Engineering
Out Of The Box
Your Game Changer.

Effective Host Simulation

WHITE PAPER

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Abstract

Adherence to **S**emiconductor **E**quipment and **M**aterials, **I**nternational (SEMI) standards is critical for semiconductor equipment. It is the responsibility of the developers who work on the equipment software to ensure compliance to SEMI standards. These developers often use high level computer languages such as C++ and C#. Unit tests need to be implemented using host simulator software. However, developers are often not comfortable writing scripts using the propriety language of host simulator software, so they rely on others to write scripts for them, or to do partial testing. **F**actory **A**utomation (FA) scripting will be of immense help to developers if made available in high level languages.

Abbreviations

Sl. No.	Acronyms (Page No.)	Full form
1	SEMI (4, 6, 7, 9, 12)	Semiconductor Equipment and Materials International
2	FA (4, 6, 8)	Factory Automation
3	FAB (6, 7)	Semiconductor fabrication plant
4	SEMI E37 (6)	The standard for communication protocol
5	SECS II (6, 9)	SEMI Equipment Communications Standard Part 2
7	OEM (7, 11)	Original Equipment Manufacturer
8	SEMI E30 (7)	Factory Automation Standard for Generic Equipment Model
9	HSMS (7, 9)	High Speed Messaging System
10	SQA (7)	Software Quality Analyst
11	UI (7, 8)	User Interface
12	300mm (7, 8, 9, 12)	The wafer diameter 300 millimeters
13	.NET (8, 9, 10, 11)	Microsoft Development platform
14	SEMI E5 (9)	SEMI Equipment Communications Standard
15	HSS (6, 7)	Host Simulation Software
16	IDE (11)	Integrated Development Environment

Helps to understand SEMI compliance levels and identify equipment deviations that can be addressed before shipping to a Fabrication plant (FAB)/actual environment

Non-availability of a debugging environment for developers makes it difficult to investigate whether the problem is associated with the script or with the implementation

Market Trends/Challenges

Host simulation software (HSS) is a testing tool used to communicate with equipment according to the SEMI E37 standard by sending and receiving SECS II messages. Host simulator software is used to verify the implementation of SEMI standards, and helps to understand SEMI compliance levels and identify equipment deviations that can be addressed before shipping to a Fabrication plant (FAB)/actual environment.

HSS is used to test equipment performance with respect to FA standards (timeouts, response time, processing time), and to automate regression testing (FA scenarios) and qualification runs.

The host simulator software is used to test the equipment software, after which the study testers write complicated scenarios using proprietary software. More often than not, when an FA test case fails, the developer is called in to investigate. He has to go through the cumbersome FA script written in the host simulator software's proprietary language. Non-availability of a debugging environment for developers makes it difficult to investigate whether the problem is associated with the script or with the implementation.

Existing HSS provides the ability to automate testing using proprietary scripting, but does not facilitate user debugging of the complex automated test case scenarios. Also, understanding the error codes of the proprietary language will not be very easy.

The user will not be able to modify the script at runtime, for he needs to compile and load it during runtime for every modification.

Challenges:

- Thorough knowledge in proprietary language
- Writing customer applications
- Debugging the automation scripts
- Creating reusable scrtips
- Changing the sequence of the scenarios at runtime
- Absence of 300mm state models

The Problems:

Semiconductor OEMs need to have the application for simulating host behavior using E37 and SEMI E30 standards.

One of the leading front-end equipment manufacturers is facing problems with:

- Writing a custom application using HSMS as a separate entity for their application is a challenge
- Writing complex automation scripts using one of the competitors' product
- Analyzing the issue in functionality of automation sequence and scripts
- Validating the 300mm state models in the host side. Normally the UI for 300mm state models is available in the equipment software side only, not in the host.

Host simulator software is used mostly by OEMs for factory automation testing. It has been used in the following test environments:

- Developers (unit testing)
- SQA Test Engineers (compliance verification)
- FAB Operators (qualification runs)

Challenges:

- Thorough knowledge in proprietary language environment
- Writing custom applications using E37 HSMS as a reusable component
- Debugging the automation scripts
- Creating reusable automation scripts
- Changing the sequence of the scenarios at runtime
- Lack of UI support for analyzing alarms and timeouts
- Lack of UI facility for 300mm message construction
- Absence of 300mm state models for existing HSS

Solutions:

- Solution provides reusable component HSMS library
- Facilitates complex factory automation logic into scripts easily, using available .NET functionalities
- Quick analysis and debugging
- Script Sequencer – a utility to create custom scenarios easily
- The user interface for the 300mm state models makes the user comfortable with analyzing the equipment's state changes dynamically from the host

Solution

The testers use the host simulator software to test the factory automation functionality of the equipment's software. The tester may have to write complicated scenarios that are difficult using proprietary software. The solution should address the complexity of the use cases during the investigation of automation related issues, this has to be fixed and it should be released as soon as possible since the issue can become the show stopper in the production operations.

Influencing factors:

- Existing solutions use proprietary language for developing automation scripts. Hence the learning process is challenging and there is no scope of debugging
- Providing automation scripts as reusable components in the .Net framework that allows users to define their own automation sequences
- Full-fledged functionalities of .Net framework components that enable users to build complex logics in the scripts, easily using thread, delegates, UI Framework, etc.
- Graphical representation of 300mm state models allow the user to analyze the state changes at runtime from the host side

Solution:

1. Provides simulation solution to link host and equipment that can be used to send and receive SECS II messages
2. Solution provides reusable component HSMS library for creating custom communication interface, for equipment or host, that enables E37 compliance
3. Facilitates complex factory automation logic into scripts easily, using available .NET functionalities through a script library. This can be run in multiple threads in parallel to improve performance

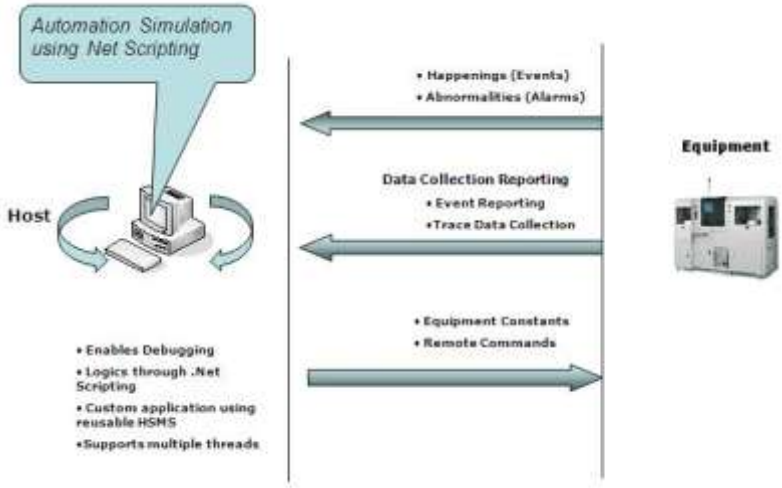
Customer Impact:

- Quick Analysis
- Reduce learning time
- Increase productivity
- Enhance quality in building scripts
- Latest technology adoption
- Quicker identification of state transition errors

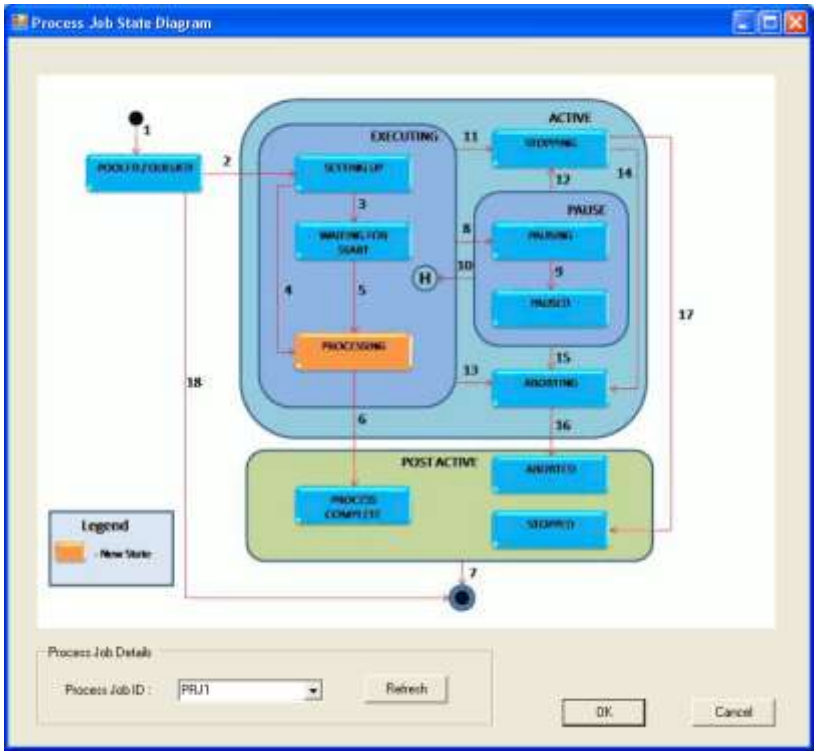
4. Quick analysis and debugging – troubleshooting of an error in the script is straightforward
5. Script Sequencer – a utility to create custom scenarios easily; helps the user change the scenario sequence at runtime or dynamically
6. Users need not know the syntax used in the entire message construction, and thus can avoid the time that would be needed to learn syntactical representation of SECS II SEMI E5; a graphical 300mm state model helps the user trace the issue easily and reduces investigation time
7. The user interface for the 300mm state models makes the user comfortable with analyzing the equipment's state changes dynamically from the host

Customer Impact

- Quick analysis: The .Net debugging feature enables the user to quickly identity defects in automation scripts
- Reduce learning time: No need to learn a separate language for writing automation scripts. Any C# programmer can implement automation scripts using .Net script support, which reduces learning time



- Increase productivity: Common functionalities in the scripts can be created as reusable components
- Enhance quality in building scripts: Easy identification of compilation errors increases the quality of the scripts
- Latest technology adoption: Provides .Net support that enables the user to build complex scenarios using .Net components
- Quicker identification of state transition errors from the host



Opens up the factory automation testing community to move from age-old proprietary to the .Net language.

Facilitates applying various complex scenarios in the host automation

Common Issues

The solution requires MS Visual Studio IDE for debugging the .Net scripts. On certain occasions, the OEM, may have to debug the host automation scripts at the customer's location. During such situations, the OEM will not have access to the MS Visual Studio IDE.

Conclusion

This opens up the Factory Automation Testing community to move from age-old proprietary language to the .NET language. This non-proprietary language helps programmers use the strengths of the latest technology. It enables users to debug the scenario in runtime, and also facilitates applying various complex scenarios in the host automation. This will enhance confidence in achieving scenarios syntactically using the languages.

Reference

www.semi.org

http://www.cimetrix.com/testconnect.cfm

http://www.peergroup.com/Products/TestApplications/SECSIMPro.aspx

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