.

Devine: Next year, with NYU, we will be coming up with a prototype repository for the NDIIPP project.

Gustman: So you will make packages that are sent to NAVCC. We are uncertain about exactly what SAMMA will do, whether it will be wrapped in the same way. It would be great to have the objects we make at NAVCC look just like the Public TV objects.

Gilmer: At AAF, we are making a tool for our SDK that will output MXF-wrapped content.

Edwards: Formats that are "like" MPEG-2 in some ways and encountered in public TV production include -- D10 (Sony's IMX) and AVID DNXHD (called VC3 in the SMPTE context). Both are documented and there are decoders.

Fleischhauer: Will public TV be adopting H.264, i.e., MPEG-4 AVC, as HD comes in more and more?

Edwards and Weiss: H.264 is coming in with new closed systems, like DirectTV satellite. But for broadcast, MPEG-2 is embedded in the ATSC digital standard and will be used by broadcasters for years to come.

Devine: Next steps? I think we should aim for a document that would serve both public TV and NAVCC. But I will take that up as a question for the NDIIPP project, we will work on this.

Next question is who to be liaison with DOD folks; for that Gustman and Oliver can talk to the folks they know.

Gustman: The question of working out METS extensions for AAF, I would like to work with Morgan on this. I want to be sure the METS data can be put into an AAF extension. And also a PBCore extension. And see this thru so that you can output an MXF from this AAF object.

Devine: I don't know, some things needs to be done with the PBS people but they have a lot to do right now, with their move. And I know Jerry (McDonough) may not be available.

Gustman: I hope Morgan Cundiff (METS at LC) will be involved. (Cundiff says yes.) Who should drive that group? NAVCC does not have a stake here, they are a receiver of PBS content.

Devine: Brad, are you willing to stay involved?

Gilmer: Yes. Anyone can take the AAF spec, see how the extensions work, and then write what you want. We at AAF could work with people to guide them.

We have standardized the object model, we are now working on the edit [something], with SMPTE.
It is often useful to talk about things outside the SMPTE process. In the standards process, you can't discuss business matters and this can be limiting.

Kutzner: The PBS heavy workload is temporary.

Devine: This project and its metadata needs to meet both needs of PBS and of Library.
I (with my NDIIPP hat on) will take this up.

- We need to liaison with DOD.
- For dealing with AAF extensions (with **Brad** as contact) –
- We need Oliver Morgan too, not sure how to do that.
- plus **Jerry**, assuming available, should look into METS as AAF extension; also PBS(MXF) relationship to AAF.

We need in the project to caucus first and see what we can do.

Arms: Re: metadata, there is an analysis task, not sure where it would go. Regarding PBCore, it is already mapped to MAVIS recently. There may not be much coverage. (**Nan** says "spotty". PODS would need to be looked at. CPB [Corporation for Public Broadcasting] has funded more work on PBCore.)

Gustman: How would you know, who would decide when there is metadata? We figure on working with Morgan Cundiff and he may have a team, he wants the METS "profile" in AAF.

Edwards: Don't forget that PBCore is developing. What people are really using is PODS, not yet PBCore.

Oliver: Morgan [Cundiff] and me and Thomas should get together. The PODS to METS mapping could happen fast; since some familiarity with PODS is available.. This would be a perfect task given what else we are doing

Devine: One goal of the NDIIPP public TV project is to create a model archive for public television If we can get our three entities together (Thirteen, GBH, PBS), it will lead the industry.

But it is hard given the cultural differences between partners. PBCore has not been well managed, but CPB is now funding the implementation of PBCore by creating toolsets,. But years of work have gone into it, we don't want to lose it. We're now trying to align PBCore with NDIIPP; thought there hasn't been much field rollout to date.

Pearson: Will PBCore carry rights info? So you don't need MPEG [MPEG-21]? Or DMS (part of MXF)?

MacCarn: There is a rights field, but . . . .

Gustman: Why not use AAF for rights?

Edwards: We all ought to study PBCore . . .

Gustman: AAF as extended to include everything, it is your wrapper.

Gilmer: Look at the wrapper, this container. The object contains video, audio, captioning. You could also have *objects inside* the container: METS, PBCore. Or you could take the METS data and put it in the extension you set up in AAF, then it is more accessible in the container but not as an [imbedded object].

Oliver: You do both. Draw another box with PODS, carry that as a blob, and also put the data in the object model.

Gustman: I'd want to put them into the object model . . . there is a risk of drift between having the same data in two places.

Oliver: In the DOD model, regarding NITF, the object has its own metadata inside it, and the image, when merged onto an ASPA file it goes two places. The government has an API that keeps the data in synch, this API [tool] is "not quite open source."

Gilmer: You need to look at what is missing, some is already in the AAF model.

Gustman: About forming a team, about the need for a project manager, need project mgr in each group. [Organizing remaining effort:] I will organize the developers to map PBCore and METS to AAF extensions.

Nan Rubin (Project Director, Preserving Digital Public Television, Thirteen/WNET)**.** We have the opportunity for another face-to-face meeting, we already have a time scheduled in Las Vegas in April at the upcoming PBS Tech Conference, just before NAB.

Weiss: Do you want an email reflector for this group?

Gustman: My contacts at DOD/NSA are Bill Butterfield, Ron Lee.

Oliver: My contact is mainly at MISB (Motion Imagery Standards Board): John Zabitchuck and scientist Guy Beakley. I will compose an email to get Gustman invited back in to these DOD discussions. We can hope to get access to a chunk of source code. The DoD project include code for doing AAF extensions.

Devine: We need to develop a budget.

[Some additional discussion and meeting ends.]

* * * * * *

NEXT STEP NOTES FROM THE WRAPPER ROUNDTABLE
[Taken from slides by M. Weiss]

(Each bold heading is a new slide.)

Origin of Input Data

- Wrapper w/input data

Submission Input Package

- Content is more important than wrapping
- Different from AIP
    - Archival Information Package
- Life cycle of archival information

Wrapper Format

- From creation to preservation
- Needs to be captured at content creation
- May be changed during life of content

Archive Contents

- Which essences
- Which metadata — 4 categories
    - Descriptive metadata (of work) -- Metadata that identifies the content of the work, including title
    - Technical characteristics -- Defines the technical information and parameters necessary to reproduce the content -- Archive management data
    - Rights data and life cycle management data, including checksums to confirm content integrity, source code for codecs, definition of file structure
    - Structure metadata -- Identification of segments, linkages between types of essence, ordering information

Registries

- Formats
- Compression algorithms

Essence Storage Formats

- Specified or not
- Compressed or not
- Image / audio sampling structure
- Compression algorithms
- File formats

Rights

- Identification of rights owners
- Identification of rights given to library

Issues

- Who holds keys to KLV structure
- Where is registry held
- Licensing of everything
- Where in archival system does specific metadata flow?
- Who decides how much metadata is enough?

Fundamental Precepts (per JBG)

- AAF used as top level wrapper format
  - Includes MXF
- SMPTE essence descriptors used to describe essence
- Content >50 Mb/s stored using J2K
- Content = 50 Mb/s stored in native form
- Content = 8 Mb/s stored in native form
- Dark essence is evil
- Dark metadata is evil
- Metadata cannot be stripped out
- AAF object model extension methods used to add metadata types, e.g.,
  - AS/PBS
  - PB Core
  - METS
- Someone must develop profiles that will map to AAF object model & identify missing parts for:
  - Distribution
  - Submission to archive

Next Steps

- Produce a more formal requirements document
  - More fully fleshed out
  - Meets needs of PBS & NAVCC
  - NDIPP project will undertake to do this
- Liaison w/DOD to accept offer to use tools available
  - Sam & Oliver
- Reconciling METS & AAF interfaces
  - Assuring METS profile can be added as AAF extension
  - Mapping PODS to METS, consideration of PB-Core
  - Adding AS/PBS, PBS-Core as AAF extensions
  - Harmonizing PB-Core w/AAF, SMPTE RP210, etc
  - LC (Morgan), AAF, NDIPP/PBS, Oliver, Jerry(?), Sam

- Set up e-mail reflector
- Develop a budget

WRAPPER ROUNDTABLE
MARCH 9, 2006 – LIBRARY OF CONGRESS
10:00a- 5:00p

Library of Congress, Madison Building
Independence Ave SE, *between* 1st & 2nd Streets
Automation Orientation Center - Room LM #G45

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WRAPPER ROUNDTABLE
RECOMMENDED READINGS

The following papers have been suggested as background for the Wrapper Roundtable.

Bibliography: Preservation File Formats for Video & Associated Metadata

Digital Longevity - Dr. Howard Besser, Professor & Director, *Moving Image Archives and Preservation Program, New York University*
http://www.gseis.ucla.edu/~howard/Papers/sfs-longevity.html

Digital Formats: Factors for Sustainability, Functionality, and Quality - Caroline Arms and Carl Fleischhauer, Office of Strategic Initiatives, *Library of Congress*

Notes on formats and wrappers by Carl Fleischhauer March 2005, revised February 2006- Carl Fleischhauer

METS: Overview and Introduction - Dr. Jerome McDonough, Assistant Professor, *Graduate School of Library and Information Science, U. Illinois at Urbana-Champaign*
http://www.loc.gov/standards/mets/METSOverview.v2.html

Using MPEG-21 DIDL to Represent Complex Digital Objects in the Los Alamos National Laboratory Digital Library - Herbert Van de Sompel
http://www.dlib.org/dlib/november03/bekaert/11bekaert.html

MXF - the Material Exchange Format – Bruce Devlin
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