Presented in the ECWC 10 Conference at IPC Printed
Circuits Expo®, SMEMA Council APEX® and
Designers Summit 05

An Open Standards Based Approach to the Exchange of Data in an Automated Electronics Assembly Operation

Louis Watson
Nacom Corporation
Griffin, Georgia

Abstract
A tier one supplier to the automotive industry has determined that a key to staying competitive in the electronics manufacturing industry is to adopt open standards for the exchange of data. Specifically, adopting the Computer Aided Manufacturing using eXtensionable markup language data exchange standards, which are being developed and maintained by the IPC as an open based standard. By making use of open standards, the cost and complexity of exchanging data on the factory floor between various machines can be significantly reduced. In addition, it prevents competitive lockout, enables portable processes, and facilitates reuse and redeployment.

Through open standards, this manufacturer of automotive components feels it can more closely monitor and correct out-of-control conditions and respond more quickly to part outages and other various negative variables that effect manufacturing. To reduce the cost of implementing CAMX, a project has been started among 9 companies to produce an application program interface (API), which can be embedded into various equipment manufacturer's software programs or equipment control programs. This will allow remote machine process interaction to reduce downtime, improve efficiency, and help eliminate manual data collection and data crunching.

Since all the assembly equipment will now be sending out the same data format, they will collect this data in a Message Broker. The message broker acts like a mailbox, collecting information from various machines that publish their run time data. Sending out information like alarms, process parametric data, cycle time and other production and process information depending on the application. The message broker has built in redundancy encase the network goes down. It will continue collecting and storing this critical manufacturing data. Now other applications will subscribe to this information residing in the message broker for real-time data analysis, trend analysis, and bottleneck analysis. We also store the historical data into a database for further analysis such as root cause analysis or comparing efficiencies across different shifts and even facilities.

Introduction
The electronics industry has needed open standards for the exchange of manufacturing data from its inception, but unlike other industries where the manufacturers themselves came together and demanded their suppliers to unite on data exchange. Like specifically, the semiconductor and process industries, which now has the SECII GEM and Field-bus standards. The electronics industry was slow to adopt the open standards process.

The Basics
The North American Electronics Manufacturing Initiative (NEMI) recognized this and created the plug and play initiative in 1994. This initiative has been through several stages and is still a dynamic engine driving the industry toward the future. We are addressing specifically the IPC 25XX series, see http://webstds.ipc.org/, and in detail the 2501, 2541, 2546, and 2547 standards as they apply to electronics manufacturing.

The IPC 2501 standard is known as the Message Broker. It defines the message format and message handling. It builds on such technologies as HTTP, SOAP, and XML to define the message format. It then acts like a mailbox sending subscription messages to applications and receiving published messages from clients on the factory floor.

The IPC 2541 addresses the generic Surface Mount Technology (SMT) process. A subset of this is the production equipment machine states. The machine state model is shown in Figure 1 below. As the diagram shows the machines start from an off state then changes to setup mode. This is where you would select the recipe or origin the machine. From Setup, the machine can go to a Ready or Down state. Ready means the machines is ready to start processing product. Inside of this machine state, we have several other states as shown below. Processing is broken down into two more states, which are Active and Executing. Active are conditions like transferring product into or out of the product. This simply means the machine is bringing product into the machine's work area to be processed. Executing is where the true work is done. It is the actual building up of the product at each machine process. The last machine state is called Down. As the name implies, the machine is not in operating condition, which means the machine is unable to process the product.

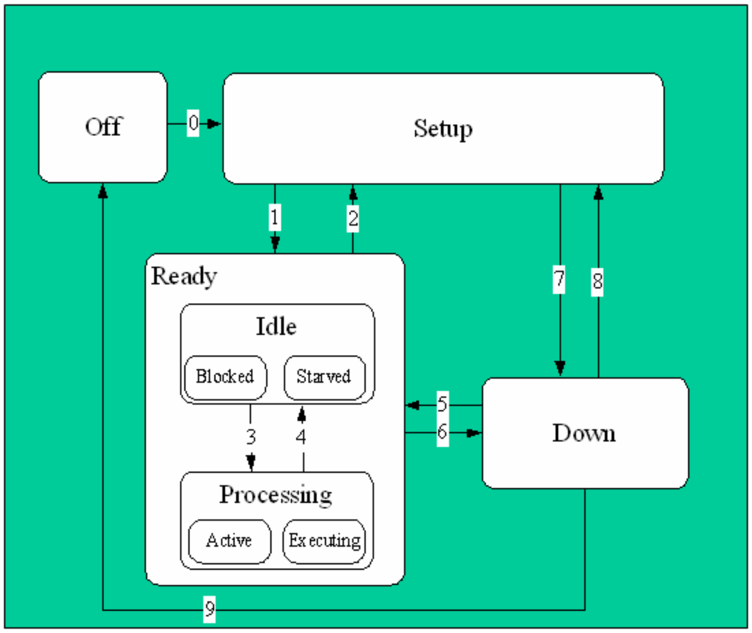

Figure 1 - IPC 2541 State Model

The IPC 2546 deals with the electronic assembly process itself. It is drilling down from the generic to the specific machine processes. It contains several sections covering different kinds of SMT processes. These are as follows: screen printing, adhesive dispensing, pick and place, reflow, and automated final assembly. Amendment two is now under final consideration for publication. This amendment adds new processes that weren't previously covered such as selective solder and conformal coating. And as this shows these standards are dynamic and evolving and are not rigid and inflexible.

The IPC 2547 standard covers the test, inspection, and rework processes. It addresses the Automated Optical Inspection (AOI) and Automated X-ray Inspection (AXI) processes. The IPC 2547 also covers the In Circuit and Functional Test processes. Together this standard helps ensure the finish product meets the customer's demands and functions as designed.

These open standards will effect and aid in real-time factory-floor data collection and reporting. The benefits are many and the pay back can be enormous just by having highly accurate reliable information to make informed decisions with. This will directly effect your company's bottom-line.

Imagine managing your factory without manual data collection or manual data manipulation. Having the ability to be more proactive to truly function as a preventative maintenance organization. Find out how your factory or multiple factories are running just by logging onto the web. Comparing production performance across lines or factories because they all are reporting apples to apples. How do you address your quality issues, reduce downtime and cycle time, improve first time capability and yield without timely accurate data.

What are we really talking about? The concept is very simple. The manufacturing equipment outputs the same data format from all the machines. This eliminates the complexity and maintainability of the system. The data is then parsed or stripped down to its XML component. The XML data is then pushed into a database. A query is run against the database and a report is generated. This is where the data is actually turned into useful information. All this is done within seconds, most of the time within milliseconds. Now an informed intelligent decision can be made.

Conclusion

The Computer Aided Manufacturing using eXtensionable markup language, (CAMX) components are an open standards web-based data exchange model. Once this CAMX standard takes off, meaning once we the electronic manufacturers start including it in our purchase specifications and demanding it from our equipment vendors. We will see most of the barriers to implementing real-time factory-floor data collection and reporting systems lowered or in some cases completely eliminated. These barriers to implementation are variables like cost and time of implementation, cost of integration, complexity, or the system is not flexible enough for re-use or redeployment.