The XMP Toolkit

Version 2.9

May 13, 2002

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1 Preface

1.1 About This Document

This Preface contains information about this document, describes its organization and the conventions used in the document, and where to go for additional information.

1.2 Audience

The audience for this document includes developers of applications who have licensed the XMP Toolkit.

1.3 Assumptions

This document assumes that you are familiar with the XMP specification, and that you are familiar with C++ and an appropriate development environment.

1.4 How This Document Is Organized

In addition to this preface, this document consists of the following chapters:

Chapter 2: The XMP Toolkit

Contains an overview of the XMP Toolkit, and a short section on implementation notes.

Chapter 3: MetaXAP

Describes the MetaXAP Class, which provides tools for reading, writing, and manipulating XMP metadata. MetaXAP is the primary interface to the XMP Toolkit.

Chapter 4: UtilityXAP

Describes the UtilityXAP class, a variety of special purpose utilities to simplify common uses of MetaXAP.

Appendix A: XMP Toolkit Exceptions

Lists the C++ exceptions that can be raised through the use of the XMP Toolkit member functions.

Appendix B: Runtime Flow of Control

Provides a detailed roadmap that follows the most important paths through the code.

Appendix C: XMP Toolkit Function List

Lists the XMP Toolkit functions along with a brief description of what each one does.

1.5 Conventions used in this Document

The following type styles are used for specific types of text:

Typeface Style	Used for:
Serifed Roman Italic Caps	Values. For example, *TRUE*, *NULL*, etc.
Sans serif bold	XMP property names. (Always prefaced with "xap" and a single colon. For example: **xap:MetadataDate**.
`Monospaced Regular`	All C++ Code, function parameters, file names, etc.
`Monospaced Bold`	Member function names in text

1.6 Where to Go for More Information

The main reference to be used in conjunction with this document is *XMP – Extensible Metadata Platform*, which contains the specification of XMP schemas, properties, value types, and the interchange format.

In addition, the following Internet standard may be of use (a longer list of standards used in XMP is included in *XMP – Extensible Metadata Platform*):

IETF Standard for Language Element Values (RFC 1766):
http://www.ietf.org/rfc/rfc1766.txt?number=1766

2   The XMP Toolkit

2.1 Overview

This document describes the XMP Toolkit which was designed to help applications with handling XMP operations such as the creation and manipulation of metadata. The availability of the Toolkit makes it easier for developers to support XMP metadata, and helps to standardize how the data is represented and interchanged. The XMP Toolkit can be licensed, royalty-free, from Adobe Systems.

This chapter includes a brief overview of the key features of the Tookit and provides some basic implementation notes.

2.2 The XMP Toolkit

The XMP Toolkit features a C++ interface which uses some modern (ANSI) features, such as *exceptions*, *STL strings*, and *bool.* It uses conservative coding and interface design for maximum portability and to make it easier for applications to adopt.

NOTE: Many namespaces, keywords, and related names in this document are prefaced with the string "XAP", which was an early internal code name for XMP metadata. Because Acrobat 5.0 used those names, they were retained for compatibility purposes.

The XMP Toolkit consists of two parts:

● *MetaXAP* manages the metadata for a managed resource such as an application document file. It defines the objects that act as containers for properties relating to a specific document, and is the primary interface to the XMP Toolkit. MetaXAP provides the top level abstraction for metadata about a document. Nodes are accessed via string pathnames which use a simplified form of XPath strings (XML Path Language: http://www.w3.org/Tr/xpath)

● *UtilityXAP* provides a variety of special purpose utilities to simplify common uses of MetaXAP. For example, MetaXAP reads and writes property values as strings. UtilityXAP has services that include conversion to or from integers and other types.

XMP metadata properties are organized by schemas (see *The XMP Metadata Framework* for more information about XMP schemas). In RDF, the schema is defined by a namespace attribute. Within each schema, properties are named via a *path string*. This path string has a very simple syntax which is modelled on the XPath standard.

The full XMP data model is supported, including values that are simple literals, nested descriptions, and structured containers. Applications should include only the `XAPToolkit.h` file, and optionally the `UtilityXAP.h` file.

In addition, the following points apply to the XMP Toolkit:

- It uses STL <string> and <stdexcept>.

- Error conditions are handled with exceptions.

- The release version of the Toolkit will not call `exit()` or `abort()` (Debug configuration uses the `assert()` macro).

- All strings are UTF-8 encoded.

- Passing *NULL* as a parameter is a fatal error unless otherwise specified.

Also, the XMP Toolkit provides minimal thread safety, as follows: multiple threads accessing distinct objects are thread-safe (no globals), and multiple threads accessing the same shared object are thread-safe for read operations, including enumeration/iteration. If any thread wishes to do a write while there may be other threads doing reads, the client is expected to provide mutual exclusion. Also, certain globally static structures are not locked: the client is expected to provide mutual exclusion, as indicated in the descriptive text.

2.3 Implementation Notes

The following sections give an overview of how the Toolkit is put together. You should read this document in combination with the comments in various header files. Begin with the implementation notes in this chapter, and then progress to the introductory sections of the chapters on the MetaXAP and UtilityXAP classes. For a detailed view of how the XMP Toolkit works, see Appendix B, "Runtime Flow of Control."

2.3.1 Overview

The XMP Toolkit implements one main object, *MetaXAP. UtilityXAP* is a collection of static utility functions. Various smaller objects, such as *XAPClock* and *XAPPaths*, are used to support the main objects. They are described later in this document.

2.3.2 Construction and Destruction

Most clients start by constructing a MetaXAP object.

As explained in the `MetaXAP.h` header file, MetaXAP is a Handle class. The only member variable is the opaque `XAPTk_Data* m_data`. At construction time, a new XAPTk_Data object is created. See `XAPTkData.h` for its member variables, which are initialized on construction.

The MetaXAP constructor that takes a XAPClock creates an object capable of tracking changes to the metadata with timestamps.

The MetaXAP constructor that also takes a buffer of XML is a convenience. It is equivalent to calling the default constructor, and immediately calling **MetaXAP::parse**.

A MetaXAP object can be used without parsing. You just create properties in it with **MetaXAP::set** and **MetaXAP::createFirstItem**. However, most objects will be filled up by parsing XML. This is done with the **MetaXAP::parse** function.

Copy construction for MetaXAP is prohibited. Instead, a **Clone** static function is provided. These objects manage large and complex data structures; making unintentional copy construction very expensive, which is why they are prohibited.

Destruction deletes the XAPTk_Data object, which in turn deletes all of the memory allocated for its member variables.

2.3.3 Memory Management

Any non-const data structure returned to the client is a copy. It is up to the client to free it. Const structures are owned by the XMP Toolkit.

When strings and other data structures are output parameters for functions, they are specified as non-const reference variables. This guarantees that storage control remains with the client. Direct return of objects is avoided in order to avoid unintended copy construction.

2.3.4 Style and Conventions

The following is an unordered list of items that will help you understand and navigate through the code.

Naming Styles

Table 2.1, "Naming Styles used in the XMP Toolkit" lists the naming styles used for the XMP Toolkit.

TABLE 2.1 Naming Styles used in the XMP Toolkit

Item	Naming Style
Types	`TitleCase`, sometimes with: `Prefix_Underbar`
Module Functions	`TitleCase`
Class Static Functions	`TitleCase (ClassName::TitleCase)`
Member Functions	`initialLowerMixedCase`
Public Enum Members	`xap_all_lower_case_with_underbars`
Private Enum Members	`initialLowerMixedCase`

Names Of Constants And Types

Public types, particularly *enums*, begin with "XAP" with no underbar. Examples are `XAPFeatures` and `XAPStructContainerType`. Most are defined in `XAPDefs.h`, though a few are defined in the class header file that they are most closely associated with.

Public constants, such as namespace names, begin with "XAP″". For example, `XAP_NS_XAP`. These are also defined in `XAPDefs.h`.

Public enum members begin with "xap_". For example, `xap_bag`.

Package constants begin with "XAPTK_". Most are defined in `XAPTkdefs.h`. For example: `XAPTK_ATTR_XML_LANG`.

Names Of Exceptions

With the exception of `xap_no_match`, all exceptions begin "xap_bad" and are derived from either `xap_error` (same sense as the Java Error class), or `xap_client_fault` (same sense as the Java Exception class). See `XAPExcept.h`.

XAPTk_ Composite Types, Module Symbols

The header file `XAPObjWrapper.h` contains data-structure typedefs built up from STL building blocks. The naming convention for these, are as follows:

TABLE 2.2   *Typedef Naming Convention*

STL	Name Pattern	Example
std::map	XAPTk_{Foo}By{Bar}	XAPTk_StringByString
std::vector	XAPTk_VectorOf{Foo}	XAPTk_VectorOfString
std::pair	XAPTk_PairOf{Foo}	XAPTk_PairOfString
std::stack	XAPTk_StackOf{Foo}	XAPTk_StackOfString

Where {Foo} and {Bar} are one of the abbreviations (that is, either the "String" or "Pair") in the second column in the following table:

Expression	Abbreviation
std::string	String
std::pair	Pair

There are also some types in the `XAPTk::namespace` that are more implementation specific. In these cases {Foo} or {Bar} describe the intended usage, rather than the base type, for example:

    XAPTk::VectorOfProps

    XAPTk::StackOfNSDefs

The name of a class is used as a prefix for *package* global functions. For example, `MetaXAP_CollectAliases` is a global function defined in `MetaXAP.cpp`.

On the other hand, when {class}_ is used as a prefix for variables, it means they are module static (private). For example, `MetaXAP_nsMap` is a static module function of `MetaXAP.cpp`.

As described above, `XAPTk_` was used prior to the introduction of the `XAPTk::namespace`.

3   **MetaXAP**

3.1 MetaXAP Overview

This section describes the MetaXAP Class of the XMP Toolkit, which is used to read, write, and manipulate XMP metadata embedded in, or associated with, managed resources.

3.2 Introduction

MetaXAP is a container class equivalent to the <RDF>...</RDF> element.

A single instance of the MetaXAP class represents the metadata about one resource (application file). A MetaXAP object contains the internal tree representation of a parsed XML stream of XMP metadata. The nodes of this tree are accessed through namespace and pathname strings. Input and output is based on a very simple cross-platform buffer-stream mechanism. Basically, you construct MetaXAP with a buffer of XML, you do read/writes on the in-memory model, and then you get a buffer of potentially modified XML back.

MetaXAP enables clients to:

- define namespaces
- get and set property values and attributes
- parse existing RDF metadata
- serialize a MetaXAP object to RDF
- enumerate all of the properties, associated with a resource, by schema, or all properties at and below a specified partial path

MetaXAP also provides a static set of known schema namespace names (see Table 3.4, "Schema Namespace Constants") which are provided as constants. When specifying a property name, you can specify a namespace prefix only when a nested property is defined in a namespace other than the parent property. This can happen when a property has a structured value.

Figure 3.1 shows a diagram of a MetaXAP tree. Properties are organized by schema name. Each property can be accessed with a path string, as described below.

FIGURE 3.1   *MetaXAP Tree Diagram*
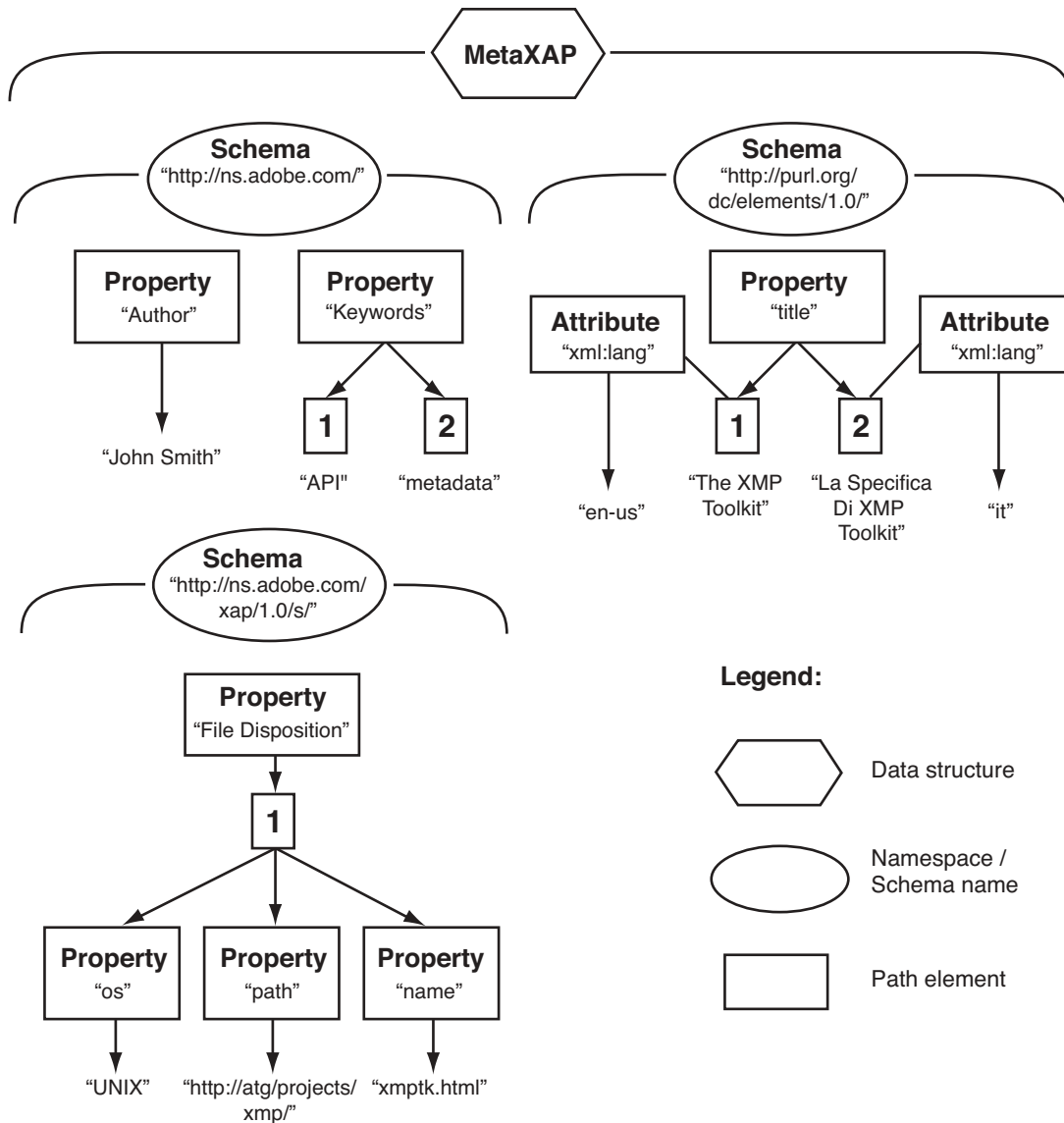
3.3 Path Composition

The MetaXAP object contains one or more trees that represent the metadata properties. Any value (leaf node) can be directly accessed by composing a path to the value using a string

notation. Containers and attributes may also be addressed with these path strings.

The path notation is modelled on the XPath standard, but uses a very narrow subset of the standard. This means that paths that are valid for MetaXAP are also valid in a general XPath implementation. The converse is not true: general XPath expressions are *not* necessarily valid paths for MetaXAP.

The paths specified to the MetaXAP object are all relative to an implicit document root. The path for the Name property is "`Name`", not "`/Name`".

The paths are not literal paths that match the RDF representation exactly. For one thing, there are multiple RDF serializations which generate the same abstract tree. Paths are normalized to the simplified representation exemplified by the diagram above. When in doubt, use paths that are returned by the enumerate functions.

The most obvious consequence of this is that when referring to structured containers, the actual element that represents each item, `rdf:li`, is elided. This means that all items of a container are referred to with a wild card in place of the `rdf:li` item, e.g., "`title/*[1]`", is the first title alternative.

Here are some examples which are based on the diagram in Figure 3.1.

The paths to all of the values (leaf nodes) associated with the "http://ns.adobe.com/xap/1.0/" namespace (`XAP_NS_XAP`), and the values as returned are:

Path	Value
`Author`	John Smith
`Keywords/*[1]`	API
`Keywords/*[2]`	metadata

The paths to all of the values (leaf nodes) associated with the "http://purl.org/dc/elements/1.0/" namespace (`XAP_NS_DC`), and their values, are:

Path	Value
`title/*[@xml:lang='en-us']`	The XMP Toolkit Specification
`title/*[@xml:lang='it']`	La Specifica Di XMP Toolkit

For containers, you may use the "`last()`" function to specify the last item in the container, whatever it may be. So, for example, the Italian alternative of the title can be found at "`title/*[last()]`".

Also, you can use ordinal numbers to select items in a container. The first item is "1". Thus, the English version of the title can be accessed with the path "`title/*[1]`".

The paths to all of the values (leaf nodes) associated with the "http://ns.adobe.com/xap/1.0/s/" namespace (`XAP_NS_XAP_S`), and their values, are:

Path	Value
`FileDisposition/*[1]/os`	URL
`FileDisposition/*[1]/path`	http://atg/projects/xmp/
`FileDisposition/*[1]/name`	xapi.html

In most cases, the path is specified all the way to a leaf node, but in some cases, it is useful to specify an intermediate node, such as for the count method below. Simply compose the path to the name of the node, and use the appropriate count terminator ('*' for element children). For example, to count the number of items that the title container has, pass the "title/*" path.

3.3.1 XPath Syntax

A MetaXAP object contains an XML tree. Any node can be accessed by composing a path to the node. These paths can be simply encoded in a string. You cannot use a fully general XPath in the XMP Toolkit. You must use paths that conform to the very narrow subset specified below.

The path notation is modelled on the XPath standard, but uses a very narrow subset of the standard. This means that paths that are valid for MetaXAP are also valid in a general XPath implementation. The converse is not true: general XPath expressions are *not* necessarily valid paths for MetaXAP.

The following is a complete BNF of the XMP path composition grammar:

```
path     ::= propPath | attrPath
attrPath ::= propPath '/' attr
propPath ::= name | propPath '/' expr
Qname    ::= name | name ':' name
expr     ::= QName | '*[' pred ']'
pred     ::= ordinal | 'last()' | QName '=' literal | attr '=' literal
attr     ::= '@' QName
```

No productions are given for name, literal, or ordinal. The only allowed attribute name is "xml:lang". An ordinal is any positive, non-zero decimal integer. A `name` is a non-qualified name (NCName) from the XML namespace grammar. Basically, a name consists of a letter or underscore followed by zero or more letters, digits, underscores, hyphens, or periods (for more details, see http://www.w3.org/TR/REC-xml-names).

A literal is a normal XML quoted string; that is it is surrounded with quotes (") or apostrophes (') and does not contain the quoting character. If it is necessary to use a quote or apostrophe in a literal, use the HTML character entity names "`"`" or "`'`", respectively (that is, using character entities as escaped versions of those characters).

There are implied prefixes and functions to the path . The implied prefix is derived from the context of the tree. Paths are always relative to that context, and begin with a child of the document node. The implied function for element and attribute leaf nodes is "`text()`", which matches all text node children of the current context node (as specified in the full XPath grammar, but not in this subset). See the member function descriptions and derived classes for additional context implications.

Here is an example of a simple RDF tree that we'll use to illustrate the syntax:

```
<rdf:RDF xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#'>
    <rdf:Description about='' xmlns:ex='http://ns.adobe.com/ex/0.0/'>
        <ex:simple>0</ex:simple>
        <ex:struct rdf:parseType='Resource'>
            <ex:a>1</ex:a>
            <ex:b>2</ex:b>
        </ex:struct>
        <ex:set>
            <rdf:Bag>
                <rdf:li rdf:parseType='Resource'>
                    <ex:a>3</ex:a>
                    <ex:b>4</ex:b>
                </rdf:li>
                <rdf:li rdf:parseType='Resource'>
                    <ex:a>5</ex:a>
                    <ex:b>6</ex:b>
                </rdf:li>
            </rdf:Bag>
        </ex:set>
        <ex:text xml:lang='en'>English text.</ex:text>
        <ex:one-of>
            <rdf:Alt>
                <rdf:li xml:lang='en-us'>trunk</rdf:li>
                <rdf:li xml:lang='en-gb'>boot</rdf:li>
            </rdf:Alt>
        </ex:one-of>
    </rdf:Description>
</rdf:RDF>
```

The paths to all of the leaf nodes in the RDF example given above, are shown in Table 3.1.

TABLE 3.1 Path Examples

Path	Value
simple	0

Path	Value
`struct/a`	1
`struct/b`	2
`set/*[1]/a`	3
`set/*[1]/b`	4
`set/*[2]/a`	5
`set/*[2]/b`	6
`text/@xml:lang`	en
`text`	English text
`one-of/*[@xml:lang='en-us']`	trunk
`one-of/*[@xml:lang='en-gb']`	boot

3.4 Property Value Features

Table 3.2 lists the features that modify the getting and setting of property values.

TABLE 3.2 *Property Value Feature Bits.*

Feature Bit	Meaning
`XAP_FEATURE_NONE`	No features, value is literal text.
`XAP_FEATURE_XML`	Value should be interpreted as XML. Example, "`<DOC>Text</DOC>`". When setting the property, your raw XML is converted by MetaXAP into literal text, with appropriate character entities for parsing characters. The property is stored using an rdf:value, and qualified with `iX:is`, whose value is "XML".
`XAP_FEATURE_RDF_RESOURCE`	Value is a URI stored as an `rdf:resource`.
`XAP_FEATURE_RDF_VALUE`	Value is stored with an rdf:value. This bit is not set for `XAP_FEATURE_XML`, even though it uses `rdf:value`.

All features bits are mutually exclusive except that `XAP_RDF_RESOURCE` can be combined with `XAP_RDF_VALUE`.

3.5 Standard Attributes

Only one standard attribute is supported, the `xml:lang` attribute.

Attribute	Usage
`xml:lang`	Special "xml:" namespace. Specifies the language/locale of the value. Uses RFC 1766 language codes.

3.6 MetaXAP Class

XMP metadata is a document-ordered collection of RDF description objects. These description objects are parsed and normalized. Properties in the description objects are organized by their schema name.

3.6.1 Storage Management

MetaXAP uses standard `<malloc.h>` and `<new>` allocators. These allocators may be overridden at XMP Toolkit compile time by defining the `XAP_CUSTOM_ALLOC` definitions, and providing an implementation *xap_custom_alloc.h* file. See *XAPTkAlloc.h* for more details.

All data passed to MetaXAP is copied. All data returned from MetaXAP is a copy that the client is responsible for freeing. When the MetaXAP class is destroyed, all of its internally allocated memory is freed.

In order to allow for flexible implementation of internal storage management, clients should know the following:

● MetaXAP to MetaXAP assignment is prohibited.

● The MetaXAP copy constructor is prohibited.

3.7 Important Types Used In MetaXAP

XAPDateTime

```
typedef struct {
    short sec;          // seconds after the minute - [0,59]
    short min;          // minutes after the hour - [0,59]
    short hour;         // hours since midnight - [0,23]
    short mday;         // day of the month - [1,31]
    short month;        // month of the year - [1,12]
    short year;         // years since 1900 (can be negative!)
    short tzHour;       // hours +ahead/-behind UTC - [-12,12]
    short tzMin;        // minutes offset of UTC - [0,59]
    long nano;          // nanoseconds after second (if supported)
    long seq;           // sequence number (if nano not supported)
} XAPDateTime;
```

This structure is used to represent dates and times from metadata, and timestamps for media management and metadata merging. If the system clock used for time is capable of sub-second resolution, the `nano` field can be used to represent the sub-second value. If the system clock is not capable of sub-second resolution, the `seq` field should be used to guarantee unique timestamps. If *seq* is zero, the *nano* field contains a valid sub-second value. See **MetaXAP::XAPClock** below.

MetaXAP::XAPClock

```
class XAPClock {
public:
  virtual void
  timestamp ( XAPDateTime& dt ) = 0;
protected:
  virtual ~XAPClock() {};
};
```

Description

Clients provide the clock used for creating timestamps. MetaXAP will never try to delete a XAPClock object.

Even though the `XAPDateTime` data structure includes time zone information, XAPClock should only generate GMT (UTC) timestamps. Code that uses **MetaXAP::XAPClock** will check to make sure that the `tzHour` and `tzMin` fields are zero. If either is not, a `xap_bad_number` exception will be thrown.

The *seq* field of `XAPDateTime` allows flexible implementation of the timestamp function. Consider an implementation based on a system clock that only guarantees time resolution to the second. Since it is likely that metadata changes will happen in far less than a second, an implementation like the following could be used:

```
class MyXAPClock : public XAPClock {
public:
    long m_seq;              // Internal counter
    struct tm m_last;        // Last timestamp
    ...
    virtual void
    timestamp ( XAPDateTime& dt ) {
        struct tm now = sysclock(); // 1-second resolution
        if (/* ... now == m_last ... */) {
            dt.seq = ++m_seq;
        } else {
            m_last = now;
            m_seq = 1;
        }
        /* ... convert now to XAPDateTime, and assign to dt ... */
        dt.seq = m_seq;
        dt.nano = 0; // We are using seq
    }
};
```

Note that the *seq* field is initialized to 1. The value 0 for *seq* is reserved to indicate that the *nano* field should be used instead. If *seq* is non-zero, `nano` should be set to 0.

If the system clock has better than second resolution, to the extent that consecutive calls to timestamp will never result in the same time, the *nano* field can be set to the sub-second value instead, and *seq* should be set to 0.

MetaXAP::XAPChangeBits

```
typedef long int XAPChangeBits;
```

Description

Each timestamp record includes an indication of how the property was last changed. Only one bit is set for any given record, except that `XAP_CHANGE_SUSPECT` may also be set for any record. This means that only the most recent change is ever recorded. Each bit is described in Table 3.3.

TABLE 3.3 XAP Change Bits

Change Bit	Meaning
XAP_CHANGE_NONE	No change bits are set.
XAP_CHANGE_CREATED	Property was created (defined).
XAP_CHANGE_SET	Property value was set.
XAP_CHANGE_REMOVED	Property was removed (undefined)
XAP_CHANGE_FORCED	The timestamp for this property was forced to a specified value.
XAP_CHANGE_SUSPECT	There is reason to believe that the timestamp record is invalid.

3.7.1 Namespace Constants

Use these namespace constants for the specified schema descriptions.

TABLE 3.4 Schema Namespace Constants

Constant	Schema Description
XAP_NS_XAP	XMP Core Schema
XAP_NS_XAP_G	XMP Graphics
XAP_NS_XAP_G_IMG	XMP Graphics: Image
XAP_NS_XAP_DYN	XMP Dynamic Media
XAP_NS_XAP_DYN_A	XMP Dynamic Media: Audio
XAP_NS_XAP_DYN_V	XMP Dynamic Media: Video
XAP_NS_XAP_T	XMP Text
XAP_NS_XAP_T_PG	XMP Text: Paged Text
XAP_NS_XAP_RIGHTS	XMP Rights Management
XAP_NS_XAP_MM	XMP Media Management
XAP_NS_XAP_S	XMP Support
XAP_NS_XAP_BJ	XMP Basic Job Ticket
XAP_NS_PDF	Adobe PDF

Constant	Schema Description
`XAP_NS_USER`	XMP User Defined
`XAP_NS_DC`	Dublin Core
`XAP_NS_RDF`	RDF

3.8 MetaXAP Member Functions

public default constructor

```
MetaXAP ();
```

Description

Creates an empty object with no clock.

public construct empty with clock

```
MetaXAP ( XAPClock* clock );
```

Description

Creates an empty object with a clock. If the `XAP_OPTION_AUTO_TRACK` option is enabled, timestamps will be kept per-property for all changes, and the **xap:MetadataDate** will be set to the last modified time of any change.

Exceptions

```
bad_alloc, xap_bad_number
```

The clock must not be NULL. This constructor will test the clock implementation to make sure it generates GMT (UTC) time (the timezone fields $tzHour$ and $tzMin$ must both be zero). If this test fails, this constructor will throw a `xap_bad_number` exception.

public construct from buffer

```
MetaXAP ( const char*      xmlbuf,
          const long int   len,
          const long int   opt = XAP_OPTION_DEFAULT,
          XAPClock*        clock = NULL );
```

Description

Constructs a populated MetaXAP from a single buffer of raw XML. The buffer is fed into an XML parser, and the MetaXAP is populated with sub-objects. If there are multiple buffers, use the default constructor instead and call **parse**.

The specified options `opt` are enabled immediately after the empty MetaXAP instance is created. This is particularly useful for enabling auto-tracking to capture creation dates for properties as they are parsed (assuming they don't already have timestamps).

If `clock` is *NULL*, no automatic tracking is done. Either the client does it manually with the get/set timestamp functions (listed below), or no timestamps are generated for this metadata.

MetaXAP destructor

```
virtual ~MetaXAP ();
```

Description

Destroy this object and all internally allocated memory.

MetaXAP::append

```
typedef long int XAPFeatures;
virtual void
append ( const std::string&   ns,
         const std::string&   path,
         const std::string&   value,
         const bool           inFront = false,
         const XAPFeatures     f = XAP_FEATURE_DEFAULT );
```

Description

Creates a new property with the specified `value`, and adds it next to the property specified by namespace `ns` and `path`. The path must specify a property in a structured container. The `inFront` parameter says whether to place the new value before or after the named position. To add a property to the end of a container, use the "`last()`" specifier, for example, "`title/*[last()]`." To add a property or attribute to the beginning of a container or list of attributes, use the pattern "`*[1]`" in the path and pass *TRUE* for `inFront`.

The **append** function is not supported for attributes.

Examples

```
m.append ( XAP_NS_XAP, "FileDisposition/*[last()]/os", "URL" );
m.append ( XAP_NS_XAP, "title/*[1]", "First Title", true );
```

All properties related to the specified property by alias or actual value that are also containers are appended as well (see **MetaXAP::SetAlias**). For example, suppose *Car* is an alias of *Vehicle*, and *Auto* is an alias of *Vehicle*. If any of *Car*, *Auto*, or *Vehicle* is appended, all that are containers are appended as well.

Exceptions

```
bad_alloc, xap_bad_path, xap_bad_type, xap_bad_number,
xap_bad_schema
```

Throws exceptions for syntactically invalid paths, and for attempting to append to a property that is not a structured container. Throws xap_bad_number if the specified ordinal is beyond "last()". Throws xap_bad_schema if ns is not registered or invalid.

MetaXAP::count

```
virtual size_t
count ( const std::string&   ns,
        const std::string&   path ) const;
```

Description

Returns the number of items in the structured container specified by ns and path.

Example

```
size_t n = m.count ( XAP_NS_DC, "title/*" );  // number of language alts
```

Exceptions

```
bad_alloc, xap_bad_path, xap_bad_schema
```

Throws xap_bad_path for syntactically invalid paths, or if the path does not end with "*". Throws xap_bad_schema if ns is not registered or invalid.

MetaXAP::createFirstItem

There are two variations:

Variation #1:

```
typedef long int XAPFeatures;
virtual void
createFirstItem ( const std::string&          ns,
                  const std::string&          path,
                  const std::string&          value,
                  const XAPStructContainerType type = xap_bag,
                  const XAPFeatures            f = XAP_FEATURE_DEFAULT );
```

Description

Creates a structured container of the specified type, and set the `value` of the first item at the end of the specified `path`, with the optionally specified features. Nodes are created as needed to ensure that the path is complete. See next variation for examples and exceptions.

Variation #2:

```
virtual void
createFirstItem ( const std::string&    ns,
                  const std::string&  path,
                  const std::string&  value,
                  const std::string&  selectorName,
                  const std::string&  selectorVal,
                  const bool          isAttr = true,
                  const XAPFeatures   f = XAP_FEATURE_DEFAULT );
```

Description

Creates a structured container of the type `xap_alt`, and set the value of the first item at the end of the specified `path`, with the specified `selectorName` and `selectorVal` as the selector of the alternation, and optional features. Expressed as an XPath predicate, the selector would be `[@selectorName='selectorVal']` if the `isAttr` is *TRUE*, otherwise it would be "`[selectorName='selectorVal']`" and `value` is ignored (just pass `selectorValue` or ""). Nodes are created as needed to ensure that the path is complete.

All properties related to the specified property by alias or actual value that are also containers are created as well (see **MetaXAP::SetAlias**). For example, suppose *Car* is an alias of *Vehicle*, and *Auto* is an alias of *Vehicle*. If any of *Car*, *Auto*, or *Vehicle* does not exist and is a container type, each is created (nothing happens to any that do exist, or are not containers).

Examples

```
//Create the first keyword
m.createFirstItem ( XAP_NS_XAP, "Keywords", "big" );

//Create the first Title, selected by xml:lang of en-us
//The path to get this item would be "Title/*[@xml:lang='en-us']"
m.createFirstItem (
    XAP_NS_XAP, "Title", "Your Photo", "xml:lang", "en-us" );

//Create the first FileDisposition, selected by sub-prop os of UNIX
//The path to get this item would be "FileDisposition/*[os='UNIX']"
m.createFirstItem (
    XAP_NS_XAP_S, "FileDisposition", "", "os", "UNIX", false );
```

Exceptions

```
bad_alloc, xap_bad_path, xap_bad_type, xap_bad_schema
```

Throws `xap_bad_path` for syntactically invalid paths and for a path that leads to a property that is already defined. Use **MetaXAP::append** to add additional items to the container. Throws `xap_bad_schema` if ns is not registered or invalid. Throws `xap_bad_type` if not a container.

MetaXAP::enable

```
typedef long int Options;
virtual void
enable ( const Options  opt,
         const bool     en ) throw ();
```

Description

Enables or disables the specified option(s), such as XAP_OPTION_DEBUG. Unrecognized options are ignored.

The options are defined in Table 3.5, "Option Enable Constants."

TABLE 3.5   Option Enable Constants

Option	When option is enabled
XAP_OPTION_NONE	No options.
XAP_OPTION_DEFAULT	Default options in force.
XAP_OPTION_ALIASING_ON	Alias mapping occurs during property get, set, etc., (see **MetaXAP::SetAlias**). If disabled, property *get*, *set*, etc., occurs on the specified property only. Enabled by default.
XAP_OPTION_ALIAS_OUTPUT	If enabled, all forms of aliased properties are written when serializing. Otherwise only the base form of each alias set is written. Disabled by default.
XAP_OPTION_AUTO_TRACK	When constructed with a XAPClock object, automatically modify **xap:** metadata properties for media management that pertain to this metadata instance. For example, calls to **set** will cause the **xap:MetadataDate** and per-property timestamps to be updated. See setup below. Enabled by default.
XAP_OPTION_DEBUG	Pre- and post-condition checking and other assertions are activated for the debug version of the Toolkit only. Disabled by default.
XAP_OPTION_XAPMETA_ONLY	If enabled, the parser will only recognize RDF elements that are descendents of the tag "xapmeta" in XAP_NS_META namespace. If disabled, the parser will recognize all RDF elements, regardless of their location in the XML document. See parse for more details. Enabled by default.
XAP_OPTION_XAPMETA_OUTPUT	A xapmeta element in the XAP_NS_META namespace is written as the outermost XML element when serializing. Enabled by default.

Example

```
meta->enable ( XAP_OPTION_TAG_ONLY, false );
```

MetaXAP::enumerate

There are three variations:

Variation #1:

```
virtual XAPPaths*
enumerate ( const int depth = 0 );
```

Description

Returns a pointer to an object that enumerates properties in this MetaXAP object. Properties are listed in document order, or the order in which they were specified. Attributes are always listed before child properties. It is the responsibility of the caller to destroy the XAPPaths object. Changes to MetaXAP (calls to non-const member functions) are not reflected in the XAPPaths object.

The `depth` parameter limits the depth of the enumeration. If the value is 0 (default), paths to all leaf nodes are enumerated, regardless of the number of steps to each leaf. If the value is 1, only the paths with one step (no slash) are generated, which correspond to the top-level nodes of the tree. If the value is 2, paths that only have two steps (one slash) or less, and generally include the attributes of top-level nodes if any, and children of top-level nodes, if any. And so on.

Example

```
string ns, prop, val;
XAPFeatures f;

XAPPaths* p = m->enumerate();
while ( p->hasMorePaths() ) {
   p->nextPath ( ns, prop );
}
if ( m->get ( ns, prop, val, f ) ) {
   cout << prop << "=" << val << endl;
}
delete p;
delete m;
```

Exceptions

```
bad_alloc
```

Variation #2:

```
virtual XAPPaths*
enumerate ( const std::string&  ns,
            const std::string&  subPath,
            const int           steps = 0 );
```

Description

Returns a pointer to an object that enumerates all of the properties in the specified `subPath`. Children are listed in the order they are specified, and attributes are always listed before child properties. It is the responsibility of the caller to destroy the XAPPaths object. Changes to MetaXAP (calls to non-const member functions) are not reflected in the XAPPaths object. The steps parameter is described above.

Example

```
string ns, path, val;
XAPFeatures f;

XAPPaths* p = m->enumerate(XAP_NS_XAP, "TestCont");
while ( p->hasMorePaths() ) {
        p->nextPath ( ns, path );
        if ( m->get ( ns, prop, val, f ) ) {
        cout << prop << "=" << val << endl;
}
    delete p;
    delete m;
```

Exceptions

```
bad_alloc, xap_bad_path, xap_bad_schema
```

Throws `xap_bad_schema` if `ns` is invalid. Throws `xap_bad_path` if the path is invalid.

Variation #3:

```
typedef enum {
   xap_before,
   xap_at,
   xap_after,
   xap_noTime,
   xap_notDef
}  XAPTimeRelOp;

virtual XAPPaths*
enumerate ( const XAPTimeRelOp    op,
            const XAPDateTime&    dt,
            const XAPChangeBits   how = XAP_CHANGE_MASK );
```

Description

Returns a pointer to an object that enumerates all of the properties whose last modified timestamp has the relation to `dt` specified by `op`. For example, if `dt` has an earlier time than the timestamp for "Foo" (i.e., "Foo" is newer than whatever dt specifies), "Foo" would be

included in the enumeration if op is `xap_after`, and would not be included if the op is `xap_at` or `xap_before`. Returns *NULL* if there are no matches.

The op `xap_noTime` matches any property that does not have a timestamp. The op `xap_notDef` is ignored. The bits set in how act as a filter against which properties are included in the comparison with op. For example, to enumerate only those properties that have been removed since dt:

```
... = meta->enumerate ( xap_after, dt, XAP_CHANGE_REMOVED );
```

Exceptions

```
bad_alloc
```

MetaXAP::extractSerialization

```
virtual size_t
extractSerialization ( char*   buf,
                       const   size_t nmax );
```

Call **extractSerialization** to incrementally extract the contents of the string saved by a preceding call to serialize. You specify the size of your buffer with parameter nmax. The function returns the number of bytes (char) that were actually copied. When the function returns 0, the extraction is complete and the private string is emptied. Subsequent calls to **extractSerialization** will result in no copies and a return value of 0, until **serialize** is called again.

Example

```
const int bufMetaMax = 1024;
char bufMeta[max];
(void) = meta->serialize ( xap_format_pretty, 0 );
while (true) {
    if ( size == 0 ) break;
    szz = meta->extractSerialization ( bufMeta, bufMetaMax - 1 );
    cout->write ( bufMeta, szz );
}
```

MetaXAP::get

```
typedef long int XAPFeatures;
virtual bool
get ( const std::string&  ns,
      const std::string&  path,
      std::string&        val,
      XAPFeatures&        f ) const;
```

Description

Gets the value at the property specified by ns and path as a string. If any node along the path does not exist, **get** returns *FALSE*, otherwise it returns *TRUE* and the string value is copied into val. The features of the string value, such as whether or not XML markup is preserved, are copied into f.

Example

```
bool is;
XAPFeatures f;
std::string v;
is = m.get ( XAP_NS_XAP, "Nickname", v, f );
is = m.get ( XAP_NS_DC, "title/*[@xml:lang='it']", v, f );
```

Exceptions

```
bad_alloc, xap_bad_path, xap_no_match, xap_bad_schema
```

Throws exceptions for syntactically invalid paths, and paths that do not match any property (such as trying to get item 5 from an existing simple value). Throws xap_bad_schema if ns is not registered or invalid.

MetaXAP::getContainerType

```
typedef enum {
   xap_alt,
   xap_bag,
   xap_seq,
   xap_sct_unknown
}  XAPStructContainerType;

virtual XAPStructContainerType
getContainerType (const std::string&  ns,
                  const std::string&  path ) const;
```

Description

Returns the type of the specified container. The `path` must specify a container type (**MetaXAP::getForm** must return `xap_container`).

Examples

```
XAPStructContainerType t =
   m.getContainerType ( XAP_NS_XAP, "FileDisposition" );
```

Exceptions

bad_alloc, xap_bad_path, xap_no_match, xap_bad_schema

Throws `xap_bad_schema` if `ns` is not registered or invalid. Throws `xap_bad_path` if the path is invalid. Throws `xap_no_match` if the `path` is syntactically valid, but does not match any defined property.

MetaXAP::getForm

```
typedef enum {
   xap_simple,
   xap_description,
   xap_container,
   xap_unknown
}  XAPValForm;

virtual XAPValForm
getForm ( const std::string&  ns,
          const std::string&  path ) const;
```

Description

Returns the type of property specified by `ns` and `path`, as shown below in Table 3.6.

TABLE 3.6   Property Type Values

XAPValForm	Meaning
xap_simple	Path to a simple value.
xap_description	Path to a nested description objects. Contains other properties as children.
xap_container	Path to a structured container. See **MetaXAP::getContainerType**.
xap_unknown	Unknown value type (treat as xap_simple with parseType="Literal").

Example

```
XAPValForm vt = m.getForm ( XAP_NS_XAP, "FileDisposition" );
```

Exceptions

```
bad_alloc, xap_bad_path, xap_no_match, xap_bad_schema
```

Throws xap_bad_schema if ns is not registered or invalid. Throws xap_bad_path if the path is invalid. Throws xap_no_match if the path is syntactically valid, but does not match any defined property.

MetaXAP::getResourceRef

```
virtual void
getResourceRef ( std::string& resRef ) const;
```

Description

Returns the reference (URI) for the resource that this MetaXAP is about. Returns the empty string "" if the description is embedded in the resource itself.

Exceptions

```
bad_alloc
```

MetaXAP::getTimestamp

```
virtual bool
getTimestamp ( const std::string&   ns,
               const std::string&   path,
               XAPDateTime&         dt,
               XAPChangeBits&       how ) const;
```

Description

Returns *FALSE* if the property specified by `ns` and `path` is not defined. Otherwise, returns *TRUE*, and copies the timestamp value into `dt`. The bits in `how` are set according to how the property was changed. If there is no timestamp record for this property, `how` is set to `XAP_CHANGE_NONE`.

Example

```
XAPDateTime dt;
XAPChangeBits how;
MetaXAP* meta = new MetaXAP();
bool Ok = meta->getTimestamp (
    XAP_NS_XAP_G_IMG, "Dimensions/stDim:w",dt, how );
```

Exceptions

```
bad_alloc, xap_bad_path, xap_bad_schema, xap_no_match
```

Throws exceptions for syntactically invalid paths. Throws `xap_bad_schema` if `ns` is not registered or invalid. Throws `xap_no_match` if `property` is not defined.

MetaXAP::isEnabled

```
virtual bool
isEnabled ( const Options opt) const throw ();
```

Description

Returns whether the specified option is enabled, such as `XAP_OPTION_DEBUG`. An unrecognized option always returns *FALSE*. Pass a single option bit.

MetaXAP::parse

```
virtual void
parse ( const char*   xmlbuf,
        const size_t  n,
        const bool    last = false );
```

Description

Parses a buffer of XML and creates the corresponding XMP objects. This function expects to be called in the order that buffers occur for a particular XML serialization. The last buffer is indicated by passing *TRUE* for `last`. It is legal for tokens, or even multibyte characters, to cross buffer boundaries.

Only one parsing cycle should be used per MetaXAP instance (a cycle is 0 or more calls to **parse** with `last==false`, 1 call to **parse** with `last==true`). Calling **parse** with `last==false` after calling it with `last==true` for the same MetaXAP instance will have unspecified results.

The **parse** function will handle any well-formed XML, and will detect RDF elements anywhere in the XML. If the `XAP_OPTION_XAPMETA_ONLY` option is enabled, only those RDF elements that are children of the "xapmeta" tag in the `XAP_NS_META` namespace are recognized as XMP metadata, all others are ignored. If the `XAP_OPTION_XAPMETA_ONLY` option is disabled, all RDF elements in the input are recognized as XMP metadata.

Calling any other functions in MetaXAP during a **parse** will yield undefined results.

Example

```
const int bufMetaMax = 1024;
char bufMeta[bufMetaMax];
MetaXAP* meta = new MetaXAP();
ifstream* metaFs = new ifstream ( "metadata.xml",
    ios_base::in | ios_base::binary);
if ( !metaFs || metaFs->fail() ) exit(-1);

    try {
            while ( !metaFs->eof() ) {
                    metaFs->read ( bufMeta, nbufMetaMax
                    meta->parse ( bufMeta, metaFs->gcount() );
            }
            meta->parse ( "\n", 1, true ); // all done
    }
    catch ( xap_bad_xml& x ) {
            cerr << x.what() << "(" << x.getContext() << "):"
                << x.getLine() << endl;
            throw;
    }
```

Exceptions

```
bad_alloc, xap_bad_xml, xap_bad_xap
```

Throws `xap_bad_xml` if the XML is not well-formed (lexical error). Throws `xap_bad_xap` if the RDF is invalid (parsing error).

MetaXAP::purgeTimestamps

```
virtual void
purgeTimestamps ( const XAPChangeBits  how = XAP_CHANGE_REMOVED,
                  const XAPDateTime*  dt = NULL );
```

Description

Purges all timestamp records for properties with any `XAPChangeBits` set in `how`. By default, purges all timestamp records for properties marked `XAP_CHANGE_REMOVED`. If `dt` is not *NULL*, all timestamps that were not purged are forced to the specified timestamp, and their `XAPChangeBits` are set to `XAP_CHANGE_FORCED`. Thus, to force all timestamps to a specific time, pass `XAP_CHANGE_NONE` as the first parameter and a non-null date and time as the second parameter.

Example

```
XAPDateTime dt;
meta->purgeTimestamps ( XAP_CHANGE_REMOVED, &dt );
```

Exceptions

```
bad_alloc
```

MetaXAP::remove

```
virtual void
remove ( const std::string&  ns,
         const std::string&  subPath );
```

Description

Removes the specified property and all of its sub-properties, if any. When a child of a container is removed, all siblings that follow that item are renumbered. Nothing is done if there is no property for the specified path.

All properties related to the specified property by alias or actual value are removed as well (see **MetaXAP::SetAlias**). For example, suppose *Car* is an alias of *Vehicle*, and *Auto* is an alias of *Vehicle*. If any of *Car*, *Auto*, or *Vehicle* is removed, all are removed.

Examples

```
m.remove ( XAP_NS_DC, "title/*[1]" );
```

Throws an exception if the path is invalid, or the path matches none of the nodes.

Exceptions

```
xap_bad_path, xap_no_match, xap_bad_schema
```

Throws xap_bad_schema if ns is not registered or invalid.

MetaXAP::serialize

```
typedef enum {
   xap_format_pretty,
   xap_format_compact
}  XAPFormatType;

const int XAP_ESCAPE_CR = 1<<0;
const int XAP_ESCAPE_LF = 1<<1;

virtual size_t
serialize ( const XAPFormatType  f = xap_format_pretty,
            const int            escnl = 0 ) = 0;
```

Description

Serializes the MetaXAP tree as XML. Call `serialize` to perform serialization, optionally specifying a format and `escnl` for filtering linebreaks. The f option `xap_format_pretty` is pretty-printed for human readability, using whitespace and indenting. The f option `xap_format_compact` minimizes whitespace and uses the most compact representation possible. The serialized data is kept in a private string.

The `escnl` bits indicate whether line ending characters should be escaped into character refs, using the HTML character entity names "``" for *CR*, and "`
`" for *LF*. This allows a client to post-filter the XML to impose line-length limitations: the unescaped version of the line-break character can be inserted into the XML, since the XML is guaranteed not to contain that character unescaped, unless formatted pretty (see below). A processing instruction is added at the beginning to indicate that the filtering was applied. The processing instruction is omitted if escnl is 0. This instruction is detected by the **parse** function of this class, and the corresponding unescaped linebreak characters, if any, are removed before buffers are passed to the XML parser. If f is `xap_format_pretty`, lines are formatted with a linebreak character as follows: *CR* if escnl is `XAP_ESCAPE_LF` only, *LF* if escnl is `XAP_ESCAPE_CR` only, *CRLF* if both bits are set. Returns a value of 0 if there is no metadata, and a value greater than zero (>0) otherwise.

The serialized metadata does not include (does not begin with) the standard xml prolog <?xml ...?>. This makes it easier to embed the serialized metadata in an existing XML document entity, such as a WebDAV property. If you are writing this serialized XML as a document entity (e.g., into a standalone file), you should prepend an appropriate prolog, such as:

```
<?xml version="1.0" encoding="UTF-8"?>
```

If the XAP_OPTION_XAPMETA_OUTPUT option is enabled, the serialized output is contained within the single tag "xapmeta" in the XAP_NS_META namespace. If the XAP_OPTION_XAPMETA_OUTPUT option is disabled, the "xapmeta" tag is omitted. In either case, all of the metadata is contained within a single RDF element.

The serialized metadata is in UTF-8 Unicode character encoding.

Exceptions

```
bad_alloc
```

MetaXAP::set

```
typedef long int XAPFeatures;
virtual void
set ( const std::string&  ns,
      const std::string&  path,
      const std::string&  value,
      XAPFeatures         f = XAP_FEATURE_DEFAULT );
```

Description

Sets the specified value at the end of the specified path, with the optionally specified features. Nodes are created as needed to ensure that the path is complete, except for items of a structured container (see **MetaXAP::createFirstItem** above and xap_bad_number below). Existing values are overwritten.

Examples

```
m.set ( XAP_NS_XAP, "Author", "Your Name" );
m.set ( XAP_NS_XAP_G_IMG, "Dimensions/stDim:w", "480" );
```

All properties related to the specified property by alias or actual value are set as well (see **MetaXAP::SetAlias**). For example, suppose *Car* is an alias of *Vehicle*, and *Auto* is an alias of *Vehicle*. If any of *Car*, *Auto*, or *Vehicle* is set, all are set to the same value.

Exceptions

```
bad_alloc, xap_bad_path, xap_bad_type, xap_bad_number, xap_bad_schema
```

Throws exceptions for syntactically invalid paths, and for attempting to change the type of the property, e.g., if "title" is a structured container (an Alt of different languages), trying to set

title to a simple value will generate a xap_bad_type exception. Throws a xap_bad_number exception if an attempt is made to set a structured item beyond "last()". Use **MetaXAP::append** to add items to a container. Throws xap_bad_schema if ns is not registered or invalid.

MetaXAP::setTimestamp

```
virtual void
setTimestamp ( const std::string& ns,
               const std::string& path,
               const XAPDateTime& dt );
```

Description

This should only be used when manual tracking is being done by the client. Sets the timestamp to dt. The XAPChangeBits for this property are set to XAP_CHANGE_FORCED.

Example

```
  meta->setTimestamp ( XAP_NS_XAP_G_IMG, "Dimensions/stDim:w", dt );
```

Exceptions

```
   bad_alloc, xap_bad_path, xap_bad_schema, xap_no_match
```

The timestamp must be GMT (UTC) time (the timezone fields *tzHour* and *tzMin* must both be zero). If there is non-zero timezone information, the xap_bad_number exception will be thrown. Throws xap_bad_path for syntactically invalid paths. Throws xap_no_match for valid paths that have no defined property. Throws xap_bad_schema if ns is not registered or invalid.

MetaXAP::setup

```
virtual void
setup ( const char *const   key,
        const std::string&  val );
```

Description

Some properties require metadata that only the client of this Toolkit can provide, such as the name of the software agent using the Toolkit. Use this function to provide values to this instance of MetaXAP for automatic tracking.

Examples

```
m.setup ( XAP_SETUP_VENDOR, "Adobe" );
m.setup ( XAP_SETUP_APP, "Photoshop" );
m.setup ( XAP_SETUP_VERSION, "10.0" );
m.setup ( XAP_SETUP_PLATFORM, "Windows" );
```

These example calls would allow the Toolkit to create an *AgentName* of "Adobe Photoshop 10.0 for Windows".

Exceptions

```
bad_alloc
```

MetaXAP::setResourceRef

```
virtual void
setResourceRef ( const std::string&  ref );
```

Descripton

Sets the reference to the resource (URI) that this MetaXAP is about.

Example

```
meta->setResourceRef ( "test:/resource/'about'/" );
```

Exceptions

```
bad_alloc
```

3.9 MetaXAP Static Functions (Class Methods)

MetaXAP::Clone

```
static MetaXAP*
Clone ( MetaXAP* orig );
```

Description

Makes a deep-copy of the MetaXAP object `orig` and returns it. Copies timestamps without changing them, if any.

> **NOTE:** Multi-threaded clients must provide mutual exclusion.

Examples

```
MetaXAP* clone = MetaXAP::Clone(meta);
```

MetaXAP::EnumerateAliases

```
static XAPPaths*
EnumerateAliases () throw();
```

Description

Returns a pointer to an object that enumerates all of the aliases defined for all MetaXAP objects. It is the responsibility of the caller to destroy the XAPPaths object. Changes to aliases (calls to **MetaXAP::SetAlias**) are not reflected in the XAPPaths object.

> **NOTE:** Multi-threaded clients must provide mutual exclusion.

MetaXAP::GetAlias

```
static bool
GetAlias ( const std::string&      aliasNS,
           const std::string&      aliasPath,
           std::string&            actualNS,
           std::string&            actualPath,
           XAPStructContainerType& cType ) throw();
```

Description

Gets the alias for the specified path, if any. The first pair, `aliasNS` and `aliasProp`, specifies a namespace and path to the property whose actual value might be found elsewhere. If there is an alias defined, `actualNS` and `actualProp` are set to the namespace and path, respectively, of the actual property and *TRUE* is returned. Otherwise, *FALSE* is returned. The `cType` is also set to the container type of the actual path: if the value form is not a container, `cType` is set to `xap_sct_unknown`.

> **NOTE:** Multi-threaded clients must provide mutual exclusion.

Example

```
string nsActual, pActual;
string pActual;
XAPStructContainerType sct;
MetaXAP::GetAlias ( XAP_NS_XAP, "TestCont", nsActual, pActual, sct );
```

MetaXAP::Merge

```
typedef enum {
   xap_policy_a,
   xap_policy_b,
   xap_policy_newest,
   xap_policy_oldest,
   xap_policy_dont_merge,
   xap_policy_ask_user
} XAPMergePolicy;

static XAPPaths*
Merge ( MetaXAP*       a,
        MetaXAP*       b,
        MetaXAP**      merge,
        const          XAPMergePolicy policy,
        const bool     justCheck = false,
        XAPTimeRelOp*  dontMergeResult = NULL );
```

Description

If `justCheck` is *FALSE* and `policy` is not `xap_policy_dont_merge` nor
`xap_policy_ask_user`, this function creates a new MetaXAP object and returns the
pointer in `merge`, after merging the metadata in instance `a` with instance `b`, and copying the
resulting metadata into `merge`. Any properties defined in `a` but not in `b`, or in `b` but not in `a`,
are defined (copied) to merge. The corresponding timestamp record is also copied unchanged.
The policy specifies what the merge does when both `a` and `b` define a property, including cases
when one has the `XAP_CHANGE_REMOVED` bit set. The policy descriptions follow:

TABLE 3.7   Merge Policy Descriptions

Policy	Meaning
`xap_policy_dont_merge`	Just compare, see below.
`xap_policy_a`	The value in a is copied to merge.
`xap_policy_b`	The value in b is copied to merge.
`xap_policy_newest`	The latest timestamped value is copied to merge.
`xap_policy_oldest`	The earliest timestamped value is copied to merge.
`xap_policy_ask_user`	Same as `xap_policy_dont_merge`.

Any property with a `XAP_CHANGE_SUSPECT` bit set is ignored and no change is made to
merge for that property, regardless of whether the bit is set in `a` or `b`. Properties with no

timestamp are treated as if they had a timestamp equal to the value of **xap:MetadataDate**. If **xap:MetadataDate** is not defined, no change is made to merge for that property for `xap_policy_newest` or `xap_policy_oldest` only.

The returned paths represent those properties in merge that were changed as a result of the policy, or if `justCheck` is *TRUE*, the paths for the properties that would have been copied into merge if `justCheck` had been *FALSE*. Does not include properties copied to merge because they were defined in a but not in b, or vice versa. Returns *NULL* if nothing is copied to merge (merge is unchanged by the call).

For `xap_policy_dont_merge` and `xap_policy_ask_user`, no new MetaXAP object is created and merge is left unchanged. If `justCheck` is *FALSE*, the paths returned represent those properties that are defined in both a and b, but that do not have identical timestamps. If `justCheck` is *TRUE*, *NULL* is returned, and if `dontMergeResult` is non-*NULL*, it is set to the result of comparing the **xap:MetadataDate** of a and b (see **UtilityXAP::CompareTimestamps**).

Example

```
MetaXAP* mergedMeta = NULL;

// Merge letting newer values override older values.
XAPPaths* newer = MetaXAP::Merge(oldMeta, newMeta, &mergedMeta,
xap_policy_newest);

 MetaXAP* deltaMeta = NULL;

// Merge letting older values override newer values.
  XAPPaths* older = MetaXAP::Merge(oldMeta, newMeta, &deltaMeta,
xap_policy_oldest);
```

Exceptions

Raises all the same exceptions as **MetaXAP::enumerate**, **MetaXAP::set**, **MetaXAP::remove**, **MetaXAP::createFirstItem**, and **MetaXAP::setTimestamp**.

MetaXAP::RegisterNamespace

```
static void
RegisterNamespace (const std::string&   nsName,
                   const std::string&   suggestedPrefix );
```

Description

For serialization to XML, clients must provide a suggested prefix for each namespace that they use. The standard namespaces (those for which a constant string is defined in this API) already have registered prefixes. Register a namespace name (which should be a URI), and a suggested

prefix for composing qualified names. Omit the composition character (such as ":" for RDF) from the prefix. Setting or creating a property in a namespace that has not been registered will result in an exception.

> NOTE: Multi-threaded clients must provide mutual exclusion.

Example

```
MetaXAP::RegisterNamespace("http://purl.org/dc/qualifiers/1.0/", "dcq");
```

Exceptions

```
bad_alloc
```

MetaXAP::RemoveAlias

```
static void
RemoveAlias ( const std::string&  aliasNS,
              const std::string&  aliasPath );
```

Description

Removes the specified alias from the alias map for all metadata objects. This function does not change any metadata values. See the important *Note* in **MetaXAP::SetAlias**, which applies to **MetaXAP::RemoveAlias** as well.

MetaXAP::SetAlias

```
static void
SetAlias ( const std::string&            aliasNS,
           const std::string&            aliasPath,
           const std::string&            actualNS,
           const std::string&            actualPath,
           const XAPStructContainerType  cType = xap_sct_unknown );
```

Description

Adds to the alias map for all instances of MetaXAP. Matching aliases are overwritten, new aliases are appended. The alias is specified as two pairs of strings. The first pair, `aliasNS` and `aliasProp`, specifies a namespace and path to the property whose actual value is found elsewhere. The second pair, `actualNS` and `actualProp`, specifies a namespace and path to the property for the actual value. The `cType` specifies the container type, if the `actualPath` represents a container or container member.

Examples

```
/* "Author" and "Title" in the XMP core schema are aliases of
   "creator" and "title" in the Dublin Core schema. */

const char* XAP_NS_XAP = "http://ns.adobe.com/xap/1.0/";
const char* XAP_NS_DC = "http://purl.org/dc/elements/1.0/";

MetaXAP::SetAlias ( XAP_NS_XAP, "Author",
                    XAP_NS_DC, "creator/*[1]", xap_bag );
MetaXAP::SetAlias ( XAP_NS_XAP, "Title",
                    XAP_NS_DC, "title", xap_alt );
```

To determine which of two properties should be the alias, and which the actual, consider which will be used most frequently by the broadest cross-section of users. If one property happens to be from a broadly supported schema, such as Dublin Core, or if one property represents an important legacy metadata format, such as IPTC, use that property as the actual, and use the new or XMP defined property as the alias.

> **NOTE:** Changes to the alias map made by calls to **SetAlias** do not automatically take effect on existing MetaXAP instances. For this reason, it is strongly recommended that all aliases be set prior to any MetaXAP objects being created, and then once they are created, no new alias settings are made until all MetaXAP objects have been destroyed.

If this is not feasible, it is possible to force an existing MetaXAP object to recognize new alias settings. For all MetaXAP objects which have the XAP_OPTION_ALIAS_ON enabled, toggle the option: that is, disable it, and then enable it again, as follows:

```
MetaXAP* meta;
if ( meta->isEnabled ( XAP_OPTION_ALIAS_ON ) ) {
    meta->enable ( XAP_OPTION_ALIAS_ON, false );
    meta->enable ( XAP_OPTION_ALIAS_ON, true );
}
```

Exceptions

```
bad_alloc, xap_bad_path
```

Throws xap_bad_path if an alias loop is defined, or if an attempt is made to make an alias of an alias, or if an attempt is made to use a property that has previously been defined as an actual value as an alias, or if the aliasPath is malformed. Only single level aliases are supported.

MetaXAP::SetStandardAliases

```
static void
SetStandardAliases (const std::string& aliasNS );
```

Description

Added in version 2.9.

Calls MetaXAP::SetAlias for standard aliases associated with a standard namespace. The aliases for each namespace are defined in the XMP framework specification. The standard aliases for all standard namespaces are set if an empty string is passed for aliasNS. Only the aliases from XMP to Dublin Core, and from PDF to XMP and Dublin Core are automatically set during toolkit initialization.

Examples

```
MetaXAP::SetAlias ( XAP_NS_EXIF );// Define standard EXIF aliases.
```

Exceptions

Any exception thrown by SetAlias will be propagated.

3.10 XAPPaths Class

This is a pure virtual base class, used to represent an enumeration of the paths to nodes of metadata.

> **NOTE:** It is up to the caller to destroy this object with the public destructor.

Examples for `hasMorePaths` and `nextPath` are shown with `MetaXAP::enumerate`.

XAPPaths::hasMorePaths

```
virtual bool
hasMorePaths()
const throw () = 0;
```

Description

Returns *TRUE* if there are more paths in the enumeration, otherwise returns *FALSE*.

XAPPaths::nextPath

```
virtual void
nextPath ( std::string&   ns,
           std::string&   path ) = 0;
```

Description

Copies the next namespace and path into the parameters. Calling this method after **hasMorePaths** has returned *FALSE* will cause the parameters to be set to empty strings.

4 UtilityXAP

4.1 UtilityXAP

UtilityXAP is a collection of static (class) functions that provide general purpose convenience routines.

4.2 UtilityXAP Static Functions (Class Methods)

UtilityXAP::AnalyzeStep

```
static bool
AnalyzeStep ( const std::string&  fullPath,
              std::string&        parentPath,
              std::string&        lastStep,
              long int&           ord,
              std::string&        selectorName,
              std::string&        selectorVal );
```

Description

Removes `laststep` from the path, and separates it into component pieces.

From `fullPath`, remove the last step and assign it to `lastStep`, and assign the front part of the path to `parentPath`. If the last step contains a predicate expression with an ordinal (which is always greater than 0), it is assigned to `ord`. If the ordinal predicate is the function `last()`, `ord` is set to 0. Otherwise, `ord` is set to –1. If the predicate is a selector, such as "`*[@xml:lang='fr']`", `selectorName` would be assigned "`@xml:lang`" and `selectorVal` would be assigned "fr". Otherwise, `selectorName` and `selectorVal` are assigned the empty string.

UtilityXAP::AppendProperties

```
static void
AppendProperties ( const MetaXAP & source,
                   MetaXAP &       dest,
                   const bool      replaceOld,
                   const bool      doAll = false );
```

Description

Appends external properties from one MetaXAP object to another. A top level property is copied from the source if it does not exist in the destination, or if replaceOld is true. If the top level name exists and replaceOld is false, the processing depends on the forms of the old and new properties. If the forms do not match, the destination is left alone. If the forms match and are simple, the destination is left alone. If the forms match andare a structure, each field is recursively processed like a top level property.

Containers are a bit more complex. If the container types (alt, bag, seq) differ, the destination is left alone. Otherwise the source is merged into the destination. For alt-by-lang containers the merge is based on the languages, a source item is copied if the language does not yet exist in the destination.

For other container types, the merge is based on the item values. Each item in the source is checked to see if it is in the destination already. This compares the values for equality, and the values of the xml:lang attribute if present. f the source item is not already in the destination, it is appened to the destination container. If the source item is a structure, the equality check recursively compares each field without regard to order. The field names and values must match, but they can be in different order. The destination may contain extra fields, it may be a superset of the source. If the source item is a container, the equality check recursively compares each item without regard for order.

Aliases in the source are ignored, things will be caught with the base properties.

The optional "doAll" parameter causes all properties to be treated as external.

NOTE: There are special cases in the implementation for containers. An item with an xml:lang value of 'x-default' is inserted at the front of an alt container instead of being appended. This preserves RDF semantics of the first item in an alt being the default. The existence checks do not care about duplicates. For example if a source bag has three copies "foo" and the destination has one, all three will match and no additional copies will be added to the destination. No attempt is made to be clever about the order of items in a sequence. For example if the first item in a source sequence is the only one missing from the destination, it is appended to the end of the destination, not inserted in front.

Example

```
UtilityXAP::AppendProperties ( sourceMeta, destMeta, false );
```

UtilityXAP::CatenateContainerItems

```
static void
CatenateContainerItems ( const MetaXAP &     meta,
                         const std::string & ns,
                         const std::string & container,
                         const std::string & separator,
                         std::string &       result );
```

Description

Catenates all of the values from a bag or sequence container into one string using the given separator between each. The namespace and path must specify an existing bag or sequence container, all of the items in the container must be simple.

Example

```
UtilityXAP::CatenateContainerItems ( meta, XAP_NS_DC, "subject",
                                     "; ", allItems );
```

Exceptions

Throws xap_bad_type if the named property is not a bag or sequence, or if any item in the container is not a simple property. Can also propagate exceptions from **MetaXAP::get**.

UtilityXAP::ChooseLocalizedText

```
enum {
    xmpCLT_NoValues      = 0,
    xmpCLT_SpecificMatch = 1,
    xmpCLT_GenericMatch  = 2,
    xmpCLT_SimilarMatch  = 3,
    xmpCLT_XDefault      = 4,
    xmpCLT_FirstItem     = 5
};

static int
ChooseLocalizedText (const MetaXAP&     meta,
                     const std::string& ns,
                     const std::string& container,
                     const std::string& genericLang,
                     const std::string& specificLang,
                     std::string&       actualLang,
                     std::string&       value,
                      XAPFeatures&        features );
```

Description

Added in version 2.9.

Selects an appropriate item in a language alternative container, based on the given "generic" and "specific" languages and the rules given below. The property indicated by the container parameter must be an RDF alternative container. All languges are represented as RFC 1766 values. One common use of the languages are a generic language such as "en" and a specific "dialect" of that language such as "en-us". The generic language may be ignored by passing an empty string.

The language of the selected item is returned in actualLang. The function result tells which of the following rules was used:

0. The container does not exist or is empty.

1. Look for an exact match with the specific language.

2. Look for an exact match with the generic language.

3. Look for a partial match with the generic language. This looks through the container in positional order for a language of the form "<generic>-<suffix>". For example, "en" would match "en-us", "en-ca", or "en-cockney", but not "enx-foo".

4. Look for an "x-default" item.

5. Select the first item in the container.

NOTE: Most clients should only need GetLocalizedText and SetLocalizedText. Those funciotns use these rules to decide what to do. Use of ChooseLocalizedText is only necessary if you really care exactly what item in the alternative is chosen.

Example

```
rule = UtilityXAP::ChooseLocalizedText ( meta, XAP_NS_DC, "title",
                                         "en", "en-us",
                                         actLang, value, features );
```

Exceptions

Throws xap_bad_type if the container is not an RDF alternative container. Throws xap_bad_path if rule #3 finds an item in the container without an xml:lang attribute.

UtilityXAP::CompareTimestamps

```
static XAPTimeRelOp
CompareTimestamps ( const XAPDateTime & a, const XAPDateTime & b );
```

Description

Compares the two timestamps and returns the relation as follows:

Condition		Returns
a < b	(a timestamp earlier than b)	`xap_before`
a == b	(a timestamp same as b)	`xap_at`
a > b	(a timestamp later than b)	`xap_after`
a ? b	(a or b does not have a timestamp)	`xap_noTime`

Example

```
order = UtilityXAP::CompareTimestamps ( firstTime, secondTime );
```

UtilityXAP::CompareTimestamps

```
static XAPTimeRelOp
CompareTimestamps ( MetaXAP*          a,
                    MetaXAP*          b,
                    const std::string&  ns,
                    const std::string&  path );
```

Description

Compares timestamps on the property with the specified namespace `ns` and `path` in instance `a` with that in instance `b`, and returns the relation as follows:

Condition		Returns
a < b	(a timestamp earlier than b)	`xap_before`
a == b	(a timestamp same as b)	`xap_at`
a > b	(a timestamp later than b)	`xap_after`
a ? b	(a or b does not have a timestamp)	`xap_noTime`
	(a or b not defined)	`xap_notDef`

Example

```
UtilityXAP::CompareTimestamps ( meta, clone, XAP_NS_XAP, "Number" );
```

Exceptions

Raises all the same exceptions as **MetaXAP::enumerate** and **MetaXAP::getTimestamp**, except that `xap_no_match` is converted into the return value `xap_notDef`.

UtilityXAP::CreateXMLPacket

```
static void
```

```
CreateXMLPacket ( const std::string&   encoding,
                  const bool           inPlaceEditOk,
                  const size_t         padBytes,
                  const std::string&   nl,
                  std::string&         header,
                  std::string&         trailer,
                  std::string*         xml = NULL );
```

Description

Use this routine to compute the header and trailer string for a packet, which you use to create a XMP packet (for information on XMP Packets, see *XMP – Extensible Metadata Platform*), or if you specify non-*NULL* XML data, it will also create the entire packet.

If the `encoding` is empty (""), it defaults to UTF-8. If `inPlaceEditOk` is *TRUE*, it marks the packet as okay to edit in-place, otherwise it marks the packet as read-only.

If positive, the `padBytes` parameter specifies the number of bytes of whitepsace padding to add to the packet. The padding is placed after the XML data, and before the trailer.

If `padBytes` is negative, its absolute value specifies the length for the completed packet, and the `xml` parameter must be non-*NULL*. The absolute value of `padBytes` must be large enough to contain the complete packet, otherwise `xap_bad_number` is thrown. The appropriate amount of whitespace padding is added to provide the specified total size. This is convenient when formatting a packet to update existing metadata in a file of unknown format.

The `nl` string is the character sequence to use as a newline between the header and the xml data if `xml` is non-*NULL*: it can be empty (""), or some combination of well-formed XML whitespace. The header is assigned to the string representing the computed header for the packet, and the trailer is assigned to the string representing the computed trailer of the packet.

The characters in `xml` specify the XML data for the packet. The same non-*NULL* parameter `xml` is assigned the complete packet, with header, trailer, and padding added. The value of `encoding` must match the encoding of the XML data, but no checking is done to guarantee that it does match.

Examples

(for UTF-8 encodings):

```
string header, trailer;
UtilityXAP::CreateXMLPacket ( "", true, val.size(), "\n", header,
    trailer, &val );
```

There is a second form:

```
static void
```

```
CreateXMLPacket ( const std::wstring&    encoding,
                  const bool             inPlaceEditOk,
                  const size_t           padBytes,
                  const std::wstring&    nl,
                  std::wstring&          header,
                  std::wstring&          trailer,
                  std::wstring*          xml = NULL );
```

Same as **CreateXMLPacket** above, except that all of the string parameters are 16-bit character strings.

> **NOTE:** This function assumes that the XML data is in the native byte order of this machine. It generates packet header text in UCS-2 encoding, with characters in the range U+0000 to U+007F, plus U+FEFF. This refers only to the additional material for the packet wrapper, NOT to the data contents, which are assumed to be XML compatible UCS-2 and are copied unchanged.

Example

(for UTF-16 encodings)

```
wstring wxml = L"<A foo='1'>\n<B>This is some \x03a3 16-bit
text.</B>\n</A>\n";
wstring wh;
wstring wt;
UtilityXAP::CreateXMLPacket ( L"UTF-16", false,
    wxml.size()*sizeof(wchar_t), L"\n", wh, wt, &wxml );
```

UtilityXAP::FilterPropPath

```
static bool
FilterPropPath ( const std::string&  tx,
                 std::string&        propPath );
```

Description

Filters UI text into valid XPath.

Converts a UTF-8 string `tx` into a valid XPath, which is also a UTF-8 string `propPath`. For example, any disallowed characters, like spaces or slashes, or any Unicode characters greater than U+007A, are converted into a series of hexadecimal digits, where every two digits represent a byte of UTF-8. Such sequences are introduced by the character pattern "-_" and closed with "_". If the original text contains "-_", it is escaped with "-__". If the converted character is the initial character, the escape is modified to be "QQ-_". If such a sequence exists in the original text, it is escaped as "QQ-__".

For example, if `tx` is the single Unicode character U+03A3 GREEK CAPITAL LETTER SIGMA in UTF-8 encoding, it is filtered into "QQ-_cea3_", which represents the two bytes *CE* and *A3* of UTF-8, in hex.

UtilityXAP::GetBoolean

```
static bool
GetBoolean ( MetaXAP*            meta,
             const std::string&  ns,
             const std::string&  path,
             bool                &val );
```

Description

Gets a property value as a boolean as specified by `ns` and `path`. Calls **MetaXAP::get**. If the property is not defined, returns *FALSE*. Otherwise, the string value provided by **MetaXAP::get** is converted into a boolean and copied into `val` and *TRUE* is returned.

Example

```
bool areYouHappy;
bool ok = UtilityXAP::GetBoolean ( meta, XAP_NS_XAP, "Happy",
    areYouHappy );
```

Exceptions

Raises all the same exceptions as **MetaXAP::get**, plus `xap_bad_xap` if the property value cannot be converted to a boolean.

UtilityXAP::GetDateTime

```
static bool
GetDateTime ( MetaXAP*            meta,
              const std::string&  ns,
              const std::string&  path,
              XAPDateTime&        dateTime );
```

Description

Gets a property value as a date and time.

Gets the Date value specified by `ns` and `path`. Calls **MetaXAP::get**. If the property is not defined, it returns *FALSE*. Otherwise, the string value provided by **MetaXAP::get** is converted into values of the `XAPDateTime` record as described below, and timezone offset from GMT, and *TRUE* is returned. If *tzHour* and *tzMin* are both 0, the time returned is UTC (GMT). The *seq* field is always set to 0, and the *nano* field is set to the subsecond time defined

in the value of the property, if any. This function implements the Date as specified in *XMP – Extensible Metadata Platform*; also see ISO 8601: http://www.w3.org/TR/NOTE-datetime.

TABLE 4.1   XAPDateTime Field Usage

XAPDateTime field	Usage	Range
sec	seconds after the minute	[0,59]
min	minutes after the hour	[0,59]
hour	hours since midnight	[0,23]
mday	day of the month	[1,31]
month	month of the year	[1,12]
year	year A.D. (can be negative!)	
tzHour	hours +ahead/-behind UTC	[–12,11]
tzMin	minutes offset of UTC	[0,59]
nano	nanoseconds after second (if supported)	
seq	sequence number (if nano not supported)	

Examples

(using HTML format for shorthand):

1994-11-05T08:15:30-05:00 corresponds to November 5, 1994, 8:15:30 am, US Eastern Standard Time.

1994-11-05T13:15:30Z corresponds to the same instant.

(C++ code example:)

```
XAPDateTime dt;
bool ok = UtilityXAP::GetDateTime(meta, XAP_NS_XAP, "UTC", dt);
```

Exceptions

Raises all the same exceptions as **MetaXAP::get**, plus xap_bad_xap if the property value cannot be converted to a date and time.

UtilityXAP::GetInteger

```
static bool
GetInteger ( MetaXAP*          meta,
             const std::string&   ns,
             const std::string&   path,
             long int             &val );
```

Description

Gets a property value as an integer.

Gets the integer value specified by `ns` and `path`. Calls **`MetaXAP::get`**. If the property is not defined, returns *FALSE*. Otherwise, the string value provided by **`MetaXAP::get`** is converted into an integer and copied into `val`, and *TRUE* is returned.

Example

```
long int gNum = sizeof(int);
bool ok = UtilityXAP::GetInteger ( meta, XAP_NS_XAP, "Number",
   gNum );
```

Exceptions

Raises all the same exceptions as **`MetaXAP::get`**, plus `xap_bad_xap` if the property value cannot be converted to an integer.

UtilityXAP::GetLocalizedText

```
static bool
GetLocalizedText ( const MetaXAP*     meta,
                   const std::string& ns,
                   const std::string& container,
                   const std::string& genericLang,
                   const std::string& specificLang,
                   std::string&         value,
                    XAPFeatures&          features );
```

Description

Get the value and features for an appropriate item in a language alternative container. Uses the rules defined for ChooseLocalizedText to select the item. Returns false for rule #0, and true for all other rules.

Example

```
found = UtilityXAP::GetLocalizedText ( meta, XAP_NS_DC, "title",
                                       "en", "en-us", value, features );
```

Exceptions

Raises all the same exceptions as **UtilityXAP::ChooseLocalizedText** and
MetaXAP::get.

UtilityXAP::GetReal

```
static bool
GetReal ( MetaXAP*           meta,
          const std::string&   ns,
          const std::string&   path,
          double             &val );
```

Description

Gets a property value as a real number.

Gets the real (double) value specified by ns and path. Calls **MetaXAP::get**. If the property
is not defined, *FALSE is returned*. Otherwise, the string value provided by **MetaXAP::get** is
converted into a real and copied into val, and *TRUE* is returned.

Example

```
double gReal;
bool ok = UtilityXAP::GetReal ( meta, XAP_NS_XAP, "Real", gReal );
```

Exceptions

Raises all the same exceptions as **MetaXAP::get**, plus xap_bad_xap if the property value
cannot be converted to a real.

UtilityXAP::IsAltByLang

```
static bool
IsAltByLang ( const XAPPathTree*  tree,
              const std::string&  ns,
              const std::string&  path,
              std::string*        langVal = NULL );
```

Description

Returns *TRUE* if the specified path evaluates to a member of a structured container that is of
type xap_alt, and which is selected by the attribute xml:lang. If a pointer to a string is
passed in langVal, the string is assigned with the value of the xml:lang attribute.

This function is handy when you are doing an enumerate. If you are searching for a particular language alternative, pass the paths returned by XAPPaths to this function to test for the sought type, and then compare the `langVal` with the language you seek.

Exceptions

Raises all the same exceptions as **MetaXAP::getForm.**

UtilityXAP::MakeLocalTime

```
static void
MakeLocalTime ( const XAPDateTime & inTime, XAPDateTime & outTime );
```

Description

Sets outTime to the value of inTime converted to a local time instead of UTC. This depends on the ANSI C functions gmtime, localtime, and mktime. Which also depend on the host system having a properly set time zone.

UtilityXAP::MakeUTCTime

```
static void
MakeUTCTime ( const XAPDateTime & inTime, XAPDateTime & outTime );
```

Description

Sets outTime to the value of inTime converted to UTC. This depends only on the timezone of inTime, it must be set correctly. Does not assume inTime is a local time.

UtilityXAP::RemoveProperties

```
static void
RemoveProperties ( MetaXAP &          meta,
                   const std::string * ns = 0,
                   const std::string * path = 0,
                   const bool          doAll = false );
```

Description

Removes external properties from a MetaXAP object. If the namespace is null, the path is ignored and all external properties in all schema are removed. If the namespace is not null but the path is null, all external properties in the named schema are removed. If the namespace and path are both non-null, the named property is removed if it is external. A schema is removed if all of its properties are removed.

The function returns true if all candidate properties are removed. It returns false if any properties are not removed because they are internal. This holds even if the namespace or path are null, in those cases the candidates are all properties in the schema.

The optional "doAll" parameter causes all properties to be treated as external.

Example

```
UtilityXAP::RemoveProperties ( meta );
UtilityXAP::RemoveProperties ( meta, XAP_NS_XAP );
```

UtilityXAP::SeparateContainerItems

```
static void
SeparateContainerItems ( MetaXAP &                    meta,
                         const std::string &          ns,
                         const std::string &          container,
                         const XAPStructContainerType cType,
                         const std::string &          values,
                         const bool                   preserveCommas );
```

Description

Separates chunks of the values string into items in a bag or sequence container. This is more than just the inverse of CatenateContainerItems. Separation is more general to allow for input from other sources or ingrained typing habits. The preserveCommas flag tells if commas should be a separator or not. If true, they are not a separator but are preserved as part of the values. Other separators are semicolon, tab, carriage return, linefeed, or multiple spaces. Any sequence of contiguous separators is one separator. Whitespace at either end of the separated values is removed. Empty values are ignored.

Example

```
UtilityXAP::SeparateContainerItems ( meta, XAP_NS_DC, "subject", xap_bag,
                                     allItems, false );
```

Exceptions

Can propagate exceptions from **MetaXAP::createFirstItem** and **MetaXAP::append**.

UtilityXAP::SetBoolean

```
static void
```

```
SetBoolean ( MetaXAP*           meta,
             const std::string&   ns,
             const std::string&   path,
             const bool           val );
```

Description

Sets a property value as a boolean.

Sets the property specified by `ns` and `path` to the specified boolean value. Calls
MetaXAP::set. Intermediate nodes on the path are created as needed.

Example

```
bool happy = true;
UtilityXAP::SetBoolean ( meta, XAP_NS_XAP, "Happy", happy );
```

Exceptions

Raises all the same exceptions as **MetaXAP::set**.

UtilityXAP::SetDateTime

```
static void
SetDateTime ( MetaXAP*           meta,
              const std::string&   ns,
              const std::string&   path,
              const XAPDateTime&   dateTime );
```

Description

Sets the property value as a date and time.

Sets the property specified by `ns` and `path` to the specified boolean value. Calls
MetaXAP::set. Intermediate nodes on the path are created as needed.

See **UtilityXAP::GetDateTime** above for the details of usage for `dateTime`. The *seq*
and *nano* fields are ignored.

Example

```
XAPDateTime dt;
UtilityXAP::SetDateTime ( meta, XAP_NS_XAP, "UTC", dt );
```

Exceptions

Raises all the same exceptions as **MetaXAP::set**.

UtilityXAP::SetInteger

```
static void
SetInteger ( MetaXAP*           meta,
             const std::string&  ns,
             const std::string&  path,
             const long int      val );
```

Description

Sets property value as an integer.

Sets the property specified by ns and path to the specified integer value. Calls **MetaXAP::set**. Intermediate nodes on the path are created as needed.

Example

```
long int num = -123456789;
UtilityXAP::SetInteger ( meta, XAP_NS_XAP, "Number", num );
```

Exceptions

Raises all the same exceptions as **MetaXAP::set**.

UtilityXAP::SetLocalizedText

```
static void
SetLocalizedText ( MetaXAP*           meta,
                   const std::string& ns,
                   const std::string& container,
                   const std::string& genericLang,
                   const std::string& specificLang,
                   const std::string& value,
                    const XAPFeatures   features );
```

Description

Set the value and features for an appropriate item in a language alternative container. Uses the rules defined for ChooseLocalizedText to determine a "display" item. The items that are set

depend on which ChooseLocalizedText rule applied. The term "preferred language" refers to the generic language if provided, otherwise to the specific language.

0. The preferred language item is created. An "x-default" item is also created if that is not the preferred language.

1. The specific language item is updated. An existing "x-default" item is updated if its value matches the old value of the specific language item.

2. If there are other items with the same generic language root, create a new item for the given specific language. Otherwise (there was just the generic item) update the generic language item; also update an existing x-default item if the old values match.

3. The specific language item is created.

4. The preferred language item is created. If the container only had the "x-default" item, that is also updated.

5. The preferred language item is created.

In addition, if an "x-default" item exists after the update it will be forced to be the first item in the container. This improves RDF interoperability, RDF specifies that the first item in an alternative should be the default.

Example

```
UtilityXAP::SetLocalizedText ( meta, XAP_NS_DC, "title", "en", "en-us",
                               "The XMP Toolkit" );
```

Exceptions

Raises all the same exceptions as **UtilityXAP::ChooseLocalizedText** and **MetaXAP::set**.

UtilityXAP::SetReal

```
static void
SetReal ( MetaXAP*          meta,
          const std::string&   ns,
          const std::string&   path,
          const double         val );
```

Description

Sets a property value as a real.

Sets the property specified by ns and path to the specified real value. Calls **MetaXAP::set**. Intermediate nodes on the path are created as needed.

Example

```
double real = 3.14159012345678;
UtilityXAP::SetReal ( meta, XAP_NS_XAP, "Real", real );
```

Exceptions

Raises all the same exceptions as **MetaXAP::set**.

UtilityXAP::SetTimeZone

```
static void
SetTimeZone ( XAPDateTime & time );
```

Description

Sets just the time zone part of the time to the local offset from UTC. Useful for determining the local time zone or for converting a "zone-less" time to a proper local time.

A XMP Toolkit Exceptions

A.1 Overview

This appendix lists the collection of C++ classes used for exceptions throughout the Toolkit.

A.1.1 Exception Classes

Errors are indicated using exceptions. Member function prototypes use the conventions listed in Table A.1, "XMP Toolkit Exceptions."

TABLE A.1   XMP Toolkit Exceptions

Potential Exceptions	Convention
No exceptions possible.	Declared throw ().
Client violates a pre-condition, or runtime exceptions possible.	Default declaration (no throw clause).

The following are the exceptions for the XMP Toolkit:

```
/* Text messages for standard exceptions. */
extern const char *const XAP_BAD_ALLOC;
extern const char *const XAP_INVALID_ARGUMENT;

/* Text messages for client faults. */
extern const char *const XAP_FAULT_BAD_FEATURE;
extern const char *const XAP_FAULT_BAD_SCHEMA;
extern const char *const XAP_FAULT_BAD_TYPE;
extern const char *const XAP_FAULT_BAD_PATH;
extern const char *const XAP_FAULT_BAD_ACCESS;
extern const char *const XAP_FAULT_BAD_NUMBER;

/* Text messages for XMP errors. */
extern const char *const XAP_ERR_BAD_XAP;
extern const char *const XAP_ERR_BAD_XML;
extern const char *const XAP_ERR_NO_MATCH;

class XAP_API xap_client_fault : std::logic_error {
public:
    xap_client_fault() throw() : std::logic_error("") {}
    explicit xap_client_fault(const char* w) throw() :
```

```
        std::logic_error(w) {}
    virtual ~xap_client_fault() throw() {}
};

class XAP_API xap_error : std::runtime_error {
public:
    virtual ~xap_error() throw() {}
    virtual const char* getContext() const throw() {
        return(m_context.c_str());
    }
    virtual const int getLine() const throw() {
        return(m_line);
    }
protected:
    xap_error() throw() : std::runtime_error("") {}
    explicit xap_error(const char *const w) throw() :
std::runtime_error(w) {}
    virtual void setContext(const char* c) {
        m_context = c;
    }
    virtual void setLine(const int line) {
        m_line = line;
    }
private:
    std::string m_context;
    int m_line;
};

class XAP_API xap_bad_feature : public xap_client_fault {
public:
    xap_bad_feature() throw() : xap_client_fault(XAP_FAULT_BAD_FEATURE)
{}
};

class XAP_API xap_bad_type : public xap_client_fault {
public:
    xap_bad_type() throw() : xap_client_fault(XAP_FAULT_BAD_TYPE) {}
};

class XAP_API xap_bad_path : public xap_client_fault {
public:
    xap_bad_path() throw() : xap_client_fault(XAP_FAULT_BAD_PATH) {}
};

class XAP_API xap_bad_access : public xap_client_fault {
public:
    xap_bad_access() throw() : xap_client_fault(XAP_FAULT_BAD_ACCESS) {}
};
```

```
class XAP_API xap_bad_number : public xap_client_fault {
public:
    xap_bad_number() throw() : xap_client_fault(XAP_FAULT_BAD_NUMBER) {}
};

class XAP_API xap_bad_xap : public xap_error {
public:
    xap_bad_xap() throw() : xap_error(XAP_ERR_BAD_XAP) {}
    explicit xap_bad_xap(const char *const c) :
xap_error(XAP_ERR_BAD_XAP) {
        setContext(c);
        setLine(0);
    }
};

class XAP_API xap_bad_xml : public xap_error {
public:
    xap_bad_xml() throw() : xap_error(XAP_ERR_BAD_XML) {}
    xap_bad_xml(const char *const c, const int l) :
xap_error(XAP_ERR_BAD_XML) {
        setContext(c);
        setLine(l);
    }
};

class XAP_API xap_no_match : public xap_error {
public:
    xap_no_match() throw() : xap_error(XAP_ERR_NO_MATCH) {}
    explicit xap_no_match(const char *const path) :
xap_error(XAP_ERR_NO_MATCH) {
        setContext(path);
        setLine(0);
    }
};
```

B Runtime Flow of Control

This roadmap will follow the most important code paths through the code. Once you are familiar with these paths, you should be able to find your way around the less important highways and byways.

MetaXAP::parse

Until the last buffer is encountered, **XAPTk_Data::parse** is used, which does some pre-parsing to deal with end-of-line filtering. Once that is dealt with, the buffers are handed over to **XAPTk_Data::innerParse**, which does the actual filtering, and eventually calls **XAPTk::DOMGlue_Parse** (in `DOMGlue.cpp`). This is where the real parsing occurs. It passes through the DOM code to the underlying expat parser. A DOM tree gets built up as the XML is parsed (**XAPTk_Data::m_domDoc**). This DOM doc is an exact representation of the XML syntax that was parsed (modulo comments, XML processing instructions, parsed entities, etc., which are irrelevant for RDF).

After the last buffer is parsed, **XAPTk_Data::loadFromTree** is called, which is where the normalization is done. The objective is to convert the exact representation of the XML serialization into a representation that is easier to manipulate. This normalized representation, which folds the many-equivalent syntax representations into one model, is a forest of trees. Each tree is represented by a class `NormTree` object. Each tree has a non-descript root, and contains all the properties that are defined for a particular schema/namespace, or for a particular ID. The ID form has many uses, one of which is to manage the timestamps for properties. More on this later.

The class `RDFToNormTrees` normalizes the raw DOM tree into `NormTrees`. It is a gigantic DOMWalker (a pure virtual base class which implements depth-first, preorder tree walks). As the `RDFToNormTrees` walks the original DOM tree, it executes a finite state machine. This state machine has 6 states:

1) **state_init**

   Looking for an `rdf:RDF` element.

2) **state_ignore**

   Ignore this element (`m_beingIgnored`) and all of its children.

3) **state_rdf**

   Found an `rdf:RDF` element, looking for an `rdf:Description` element.

4) **state_desc**

   Found an `rdf:Description` (or parseType='Resource', or implicit description), looking for properties.

5) **state_prop**

Found a property, looking for a value, a structure container, a nested description, or a special case (see code for details).

6) **state_container**

Found a container, looking for a list member.

A side-effect of certain state transitions is the construction of nodes in a `NormTree`. When the `RDFToNormTrees` object is finished walking the original tree, it deletes the original DOM Document, and leaves behind two `std::map` data structures `XAPTk_Data::m_bySchema`, and `XAPTk_Data::m_byID`. The former maps a schema/namespace name to a `NormTree` of RDF properties and values, the latter maps a schema/namespace name to a `NormTree` used to store timestamps (a stylized RDF bag of properties).

`XAPTk_Data::loadFromTree` continues by enumerating the schema/namespaces loaded in `XAPTk_Data::m_bySchema`. The corresponding `NormTree` in `XAPTk_Data::m_byID` is looked up by this namespace. The encoded timestamp properties are loaded into a more convenient data structure (`XAPTk_ChangeLog`, `XAPTk_PunchCardByPath`, and class `PunchCard`, all defined in `XAPTk_Data.h`). See `XAPTk_Data::m_changeLog`.

Finally, `XAPTk_Data::loadFromTree` returns. The last thing that **MetaXAP::parse** does is detects if aliasing is enabled. If so, it verifies that linked values that are defined are equal, and populates any linked values that were not defined. This is a side-effect of flipping the `XAP_OPTION_ALIASING_ON` flag, which calls `VerifyAndPopulate` (static module function in `MetaXAP.cpp`).

MetaXAP::SetAlias

After validating that the parameters are legal, an entry is added to the static `MetaXAP_aliasMap` (defined in `MetaXAP.cpp`). This maps an alias property to an actual property.

Aliases are treated as linked values. This is implemented by actually instantiating all properties that share the same value, and setting/copying the value. This is done by `VerifyAndPopulate` (see above), and by each non-const function of MetaXAP that can alter property values, utilizing a pre-computed list of linked values generated by `PreResolveAlias`, which is called at the end of **MetaXAP::SetAlias**.

The job of `PreResolveAlias` is to resolve all alias lookups (and actual to alias reverse lookups), and build this information into a sparse matrix, implemented with nested `std:map` structures: `MetaXAP_InfoMap` and `MetaXAP_ResolvedAliases`, both defined in `MetaXAP.cpp`. The sparse matrix is stored in the static variable `MetaXAP_resolvedAliases` (in `MetaXAP.cpp`).

Both the alias and actual properties are entered into the `MetaXAP_ResolvedAliases` map as keys. The values are maps which list all of the other properties that are linked by value. So if I do this:

```
MetaXAP::SetAlias("dc", "Foo", "xap", "Bar");
// Alias = <dc,Foo>
// Actual = <xap,Bar>
```

The `MetaXAP_ResolvedAliases` structure will contain:

```
MetaXAP_ResolvedAliases: {
    [<dc,Foo>] = MetaXAP_InfoMap : {
                [<xap,Bar> = MetaXAP_AliasInfo: {
                            actual = true;
                            aliasSingle = true;
                            ...
                            }
                }
    [<xap,Bar>] = MetaXAP_InfoMap : {
                [ <dc,Foo> = MetaXAP_AliasInfo: {
                            actual = false;
                            aliasSingle = true;
                            ...
                            }
                }
}
```

The meaning of `aliasSingle`, the four flavors of aliases, and the other fields of `MetaXAP_AliasInfo` are described in the comment above `PreResolveAlias`. Search for `COMMENT_ALIAS_FLAVORS`.

If another alias for <xap,Bar> is added, <xy,ZZY>, the structure will contain:

```
MetaXAP_ResolvedAliases: {
    [<dc,Foo>] = MetaXAP_InfoMap : {
                [<xap,Bar>] = MetaXAP_AliasInfo: {
                            actual = true;
                            aliasSingle = true;
                            ...
                            }
                }
    [<xap,Bar>] = MetaXAP_InfoMap : {
                [ <dc,Foo>] = MetaXAP_AliasInfo: {
                            actual = false;
                            aliasSingle = true;
                            ...
                            }
                [ <xy,ZZY>] = MetaXAP_AliasInfo: {
                            actual = false;
                            aliasSingle = true;
```

```
                                 ...
                             }
                      }
        [<xy,ZZY>] = MetaXAP_InfoMap : {
                  [<xap,Bar>] = MetaXAP_AliasInfo: {
                             actual = true;
                             aliasSingle = true;
                             ...
                             }
                  }
  }
```

Notice that the `MetaXAP_InfoMap` for <xap,Bar> now has two entries, which are the two properties whose values are linked to <xap,Bar>. This ensures that if the value for <xap,Bar> is changed directly, the other two properties will also get changed. More about how this works will be discussed in `MetaXAP::set`.

MetaXAP::get

Right away, **XAPTk_Data::get** is called. First, XPath is evaluated against the appropriate `NormTree`, looked up by schema/namespace name. If no node is found, it returns *FALSE*.

Next, the form is checked to make sure it is simple (you can't do a **get** on anything but `xap_simple`).

If the node is an attribute, its value is returned.

If the node is an element, **XAPTk_Data::extractPropVal** is called, which in turn calls `NormTree`**::getText**. The children of the element are examined; if it has no children, an empty string is returned. If it has exactly one child that is a text node, its text value is returned. Otherwise, a number of special cases involving XAPFeatures have to be dealt with.

Notice that there were no aliases to deal with. That's because the linked value implementation has already accounted for aliases. The value returned has already been copied from the actual by other code.

MetaXAP::set

After validating input parameters, any possible aliases, associated with this property via `MetaXAP_CollectAliases`, are collected.

BEGIN MetaXAP_CollectAliases

Remember, all non-const functions that alter property values call `MetaXAP_CollectAliases`, so this description also applies to **append**, **remove**, etc.

If aliasing is not enabled, don't do anything.

Otherwise, the first objective is to find a valid value for the **MetaXAP_ResolvedAliases::iterator** entry. CheckAliases is used to see if this

path is an actual (target of aliases). If so (`CheckAliases` returns *FALSE*), lookup the path in `MetaXAP_resolvedAliases`, save if valid. Note that the conformed path is tried first (from **`XAPTk::ConformPath`**, in `xaptkfuncs.cpp`), which is the longest path prefix that contains no wildcards (*). Also, the structured container type (sct) is needed, which is normally filled in by `CheckAliases`, but since it returned *FALSE*, it must be figured out. We get the `MetaXAP_InfoMap`, and try to find a matching member. If not found, the full path (without conformance) is tried, since flavor 3 and flavor 4 (described in `COMMENT_ALIAS_FLAVORS`) have wildcards in their canonical actual paths. If not found, just use the first entry as a best guess. In any case, remember that the original path is an actual.

If `CheckAliases` returned true, we just get the matching entry, and `sct` is already assigned by `CheckAliases`.

If the pointer to the output parameter `cType` is not *NULL*, we assign `sct` to the variable it points at.

Our next objective is to massage the canonical path stored in the alias entry into an actual path that corresponds to the one passed into `MetaXAP_CollectAliases`. The variable `savedPath` holds any variable part of the path that was detected during `CheckAlias` or `ConformPath` earlier. If it is non-empty, we need to remember to tack it on any container paths we collect as target linked values. If the original path was an alternate by language, remember that too. We need to determine if the target is single (not a container). `xap_sct_unknown` means single. If `sct` is some other value and the original path is not actual, `isSingle` is *TRUE* only if we are flavor 3 or 4.

If the `savedPath` has `last()` in the predicate, we convert it to the appropriate canonical path.

Now that we have all of the information we need, we build a list of target paths for linked values. We iterate over the `MetaXAP_InfoMap` value of entry. The iterator is item. We do a little extra work to guarantee that the first slot (0) in the list is always the target of the actual, which is always in the second slot (1). This is easy when the original path was an alias (just put the original path is slot 0, and the looked up actual in slot 1). It's harder when the original path was an actual, we have to pick some alias path to put into slot 0: that's why there is a big block of code that starts "`if (isActual)`". We arrange all this by saving the corresponding paths in `matchOrig`, `fullOrig`, `matchActual`, and `fullActual`.

We're building our list in the output parameter `props`, which is a vector. Normally, we just want to put `fullOrig` in the first slot, and `fullActual` in the second. However, there is one special case where the original path was an actual, and has targets, but none of the targets qualify for one reason or another. For example, if the actual is member 2 of a

container, but all aliases are either targeted at member 1 or the whole container, nothing actually matches. See the comment in the block that starts:

```
if (isActual && !(foundActual && foundAlias)) {
```

The items in `MetaXAP_InfoMap are searched`, skipping matches for actual and its alias, since they are already loaded in the list. If any fixup is needed, we append the variable parts as needed. Finally, we return *TRUE*.

END MetaXAP_CollectAliases

If there were no aliases collected, just call `XAPTk_Data:set`. Otherwise, loop through the list of linked values, and call **XAPTk::set** on each, catching and ignoring errors for all but the original path.

In **XAPTk_Data::set**, we evaluate the path and convert character escapes to raw characters. If we evaluate to a node, we replace its value with **XAPTk_Data::replaceProp**. Otherwise, if the container type is unknown (not a container), we call **XAPTk_Data::createProp**. If it is a container, we figure out what type. If the container does not exist, we call the type-specific form of **XAPTk_Data::createFirstItem**, otherwise, **XAPTk_Data::append** is called.

In **XAPTk_Data::replaceProp**, `NormTree is looked up` and a determination is made if this is an element or an attribute. The appropriate form of **NormTree::setText** is called, and also update the timestamp by calling **XAPTk_Data::punchClock**.

In **XAPTk_Data::setText**, handle special cases and features, then set the text child to the value passed in.

In **XAPTk_Data::createProp**, we lookup the `NormTree`, creating one if needed. We use the form of `NormTree:evalXPath` which creates a node if one is not found. The rest of the code looks just like **replaceProp**.

In **XAPTk_Data::createFirstItem**, we create the container of the appropriate type, and then create the first member item. The rest of the code is just like **replaceProp**, except that we set the timestamp on the entire container, rather than individual members.

In **XAPTk_Data::append**, we find the member item specified, climb the tree to get information about the container (parent), and then create a new node and place it as specified by the input parameters. We set the timestamp on the whole container.

MetaXAP::enumerate

All forms of enumerate directly call **XAPTk_Data::enumerate**.

In **XAPTk_Data::enumerate**, figure out if everything is being enumerated, or just certain schemas, subPaths, or depths in steps. For each schema, call **NormTree::enumerate**.

In **NormTree::enumerate**, we create a Paths object (`Paths.cpp`), and construct a `DW4_enumeratePropElem` DOMWalker, passing the Paths object as a parameter. `DW4_enumeratePropElem` is defined in `NormTree.cpp`. It basically walks the tree, and for

each element that meets the input criteria (number of steps, or leaf nodes only), it computes a canonical path and appends it to the Paths object.

`MetaXAP::serialize`

In **`XAPTk_Data::serialize`**, we first deal with header information, then the `rdf:RDF` boilerplate. Then we iterate through each of the normalized trees in `m_bySchema`. We call `NormTree::serialize` for each one. Then we tack on the timestamp info, if any, with **`XAPTk_Data::serializeTimestamps`**, then more boilerplate and trailer stuff.

In **`NormTree::serialize`**, which is implemented in `NormTree_serialize.cpp`, we arrange for the proper line ending, and then we add the boilerplate for `rdf:Description`, which is one top-level per schema. We loop through all the namespace definitions, and write out any that we need. Finally, we construct a DOMWalker to serialize the `NormTree`: a `SerializePretty` for pretty-printing, a `SerializeCompact` for compact notation.

Both DOMWalkers handle all the nasty details of writing out the syntax. There are many special cases to handle. See comments in the code for details. There's also a big block of comments at the beginning of `NormTree.cpp`, which explains the internal layout of `NormTrees`.

In **`XAPTk_Data::serializeTimestamps`**, We iterate through `m_changeLog`. Each entry is a `XAPTk_PunchCardByPath` map, which contains a timestamp entry for each property that changed. The body of the loop writes out an `rdf:Description` with an ID that is set to the namespace name for each schema that has properties that were changed. There is one property, `XAPTK_TAG_TS_CHANGES`, which is a *Bag*. Each member item of the *bag* is a timestamp entry, written in a compact, comma separated value notation.

`NormTree::evalXPath`

This simple XPath evaluator uses a very restricted subset of the XPath notation (see Section 3.3.1, "XPath Syntax"). It takes the input expression and separates each `Step` by parsing out the slashes with **`XAPTk::ExplodePath`** (defined in `xaptkfuncs.cpp`). For each step, we do a lexical analysis, and then an evaluation. The side-effects of the evaluation is a Node pointer, stored in current. XPaths always evaluate to a single Node, rather than a node list.

The lexical analysis generates `XAPTk_Token` class objects (defined in here), which are appended to a `VectOToken` (defined here). Begin and end iterators to the original step string are saved in the token for type tChars. All token types start with "t".

In evaluation, we use a finite state machine, which may be described as follows:

1) **sInit**

On tDot, next state is sEmpty.

On tAt, next state is sAttr.

On tStar, next state is sList.

On tChars, next state is sName: if there are no more tokens, recover the element node name and look it up with **NormTree::selectChild**. If not found but required, create a node. Set current an continue to next step.

Otherwise, throw `xap_bad_path`.

2) **sEmpty**

If there are no more tokens, set return value to current.

Otherwise, throw `xap_bad_path`.

3) **sAttr**

On tStar, if there are no more tokens, set return value to current, else throw `xap_bad_path`.

On tChars, cast current to `Element*`. If *NULL*, or there are more tokens, throw `xap_bad_path`. Otherwise, recover the attribute name from the token, get the attribute, create it if required, and set current to it.

Otherwise, throw `xap_bad_path`.

4) **sList**

On tLB, throw `xap_bad_paths` if boundary conditions not met, otherwise next state is sPred and save some state.

Otherwise, if there are more tokens, throw `xap_bad_path`,

else set return value to *current*.

5) **sName**

On tLB, next state is sPred.

On tParens, recover function name from token. If name is not supported, throw `xap_bad_path`, else set return value to *NULL* since functions are not yet supported.

Otherwise throw `xap_bad_path`.

6) **sPred**

On tAt, next state is pAttr.

On tChars, if token is not a number, next state is pName, else it is pOrd. Remember the left hand side (lhs) by assigning the current token index (tix) to it.

Otherwise throw `xap_bad_path`.

7) **pAttr**

On tChars, next state is pAName, remember left hand side (lhs) by assigning current token index (tix) to it.

Otherwise throw `xap_bad_path`.

8) **pAName**

On tEquals, next state is pMatch.

Otherwise throw `xap_bad_path`.

9) **pName**

On tEquals, next state is pMatch.

On tParens, next state is pFunc.

Otherwise throw `xap_bad_path`.

10) **pFunc**

On tRB, recover function name from token; if it isn't "`last`", throw `xap_bad_path`. Set current to the last child of former value of current.

Otherwise throw `xap_bad_path`.

11) **pMatch**

On tChars, set the right hand side (rhs) to the current token index, and next state is pVal.

Otherwise throw `xap_bad_path`.

12) **pVal**

On tRB AND this is the last token, perform the match, creating the node if required. Assign it to current.

Otherwise throw `xap_bad_path`.

If at any point `ret != NULL` , and we are at the last token or step, break out of the loop.

C XMP Toolkit Function List

MetaXAP Static Functions (Class Methods)

MetaXAP::Clone	Makes a deep-copy of the MetaXAP object and returns it.
MetaXAP::EnumerateAliases	Returns a pointer to an object that enumerates all of the aliases defined for all MetaXAP objects.
MetaXAP::set	Extracts an externally saved serialization and saves as a string in a specified buffer.
MetaXAP::GetAlias	Gets the alias for the specified path, if any.
MetaXAP::Merge	creates a new MetaXAP object containing merged metadata.
MetaXAP::RegisterNamespace	Register a namespace name (should be a URI), and a suggested prefix for composing qualified names.
MetaXAP::RemoveAlias	Removes the specified alias from the alias map for all metadata objects.
MetaXAP::SetAlias	Adds to the alias map for all instances of MetaXAP.
MetaXAP::SetStandardAliases	Defines standard aliases for standard namespaces.

MetaXAP Types

MetaXAP::XAPClock	Clients provide the clock used for creating timestamps.
MetaXAP::XAPChangeBits	Each timestamp record includes an indication of how the property was last changed.

MetaXAP Constructors

public default constructor MetaXAP ();	Create an empty object with no clock.
public construct empty with clock MetaXAP (XAPClock* clock);	Creates an empty object with a clock.

public construct from buffer MetaXAP	Constructs a populated MetaXAP from a single buffer of raw XML.
MetaXAP destructor ~MetaXAP ();	Destroy this object and all internally allocated memory.

MetaXAP Public Member Functions

MetaXAP::append	Creates a new property with the specified `value`, and add it after the property specified by namespace `ns` and `path`.
MetaXAP::count	Returns the number of items in the structured container specified by `ns` and `path`.
MetaXAP::createFirstItem	Creates a structured container of the specified type.
MetaXAP::enable	Enables or disables the specified option(s), such as `XAP_OPTION_DEBUG`.
MetaXAP::enumerate	Enumerates MetaXAP object properties
MetaXAP::extractSerialization	Exttracts an externally saved serialization and saves as a string in a specified buffer.
MetaXAP::get	Gets the value at the property specified by `ns` and `path` as a string.
MetaXAP::getContainerType	Returns the type of the specified container.
MetaXAP::getForm	Returns the type of property specified by `ns` and `path`
MetaXAP::getResourceRef	Returns the reference (URI) for the resource that this MetaXAP is about.
MetaXAP::getTimestamp	Returns *FALSE* if the property specified by `ns` and `path` is not defined. Otherwise, returns *T*
MetaXAP::isEnabled	Returns whether the specified option is enabled, such as `XAP_OPTION_DEBUG`.
MetaXAP::parse	Parses a buffer of XML and create the corresponding XMP objects.
MetaXAP::purgeTimestamps	Purges all timestamp records for properties with any `XAPChangeBits` set in `how`.
MetaXAP::remove	Removes the specified property and all of its sub-properties, if any.

MetaXAP::serialize	Serializes the MetaXAP tree as XML.
MetaXAP::set	Sets the specified value at the end of the specified path, with the optionally specified features.
MetaXAP::setTimestamp	Sets the timestamp.
MetaXAP::setup	Enables client application to provide metadata to this instance of MetaXAP for automatic tracking.
MetaXAP::setResourceRef	Sets the reference to the resource (URI) that this MetaXAP is about.

UtilityXAP Static Functions (Class Methods)

UtilityXAP::AnalyzeStep	Removes last step from path, break it into pieces.
UtilityXAP::AppendProperties	Copies properties from one MetaXAP object to another.
UtilityXAP::CatenateContainerItems	Catenates the individual items of a bag or sequence container into a "composite" string.
UtilityXAP::ChooseLocalizedText	Selects an item in an "alt Text" container.
UtilityXAP::CompareTimestamps	(1) Compares a pair of timestamps. (2) Compares the timestamps on a property in a pair of MetaXAP objects.
UtilityXAP::CreateXMLPacket	Use this routine to compute the header and trailer string for a packet, which you use yourself to create a XMP packet.
UtilityXAP::FilterPropPath	Filters UI text into valid XPath.
UtilityXAP::GetBoolean	Gets a property value as a boolean as specified by ns and path.
UtilityXAP::GetDateTime	Gets a property value as a date and time.
UtilityXAP::GetInteger	Gets a property value as an integer.
UtilityXAP::GetLocalizedText	Gets the value of an item in an "alt Text" container.
UtilityXAP::GetReal	Gets a property value as a real.
UtilityXAP::IsAltByLang	Returns *TRUE* if the specified path evaluates to a member of a structured container that is of type xap_alt, and which is selected by the attribute xml:lang.

UtilityXAP::MakeLocalTime	Converts a timestamp to be expressed as a local time.
UtilityXAP::MakeUTCTime	Converts a timestamp to be expressed as a UTC time.
UtilityXAP::RemoveProperties	Removes properties or entire schema.
UtilityXAP::SeparateContainerItems	Separates a "composite" string and stores the individual items into a bag or sequence container.
UtilityXAP::SetBoolean	Sets a property value as a boolean.
UtilityXAP::SetDateTime	Sets the property value as a date and time.
UtilityXAP::SetInteger	Sets property value as an integer.
UtilityXAP::SetLocalizedText	Sets the value of an item in an "alt Text" container.
UtilityXAP::SetReal	Sets a property value as a real.
UtilityXAP::SetTimeZone	Sets the timezone of a timestamp to the local offset from UTC.