The Integration of add-on Sensors into the Manufacturing Tool Environment - recent Models and future Needs
Sensor integration

- **Aim**
  - Unification of tool and sensor data together with process data, like LotID, Recipe etc.

- **Problem**
  - Integration of add-on Sensor causes problems because the manufacturing tools are not equipped with a standard data interface. EDA interface will not be usable for integration of add-on sensors.

- **Reason**
  - IC manufacturer have not seen the necessity of a sensor interface yet. 6 of 8 device makers do not need E54 Sensor Actuator Network (ISMI - FAST III 2005).
  - Majority of equipment supplier does not need for SAN (ISMI - FAST III 2005).

- **Result**
  - Only tool data will be available → no higher level of APC because add-on sensor data are not usable.
Requirements on Sensor Interface

- **High volume production:**
  - Data reduction necessary for analysis.
  - High speed data transfer.

  → Automatic Data Analysis

- **Transfer of Logistics:**
  - LotID, Recipe, Process Step, WaferID
    - Necessary for identifying the data.
    - Data without logistics not usable.
    - Sensor may need logistics for measurement (Optical Sensor).

- **Process step should be known**
  - Analyzing the whole process could cause wrong results.

- **Time synchronisation between tool data and sensor data.**
  - Necessary to analyze time critical data.
Recent Models of Sensor Integration

Different solutions have been developed integrating add-on sensors.

- **“Box”**
  - Host computer working as SECS or EDA path through
  - Has Sensor Network interface with standardized or proprietary protocol.
  - Sensor data and tool data merged inside the box.
  - One tool supplier has integrated a Box already.
  - Monetary effort.

- **SECS**
  - Sensor has a SECS interface and behaves like a tool.
  - Transfer of logistics not standardized.
  - Critical: Time synchronisation between sensor and tool data.
  - Effort to develop host program and data merging.

- **Proprietary sensor interface**
  - Few equipment supplier offer a sensor interface.
  - No further Effort to integrate an add-on sensor.
continued

- **Internal sensor bus of the tool**
  - The internal field bus of the tool is expanded to a gateway.
  - The gateway is connected to a Sensor Network.
  - No logistical data available.

- **Modbus**
  - Add-on sensors are connected to a Modbus network.
  - The network is managed by a host which is not connected to the tool.
  - Caution: Modbus does not mean compliance to E54 automatically.
  - Time synchronisation between tool and sensor data.
  - Monetary effort to establish sensor host.
Box as SECS Path-Trough and Sensor Host

- “Box” easy to implement.

**Diagram:**

- Tool/APC Controller
- SECS or EDA
- Add-On Sensor
- Add-On Sensor
- Box
- Tool
- Sensor data appear as coming from the tool
Data Coupling using SECS

- Important: Merging tool data and sensor data requires good time synchronisation.
Proprietary Sensor Interface

- Sensor interface integrated in the tool – open for add-on sensors.
- Realized at LAM 2300 dry etcher
Using internal Sensor Bus of the Tool

- Gateway translates from the field bus protocol to the TCP sensor network.
Future Needs

In future the tools should be equipped with TCP based sensor interface. Recent network communication standard are defined in SEMI E54.

- **Modbus/TCP**
  - Modbus over TCP.
  - Object Messaging Protocol.

- **Ethernet/IP**
  - Control and Information Protocol.
  - CIP (DeviceNet) over TCP.

- **Profinet**
  - Profibus over TCP.

An EDA will be necessary as interface for APC applications.
Modbus/TCP E54.9

- Modbus is wrapped into TCP/IP.
- Easy to implement.
- Additional functionality probably necessary.
- Object messaging protocol (uses E54) for addressing.
- Source codes available.
- Max. length of telegrams 197 Bytes → Fragmentation necessary.

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<th>Data</th>
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Function code 91:
Object messaging

Sub field of message data

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<th>ClassID</th>
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<th>Data</th>
<th>Data</th>
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Modbus/TCP telegram
Ethernet/Industrial Protocol E54.13

EIP is based on the Control and Information Protocol CIP.

- **Transfer of Control and Information Messages**
  - Control Message: Short, fast, unacknowledged Message, transferring real-time data, e.g., sensor data. Transfer via UDP.
  - Information Messages: Longer, error ensured, non-real-time message, e.g., configuration and diagnostics. Transfer via TCP.

- **CIP makes use of abstract Object Model**

- **Consumer – Producer Architecture:**
  - Producer sends messages as broadcast. The interested consumers read the message.

- **Sufficient functionality implemented**
  - i.e. time stamp, heart beat, …
Profinet E54.14

- Consumer – Producer Architecture.
- Profinet allows direct interfacing of decentralized sensors on the Ethernet.
- Configuration is performed via a device description file (GSD).
- Coupling with Profibus via Proxy.
- Sufficient functionality.

DCOM used as Application Protocol.
EDA Interface and ad-on Sensor Integration

EDA interface delivers tool data together with sensor data
EDA Equipment Data Acquisition.

EDA Interface

Equipment

EDA

E54 SAN

TOOL SENSOR

Add-On SENSOR

Standard Sensor Interface E54
Sensor in FAB Environment

Data of add-on sensor could improve the quality of APC.

EDA Equipment Data Acquisition
EPT Equipment Performance Tracking

APC Advanced Process Control
Summary

- APC without using data of smart sensors will not reach higher quality.
- Manufacturing tool must be equipped with a sensor interface to connect add-on sensors in future. Tool specification has to be changed.
- The sensor interface of the tool shall be based on Ethernet in compliance to SEMI E54.
- Sensor data and tool data will be unified in the tool.
- The EDA interface delivers tool data and sensor data together. The sensor data appear as coming from the tool.
- Tool with sensor interface for add-on sensors available (LAM 2300).
- “Box” fulfils the requirements on a sensor interface. The installation is very easy.