IPC-2510 GenCAM Editorial Comments

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INTRODUCTION

The Engineering Information Systems Laboratory is an academic research group at the Georgia Institute of Technology. One of our major focus areas is analysis theory and methodology (ATM) - the study of the engineering analysis process and how to improve it. Recent research projects, such as the DARPA-funded TIGER (Team InteGrated Electronic Response) project, have focused on how neutral standards are useful to automate the engineering analysis process. We would like to share our comments from this perspective on the Interim Final Draft of IPC-2510 GenCAM standard.

BACKGROUND

We use the term Engineering Service Bureau (ESB) to describe a Inter/Intra-net based organization focused on the cost-effective delivery of highly automated, product-specific self-service analysis. To date our research has concentrated on using ISO 10303 (STEP- Standard for the Exchange of Product data) as a neutral representation of product data. Since extraction of important information necessary for analysis can be automated, it is possible to enable friendly analysis usage by non-analysts. Although IntrAnet-based ESBs inside larger companies are envisioned to enhance designer access to analysis, our chief focus to date has been on providing sophisticated analysis to the Small to Medium-sized Enterprise (SME). In both the ProAM project and the TIGER Project, participating SMEs have been Printed Wiring Board Fabrication Facilities.

There are several important reasons why SMEs should run analyses such as those enabled by an ESB. Typically, SMEs are experts in a particular product or process niche. They have much greater detailed product knowledge and more precise process knowledge than those entities operating outside that niche. Larger quantities of more accurate data result in significantly better analysis. SMEs can apply these analysis results to achieve:

- Product improvements (DFM, product reliability)
- Process troubleshooting
- Process optimization

The end goals of enabling sophisticated analysis by SMEs are the “motherhood and apple pie” of the business world: lower cost, better quality, and fewer delays.

RELEVANCE TO GENCAM

How this paradigm fits within a GenCAM scenario can be graphically illustrated with the diagrams below. Figure 1 shows how a GenCAM file forms the basis of communication between a printed board designer and a printed board manufacturer. The use of GenCAM file formats improves this process in many ways, particularly as the design iterates between designer and manufacturing facility. Such iteration may correspond to a design evolution from an initial prototype to final release, or it may arise as unintended design features are discovered, (i.e. bugs). However, the ‘wheel of iteration’ is relatively large, and a significant portion of time may be wasted while it ‘spins’. Although a vast improvement on current processes, it is still less than ideal in some respects.

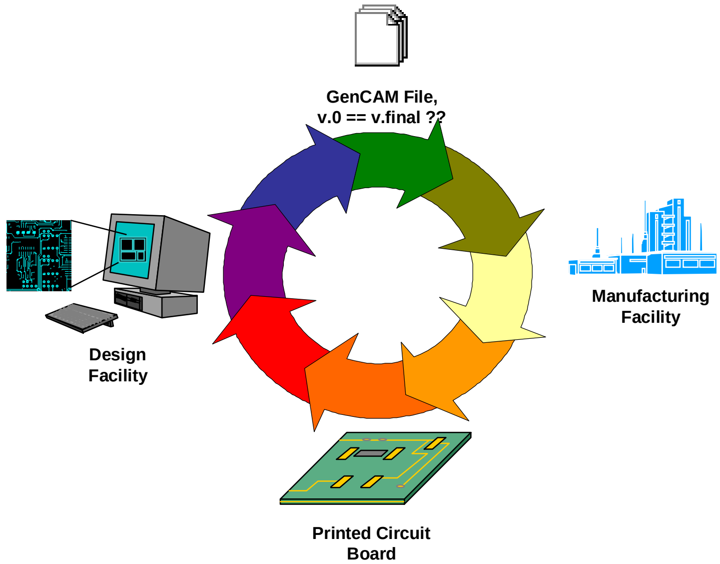

Figure 1: Prototype Through Production Development Of PWB With GenCAM

Figure 2 illustrates how the same design scenario might play out with the use of sophisticated analysis tools available over the Internet from an Engineering Service Bureau. The same 'wheel of iteration' is again present, but this time it occurs in a virtual domain (and is therefore 'smaller' and 'spins faster'), between the design facility and one or more ESBs. ESBs can provide a variety of analysis services such as 'virtual bare board testing', 'virtual soldering', and predictive reliability metrics. The comparative ease of evaluating many such metrics leads to improved product quality and reduced processing costs for the final version of the design ('v.final' in the figure below).

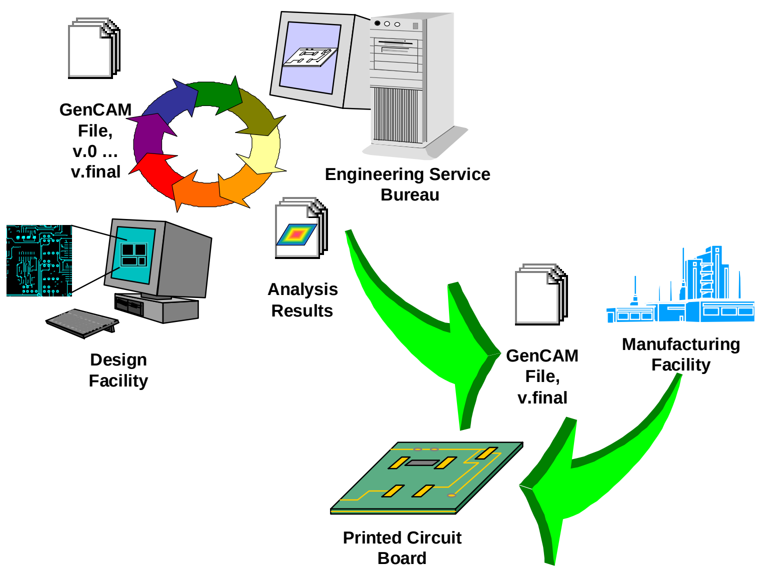

Figure 2: Prototype Through Production PWB Development With Engineering Service Bureau and GenCAM

CONCLUSION

Although this usage of GenCAM was not envisioned in the initial scope of the GenCAM series of standards, many of the features of GenCAM are well suited to supporting this advanced engineering collaborative scenario. The following pages document the few minor changes we feel will further augment GenCAM's role as a premier neutral standard for driving automated analysis.

SUGGESTIONS

1 XML FORMAT OF GENCAM

It would be useful for the IPC to supply a mapping of the GenCAM standard to XML. The benefits of an XML version of GenCAM can be divided into two related groups: a) inherent strengths in XML as a representation, and b) suitability for use in the Intra/Internet ESB scenario described above.

1.1 XML Representational Strengths

The Extensible Markup Lanugage (XML) is a data format for structured document interchange on the Web.[1] XML was developed as a successor to HTML, but it allows the structure of textual data to be expressed, not just its formatting. This means it can extend the domain of what Web data means.

XML is actually a metalanguage to let you design your own markup language. A regular markup language defines a way to describe information in a certain class of documents (e.g. HTML). XML lets you define your own customized markup languages for many classes of document. It can do this because it's written in SGML, the international standard metalanguage for markup languages.

XML can provide more and better facilities for browser presentation and performance. Because authors and providers (such as the IPC!) can design their own document types using XML, document types can be explicitly tailored to an audience. The cumbersome fudging that has to take place with HTML to achieve special effects should become a thing of the past: authors and designers will be free to invent their own markup elements.

Information content can be richer and easier to use, because the hypertext linking abilities of XML are much greater than those of HTML. Existing HREF-style links will remain usable, but the new XML linking technology is based on the lessons learned in the development of other standards involving hypertext, such as TEI and HyTime and in SGML browsers like Panorama and Multidoc Pro. The new linking capabilities let you manage bidirectional and multi-way links, as well as links to a span of text (within your own or other documents) rather than to a single point.

Information will be more accessible and reusable, because the more flexible markup of XML can be used by any XML software instead of being restricted to specific manufacturers as has become the case with HTML. Valid XML files are legal SGML documents also, so they can be used outside the Web as well, in an SGML environment (once SGML software vendors adopt the XML specification).

1.2 GenCAM XML – ESB Synergies

The inherent structure of XML files makes them easy to parse. XML parsers have been written in less than 26K of Java (http://www.microstar.com/XML/AElfred/) and less than 5k of Javascript (http://www.jeremie.com/Dev/XML/). The low footprint of such parsers means that it would be attractive to embed a GenCAM parser in the web page that acts as the interface for a designer to access sophisticated product analysis. The designer could point the parser to the correct XML GenCAM file, and the parser could operate on the file on the local machine. The designer never lets his design leave his computer- only abstract parameters needed for analysis are encrypted and sent through the Internet to the ESB. In addition to the added security of such an approach, it is also bandwidth-conservative: it is much less expensive to send the parser to the client than to send the data file to the host.[2]

XML files have Document Type Definitions (DTDs). A DTD is usually a file (or several files to be used together) which contains a formal definition of a particular type of document. This sets out what names can be used for elements, where they may occur, and how they all fit together. A DTD for GenCAM XML files would be identical to the contents of the IPC-251x series of documents for describing what is legally allowable in GenCAM. The distinction is that the DTD is computer-processable. That is, the DTD is a formal language which lets processors automatically parse a document and identify where every element comes and how they relate to each other, so that stylesheets, navigators, browsers, search engines, databases, printing routines, and other applications can be used. We believe this will be important because it will enable legal file modifications (workarounds) without necessarily having access to the

[1] Much of the information for this section was drawn from material available in the XML FAQ, http://www.ucc.ie/xml/#FAQ-IMPORT

[2] This statement assumes that the GENCAM December 1997 file “board1.camn" provided by Harry Parkinson is a representative size at ~700k and that only a limited family of related analyses will be repetitively performed on a given board.

originating application. This is especially important in collaborative design environments. (See the section on layup design below for a specific example.)

An XML version of GenCAM will be very easy to view and interact with, possibly even easier to navigate than a plain text file. As both the major Web browser manufacturers, Microsoft and Netscape, have pledged native support for XML in the next generation of web browsers[3], viewing XML files will become as effortless as viewing HTML files is now. (This is significant from the ESB point of view because we envision the web browser as the graphical interface of choice for remote analysis tool operation.) And browsing an XML file in an intellegent browser will have lots of advantages. Initial versions of XML parsers make the contents of the file navigable by pointing and clicking, much as we navigate through the directory structure on Windows machines now. This makes it easy to support multiple levels of abstraction; viewing only one section, hiding attributes below a certain level, etc. An example of this nested navigation structure is given below.

To illustrate the 'look and feel' of XML, consider the following example drawn from pg. 73 of the Interim Final Draft, Volume 1, of the IPC-2511 standard. Here we have a fragment of GenCAM syntax:

```
$PACKAGES
PACKAGE: "CAP_SUPPRESS_TYPE_24", "P34", "CERAMIC_DIP";
PINS: 24, "TH_RIBBON", 100, SIDE;
TARGET: "FIDUC_X", TARGETMARKER, "Padstack12", (0,0);
$ENDPACKAGES
```

Table 1: GenCAM Example From Page 73 IPC-2510 Interim Final Draft

Here is an example of what this fragment might look like in XML, in textual form:

```
<?xml version="1.0" standalone="yes" ?>
<PACKAGES>
<PACKAGE>
<PACKAGE_NAME> CAP_SUPPRESS_TYPE_24</PACKAGE_NAME>
<PRIMITIVE_REF>P34</PRIMITIVE_REF>
<PACKAGE_TYPE>CERAMIC_DIP</PACKAGE_TYPE>
<PINS>
<PIN_COUNT>24</PIN_COUNT>
<PIN_TYPE>TH_RIBBON</PIN_TYPE>
<PIN_PITCH>100</PIN_PITCH>
<PIN_EXIT>SIDE</PIN_EXIT>
</PINS>
<TARGET>
<TARGET_NAME>FIDUC_X</TARGET_NAME>
<TARGET_SURFACE_REFERENCE>TARGETMARKET</TARGET_SURFACE_REFERENCE>
<TARGET_REL_CENTER_POSITION>Padstack12< /TARGET_REL_CENTER_POSITION>
<TARGET_ROTATION>(0,0)</ TARGET_ROTATION>
</TARGET>
</PACKAGE>
</PACKAGES>
```

Table 2: XML Textual Form of PACKAGES Section Example

The GenCAM native format is 150 non-space characters in size, whereas the XML format is 541 non-space characters in size. Other researchers working with XML versions of STEP files have noted increases in file space of this magnitude (3-6x).

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[3] Netscape's plans for including XML support in Mozilla/Communicator 5 are outlined at http://www.mozilla.org/rdf/doc/xml.html
A preview version of Microsoft's IE Explorer 5.0 with some limited XML support is available at http://www.microsoft.com/sitebuilder/ie/ieonsbn.htm

Note however, that when reading the XML version, the explicit tag names make many of the data values more meaningful by supplying additional semantic content to the human reader. Reading the textual format is not the only way to view an XML file, however- as mentioned above, it is more likely that most XML files will be read with the assistance of browsers in the future, much as we view HTML mainly through a web browser today.

A simple browser (the 5k Javascript version mentioned above, available at http://www.jeremie.com/Dev/XML/test/) with no style information (that is, no external information about how to present the information in a logical way) presents the information in the above example as follows:

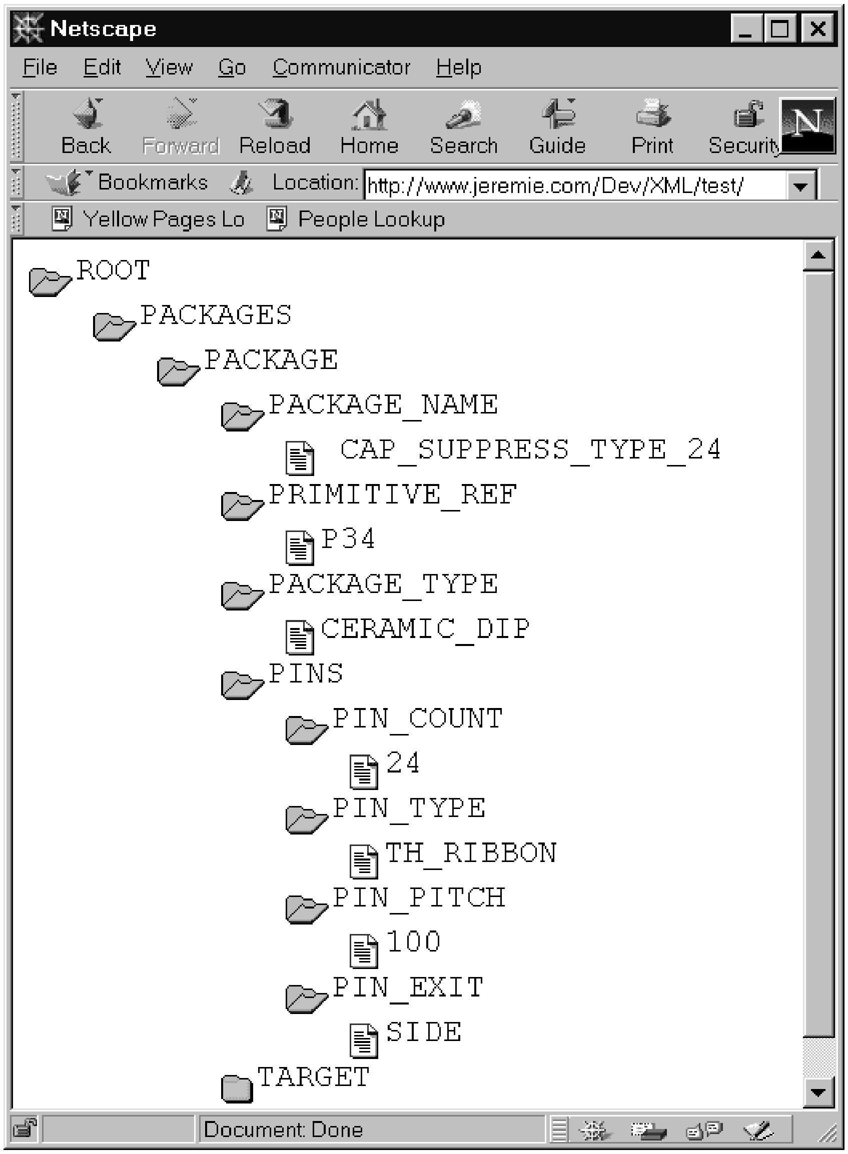

Figure 3: Browsing The XML Version Of GenCAM Without a StyleSheet.

The addition of a style sheet (XSL), which provides rules for converting XML into another format, such as HTML, could make the browser-viewable XML even more readable and compact than the above example. ('More readable and compact' might mean standard HTML headings and ordered lists, etc.) The IPC could publish these 'stylesheets' on the Internet. The extended linking capabilities of XML would then allow XML GenCAM files to point to this stylesheet resource on the IPC webserver, so that XML browsers always get the latest and greatest version of the stylesheet. Users could then further customize the display according to their personal preferences and interest.

2 CAPTURING MATERIALS INFORMATION

The current GenCAM draft specifies that materials shall be identified by a freeform string, for example as in IPC-2511, Section 4.8.8.4, BARRELDESC. The problem with this approach is that a human is required to interpret the meaning of the string. Greater automation[4] is possible if symbols (i.e. one of a possible series of keywords) instead of strings are used. In addition, the current string-based approach does not capture all the information sometimes required, even when read by an engineer. Consider this request for help recently (July 1st) posted to TechNet:

Posting number 21251, dated 1 Jul 1998 11:42:33

Date: Wed, 1 Jul 1998 11:42:33 -0400
Reply-To: "TechNet E-Mail Forum." <TechNet@IPC.ORG>, Charles J Wills <cwills@JUNO.COM>
Sender: TechNet <TechNet@ipc.org>
From: Charles J Wills <cwills@JUNO.COM>
Subject: Stiffer FR4 material?

We have a pcb that measures about 13" x 5", 6 layers (2 power and 4 signal), FR4, 0.062" thick (plug in IBM PC card). This board seems to be very flexable—more than other boards of the same size that we have seen. Is there a specific type of FR4 we can specify to make the board "stiffer"?

Thanks,

Charles

And the following possible answer:

Posting number 21260, dated 1 Jul 1998 12:49:21

Date: Wed, 1 Jul 1998 12:49:21 EDT
Reply-To: "TechNet E-Mail Forum." <TechNet@IPC.ORG>, Lwallig@AOL.COM
Sender: TechNet <TechNet@ipc.org>
From: Lyle Wallig <Lwallig@AOL.COM>
Subject: Re: Stiffer FR4 material?
X-To: cwills@JUNO.COM
Mime-Version: 1.0
Content-type: text/plain; charset=US-ASCII
Content-transfer-encoding: 7bit

Charles,

Regarding PWB that appears to be less stiff, let me offer the following:

Stiffness increases with the cube of the thickness, so check the PWB to make sure that you are getting the same dielectric thickness and also copper thickness.

Assuming the thickness check is OK, have your supplier give you the glass fabric construction for the laminate used in the PWB and look at the glass to resin ratio. High volumes of glass will give stiffer products and thick, heavier glass fabrics like 7628 are preferred over 108 fabrics. It is possible your PWB supplier changed his laminate sources and for the same .062 thickness laminate this new supplier uses a different glass fabric construction than the old supplier.

Regards,
Lyle Wallig

The current string based description of layup materials, if the example on page 69 (i.e. in Section 4.8.12) of IPC-2511 is taken to be representative[5] does not include information on the type of glass fabric or the percent epoxy.

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[4] Including both the automated ESB analyses described above and automated construction of PWAs from electronic files such as being investigated in the Internet Commerce for Manufacturing Project.

[5] We presume the designation of all the dielectric layers as DIELCORE in this example to be a typographical error. We would expect at least one layer to be DIELPREG.

Thus we suggest a new section $MATERIALS. This section is comprised of the unique string used to identify materials in the other sections, and a symbol (or series of symbols) from an approved list. Hence the identifying string used in LAYER and BARRELDESC are essentially coupling to the materials parameters described here. This places the additional constraint on the free form string in that it must be unique within the file to that material.

We suggest the key words conform to a hierarchy of major constituent and optional descriptive adjectives. The optional descriptive adjectives are not free form, however, they must also come from the approved list of key words. Descriptive adjectives cannot be mixed and matched.

Finally, a free form comment field may be added after the descriptive adjectives.

Here are some example entries for a $MATERIALS section.

```
$MATERIALS
“Gold1”, GOLD, IMMERSION
“Gold2”, GOLD, ELECTROLYTIC

“Cu1”, COPPER, FOIL, ELECTRO_DEPOSITED
“Copper”, COPPER, FOIL, ROLLED_ANNEALED
“Cu2”, COPPER, FOIL, DOUBLE_TREAT
“CuRT”, COPPER, FOIL, REVERSE_TREAT

“FR4L1”, 3070, 170, 65, “Allied Signal FR406 Tetrafunctional Epoxy Laminate”
$ENDMATERIALS
```

3 MISCELLANEOUS EDITORIAL COMMENTS

We found the following typographical or minor errors in the documents.

- The URLS listed on page 6 and 39 of IPC-2511, and page 13 of IPC-2514, referencing www.ipc.org/gencam/registered/attributes, www.ipc.org/gencam/bnf-*, and www.ipc.org/gencam/registered/software_packages are not yet active as of July 6, 1998.

- IPC-2511, Section 4.8.2.2, page 41 references Table 3.3 as a definition of a valid ISO registration identifier. However, the caption for Table 3.3 reads “**Example** of Native Language Codes”, so it is not clear if Table 3.3 is the exhaustive set of all ISO registrations, or if others are defined elsewhere.

- IPC-2511, after Section 4.8.2.10, HEADER Section Example, page 43. The History increment is zero although a MODIFIED parameter indicates the file has changed since it was first produced. The same issue is seen in IPC-2514, Section 6.4.1.10, HEADER Section Example, page 14. This raises a question- since the GenCAM format is text based, what are the consequences of the HISTORY increment not being correctly updated after a manual edit (that is, editing the file in vi, emacs, notepad, etc.) of the file?

- IPC-2511, Section 4.8.3.4, page 44, the TRANSACTION statement lists only 3 types of transaction. We believe a fourth transaction, request for proposal (RFP) is appropriate in collaborative engineering environments. That is, the contracting organization may not know enough about the design to permit a true RFQ. Instead, they are requesting the subcontractors propose alternative designs (i.e. perform collaborative engineering functions) to meet certain broad specifications.

- IPC-2511, Section 4.8.13.2, PAD and 4.8.13.3, HOLE, page 70. Both of these descriptions state that any mirroring should be done before the pad is rotated, but the rotation parameter occurs before the pad shape mirror definition. This may not be important to the computer, but it would seem conceptually more consistent to reverse the order of these parameters.

- IPC-2511, after Section 4.8.13.4, a PADSTACKS Section Example, page 71. The syntax of the PROFILE section does not appear to be up to date (That is, PROFILE instead of PROFILEDESC is used, and BARREL instead of BARRELDESC is used.)

- IPC-2511, Section 4.8.14, PACKAGES, page 72. The BNF options listed do not include SIDE, which is used in the example on page 73 right after the ATTRIBUTE section.