Addressing Publishing Issues with Hypermedia Distributed on the Web

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Abstract

The content and structure of an electronically published document can be authored and processed in ways that allow for flexibility in presentation on different environments for different users. This enables authors to craft documents that are more widely presentable. Electronic publishing issues that arise from this separation of document storage from presentation include (1) respecting the intent and restrictions of the author and publisher in the document's presentation, and (2) applying costs to individual document components and allowing the user to choose among alternatives to control the price of the document's presentation. These costs apply not only to the individual media components displayed but also to the structure created by document authors to bring these media components together as multimedia.

A collection of ISO standards, primarily SGML, HyTime and DSSSL, facilitate the representation of presentation-independent documents and the creation of environments that process them for presentation. SMIL is a W3C format under development for hypermedia documents distributed on the World Wide Web. Since SMIL is SGML-compliant, it can easily be incorporated into SGML/HyTime and DSSSL environments.

This paper discusses how to address these issues in the context of presentation-independent hypermedia storage. It introduces the Berlage environment, which uses SGML, HyTime, DSSSL and SMIL to store, process, and present hypermedia data. This paper also describes how the Berlage environment can be used to enforce publisher restrictions on media content and to allow users to control the pricing of document presentations. Also explored is the ability of both SMIL and HyTime to address these issues in general, enabling SMIL and HyTime systems to consistently process documents of different document models authored in different environments.

Introduction

The World Wide Web offers the promise, and more and more the reality, of widely distributed and widely accessible electronic publication of related hypermedia data. In order for this data to be applicable to a wide variety of presentation styles, circumstances and future technology changes, it must be represented in a presentation-independent format that does not prescribe aspects of its presentation. In order for such data to be presented, a mechanism must exist that can process it to generate a presentation appropriate for a given situation.

Allowing flexibility in document presentation complicates the author's and publisher's task. All possible variations in how a document is presented must be accounted for. Authors and publishers need to be able to specify certain restrictions on how documents and portions of documents are presented, and presentation environments need to account for these restrictions.

With electronic distribution a presentation may consist of media objects and data obtained from a wide variety of sources. Each source may have different price scales, mechanisms and restrictions for these media objects, and thus pricing final presentations can be complicated. In a hypermedia presentation, each navigational step of the user adds to the presentation's price. Thus, the user will want to know the cost of each possible step, and to be able to select less expensive alternatives for a given navigational choice.

This work represents storage structure with the ISO standard HyTime (Hypermedia/Time-based Structuring Language) [8][6]. HyTime specifies the representation of hypermedia documents in a presentation-independent format. HyTime is defined as a subset of Standard Generalized Markup Language (SGML) [11][7], which defines the structure of electronic documents in general.

This work represents the transformation between storage and presentation with the ISO standard DSSSL (Document Style Semantics and Specification Language) [10]. DSSSL defines the transformation of SGML documents into formats that present them. Thus DSSSL systems can accept HyTime as input. The use of DSSSL with HyTime was recently made easier with the release of the second edition of HyTime, which contains new facilities for use with DSSSL.

This work represents the presentation of hypermedia documents with SMIL (Synchronized Multimedia Markup Language, pronounced 'smile') [18]. SMIL encodes final-form hypermedia presentations distributed on the Web. It is being developed by the W3C as a potential W3C recommendation. With W3C's promotion and the public-domain SMIL browsers to be released with its version 1.0 publication in the Spring of 1998 it is expected that SMIL will be a widely-used means of distributing published hypermedia. SMIL is defined as a subset of XML (Extensible Markup Language) [20], which is in turn a subset of SGML. Thus, DSSSL can encode transformations that output SMIL.

Public-domain tools exist that make the cooperative use of HyTime, DSSSL and SMIL for electronic hypermedia publications widely implementable. SP [4] is a public domain tool that can parse and validate SGML and HyTime documents. Jade (James' DSSSL Engine) [3] is a public-domain tool for processing DSSSL style sheets. XP (XML Parser) [5] is a public-domain XML parser which can be used to validate SMIL documents. GRiNS (A GRaphical INterface for creating and playing SMIL documents) is a public-domain tool that plays SMIL documents [2]. These standards and tools can be used together to create an environment that processes documents from stored hypermedia data into final presentations.

This paper introduces the Berlage hypermedia authoring and browsing environment. This environment incorporates the use of HyTime to represent hypermedia documents in a format independent of its presentation. It also incorporates the use of DSSSL to specify the different mapping of these documents to their final presentations. Finally, Berlage generates and presents presentations encoded in SMIL. The Berlage environment consists of public-domain tools to demonstrate how such environments can be readily implemented on a wide scale. For this work the Berlage environment design was adapted to be able to account for the electronic publishing issues discussed.

First, some background information regarding the standards and tools involved and the Berlage environment is presented. Then the electronic publishing issues are discussed in general, in terms of the Berlage environment and in terms of an example application running on the Berlage environment. Finally, the broader applications of these issues, formats and tools are explored and a conclusion is provided.

Background

HyTime

HyTime is an ISO standard for representing presentation-independent hypermedia data. It is built upon SGML, which provides the basic structuring information that applies to document data in general. HyTime adds more complex structuring constructs and attaches hypermedia semantics to certain patterns of composites of this structure. The basic hypermedia semantics that HyTime represents include hyperlinking, which establishes descriptive relationships between document objects, and scheduling, which puts document objects in coordinate systems that can represent spatial and temporal relationships.

HyTime and SGML are generally considered to encode documents that are presentation-independent. They can apply to a wide variety of presentation situations but do not themselves represent particular presentations. HyTime and SGML documents typically must be processed
into a different format appropriate for final presentation.

HyTime and SGML are meta-languages. They encode not only individual documents but also the document sets to which they belong. A document set is defined by an SGML document type definition (DTD). An individual document conforms to a particular DTD. A DTD defines a specific syntax, in terms of SGML constructs, that its documents must follow. HyTime inherits from SGML the use of DTDs to define individual document sets.

A DTD is one way to define a set of SGML documents in terms of restricted SGML syntax. Another way, defined in the HyTime second edition, is with SGML architectures. One difference between DTDs and architectures is that architectures define a looser, broader syntax. Multiple document sets, as defined by DTDs, can conform to a single architecture. Further, architectures can inherit from other architectures. An SGML architecture is defined by a piece of code called a meta-DTD. A meta-DTD specifies what composites of constructs from SGML, this architecture and other architectures make up each of this architecture's constructs. HyTime itself is an architecture and is defined with a meta-DTD.

HyTime also provides for defining properties, which apply semantic labels to composites of SGML and HyTime constructs. This facilitates the querying of the data represented in a document, and thus it facilitates the processing of HyTime documents into documents of other formats, including those for presentation. Typically, many different constructs can be used to represent the same property. In such cases, it is easier to query by the property than by all the possible different combinations of constructs that can represent that same property. HyTime constructs for defining properties can be used for individual documents, for document sets, and for architectures. The HyTime property-set facility was extended in the second edition of HyTime to be more readily processed by DSSSL style sheets. These facility includes the ability to define new property sets.

DSSSL

DSSSL is a scheme-like language that describes how an SGML document is transformed into another SGML document or into a non-SGML format. Because HyTime documents are SGML documents, any HyTime document can be transformed by DSSSL. A DSSSL program is typically called a style sheet. The separation of style from structure and content enforced with the distinction between DSSSL and HyTime facilitates the creation of particular styles by the author that can be applied to documents of the same document set.

The design of typical DSSSL usage is shown in Figure 1. This diagram shows how an SGML document is processed with an accompanying style sheet for that document by a DSSSL engine. The DSSSL engine determines the mapping encoded by the style sheet and generates the appropriate transformation of the source document into the presentation format.

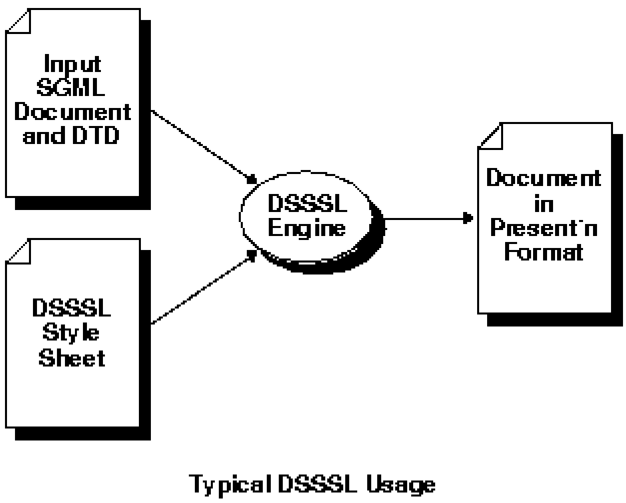


Figure 1: Typical DSSSL Usage Addressing Publishing Issues with Hypermedia Distributed on the Web

DSSSL is designed to work with HyTime-defined properties, as specified in the HyTime second edition. A style sheet can ask for the property of a document object with one function call, rather than requiring a complex section of code that checks for all the syntax composites that could define that property. No mechanism for recognizing these properties is specified.

One possible means for recognizing properties and determining their values is the defining of DSSSL functions that provide access to these properties.

SMIL

SMIL is a format representing hypermedia presentations on the Web. It incorporates basic hypermedia principles such as spatial layout, temporal composition, synchronization and navigational hyperlinking. It also has constructs that adapt presentations to the characteristics of individual environments and users. SMIL specifies the display of multiple media items in a coordinated fashion: displaying visual items and related locations on the screen, and synchronizing the timing of the presentation of these media items. SMIL specifies the display of navigational interface that allows the user to select what portions of the presentation to currently display. What is novel about the use of SMIL is its promise of wide implementation and adoption, making SMIL documents viewable by a large audience.

SMIL has an easy-to-author format whose syntax resembles HTML. SMIL is defined using an XML DTD [19], just as HTML syntax is defined with an SGML DTD. Since SMIL documents are XML documents, they are SGML documents, and thus are easily processed as output, and as input, of DSSSL transformations.

The Berlage Environment

Berlage (named after H.P. Berlage, the architect of several important buildings in Amsterdam, The Netherlands) is a hypermedia environment that uses public-domain standards and tools. An diagram of the environment design is shown in Figure 2.

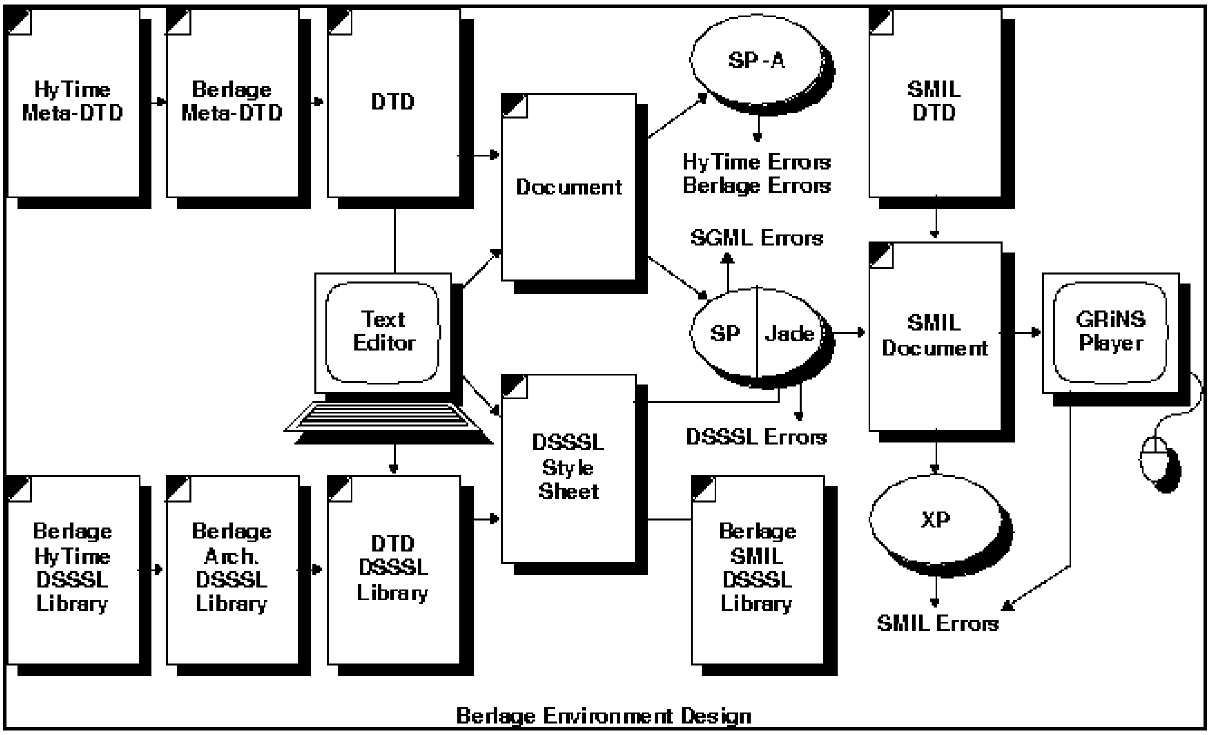


Figure 2: Berlage Environment Design

HyTime is used by Berlage to represent stored hypermedia data. SMIL is used to encode the hypermedia presentation of Berlage documents. DSSSL is used in the Berlage environment by authors to encode a potential wide variety of presentations of the same source document. A large document can be written once for long-term storage, and it can be presented in many different ways without re-editing the original document. With the document content and general structure being established by HyTime, the author of DSSSL style sheets can focus on the desired style of presentation, the mapping of the navigational interface, and the adapting of the presentation to particular environments and individual users.

The Berlage environment includes the Berlage architecture. It specifies how SGML and HyTime are used to represent certain hypermedia semantics that potentially apply to a wide-variety of documents but are not represented specifically by HyTime. The Berlage architecture was introduced in previous work [12]. As with any SGML architecture, its syntax is defined by a meta-DTD.

Standard text editors are used to create Berlage documents, DTDs and style sheets. Berlage documents are run through SP to validate them or to provide error messages to assist the author in checking the document's SGML, HyTime and Berlage architecture conformance. A Berlage document and corresponding style sheet are input to Jade and a SMIL document is generated. The validity of the resulting SMIL code can be checked by processing it with the SMIL DTD through the XP XML parser. This SMIL document is then presentable across the Web with GRiNS players.

All Berlage documents are parsed with their DTDs. Each Berlage DTD includes by reference the Berlage meta-DTD, which in turn includes by reference the HyTime meta-DTD. This enables SP to validate HyTime and Berlage conformance as well as SGML conformance. DSSSL function libraries are defined for each architecture. These contain functions for accessing the properties defined for each architecture in the Berlage documents being processed. Functions that process documents of one DTD as input can be put in a DTD DSSSL library to be used by all style sheets for that DTD. The environment also includes a library of DSSSL functions for generating SMIL output. These libraries can then be included in a style sheet in the Berlage environment.

Addressing Electronic Publishing Issues

This section discusses certain electronic publishing issues as they occur in hypermedia environments that use presentation-independent storage. This discussion refers to the Berlage environment, but the issues apply to any application of the standards used or to any hypermedia environment that maintains a distinction between storage and presentation. An example application used to illustrate this discussion is presented first. Then each of the issues and how they are addressed is described in detail. These descriptions are facilitated with Table 1, which states what facilities in key components of the Berlage environment can be used to address each electronic publishing issue.

	Presentation Constraints	Media Object Pricing	Structure Pricing
HyTime	Wand	Activity Policy, type 'access'	Location of Structure
Berlage	Presentation Restriction	Charge, type 'presentation'	Charge, type 'generation'
SMIL	Channel Scaling, Z-Ordering	Text with Price Information	*not applicable*
DSSSL	Properties beyond SGML	*no additional facilities used*	Tallying Price During Transformation
Processing Issues	Restriction Maintained at All Levels of Processing	Fee Applied at User Presentation Runtime By Media Servers	Fee Applied at Presentation Generation Time

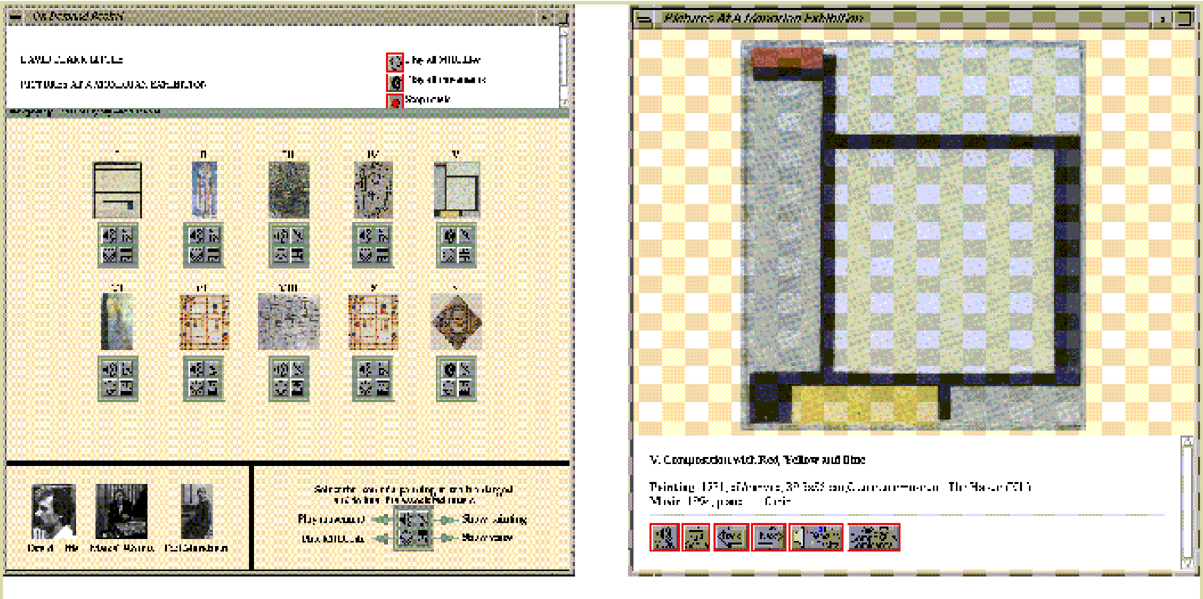
What Facilities of Key Berlage Environment Components Address Each Electronic Publishing Issue

Table 1: What Facilities of Key Berlage Environment Components Address Each Electronic Publishing Issue

Example Application

This paper uses an application entitled Pictures at a Mondrian Exhibition to illustrate the electronic publishing issues involved in hypermedia storage and presentation. This hypermedia application was developed in conjunction with the CMIFed project [17], which provides much of the conceptual and implementation foundation for the work in this paper. The Mondrian application has a visual, musical and informative aspect. The visual aspect consists of images of 10 paintings by the artist Piet Mondrian from the exhibition Mondrian from Figuration to Abstraction, shown in the Gemeentemuseum, the Hague, from February 20th to May 29th, 1988. The musical aspect consists of 10 piano compositions written by David Clark Little and played by Marcel Worms, with each composition written for one of the paintings. The informative aspect consists of text and oral descriptions of the paintings, the compositions and the artists involved. The document, and the user’s interaction with its display, coordinates the presentation of objects from these three aspects.

A screen dump from a presentation of this document is shown in Figure 3. The left display gives the user a high-level navigational interface, showing thumbnails of the 10 paintings and allowing each to be selected for presentation. The right display presents one painting at a time. Typically the composition for a painting is played in conjunction with its display in this display, though user interaction can override this. This right display has buttons for playing the composition, showing the score, and accessing the composer’s comments on each painting and composition. During "On Demand Recital" mode, the user can select any painting at any time for display from the left display. The user can also request a "concert", in which the paintings and their compositions are presented sequentially without further interaction.



Displays of Example Document Presentation

Figure 3: Displays of Example Document Presentation

Media Object Presentation Restrictions

Sometimes providers of media content in distributed electronic document environments place restrictions on how their media can be presented. When final form presentations of such media are not fixed at authoring time, the authoring environment needs to provide the ability to specify the necessary restrictions and the whole environment needs to ensure that they will be followed in every presentation generated by the environment.
Such a restriction was placed on the images of the paintings contained in the Mondrian application. It was required that these images always be shown in their entirety and original orientation during any of the document's presentations, without any cropping, covering or rotating.

Implementing media object presentation restrictions impacts different areas of the Berlage environment design. The first concern is how to represent the restrictions at the storage level. The approach used in the Berlage environment is to represent as many of the desired hypermedia document semantics as possible with HyTime constructs. Of the semantics that remain, those that potentially apply to a wide variety of document sets have Berlage architecture constructs designed for them that use HyTime constructs with a few addition Berlage-specific SGML constructs to represent the full semantics desired.

HyTime

This approach was taken in this work for representing media object presentation restrictions at the storage layer. In HyTime, the rendition module contains constructs that represent how a portion of a structured document can be modified when transformed to a different structure. The type of structure focussed on by the rendition module is numeric: the rendition module describes how components within one coordinate system are transferred to another. An example may be the transfer of a world map measured with longitude and latitude coordinates to a flattened representation of the map such as the Mercator projection, measured in flat height and width. The rendition module also specifies how media objects placed in the first coordinate system are processed or filtered for inclusion in the second. The HyTime construct wand specifies the processing of this type that occurs for a given media object during a transformation from one coordinate system to another. The HyTime standards does not specify the processing itself, only the packing of its encoding as a wand construct.

Berlage

The Berlage prestrict (presentation restriction) construct is used by the Berlage environment to encode media object presentation restrictions. The Berlage prestrict construct inherits from the HyTime wand. Whereas the wand construct represents in HyTime that some unspecified processing happens on a document object, the prestrict goes further by assuming this processing is presentation-oriented and by saying that this processing has certain restrictions on it. The exact nature of this process, like with HyTime, is still not specified at the Berlage level.

Each Berlage prestrict is recognized by every HyTime system as somehow specifying how the coordinate system component it refers to is to be processed for inclusion in another coordinate system. With prestrict it is assumed that the source coordinate system is a storage-level presentation-independent structure, and that the destination coordinate system represents the document's final presentation. It is also assumed that the document object to be transferred between the coordinate systems is a single media object.

The prestrict construct has a attribute named prestrict whose values describe restrictions of a media object's presentation. One possible value is nocrop, which means that the media object is not to be truncated or shortened in any way when processed for presentation. After a HyTime system recognizes the wand components of a prestrict as specifying how a media object is to be processed, a Berlage system recognizes that this processing is not allowed to involve any cropping or truncated of the media object for final presentation.

SMIL

There are several SMIL constructs that can assist in assuring presentation constraints on media objects. Media objects such as images are assigned to SMIL constructs called channels, which encode certain aspects of how they are processed for presentation. For images, channels primarily specify their location on the screen. Channels also specify how images are processed to be placed in their channels if they do not match in size or aspect ratio. This specification is done with the scale construct. If a channel has its scale construct assigned the value of "meet" then images displayed in that channel with always be made to fit inside the screen space the channel has assigned without overlapping that space, and thus having that overlap cropped. Thus, images specified by a Berlage prestrict as not being cropped can be displayed in their SMIL presentations with channels whose scales are assigned to "meet" help ensure that the "nocrop" presentation restriction is maintained.

Another SMIL construct that assists in ensuring that visual media objects are not cropped is z-order. The z-order construct specifies the order in which channels with overlapping screen displays are presented. Visual media objects with Berlage constructs as having a "nocrop" presentation restriction can be displayed in channels with lower z-orders, thus putting them more in the foreground and making it less likely that they will be overlapped by other displayed visual objects.

DSSSL

The primary function DSSSL uses to work with HyTime is node-properties. This function takes as input a document object and a specification of a property and returns the value of the property that the object has. A set of properties is defined for SGML constructs which DSSSL style sheets use to get the information on input SGML documents on which they base their transformations.

The second edition of HyTime defines properties for HyTime constructs. It also introduces constructs for specifying collections of new properties called property sets. A DSSSL engine that is programmed with such property sets can refer to and process such properties in the same manner with which they process SGML properties.
The primary HyTime property that applies to media object presentation restrictions in the Berlage environment is modifier. A media object that is included by HyTime code in a coordinate system can have a modifier property. The value of this property is a reference to the segment of SGML code that defines how that media object is to be modified when rendered. The processing of this segment of SGML code to specify this modification is outside the scope of HyTime.

The Berlage meta-DTD specifies a property set for properties encoded by Berlage constructs. One such property is the prestrict (presentation restriction) property. This property can apply to a document object identified by HyTime properties as a media object's modifier. The value of this property is the collection of presentation restrictions that apply to that media object when it is rendered for presentation. One possible member of such a returned collection of presentation restrictions is "nocrop".

A DSSSL style sheet can use these properties to help insure that
visual media objects that should not be cropped during presentation will not be. For a given visual media object, DSSSL code can ask for the value of its HyTime modifier property. It can then ask for the Berlage prestrict property of the document object referenced by the modifier property. The DSSSL code can specify that, if the returned prestrict property value indicates a "nocrop" restriction on that media object, then the SMIL code for the presentation that includes the object shall have "meet" assigned to the scale attribute of the channel on which the object is displayed. In these cases the channel can also be specified with a low z-order to further ensure that the
visual media object with not be cropped or overlapped.

Price for Media Object Presentation

Currently most media information distributed on the Web is available free of charge. However, an increasingly large amount of such data is charged for. As the mechanisms for monitoring the exchange of priced media data and for collecting fees for its use are more widely adopted, the richness of available media data will increase. When different priced media objects can be used in different combinations for varying presentations of them, the price of each combined multimedia presentation can vary as well. Further, each interaction from the user that causes more media data to be displayed in effect has a price. Such an interaction will cost the user the total amount of the prices of the media objects that get displayed as a result of that interaction. It is useful for the user to know how much each interaction will cost. It is also useful for the user to be able to control the price by more interactively determining which media objects to select among varying alternatives of the same object that have different qualities and prices.

The Mondrian document contains media objects of the type that are typically subject to such pricing. The images are of paintings that are owned by various museums. Museums frequently require financial compensation for the electronic display of images of paints they own [1]. The document also contains recorded music, for which compensation for its playing is also sought by its provider. Several simplifying assumptions are made with the implementation of media object charging in the Berlage environment. One assumption is that during presentation the media servers that provide the media objects handle the charging of the user for their access. The actual charging of media object access is not handled by the Berlage environment, only the representation and processing of the prices involved. Another assumption is that the user will not be shown the accumulated price of the presentation as it progresses. One more is that the pricing of available navigation steps do not account for the accessing of media objects that have already been downloaded and thus exist in the client cache, will not require subsequent accesses of the media server and will not be charged for. These assumptions were made so that runtime processing for the presentation are not be necessary. Adding runtime processing to this environment would enable these and other functions to be implemented.

HyTime

To represent these pricing concerns at the storage layer HyTime activity policy constructs are used. These constructs state that certain types of activities which occur for a referenced document component should be monitored in a certain way. The type of HyTime-defined activity that is of concern here is access. The HyTime construct involved is the actrule (Activity Policy Association Rule). This construct specifies a certain process to perform when a certain type of activity occurs on a referenced document object. The process to perform is specified by referencing the section of SGML code that defines the process. How such a process is defined falls outside the scope of HyTime. For the Mondrian document, an activity policy could associate the charging of a fee with the accessing of a painting image or song recording. The activity type, such as "access", is defined by HyTime. Potential means of referencing the document object and the process to perform when it is accessed are defined by both SGML and HyTime constructs. How a segment of document code specifies the process to perform is outside the scope of HyTime.

Berlage

Because many document sets can be expected to represent charging information for included media objects, the Berlage architecture includes a construct called charge to represent this type of information. Each Berlage charge construct is a document portion referenced by a HyTime activity rule to perform an activity when a document object is accessed. A charge construct specifies that some type of charge is to be applied for accessing that object. The Berlage charge amount (chargeamt) constructs states what the price is for the charge construct it is associated with. Berlage recognizes different circumstances under which charges for access can be applied, represented by the Berlage construct charge type (chargetype). The Berlage charge type of "presentation" applies for media object presentation.

SMIL

During hypermedia presentations that include priced media objects the user may with to know the resulting cost of activation for each available navigation choice. SMIL has no specific construct for representing this because it is too specific a concept to apply to hypermedia presentations in general. However, such information can be included as part of the presentation. One possible technique is to display a small segment of text stating a navigational choice's price next to the portion of the display that activates that choice.

DSSSL

Properties can be used by DSSSL code to address media object price issues in a manner similar to how they were used earlier to address presentation restriction issues. For a given media object, the value of its HyTime property policies can be asked for, which returns the list of policy specifications, or activity rules, that apply to that object. Each activity rule can have its Berlage charge type (chargetype) property value checked to see if the property has been defined and if its value is "presentation". Such activity rules can also have their Berlage charge amount (chargeamt) properties return the price of the media object's presentation.

When DSSSL code encounters priced media objects in this fashion, it can then generate the appropriate presentation portions. For example, when the display of SMIL navigational hyperlinks is being generated, a DSSSL style sheet can process the media objects shown in the destination of each hyperlink, add the amounts returned when the chargeamt property is applied to each and display that amount as text with the hyperlink starting area on the screen.

Price for Use of Hypermedia Structure During Transformation

Just like creators of media data, authors of the structure that encapsulates it also wish to be compensated for their work. The Berlage environment provides this by enabling prices to be assigned to portions of authored hypermedia structure, similar to how costs are applied to media content. While the mechanisms for referring to media content in SGML systems are simple, referring to portions of document structure is more complex. The primary concern for implementing the pricing of document structure in the Berlage environment has been with providing and processing this type of referencing.

While the Berlage environment assumes that users are charged for media objects during presentation runtime, it assumes that it is the generators of presentations that are charged for use of authored structure. As a result, these charges are applied at the time of the generation of the SMIL presentation code and not during its presentation to the final user. More specifically, charges for structure are applied during the DSSSL transformation that generates a SMIL presentation. No further structure-related charges are applied during the presentation of this SMIL code.

HyTime

The location address module provides a rich set of constructs for referencing portions of document content and structure. SGML constructs alone are typically enough to reference full media objects, as is done in addressing media objects for presentation pricing. Media objects are typically full files, and SGML alone can easily reference these. However, more complex means of reference are typically required for portions of document code that represent structure. The HyTime location address module constructs enable the type of referencing required to apply prices to document structure. The activity policy facilities apply to media object pricing in the same manner that they can be applied to structure pricing, except that with structure pricing the referencing done by the activity policy constructs uses HyTime location addressing rather than the simpler SGML referencing.

Berlage

The Berlage charge type "generation" specifies that the charge associated with the referenced document object is to be applied at generation time, not at presentation time. Typically, as described above, this referenced document object is some portion of SGML/HyTime/Berlage code that specifies the structure of the source document. The "generation" charge type is used in conjunction with the Berlage charge construct, described earlier.

DSSSL

The main difference between DSSSL code for pricing during transformation and during presentation is not in how source document information is accessed but in what is done with it when it is. DSSSL code can access prices that apply during generation in the same manner described earlier for the pricing of media objects in presentation, with the minor difference that the Berlage charge type property would be checked for a value of "generation" rather than "presentation". However, this price typically has no effect on the generated SMIL code, since it does not apply to the presentation. Instead, the DSSSL style sheet needs to recognized when priced source document structure has been used and track the accumulation of that price. At the end of a transformation, the style sheet would then output the price for use of document structure along with the generated presentation.

Broader Application of these Standards, Tools and Libraries

The constructs discussed and the example presented in this paper touch on only a few of the representational facilities of HyTime. The HyTime constructs and properties used in the example refer only to the pricing and display restrictions of hypermedia data and structure. Many other aspects of hypermedia structure could be represented and processes as well in the Berlage environment.

DSSSL has been mainly created for and applied to the transformation of text documents to page-based presentation. Earlier work discusses the use of DSSSL to address style issues that are particular to hypermedia [16]. The techniques discussed in this paper can be applied to implementing style sheets that address these issues following the principles described.

SMIL is only one of the possible output presentation formats for Berlage and similar environments. Berlage can, by using appropriate style sheets, output HTML for hypertext presentation. It can also output formats for print such as PostScript. Earlier work discusses how DSSSL can be used to transform HyTime documents to MHEG-5 presentations [14]. MHEG-5 [9] is a format which provides fewer adaptive and synchronization facilities than SMIL, offers a more visually complex navigational interface than SMIL and is designed for hypermedia presentations in minimal resource environments, such as set-top boxes that work with broadcast television.

Conclusion

This paper discussed certain electronic publishing issues as they apply to the storage of long-term large-scale hypermedia data and their transformation into final-form presentations. These issues are the pricing of individual media objects, the pricing of hypermedia structure, and user control of the pricing of a presentation derived from these data objects and structure. The Berlage environment was introduced, which is an application of existing non-proprietary standards and tools to store and display presentation-independent hypermedia data. Berlage demonstrates how the storage and presentation of distributed hypermedia can be readily implemented with the standards HyTime, DSSSL, and SMIL and the tools SP, Jade and GRiNS. Berlage's application of the standards and tools was illustrated with a simple example. The application of these issues using the Berlage environment and related standards was described.

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