Next Generation Smart Manufacturing: Collaboration Towards Enabling Practical Predictive Analytics and Traceability Across the Electronics Supply Chain

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Machine to Machine Communications: Enabler for Digital Twin

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The Return of Vertical Integration: The Electronic Outsourcing Challenge
Jim Walker, WLP Concept, maseratijim@gmail.com

Electronics Industry Dynamics: Leveraging Standards Across Electronics Industry Segments

Converging Technologies Create Competition for Value Added: Silicon, Package, Board

- Foundry (Fab)
- 3D/WLP
- OSAT (Pkg/Test)
- SiP/MCP
- EMS (System)

- Chip Stack, WL-CSP
- Package Stack, MCP/POP

Timeframe
2-5 Years

Opportunity
$4B+

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Electronics Industry Dynamics

- New “backend” technologies driving change
  - FO-WLP development and adoption
  - Blurring of segment lines Semiconductor Front End, Back End and PCBA/SMT
  - Consolidation of SEMI and SMT equipment suppliers i.e., K&S-Assembléon, ASM-Siemens, etc.
  - Wafers as carriers driving SMT type equipment in the Semiconductor Back End
  - OSATs versus Foundries

- Common Connectivity across industry segments is an ideal strategy
  - Reduces engineering costs for all equipment suppliers
  - Simplifies host systems – Enables the Digital Thread, Digital Twin
  - Allows advancement towards Plug-N-Play & Smart Manufacturing
  - Reduces the industry cost of ownership
GEM Evolves & Adapts to Meet Industry Needs:
Leveraging Standards Across Electronics Industry Segments

- High Margins, High Manufacturing Complexity: GEM, GEM300
- Medium Margins, High Manufacturing Complexity: SEMI-FE, SEMI-BE
- Medium Margins, Medium Manufacturing Complexity: Undecided
- Medium Margins, Low Manufacturing Complexity: SMT (PCBA)
- Low Margins, Low Manufacturing Complexity: PCB

TPCA Supporting GEM Functionality Draft Standard - Guide For PCB Equipment Communication Interfaces (Automation Technology Committee - SEMI A##)
Guide for PCB Equipment Communication Interfaces

Rationale
Currently, there is no PCB equipment communication interface standard. The PCB supply chain proposes to have a SECS/GEM structure communication protocol and exclude those items that are not applicable in this industry. It will be helpful in leading the PCB industry to establish automation technology.

Scope
The guide for the PCB equipment communication interface will be based on SEMI E4, E5, E37, E37.1, and E30. Some capabilities in E30 are not required (ex: Spooling, Limits Monitoring, E139 recipes, large E42 recipes, large PP transfer and formatted PP transfer). PCB equipment shall use the format unsigned integer of 4 Bytes length (Format 54) for some data items. PCB equipment shall support the Data Variables that are defined in SEMI E30.
SEMII & TPCA Collaborate: M2M Communications

Timeline

March
TPCA submitted request to SEMI Automation Technology Committee to form the PCB Equipment Communication Interface Task Force (Taiwan Chapter)

April
NARSC approved formation of the Taiwan Chapter of the SEMI Automation Technology Committee (3 April 2017)

May
Automation Technology Taiwan Chapter had their first meeting. Approved the formation of the PCB Equipment Communication Interface Task Force led by ASE, Symtek, and ITRI.

Next Steps
Drafting 1st standard, *Guide For PCB Equipment Communication Interfaces - SEMI A##*

Goal
Issue first ballot in Fall 2017 for global review by members of the Automation Technology Committee.

Next Meeting
16 August 2017, 14:00 Taiwan Printed Circuit Association (TPCA) Office
SEMI & TPCA Collaborate: M2M Communications

Future Org Chart for Global Automation Technology Chapter

ISC: International Standard Committee
RSC: Regional Standard Committee

Europe RSC

Europe TC Chapter of Automation Technology Global Technical Committee
C: Christian Hoffmann (PEER Group)

Global Equipment Interface Specification (EIS) TF
L: Carsten Born (VITRONIC GmbH)

PV Wafer Traceability TF
L: TBD

Japan RSC

Japan TC Chapter of Automation Technology Global Technical Committee
C: Makoto Ishikawa (Nisshinbo Mechatronics)
C: Teruki Ito (Mitsubishi Electric)
C: Terry Asakawa

Global Equipment Interface Specification (EIS) TF
L: Katsuyoshi Takahashi (Mitsubishi Motors)

Japan TC Chapter of Automation Technology Global Technical Committee
C: K.C. Chou (ASE)
C: Jen-Hui Tsai (MMSL, ITRI)
C: Gwo-Sheng Peng (CMS, ITRI)
C: C.S. Wu (MIROD)

NA RSC

Taiwan TC Chapter of Automation Technology Global Technical Committee

PB Equipment Communication Interface (PCBECI) TF
L: Chi-Yuan Chang (SynTek)
L: Chi-Ping Chen (ITRI)
L: Fibo Chang (ASE)
Smart Manufacturing / Industry 4.0 – Digital Thread

Product Company
- Product Lifecycle
- Logistics
- Product Design Data
- Traceability

Manufacturer (EMS, IDM, Foundry, OSAT, etc.)
- Process Control
- Shorter Downtime
- Configuration Flexibility
- Traceability

Supplier
- Remote Diagnostics & Maintenance
- Yield Improvement
- Adaptability

Multi Direction Data Communications – Digital Thread

Host System
- VC Equipment Control
- Information
- Equipment
- Information
- Material
- Equipment
- Information
- Material
- Equipment
- HC Material Control

Digital Thread

Hardware Innovation Group
Smart Manufacturing / Industry 4.0 – Digital Thread

Design

Manufacturing

Reliability

Multi Direction Data Communications – Digital Thread
Smart Manufacturing / Industry 4.0 – Digital Thread

Digital Twin Enabler

Manufacturing Execution System (MES)

Data Analytics

2way Communications

Equipment

2way Communications

Digital Thread

Equipment

2way Communications

Equipment

2way Communications

Digital Thread
Manufacturing Equipment Data - Smart Manufacturing

Event Notification
- Collection Events
  - Notify the host of processing events, errors
- Alarms
  - Notify the host of dangerous states

Data Gathering
- Host Polling
  - Host may request data as desired
- Machine Polling (Traces)
  - Host configures the equipment to send data periodically
- Event Reports
  - Host configures data to be reported with a collection event
- Limits Monitoring
  - Host defines limit boundaries for a status variable
  - Equipment notifies host when a boundary is crossed
Manufacturing Equipment Data - Smart Manufacturing

Equipment Control & Configuration
- Change equipment constant settings
  - Change modes & configure behavior
  - Modify elements of process program
- Remote control
  - START, STOP, PAUSE, RESUME, ABORT
  - Machine specific commands

Recipe Management
- Transfer process program files to and from the equipment
- Select a process program remotely
- Query the current process program and list of available programs
- Delete process program files on the equipment
- Notify the host when the equipment operator makes any process program file changes
Terminal Services
- Equipment and host operator exchange messages
- Acknowledge for operator

Fundamental State Machines
- Equipment behaves in a predictable, consistent way
- Communication State Machine
  - Well defined means to establish communication
- Control State Machine
  - Equipment determines the level of host control
  - Remote, Local, or Off-line
- Spooling State Machine
  - Equipment may persist valuable messages when communication is lost. Restore the messages when re-established.
- Processing State Machine
  - UML/Harel Notation
  - Machine-defined
  - States and State transitions