UNLEASHING THE POWER OF XML

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Abstract: Over the last few years XML has been growing in importance as a language for describing the meta-data associated with a complete flight test. Three years ago ACRA CONTROL introduced XidML as an open, published XML standard describing flight test data acquisition from the air to the ground. Recently, XML has been adopted by the TMATS RCC committee and is currently being studied by iNET. While many papers have focused on what XML is and why it is a powerful language, few have related this to practical benefits for the end user. This paper attempts to address this gap. The paper describes simple cost effective tools for generating XML through an intuitive GUI, validating XML information against a schema and transforming XML into useful reports. In particular a suite of value added tools for XidML is described.

Keywords: XML, Meta-data

1 INTRODUCTION

A vast amount of time is spent translating and re-translating the same information to suit the formats required by various heterogeneous software programs and databases. Each translation takes time and introduces the possibility of error. Manual translation is normally required since there is a meaning to the data (meta-data) that is held in the brain of the translator, or in some training manuals or software documentation somewhere. Extensible Markup Language (XML) is a tool that permits the meta-information to be linked to the information itself, opening the door to permit computers to do this tedious translation work.

XML has been used for the storage and interchange of structured data since 1997. Originally developed to automate document indexing and storage, its suitability for data exchange over the web has led to its widespread adoption and implementation. Over the last few years its use has become increasingly common in the flight test industry [1,2,3,4] While XML offers obvious advantages in terms of standardization and inter-operability of different packages, a correctly implemented XML platform offers significant added value in the form of tools and software to simplify user tasks.

In 2004 ACRA CONTROL published it's Extensible Instrumentation Definition Markup Language (XidML) as an open standard for use by the flight test instrumentation industry [5,6]. XidML offers the ability to completely and comprehensively describe all parameters, instrumentation and processes for a flight test program in a single schema. XidML has been

maturing since then, with a XidML committee consisting of users meeting every 6 months or so to release an updated version. In addition, ACRA CONTROL has developed a set of tools that offer vendor neutral services to users of XidML.

2 WHY DOES XML MATTER? – AN XML BASED ARCHITECTURE

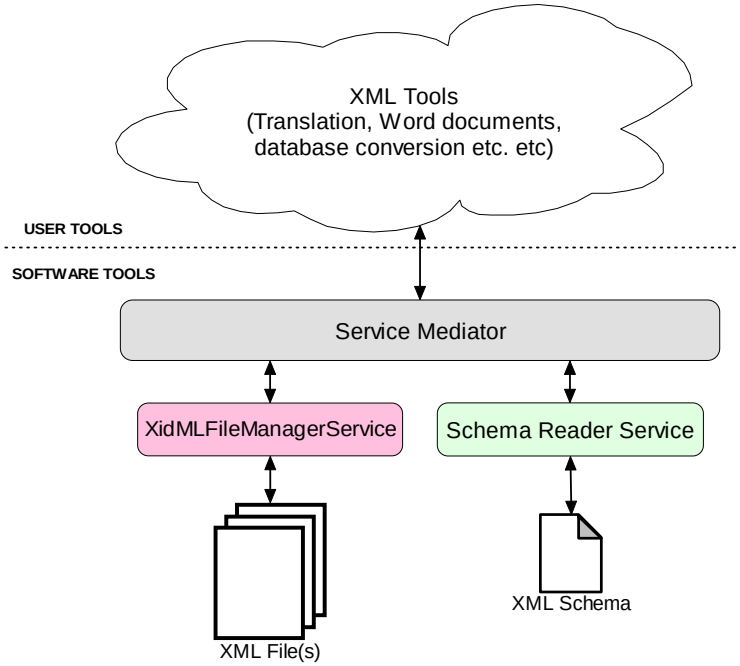

Figure 1: An XML architecture provides open access to the data at al levels

XML as a technology has been leveraged to under-pin a host of new technologies with confusing and opaque acronyms: SOA, SOAP, WDSL and so on. These arcane technologies are of great interest to software developers and make a lot of the web services we have today work (like booking an airline ticket on-line). But do they have any relevance for a flight test instrumentation engineer?

The answer is yes. With an XML based architecture for the management of the reams of information needed to configure a flight test installation we can leverage these and other technologies to simplify everyday tasks.

1. With an XML base, software interfaces can be used to permit other software programs to access the data without having to get lost in the details of the file structure. This greatly simplifies the task of integrating disparate hardware and software packages into a cohesive whole for the companies and programs that are managing large flight test programs.
2. Because XML is a universal standard, and schema such as XidML are published on the internet (www.xidml.org), user tools can be created that are independent of a particular vendor or application for managing the XML data. The rest of this paper discusses some user tools based on an open, published XML architecture.

3. It is possible to conceive of a world where the instrumentation itself is the "XML server" and all that an engineer needs to program, configure and validate his installation is a web browser.

3 SOME XML TERMINOLOGY

In this section we discuss some key terms useful for discussing XML tools.

An XML file is a tagged text file. For example, a XidML representation of a PCM frame is shown in figure 1. The text within "<…>" is a tag and is used to define the meaning of the data that follows, up to the end-tag which is defined by "</…>". It is this use of simple tags that enables computers to automatically parse XML files and extract the data. Data units within tags are called ***elements***.

A ***schema*** is a specification for an XML file. For example, the XidML schema states that the PCM frame description must have a <*Properties*> tag, and that that tag must contain one and only one <*BitsPerMinorFrame*> element which must be in integer. So given a set of rules defined by a schema we can write XidML files that we know are valid and can be used by any tool that can work with XidML files, and also many generic tools that work with any XML file.

A ***style-sheet*** is a special type of XML file that defines how data within an XML file can be extracted and written in a different format – either as another XML file or as HTML (a web page) or as some completely different format. This is a powerful feature that some tools can use to add value.

4 TOOLS - OVERVIEW

Tools for manipulating XidML fall into two main categories (see figure 2):

1. Generic Tools: these tools "piggy-back" on the wide range of XML tools available to add specific functions for generating reports, validating configuration files and translating from XidML to other XML formats.
2. Domain Specific Tools: These tools build on a knowledge of the flight test instrumentation domain and XidML structure to provide vendor independent interfaces for generating XidML files and performing specific functions such as building PCM frames or auto-balancing.

There is a third category of tools: vendor specific. These tools take XidML input and generate proprietary output tailored for the target systems. These tools are not discussed in this paper.

All XML tools supplied by ACRA CONTROL share certain key features:

```
<X-IRIG-106-Ch-4-1.2 Name="MyPCMFrame">
        <PackageRate>200</PackageRate>
        <Properties>
                <MajorFrameProperties>
                        <BitsPerMinorFrame>1024</BitsPerMinorFrame>
                        <MinorFramesPerMajorFrame>4</MinorFramesPerMajorFrame>
                        <DefaultDataBitsPerWord>16</DefaultDataBitsPerWord>
                        <DefaultMostSignificantBit>First</DefaultMostSignificantBit>
                        <FillPattern>AAAA</FillPattern>
                </MajorFrameProperties>
                <SynchronizationStrategy>
                        <SubframeSynchronizationStrategy>
                                <SFID>
                                        <MinorFrameOffset_Words>1</MinorFrameOffset_Words>
                                        <StartValue>0</StartValue>
                                        <Increment>1</Increment>
                                        <MostSignificantBit>First</MostSignificantBit>
                                </SFID>
                        </SubframeSynchronizationStrategy>
                        <SyncWord>11111110011010110010100001000000</SyncWord>
                </SynchronizationStrategy>
                <Modulation>
                        <PCMCode>NRZ-L</PCMCode>
                        <DclkPhase>0</DclkPhase>
                        <PCMPolarity>True</PCMPolarity>
                </Modulation>
        </Properties>
        <Content>
                <Parameter Name="F0W2">
                        <Location>
                                <MinorFrameNumber>0</MinorFrameNumber>
                                <Offset_Words>2</Offset_Words>
                                <Occurrences>8</Occurrences>
                        </Location>
                </Parameter>
        </Content>
</X-IRIG-106-Ch-4-1.2>
```

Figure 2: Parameter definition (partial) in XidML

1. Tool can operate as a stand-alone graphical user interface tool, or it can be run as a command line tool with no user interaction.
2. User input can be provided via a GUI or via an XML file (called a CmdML) file.
3. Results are reported both in a message window and in an output XML (called MsgML) file.

Thus the tools are designed to operate either stand-alone, as components of another user interface program, or as components of a script or automated process.

4.1 GENERIC TOOLS

There are several types of generic tool that can be tailored for use with XidML. In general these utilize XML standards such as schemas and style-sheets, or third party developers tools such as parsers.

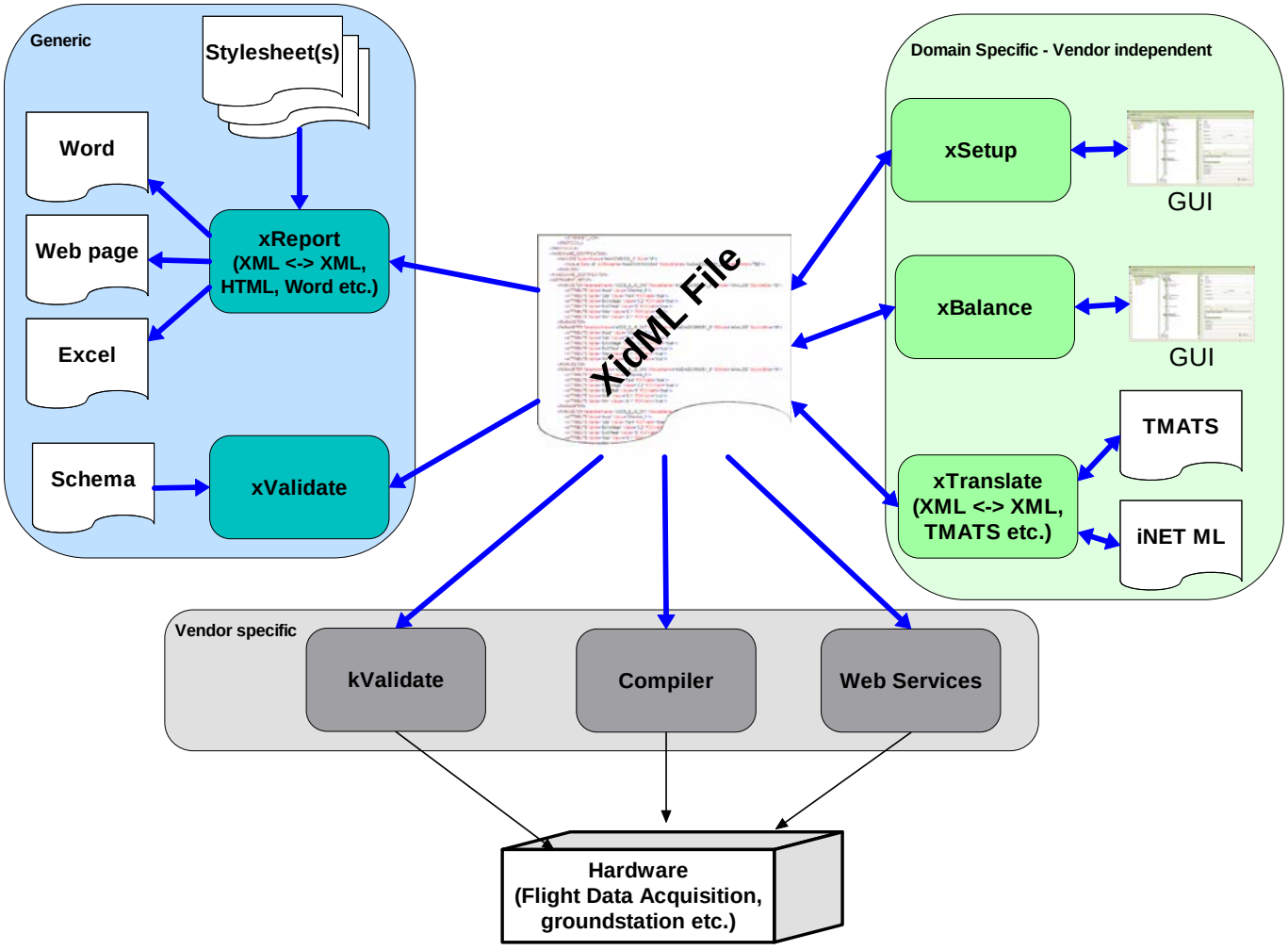

Figure 3: Tool categories for XidML

4.1.1 VALIDATION - X-Validate

X-Validate is a tool that checks a XidML file against the schema and reports any errors it locates. A validator simply parses and checks an XML file to ensure that it is properly formed XML. If the schema is available it will use that to further check the file structure and content. Note that the schema does not necessarily have to ship with the instance file – if it is available on the web the validator will find it and use it.

There are many XML validators on the market and all XML editors (XMLSpy®, <oXygen/>® and Stylus Studio® for example) will also validate XML. A validator in itself is only as good as the schema it validates against. Consider the following example:

```
<Book>
     <Price>qwerty</Price>
</Book>
```

A well-written schema will encode a rule that the price element must be numeric – thus permitting a validator to catch the above entry as an error. In fact, the schema could mandate a "currency" attribute and the format of the number so that only an entry like the following would be considered valid:

```
<Book>
        <Price currency="USD">23.99</Price>
</Book>
```

Great care has been taken with the XidML schema to encode as many rules as practical into the schema itself. Thus any editor that supports validation can be used to test and develop a XidML file greatly simplifying the task of integrating XidML based systems into an existing IT infrastructure.

While XidML is generic to any hardware, it is used by ACRA CONTROL for configuration of their own KAM-500 data acquisition system. The tool kValidate provides a level of checking beyond what is possible with X-Validate. For example, X-Validate can check that the gain setting for a particular hardware module is numeric, but kValidate can check if the hardware physically supports that gain setting.

4.1.2 TRANSLATION – X-Report

XML is easy to transform into other formats using style-sheets. Style-sheets are actually XML files that describe how to convert an XML file into another format – usually some other ASCII text format. They are traditionally used to display XML information in HTML format for web pages, but can be used in many other ways. Style-sheets are one of the most important value-added tools for XML. There are many free tools that take a source XML file and a style-sheet as input, and generate the target document. Msxsl® is a free download from Microsoft, and there are many others such as Saxon and Xalan.

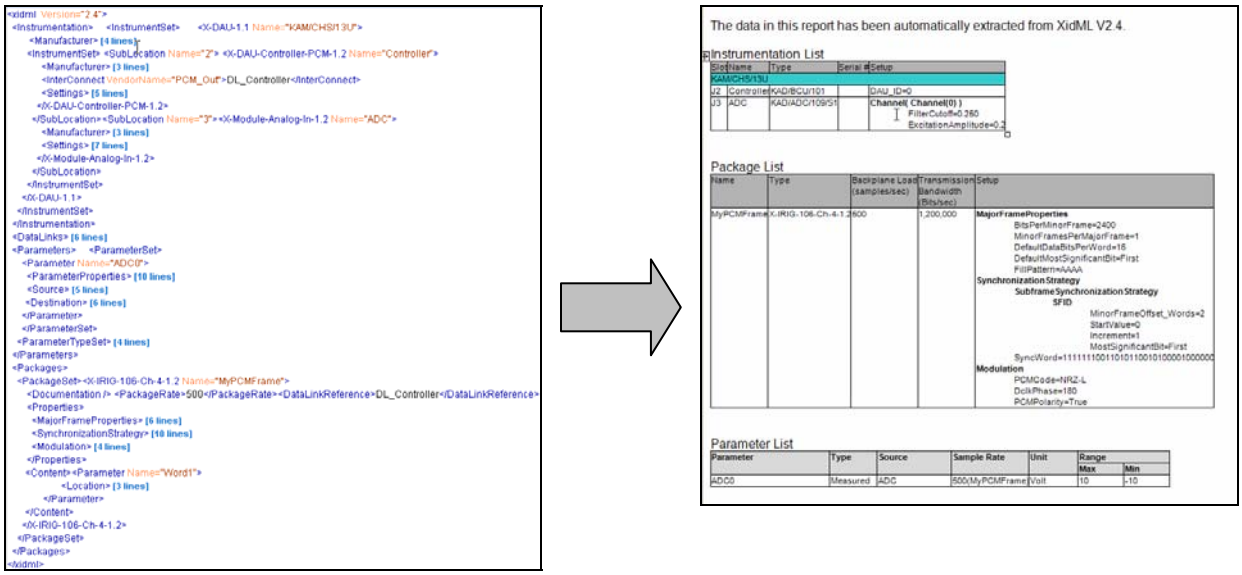

Figure 4: Transforming XidML into a Word Document

The X-Report tool is simply a wrapper for one of these tools, and allows a style-sheet to be applied to a XidML file to extract important information for report purposes. For example, a HTML page listing all the hardware defined in a XidML file can be generated. With the advent of Microsoft Office 2003, Microsoft office tools support XML as a format for words documents and spreadsheets. This permits powerful and informative reports to be generated in word format from XidML with minimum effort.

Figure 4 shows a XidML file that has been transformed into a Word document.

Style-sheets provide a powerful way to generate multiple different types of output from a single source document. This eliminates several stages of human interfacing with their associated risk of introducing errors. In database design, a lot of effort goes into ensuring that information appears once and once only to avoid having to change it in multiple places. Style-sheets allow the same concept to be applied to meta-data management for flight test. By making the XidML file the "record" the data can be referenced and exported to many other forms – reports, databases and logs.

4.2 DOMAIN SPECIFIC TOOLS

While generic tools already provide significant value-added support for XML, domain specific tools utilize a knowledge of what the XidML file is describing to add value. These can take advantage of the fact that we know we are describing a test configuration, or a PCM frame, to add manipulative power to the XidML representation. Note that these tools "don't care" about the final vendor hardware, or implementation details, they are concerned only with manipulating XidML.

4.2.1 EDITING AND CREATING XIDML FILES - X-Setup

Although a XidML file can be written in any text editor, X-Setup provides a graphical user interface for creating XidML files. It uses knowledge of the XidML structure to present the key elements in an easily recognizable way. An important feature is the ability to manage libraries of XidML files, permitting the user to drag and drop elements from existing files into new files.

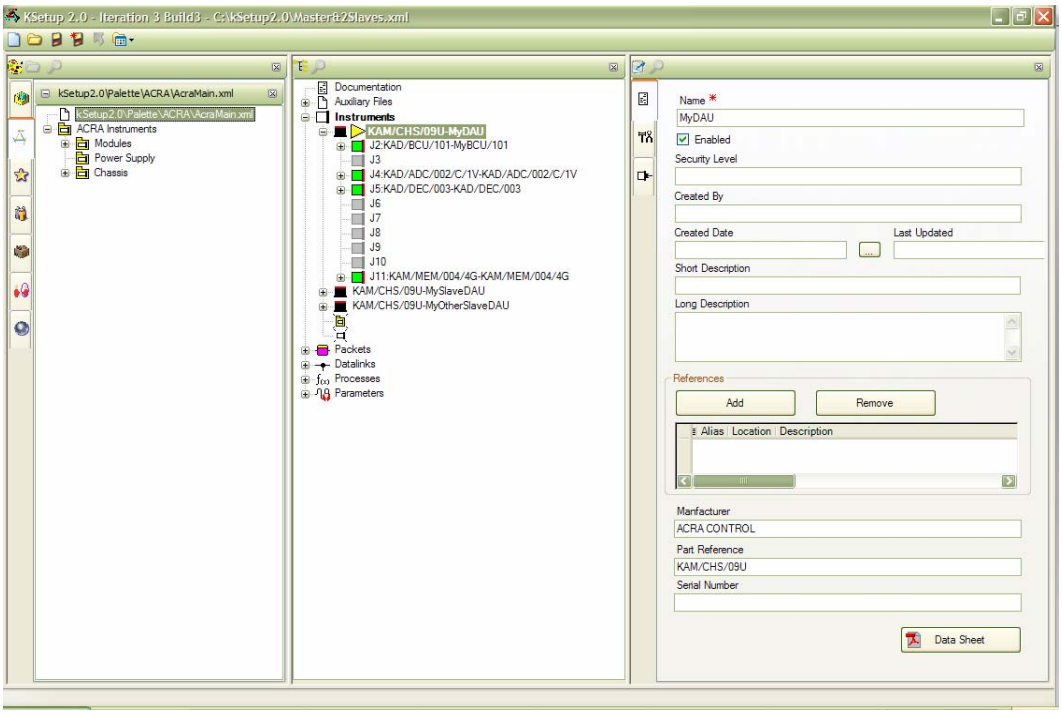

Figure 5: Screenshot of X-Setup

Much of the user interface of X-Setup is auto-generated based on the content of the XidML file. Further functionality can be enhanced (e.g. range checking) by creating XML file descriptions of what should be in the XidML and linking them to X-Setup.

Because it essentially just a XidML generator/editor, X-Setup can be used to configure any hardware or display software that can import XidML datafiles, regardless of who the vendor is. This is in contrast to existing solutions for multiple hardware configuration which are based on proprietary information stored in databases.

4.2.2 TRANSLATING - X-Translate

X-Translate is a more powerful version of X-Report and is used where a traditional style-sheet is not powerful enough to transform the XidML into a new format, or vice versa. X-Translate currently supports transformation to and from the evolving iNET ML format, with plans to support TMATS XML as users demand.

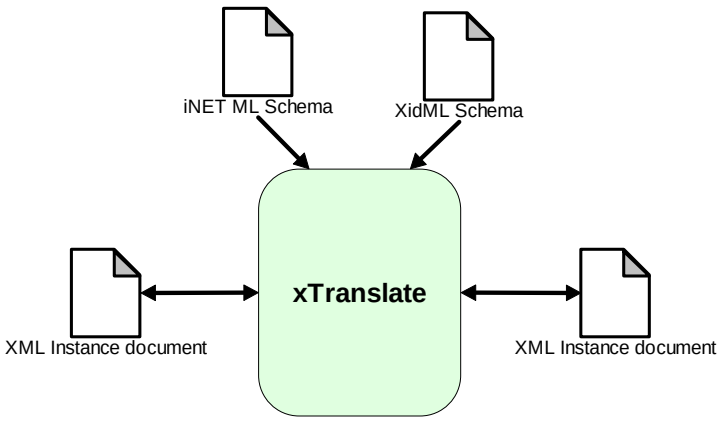

Figure 6: Document Translation

5 CONCLUSION

XML has simplified processes and provided powerful ways of storing and sharing data in many industries. Only recently has the flight test community begun to consider. XidML was the first published schema for the flight test community and provides a platform for a range of tools that make life easier for the test engineer. From generic tools that simplify the tasks of creating, moving, storing and interpreting the flight test data, to domain specific tools that assist in building and tweaking the configuration, to vendor-focussed tools that use XidML to configure the hardware, the power of XML is at last available for the flight test community.

6 REFERENCES

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