AN XML SCHEMA FOR AIRBORNE TELEMETRY BASED ON THE IRIG TMATS STANDARD

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ABSTRACT

XML is a simple and powerful way to handle on data transfers between organizations, applications and/or computer systems. Currently, there is a significant effort within NASA to transition to XML vocabularies as the means of exchanging electronic data. XML can provide a useful way to transfer telemetry attributes data between customers and systems. The current standard for airborne telemetry data description is the Telemetry Attributes Transfer Standard (TMATS). TMATS is a well-defined, structured specification that will map into XML extremely well. This makes XML an excellent choice to supplement TMATS for the interchange of telemetry attribute information. The Western Aeronautical Test Range (WATR) at NASA Dryden Flight Research Center (DFRC) is defining an XML Schema that will be used in support of the WATR Integrated Next Generation System (WINGS). This paper describes this work in progress.

KEY WORDS

Telemetry, TMATS, XML, Telemetry Attributes Transfer Standard

INTRODUCTION

The Western Aeronautical Test Range (WATR) at NASA Dryden Flight Research Center (DFRC) is developing its next generation real time acquisition and processing system, the WATR Integrated Next Generation System (WINGS) Mission Segment. The purpose of the WINGS Mission Segment is to acquire data from a variety of sources and process that data for subsequent display and analysis by project engineers in the WATR Mission Control Centers (MCCs) in real-time and near real-time. One of the primary goals of WINGS is to provide a flexible, re-configurable system for ground support of the wide variety of experimental vehicles assigned to Dryden. WINGS is being implemented in an evolutionary phased approach.

As a significant part of the WINGS architecture, it is planned to implement the mission configuration segment of the WINGS system around a World Wide Web enabled set of Extensible Mark-up Language (XML) data objects.

WINGS must support the import and export of mission configuration data and telemetry attributes from the wide variety of projects and missions. WINGS architecture also defines the use of the Inter-range Instrumentation Group's (IRIG) Telemetry Standard (IRIG 106) Telemetry Attributes Transfer Standard as a mechanism of importing new program information into the WATR. Therefore, an effort has begun which begins with the definition of an XML schema to support the TMATS standard file format and can easily be incorporated into the WINGS overall mission configuration plans. Figure 1 pictorially represents how the use of TMATS and a variety of other Configuration Information will be used to prepare for a Flight Research Mission at DFRC.

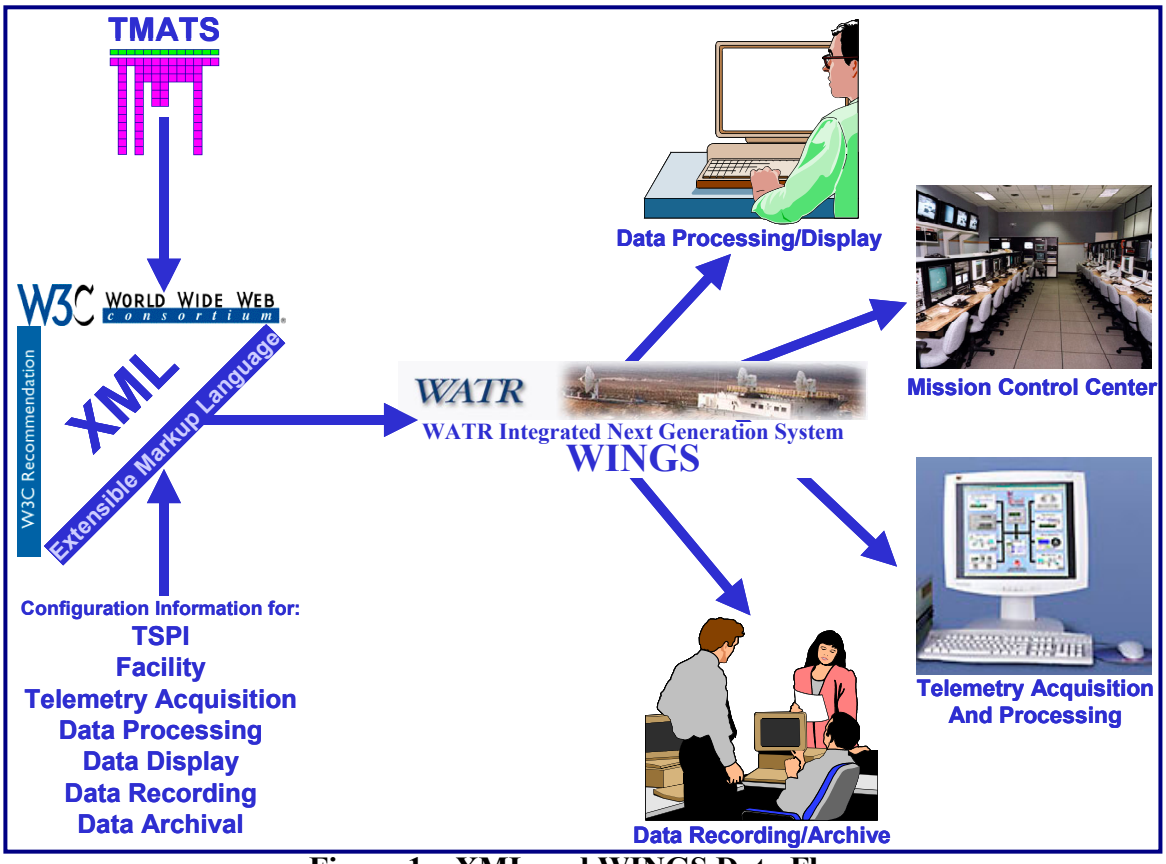


Figure 1 – XML and WINGS Data Flow

This paper describes the efforts that are currently under way to take the existing TMATS standard and create an XML Schema which can easily import a TMATS file and create an XML file which will carry all of the necessary information to support mission setup for the WINGS.

WHAT IS TMATS?

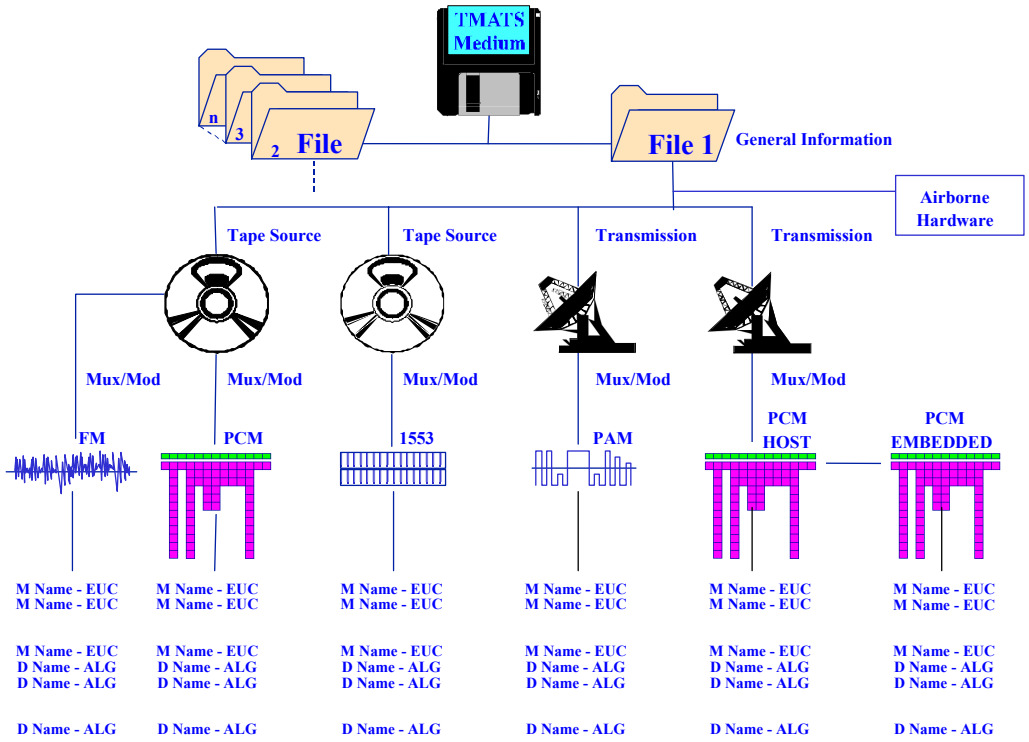
As with standards in other industries, the standards developed by the Telemetry Group of the Inter-Range Instrumentation Group (IRIG) of the Range Commanders Council (RCC) are designed to provide

a standard platform for the development, implementation, and utilization of telemetry systems by the user and vendor community.

In early 1993, the IRIG introduced the TMATS, which was published in IRIG 106-93 as Chapter 9 (updated in 1996, 1999, 2001, and coming in 2003). This long needed standardization was designed to provide a common thread through which test programs could move from one test range to another significantly reducing amount of re-work and cost in the setup environment.

As described in Chapter 9 of IRIG 106, the purpose of TMATS is *"... to provide a common format for the transfer of information between the user and a test range or between ranges. This format will minimize the 'station unique' activities that are necessary to support any test item. In addition, it is intended to relieve the labor intensive process currently required to reformat the information by providing the information on computer compatible media, thus reducing errors and requiring less preparation time for test support."* [1]

The attributes defined by TMATS (shown in Figure 2) are those parameters required by the receiving/processing system to acquire, process and display the telemetry data received from a test item or source. Each attribute is represented by a unique code name and associated data (syntax).



Telemetry Attributes Transfer Standard

Figure 2 – The TMATS Standard

TMATS is divided into Groups of telemetry attributes, which are described in Table 1.

Attribute Group	Description
General Information	Defines various top-level program definitions and defines each data source used within this TMATS file.
Transmission Attributes	Describes each RF link that was defined in the General Information Section.
Tape Source Attributes	Describes each tape data source defined in the General Information Section.
Multiplex/Modulation Attributes	Defines each FM/FM, FM/PM, or PM/PM multiplex characteristic. For analog measurement, this section defines a link to the Data Conversion Section.
PCM Format Attributes	Defines the format and various characteristics of a PCM data stream. This definition includes subframe and embedded format descriptions.
PCM Measurement Attributes	Defines and describes each PCM measurand to the system. This definition includes the measurand location(s) and measurement names.
1553 Bus Data Attributes	Defines each 1553 data stream by defining the various messages and their locations.
PAM Attributes	Definition of the Pulse-Amplitude Modulation system. This includes PAM format characteristics and measurement attributes.
Data Conversion Attributes	Defines the various conversions that are to be applied to defined measurements.
Airborne Hardware Attributes	This section was recently added to the TMATS specification (5 May 1995). It defines the specific configuration of airborne instrumentation hardware in use on the vehicle under test.

Table 1 – TMATS Telemetry Attributes Groups

WHAT IS XML?

Extensible Markup Language, abbreviated XML, describes a class of data objects called XML documents and partially describes the behavior of computer programs which process them. XML is an application profile or restricted form of SGML, the Standard Generalized Markup Language. By construction, XML documents are conforming SGML documents.

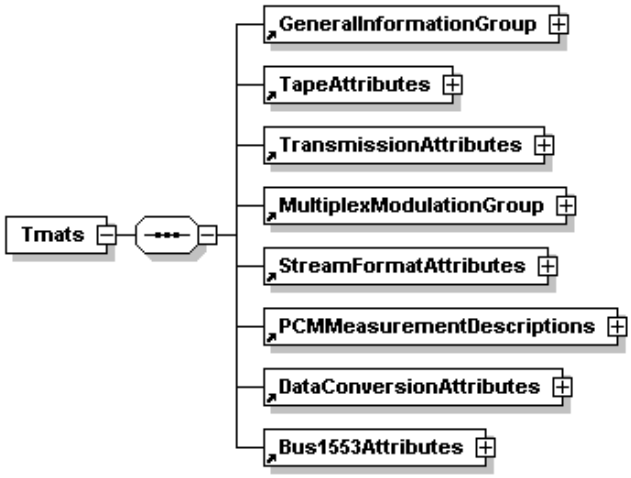
XML documents are made up of storage units called entities, which contain either parsed or unparsed data. Parsed data is made up of characters, some of which form character data, and some of which form markup. Markup encodes a description of the document's storage layout and logical structure. XML provides a mechanism to impose constraints on the storage layout and logical structure.

A software module called an XML processor is used to read XML documents and provide access to their content and structure. It is assumed that an XML processor is doing its work on behalf of another module, called the application. This Extensible Markup Language (XML) 1.0 (Second Edition) (provided by the World Wide Web Consortium (W3C) as a Recommendation) specification describes the required behavior of an XML processor in terms of how it must read XML data and the information it must provide to the application.

XML was designed to enhance the interchangeability of information between applications. Very much like TMATS, XML has been accepted by the industry as the most appropriate mechanism of sharing information for a wide variety of applications ranging from financial information to highly technical data such as telemetry attributes.

THE TMATS XML SCHEMA

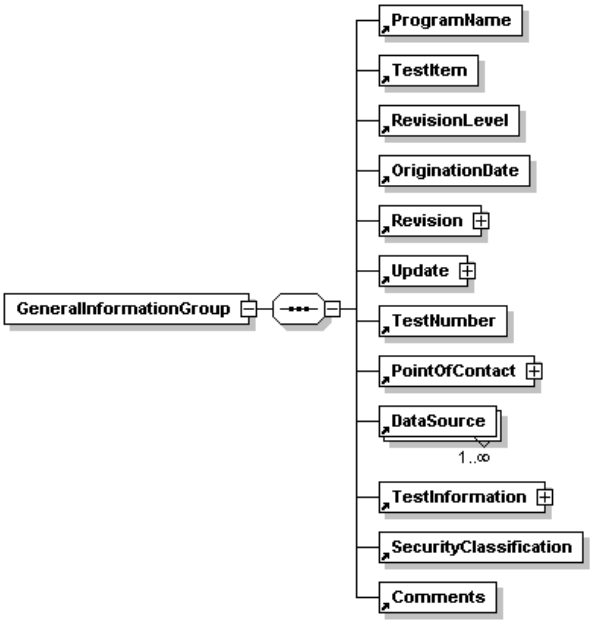
The schema being developed for TMATS has a one-to-one relationship to the attributes that are defined in the telemetry standard. At the top level, shown in Figure 3, each of the TMATS Groups are defined:




```
<xs:element name="Tmats">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="GeneralInformationGroup"/>
      <xs:element ref="TapeAttributes"/>
      <xs:element ref="TransmissionAttributes"/>
      <xs:element ref="MultiplexModulationGroup"/>
      <xs:element ref="StreamFormatAttributes"/>
      <xs:element ref="PCMMeasurementDescriptions"/>
      <xs:element ref="DataConversionAttributes"/>
      <xs:element ref="Bus1553Attributes"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
```

Figure 3 – Top Level XML Schema for TMATS

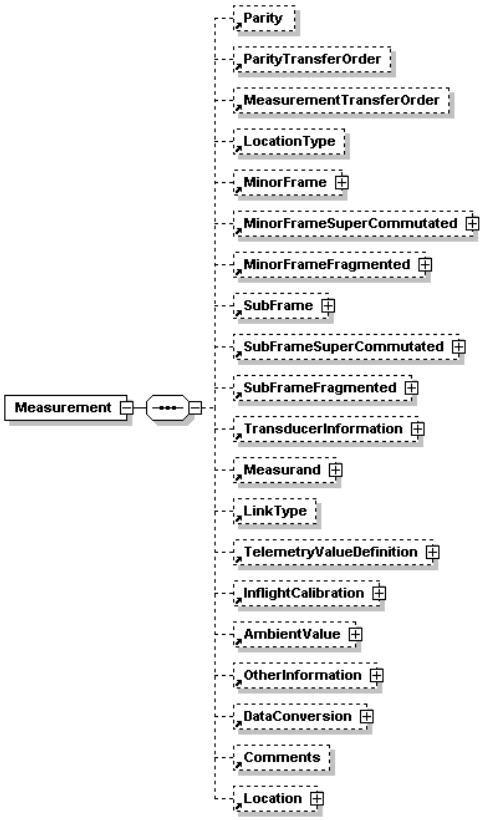
As an example of the XML Schema for TMATS, Figure 4 presents the structure defined for the General Information Group of TMATS. Each element (TMATS attribute) is defined along with specific programmatic information as to the specific data to be supplied, including: List of Possible Choices, Range of Values Allowed, Type of Values Allowed, Character String Length, etc. This information comes directly from Chapter 9 of the IRIG 106 Telemetry Standard.




```
s:element name="GeneralInformationGroup">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="ProgramName"/>
      <xs:element ref="TestItem"/>
      <xs:element ref="RevisionLevel"/>
      <xs:element ref="OriginationDate"/>
      <xs:element ref="Revision"/>
      <xs:element ref="Update"/>
      <xs:element ref="TestNumber"/>
      <xs:element ref="PointOfContact"/>
      <xs:element ref="DataSource" xOccurs="unbounded"/>
      <xs:element ref="TestInformation"/>
      <xs:element ref="SecurityClassification"/>
      <xs:element ref="Comments"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
```

Figure 4 – Top Level XML Schema for the General Information Group

Another, more complicated, example of the XML Schema for TMATS is shown in Figure 5. This describes the telemetry attributes required to define a measurement in the standard.




```
<xs:element name="Measurement">
 <xs:complexType>
  <xs:sequence>
   <xs:element ref="Parity" minOccurs="0"/>
   <xs:element ref="ParityTransferOrder" minOccurs="0"/>
   <xs:element ref="MeasurementTransferOrder" minOccurs="0"/>
   <xs:element ref="LocationType" minOccurs="0"/>
   <xs:element ref="MinorFrame" minOccurs="0"/>
   <xs:element ref="MinorFrameSuperCommutated" inOccurs="0"/>
   <xs:element ref="MinorFrameFragmented" minOccurs="0"/>
   <xs:element ref="SubFrame" minOccurs="0"/>
   <xs:element ref="SubFrameSuperCommutated" minOccurs="0"/>
   <xs:element ref="SubFrameFragmented" minOccurs="0"/>
   <xs:element ref="TransducerInformation" minOccurs="0"/>
   <xs:element ref="Measurand" minOccurs="0"/>
   <xs:element ref="LinkType" minOccurs="0"/>
   <xs:element ref="TelemetryValueDefinition" minOccurs="0"/>
   <xs:element ref="InflightCalibration" minOccurs="0"/>
   <xs:element ref="AmbientValue" minOccurs="0"/>
   <xs:element ref="OtherInformation" minOccurs="0"/>
   <xs:element ref="DataConversion" minOccurs="0"/>
   <xs:element ref="Comments" minOccurs="0"/>
   <xs:element ref="Location" minOccurs="0"/>
  </xs:sequence>
  <xs:attribute name="Name" type="xs:string" use="required"/>
 </xs:complexType>
</xs:element>
```

Figure 5 – Top Level XML Schema for Measurement Definition

HOW TO USE THE TMATS XML STRUCTURE

Once the TMATS XML Schema is complete and fully supports the complete telemetry attributes transfer standard, several applications will be developed to take full use of this effort. These include:

1. An application that will import a standard TMATS file and translate it into the XML language defined above.
2. An application that will import an XML file and create a standard TMATS file.
3. For those telemetry vendors who utilize XML in their hardware and software configuration environment (there are several today), an Extensible Stylesheet Language Transformation (XSLT) utility will be developed to transform the TMATS XML into the vendor specific XML structure.

The finalized version of the TMATS XML schema will be made available to the industry on the Web for use by other members of the telemetry community. This should occur by late summer 2003.

CONCLUSIONS

Since its inception in the early 1990s, TMATS has gained popularity and overcome the skepticism from both the telemetry vendor and user communities. This is largely due to TMATS' ability to significantly reduce the time necessary to bring a new program to test readiness. Coupling the definitive TMATS standard with the platform independent XML technology should further enhance the usability and extensibility of this telemetry standard.

It should be noted that a standard interface between instrumentation groups and ground stations is extremely valuable not just for ease of use and portability among ground processing stations but also for commonality, report generation, calibration archiving and pre-flight checkout for instrumentation personnel. All of these things contribute to lower risk, less cost and less chance of program delay to the ultimate customer -- the test project.

REFERENCES

[1] "Telemetry Standards", IRIG Standard 106, May 1996, Secretariat, Range Commanders Council, U.S. Army White Sands Missile Range. http://jcs.mil/RCC/

[2] Extensible Markup Language (XML) 1.0 (Second Edition), W3C Recommendation 6 October 2000 Latest version: http://www.w3.org/TR/REC-xml , Copyright© 2000 W3C® (MIT, INRIA, Keio), All Rights Reserved.

[3] B. Downing – **An XML Vocabulary for TMATS –**Proceedings ITC/USA 2000, San Diego, CA Oct. 2000