Implementing the ATML Test Station and Test Adapter Standards

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Abstract – **The ATML family of standards have now been published through the IEEE and are beginning to be implemented in the test industry. This paper explores two of these ATML standards, the IEEE Std 1671.6 ATML Test Station Description and the IEEE Std 1671.5 ATML Test Adapter Description. These standards describe a test station and test adapter in an electronic format adhering to the XML standard. A description of the standards will be provided along with some suggestions on applications that could benefit from their incorporation. Some of the applications that will be explored are: test diagram generation, test station capability comparisons, test adapter fabrication, resource management and path allocation. In addition the ATML WireLists schema will be discussed, which is associated with the ATML Test Station and Test Adapter standards. This paper hopes to encourage the use of these standards by providing some guidance and resource materials to assist in their implementations.**

I. INTRODUCTION

The Automatic Test Markup Language (ATML) standards are beginning to gain industry interest and acceptance. These standards promise to reap significant cost savings for Automatic Test System (ATS) programs through the standardization and reuse of test data. This paper focuses on two of these standards the IEEE Std 1671.6 ATML Test Station Description and the IEEE Std 1671.5 ATML Test Adapter Description. The goal of this paper is to provide information and resources to assist in implementing these two ATML standards. The ATML Test Adapter Description standard provides information to describe Test Program Set (TPS) interface hardware, adapters, cables, load boxes etc., which are used in a TPS to test a UUT. The ATML Test Station Description standard provides information to describe an Automatic Test Station. These two standards and their associated XML schemas will be explored along with the closely linked ATML WireLists schema, which is a system description of how multiple ATML hardware schemas can be combined from a connectivity standpoint.

II. ATML STANDARDS

The ATML working group has generated eight standards which have now been published within the IEEE SCC20 working group, each related to specific areas of ATS. These eight ATML components are Test Results, Test Configuration, Test Description, Instrument Description, Diagnostics, UUT Description, Test Adapter Description and Test Station Description. The development of the ATML standards has been a cooperative effort of many test industry companies and DoD ATS users. Two of the ATML components were incorporated into existing standards: the Diagnostics has been published in the AI-Estate IEEE Std 1232, and the Test Results has been incorporated into the SIMICA IEEE Std 1636.1. The rest have been published as ATML 1671 component standards. The main ATML 1671 standard has completed its trial use period and was recently reaffirmed in the IEEE ballot process. This main 1671 standard provides the overall framework for ATML along with common schemas which are used by the individual component standards. All of the component standards, such as the Test Station and Test Adapter described in this paper, are now in the trial use period and will soon go up for reaffirmation ballot in the IEEE. The ATML standards provide a structure and format for describing test related data adhering to the XML standard. There are a number of companies and DoD entities that are beginning to use ATML on ATS programs. This interest in ATML has begun to drive commercial tool vendors to develop software tools which support the generation of ATML instance files. Availability of tools is a key component to ensuring the standards gain widespread use. ATML promises to provide interoperability between tools and multiple test platforms through the standardization of common test related data. The ATML group has produced successful demonstrations at Autotestcon 2008, and 2009 which have provided some real world applications of ATML. Note that these demonstrations highlighted just a few of many possible applications of ATML.

III. TEST ADAPTER & TEST STATION DESCRIPTION SCHEMAS

XML schemas are used to define the format and relationships of the ATML data. The ATML Test Adapter Description schema contains information to describe the ATE interface hardware required for the test of a UUT such as a test adapter, cables or load box. This XML schema describes the connectors, wiring and components within the interface hardware. The ATML Test Station Description schema

contains information about a test station. It defines the instruments, switching and connectivity within an ATE.

Each of the ATML component schemas, such as the ATML Test Station and Test Adapter, utilize common schemas and data types which are part of the main 1671 standard. The common schemas used by the Test Station and Test Adapter are Common, HardwareCommon and TestEquipment. These common elements allow for consistent data types to be used throughout the ATML schemas. The Common schema provides data types that are shared between all ATML schemas. The HardwareCommon schema defines elements that are specific to the hardware related schemas, UUT Description, Instrument Description, Test Station and Test Adapter. As the Test Station and Test Adapter standards were being developed initially the group had two separate schemas containing different elements, as work progressed it became more apparent that the characteristics that the group wanted to standardize on for a test station were very similar to those for a test adapter. The group decided to form a common schema, the Test Equipment schema, which would be shared by both the test station and test adapter. The Test Station and Test Adapter schemas now contain identical elements and attributes with the exception that a test station has a required Instruments element which a Test Adapter does not have. See figure 1 for the relationships of these schemas for the Test Station Description schema, note that this diagram is similar for the Test Adapter Description schema. Figure 2 shows the main elements and attributes that are used to define the Test Station or Test Adapter (referred to as the test equipment item in the figure).

In addition to the ATML Test Station Description and Test Adapter Description schemas there are related ATML Test Station Instance and Test Adapter Instance Schemas. These schemas, though not of particular interest to this paper, are used to define a particular instance of the item, where the description schema covers a class of the item. For example if the intent was to generate an ATML file to describe a CASS test station type the Description schema would be used but if one is to describe a particular instance of a CASS station (SN 0121) then the Instance schema would be used. These Instance schemas are also defined in the 1671.5 and 1671.6 standards. The Instance schema should not be confused with the instance file described in section VII.

IV. REQUIRED VS OPTIONAL ATML DATA ITEMS

Within the ATML schemas the particular data items, whether elements or attributes, are designated either required or optional. Required data items must be populated for all cases in order to conform to the particular schema. The optional data items may be populated or not included and that is left up to the discretion of the user. As one can see from the list of elements in figure 2, not all of these data items would be applicable and/or of interest in all use cases and that fact has driven the decision to list most of them as optional. The need for designating some of the data optional and some required is due to the fact that the ATML standards were designed to support many different use case scenarios used in support of many different ATS programs.

When requiring ATML compliant files on an ATS program it would be prudent to delineate which of the optional data items need to be populated. If these requirements are not levied then the delivered files could have very different data content and may not be useful for the intended applications. Simply noting that the solution needs to be ATML compliant is typically not adequate. As a suggestion, an ATML requirement could be stated as follows: “The Test Station shall be defined using the ATML IEEE Std 1671.6 Test Station Description and at a minimum the following data items shall be populated: version, name, description, identification, interface, components, control, documentation, calibrationRequirements, environmentalRequirements, powerRequirements, physicalCharacteristics, networkList, facilitesRequirements, controllers, software, resources, switching, terminalBlocks and instruments”. Note that within each of the above elements there are additional child elements and attributes and it may be necessary to specify all the child elements that should be populated. Another suggestion is to add a note that states that the ATML file defining the test station should be sufficient to support the following use cases, then list the intended uses.

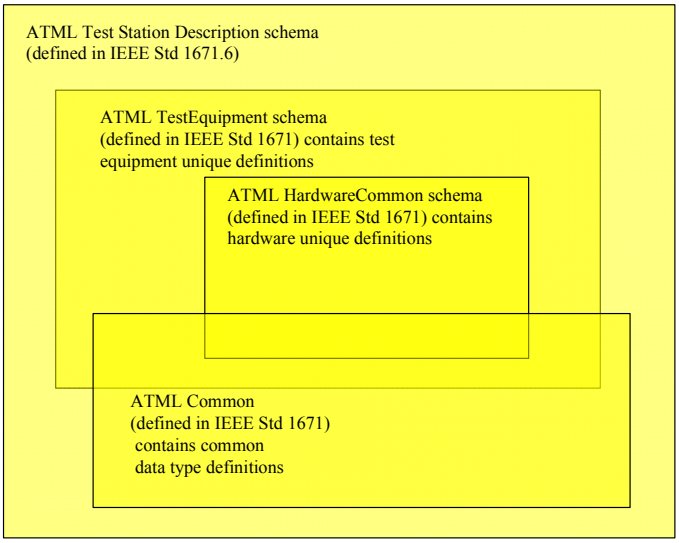

Figure 1, Test Station schema components

Element or Attribute Name	Description of element/attribute and its child elements
Version	Version of the test equipment item described in this file
Name	Name of this test equipment item
Description	Text description of this test equipment item
Identification	Identification includes reference designator, model name and numbers, manufacturers of this item and their information
Interface	This describes the electrical interface to this item and includes a description of the connectors, ports and pins. References to these interface ports is used in the networkList.
Components	This contains any sub-assemblies to this test equipment item
Parent Components	This contains information about the next higher assembly if applicable
Control	Contains a list of drivers, firmware, control language and tools used to control the test equipment item
Documentation	This element references all documentation related to this test equipment item. This could include document numbers and/or URLs.
Configuration Options	These are options for configuring the item which can be modified but persist after a power-up cycle. This is more commonly used in a test station (e.g., RF Mode or Analog Mode)
FactoryDefaults	These are defaults for factory settings of the test equipment item. This is more commonly used in a test station.
Calibration Requirements	This element could include how often the item needs to be calibrated, the support equipment needed to calibrate and/or the calibration procedure.
Operational Requirements	The operational requirements for the test equipment item (e.g., Warm-up time)
Environmental Requirements	This contains the environmental requirements for operating and storage of the test equipment item, information such as temperature, humidity and/or vibration.
Power Requirements	This element contains the AC and DC power requirements for operating this test equipment item.
Physical Characteristics	Identifies the physical characteristics of the test equipment item, such as the mass, volume, and measurements.
Errors	Contains all errors associated with this test equipment item. A possible use is to hold Built In Test (BIT) errors or test station runtime errors.
NetworkList	This element is used to represent the connectivity of the test equipment item. This element references the defined ports from the Interface, Resources, Switches and Terminal Block elements and defines how they are connected.
LegalDocuments	This will contain documents related to safety warnings, warranties, licenses and conformance.
Facilities Requirements	This element contains requirements on the facility that this test equipment item is operated in (these are non-power as power requirements are shown above) hydraulics, cooling, pneumatic and a reference to related documentation.
Controllers	This contains capabilities of the test equipment controller such as processor type, memory, video capability and software.
Software	This identifies software which is part of this test equipment item such as test station self test, runtime software, operating system and calibration software.
Paths	This element shall identify the characteristics of signal paths through the test equipment item. The begin and endpoints of the path are identified along with the characteristics of the path such as Resistance.
Specifications	This is a list of all specifications relevant to this test equipment item.
Resources	This element contains all resources in the test equipment item that source, measure or modify signals. The resource description and interface are contained in this element.
Switching	This element contains all switches in the test equipment item and their interface. Also includes a definition of their switching capabilities. This element can be used to trace signal paths through the system.
Capabilities	This element contains the capabilities of the resources in a test equipment item. The IEEE Std 1641 Signal and Test Definition is used to define the signal capabilities.
TerminalBlocks	This element contains a definition of the terminal block connections in the test equipment item. This can be used to trace signals through the system.
Security Classification	This element identifies the security classification of this test equipment item
Instruments	This contains all the instruments in a test station and their location (reference designator) and address for communication. This element is not present in the Test Adapter schema. The ATML Instrument Description instances for these instruments can be referenced in this element.

Figure 2, Test Station and Test Adapter Elements

V. ATML DATA EXTENSTIONS

ATML standards allow for extension points in a number of places in the schemas to allow the user to add elements that may be required for a particular application but are not defined in ATML. The use of extensions should be minimized since this can affect the sharing of this ATML data by different applications as it is not standardized in the ATML schema. Note that extensions can affect interoperability between tools and systems which is a key benefit of ATML

VI. ATML WIRELISTS SCHEMA

The WireLists schema is a system level schema and part of the common 1671 ATML main standard. The WireLists fills a void in ATML discovered in a past Autotestcon ATML demonstration which was the inability to associate pins from one ATML entity to another. Since each of the ATML instance files are stand alone, and have no knowledge of the content of other instance files, there was no way to know which pin on a UUT was connected to which pin on a test adapter. The WireList element of the WireLists schema makes this association. In addition the Wirelists schema contains the TestWireList element which is a collection of networkList elements representing a path from a test station instrument all the way to a UUT pin on a per test basis. This element was created specifically to address the test diagram use case, which provides the complete signal paths used in each test for stimulus and measurements. Generation of this element can be very time consuming and error prone without proper ATML support tools.

VII. ATML INSTANCE FILES

The key information contained in the ATML standards is in the form of XML schemas as noted above. These schemas are used as a template for populating data for a particular item and this populated file is called an XML instance file. These instance files contain all the information to describe the item of interest and these files are then used in various ATS applications. The instance files can be created manually, with a text editor or with an XML editor program such as XML SPY, however manual generation can be very time-consuming, cumbersome and error prone. This fact has driven the need for software tools to automate the generation of these instance files. There are a number of companies that have developed or are in the process of developing tools to support these ATML standards. Some of these tools have been used in previous ATML Autotestcon Demonstrations.

VIII. ATML TEST STATION AND TEST ADAPTER APPLICATIONS

Test Diagram Generation

Test Diagrams show the wiring from test station instruments to UUT pins for the stimulus and measurement signals for each test in a test program. They provide the test program operator with valuable information about the routing of signals to enhance troubleshooting of the TPS when it does not function properly. Much of the information required to generate these paths is contained in ATML schemas, which allows for automating the process using this data. Test Diagram generation is one use case which can benefit from the use of ATML Test Station and Test Adapter files. The WireLists file is also needed for this use case and possibly the Test Description file. See Figure 3 for a possible test diagram automated process using ATML files.

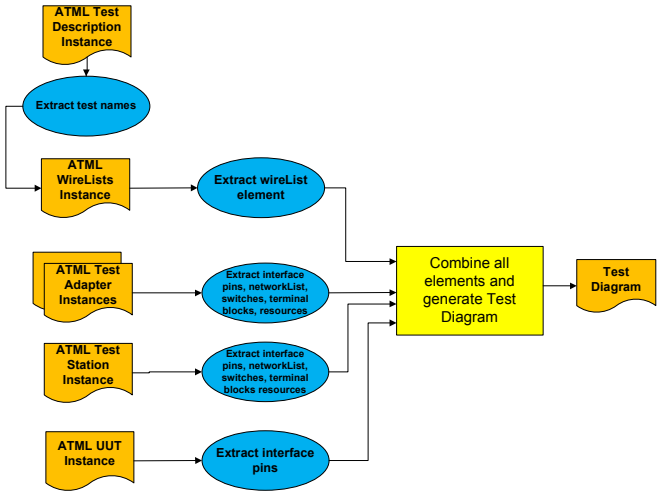

Figure 3, Test Diagram process

Resource Management and Path allocation

The information to manage resources and to allocate paths could be contained in the ATML Test Station and Test Adapter instance files. The resource capabilities and the paths needed to connect those to the UUT can be determined by analysis of the ATML files. The capabilities element provides the signal capability of the resources and would be defined using the IEEE Std 1641 Signal and Test Definition. The ability to determine if these signals can be routed to specific UUT pins could be determined by analyzing the switching and networkList elements from the test station and test adapter files. The WireLists file would also be needed in this application to associate the ports from the different files.

Test adapter fabrication

With the ATML definition of the test station and the UUT an application could be developed to map the resources to the pins required, in essence mapping out the needs of the test adapter. This data could be used as input for test adapter wire lists to support the fabrication of test adapters. This process may also include the ATML Test Description for the knowledge of what signals are required at the UUT interface.

Test station capability comparisons,

Another possible application of the ATML Test Station and Test Adapter standards is in a process to compare capabilities of different test stations. This could be useful when a Test

Program is re-hosted on a new test station. A comparison of the capabilities of the two stations could be executed and voids identified. The test station capabilities could also be compared to the UUT test requirements to see if all the capabilities needed to test a particular UUT are present in the new station (see figure 4). This could quickly identify voids which may need to be addressed prior to finalizing on an ATE design and/or the re-host of a TPS.

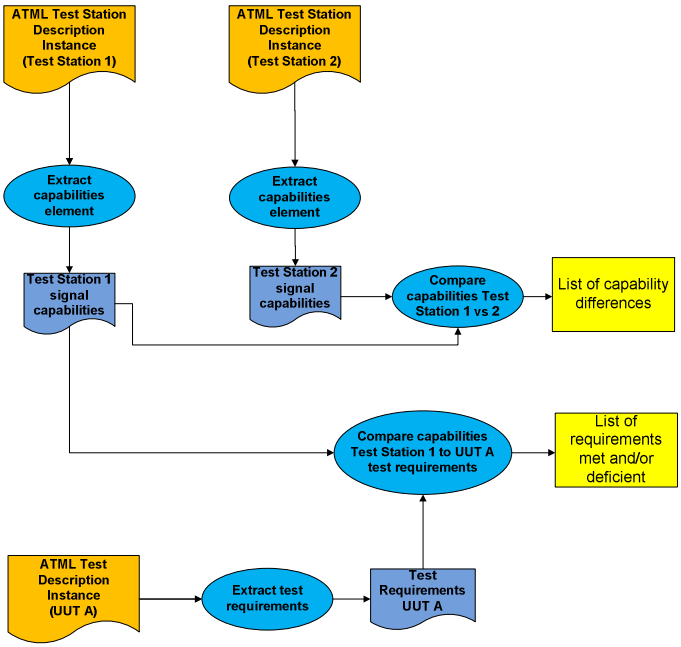

Figure 4, Test Station capability comparison

IX. ATML STANDARDS REFERENCE MATERIAL

The ATML standards have all been published by the IEEE and are available for purchase at IEEE.org. The ATML schemas, which is the crux of the standards, are available for download free of charge at http://grouper.ieee.org/groups/scc20/ATML/. Many companies have participated in the definition of the ATML standards and some have ATML tools and resources available, check the ATML related company websites. The ATML work has been incorporated into the IEEE SCC20, for information on participating in this working group see http://grouper.ieee.org/groups/scc20.

X. SUMMARY

In this paper, we have examined two of the ATML standards, the IEEE Std 1671.6 ATML Test Station Description and the IEEE Std 1671.5 ATML Test Adapter Description. Definitions of these standards have been provided and the generation of the associated ATML instance documents was discussed. The use of the ATML WireLists schema was shown to be a key component for applications of the ATML Test Station and Test Adapter standards. Possible uses of these two ATML standards were provided. In addition the issue of ATML data elements that are required vs optional was discussed and how tight control of these elements and attributes is essential for the management side of an ATS program, when mandating ATML compliance.

ATML promises significant cost and schedule savings on existing and future programs through the standardization of test data. As the use of these standards increases in the test industry, this should yield more efficient test processes in the ATS arena.