



7. AEC/APC Europe  
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# The Integration of add-on Sensors into the Manufacturing Tool Environment - recent Models and future Needs

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# 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

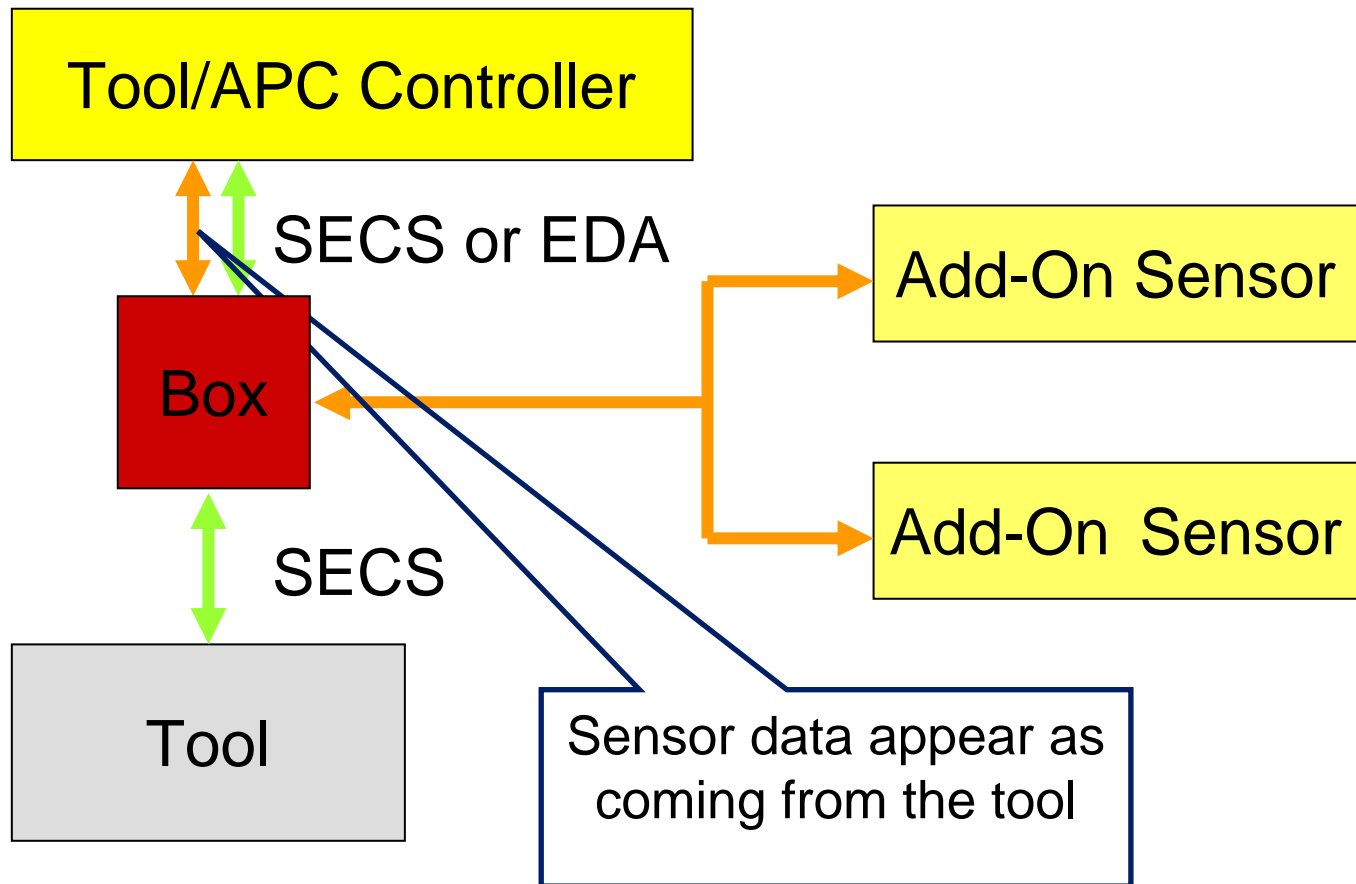
- The internal field bus of the tool is expanded by a gateway.
- The gateway is connected to a Sensor Network.
- No logistical data available.

## ❑ 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.

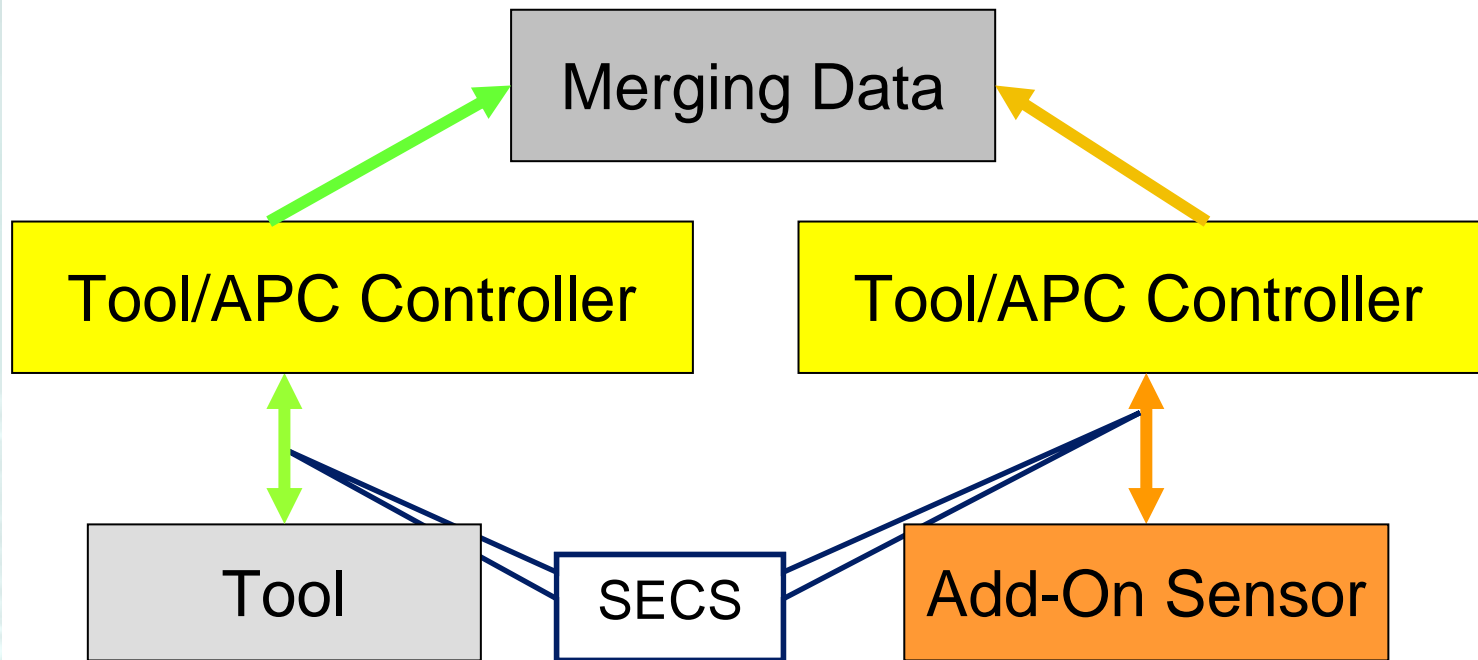
# Box as SECS Path-Trough and Sensor Host

- “Box” easy to implement.



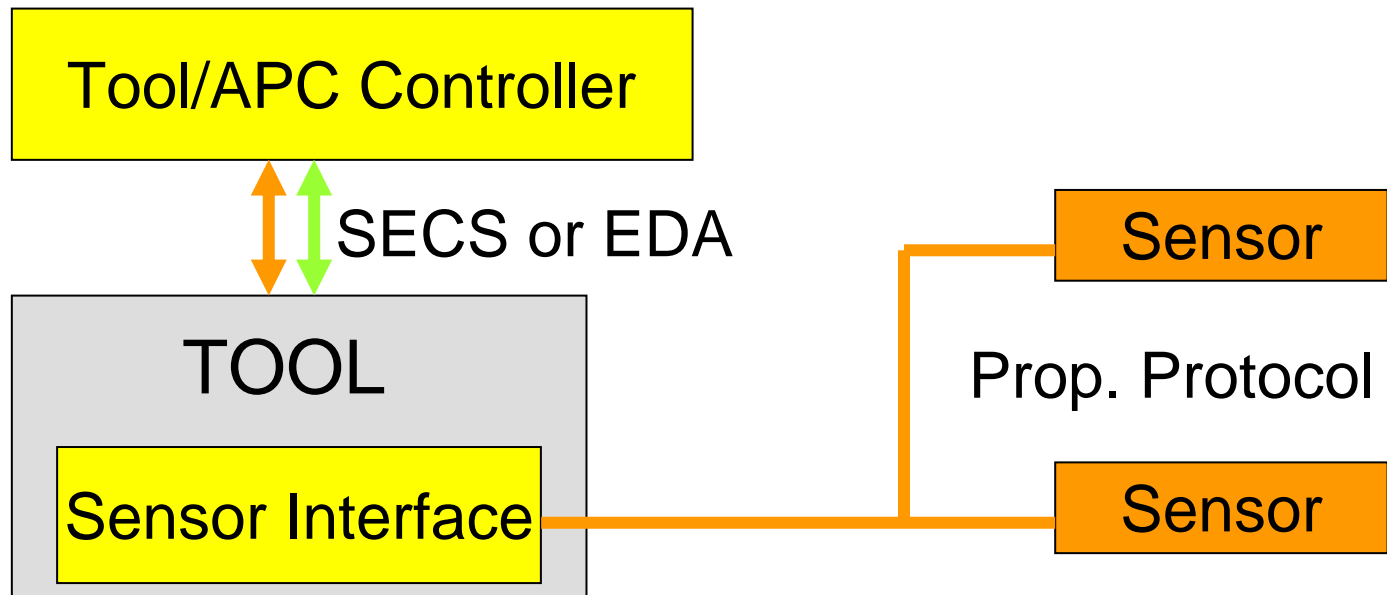
# Data Coupling using SECS

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



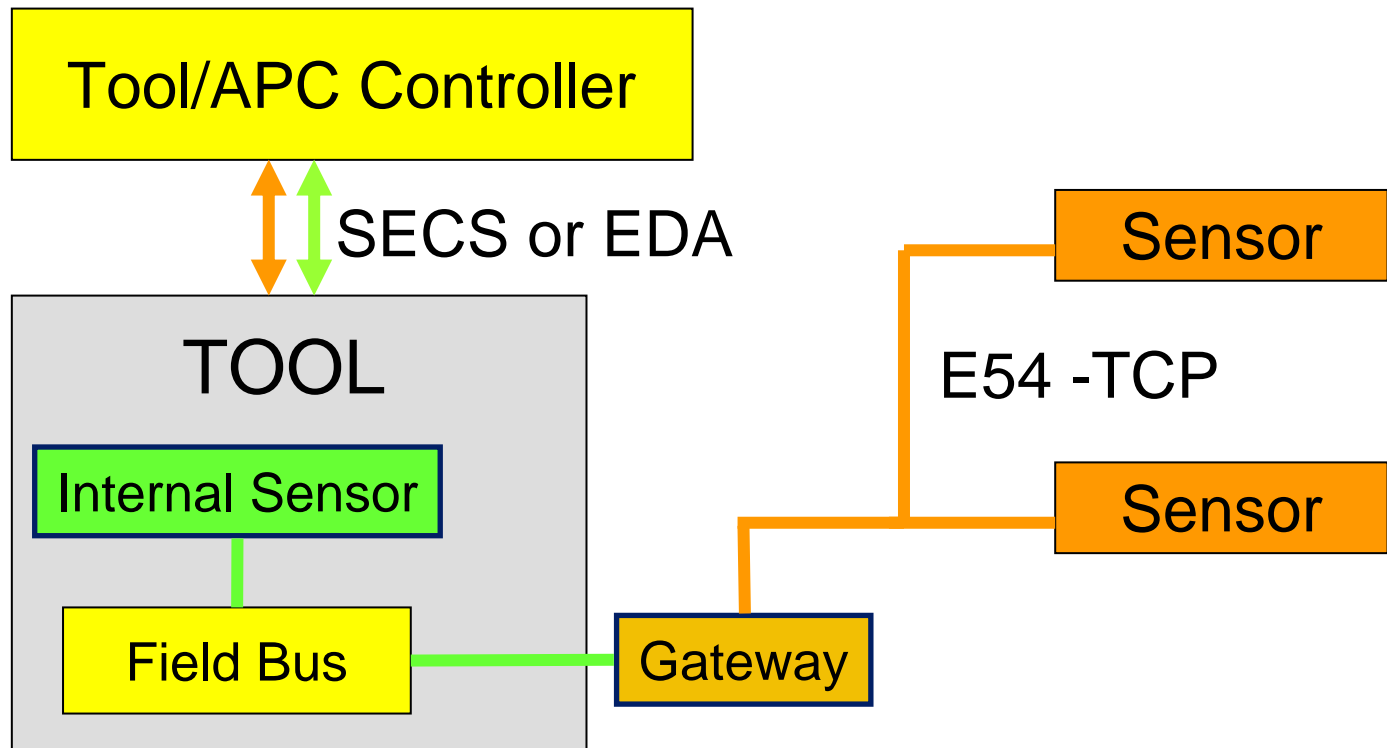
# Proprietary Sensor Interface

- ❑ 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

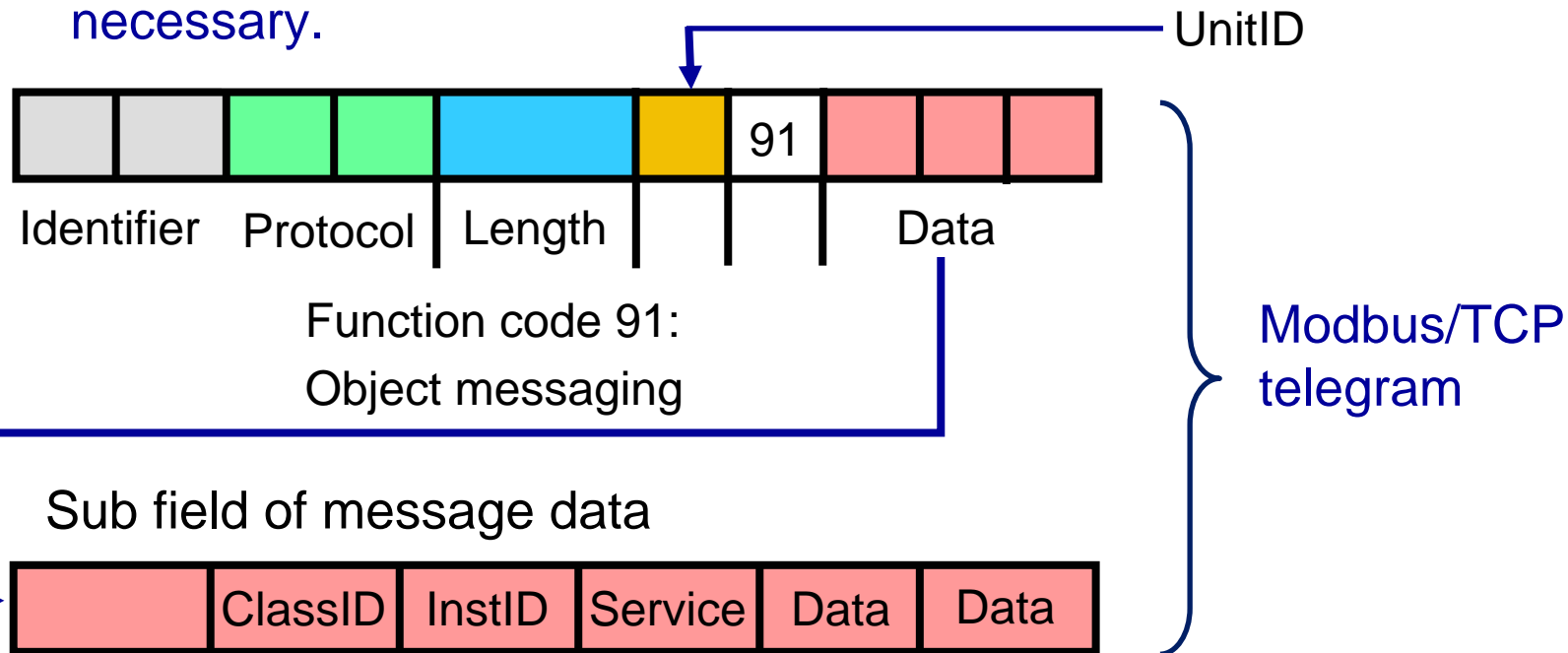
In future the tools should be equipped with TCP based sensor interface. Recent network communication standard are defined in SEMI E54.

- ❑ **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

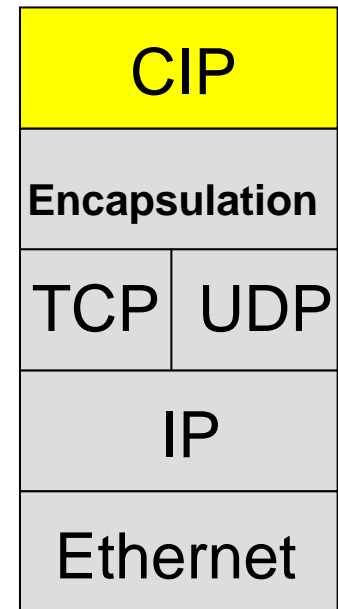
- ❑ Modbus is wrapped into TCP/IP.
- ❑ Easy to implement.
- ❑ Additional functionality probably necessary.
- ❑ Object messaging protocol (uses E54) for addressing.
- ❑ Source codes available.
- ❑ Max. length of telegrams 197 Bytes → Fragmentation necessary.



# 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, ...

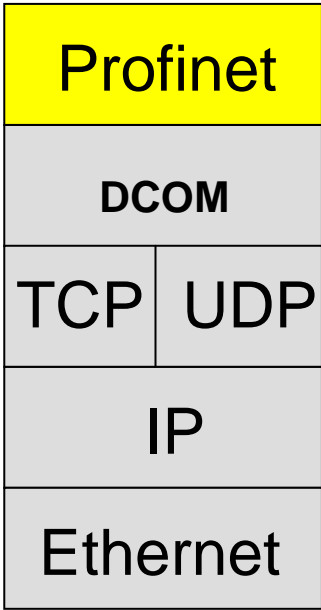


Layer model of EIP

# Profinet E54.14

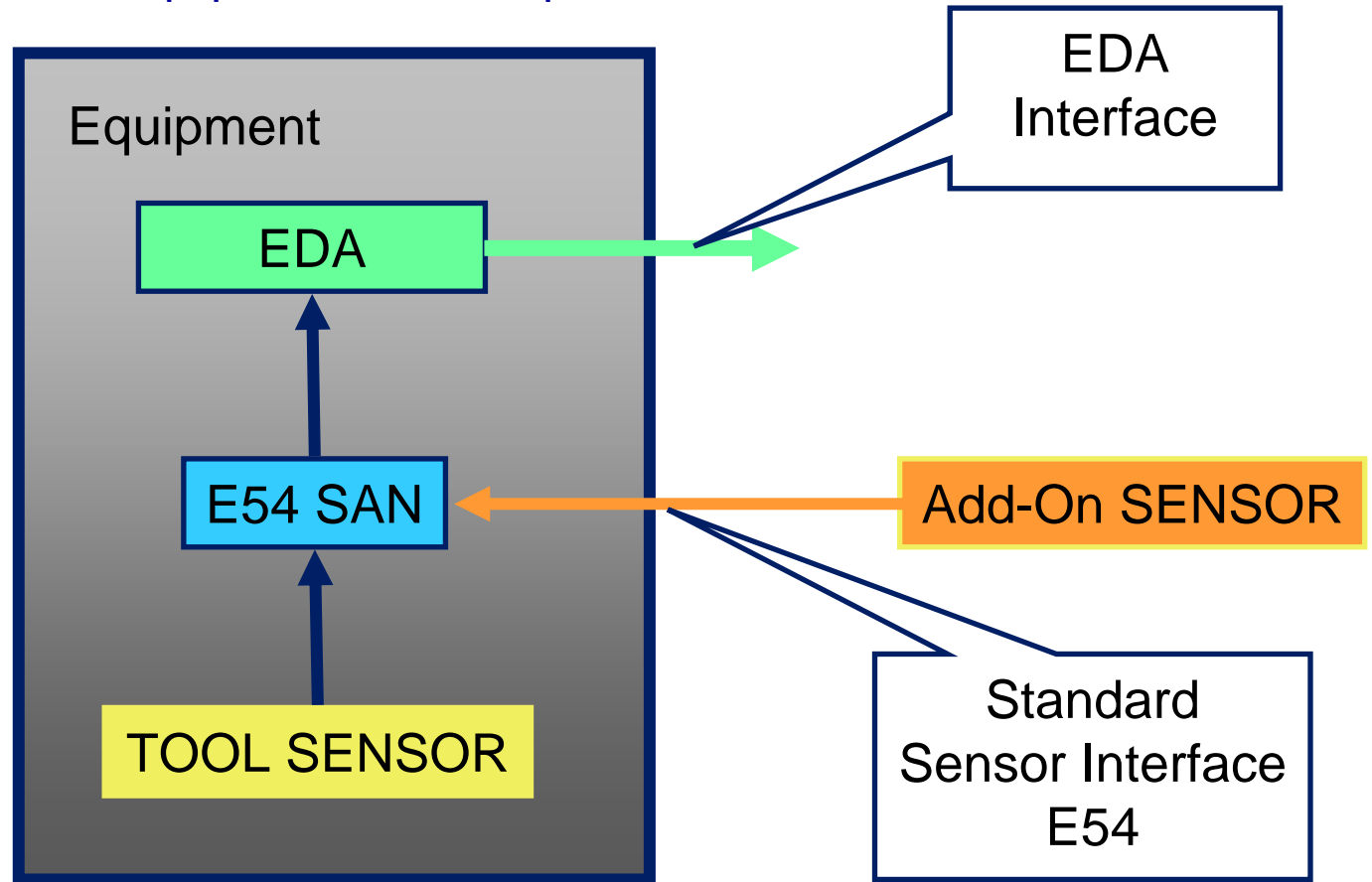
- ❑ Consumer – Producer Architecture.
- ❑ Profinet allows direct interfacing of decentralized sensors on the Ethernet.
- ❑ Configuration is performed via a device description file (GSD).
- ❑ Coupling with Profibus via Proxy.
- ❑ Sufficient functionality.

DCOM used as  
Application Protocol.



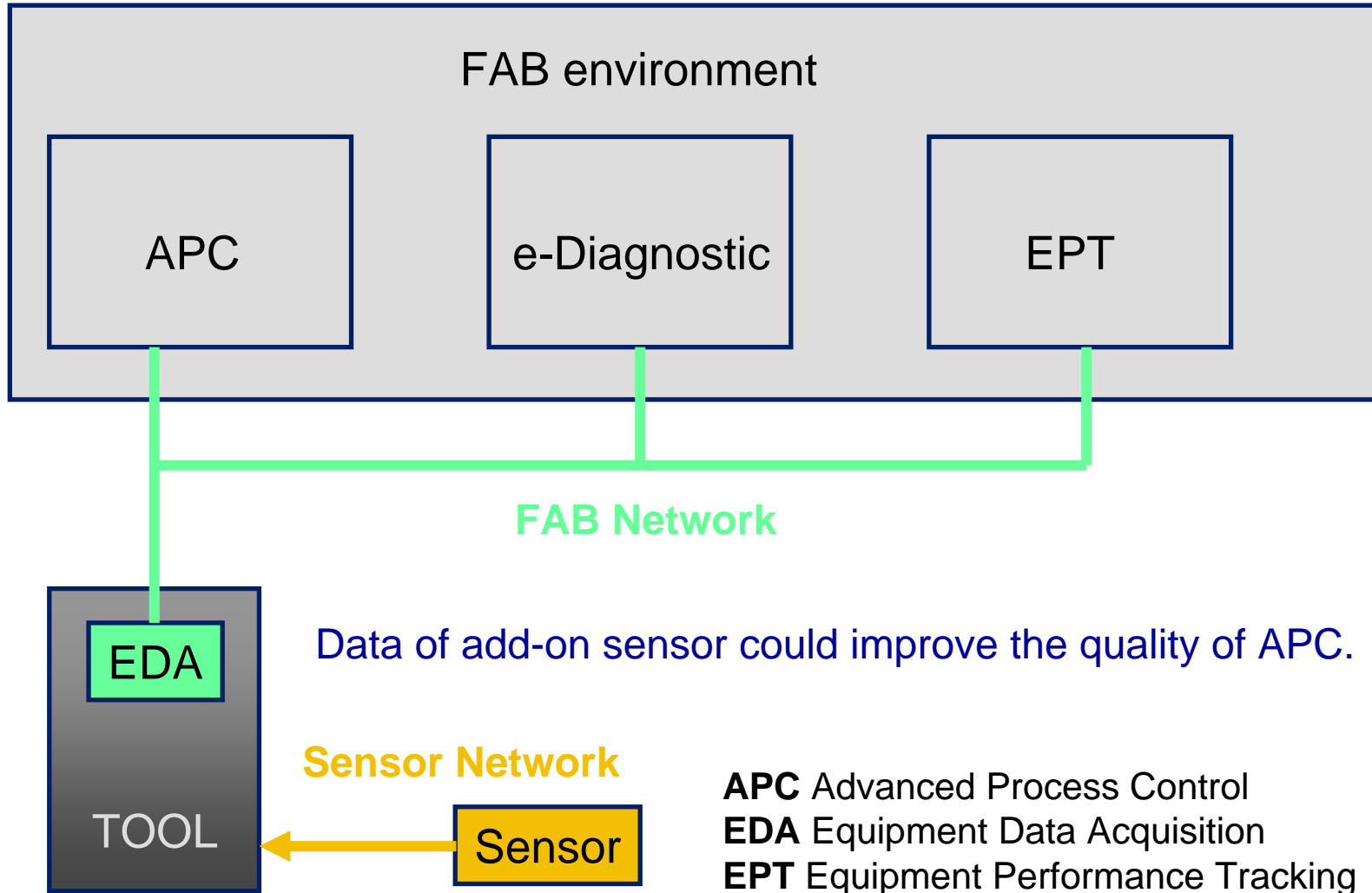
# EDA Interface and ad-on Sensor Integration

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



# Sensor in FAB Environment

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

Sensor Network

**APC** Advanced Process Control  
**EDA** Equipment Data Acquisition  
**EPT** Equipment Performance Tracking



# 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.