Advanced Automation based on Standards

How other industries can profit from automation concepts in semiconductor manufacturing

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Agenda

- **Advanced automation in semiconductor manufacturing – why?**
- Standards & automation concept
- Potential for other industries
- The chance of working together

Advanced automation in semiconductor manufacturing

… what comes to mind

Sources: finfacts.ie, computer-oiger.de, xbitlabs.com, de.wikipedia.org, dailytech.com

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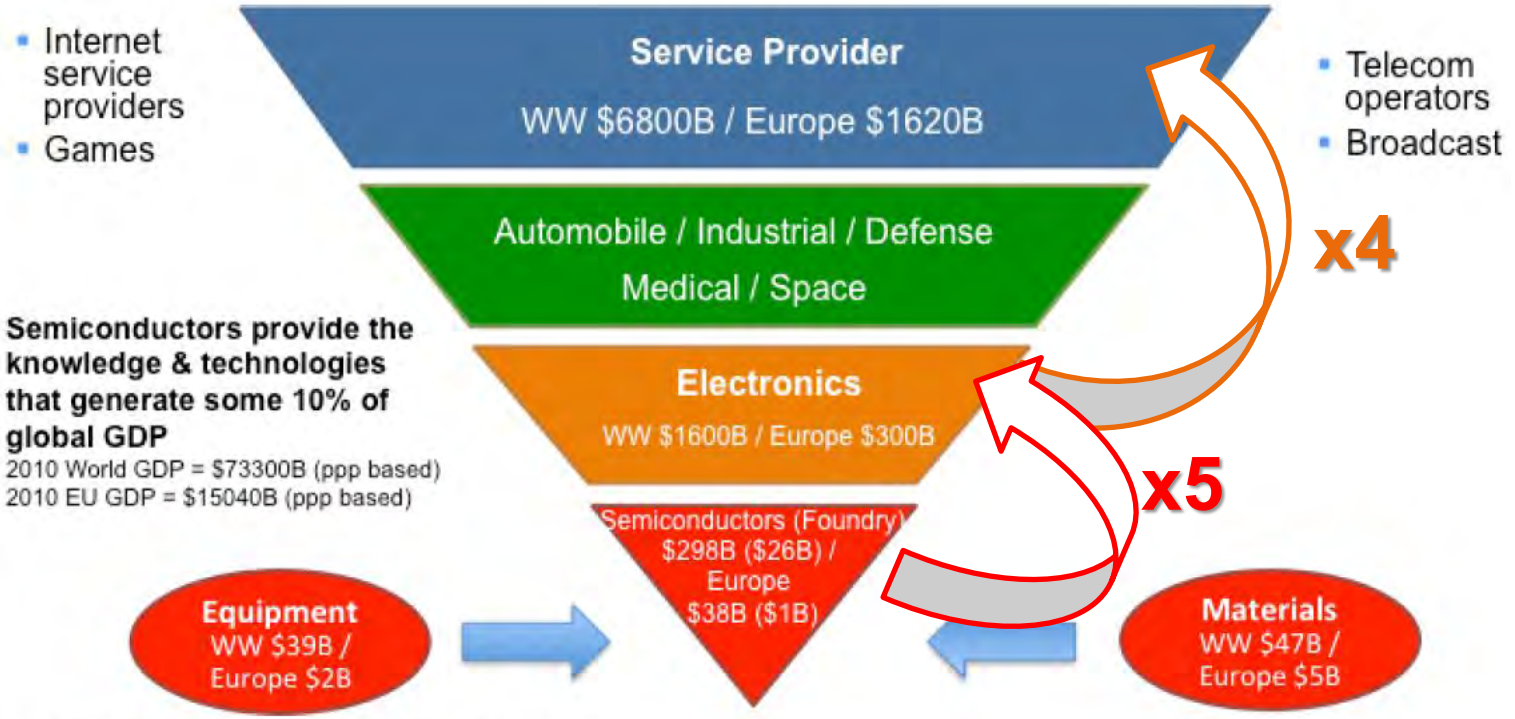
Advanced automation in semiconductor manufacturing

Economic leverage of semiconductor value chain



Source: DECISION/ESIA/IMF/WSTS, 2011

- high growth trend (9% over the last 20 years)
- high volatility

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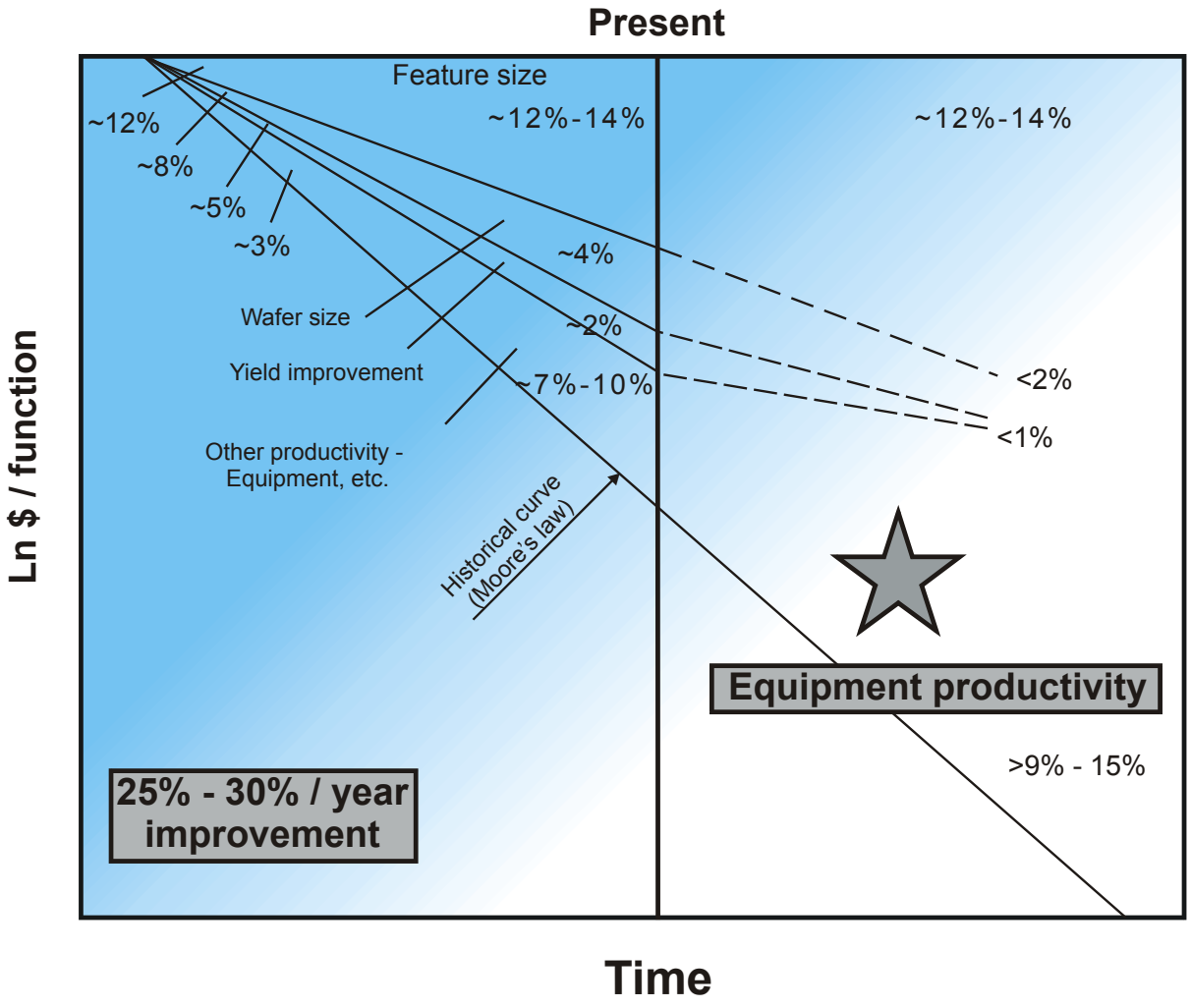
Advanced automation in semiconductor manufacturing

The productivity gap



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- **Standards & automation concept**
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Standards

Some history

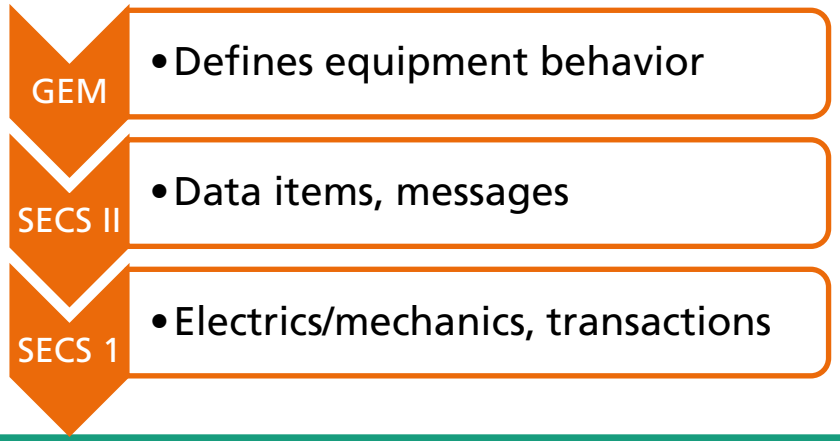
Most famous standard: „SECS/GEM“

- 1978: Hewlett-Packard proposed that standards be established for communications among semiconductor manufacturing equipment.
- 1980/1982: SEMI published the SECS-1/SECS-II standards
- 1992: GEM standard published
- Continued: HSMS, GEM300, EDA/Interface A, …

semi

„Semiconductor Equipment and Materials International“

- Founded in 1970
- Tradeshows (SEMICON), conferences, networking
- **Industry standards** (> 800 standards and safety guidelines)
- USA - Japan - Europa - Taiwan - Korea - China
- www.semi.org



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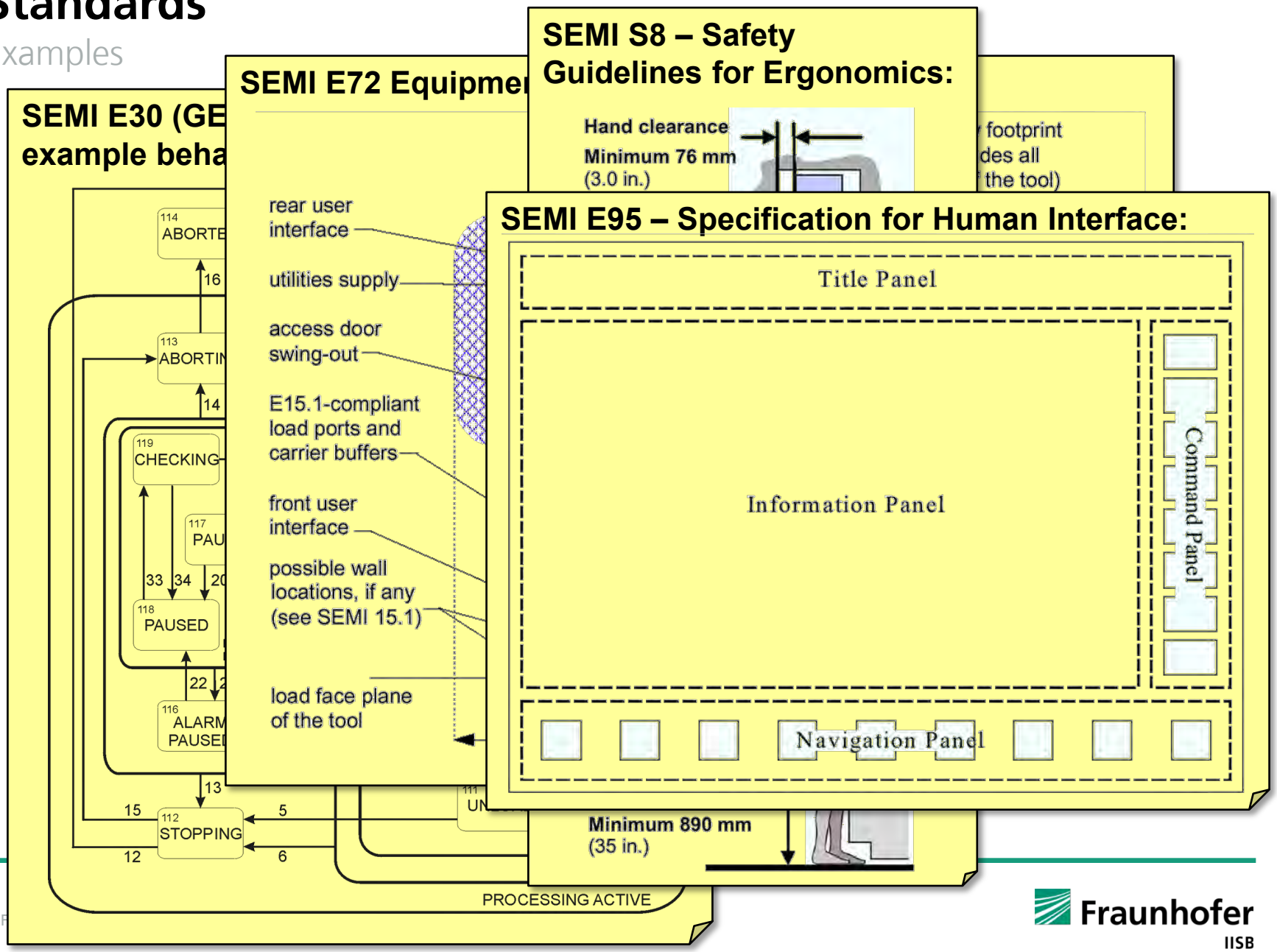
Standards

Examples



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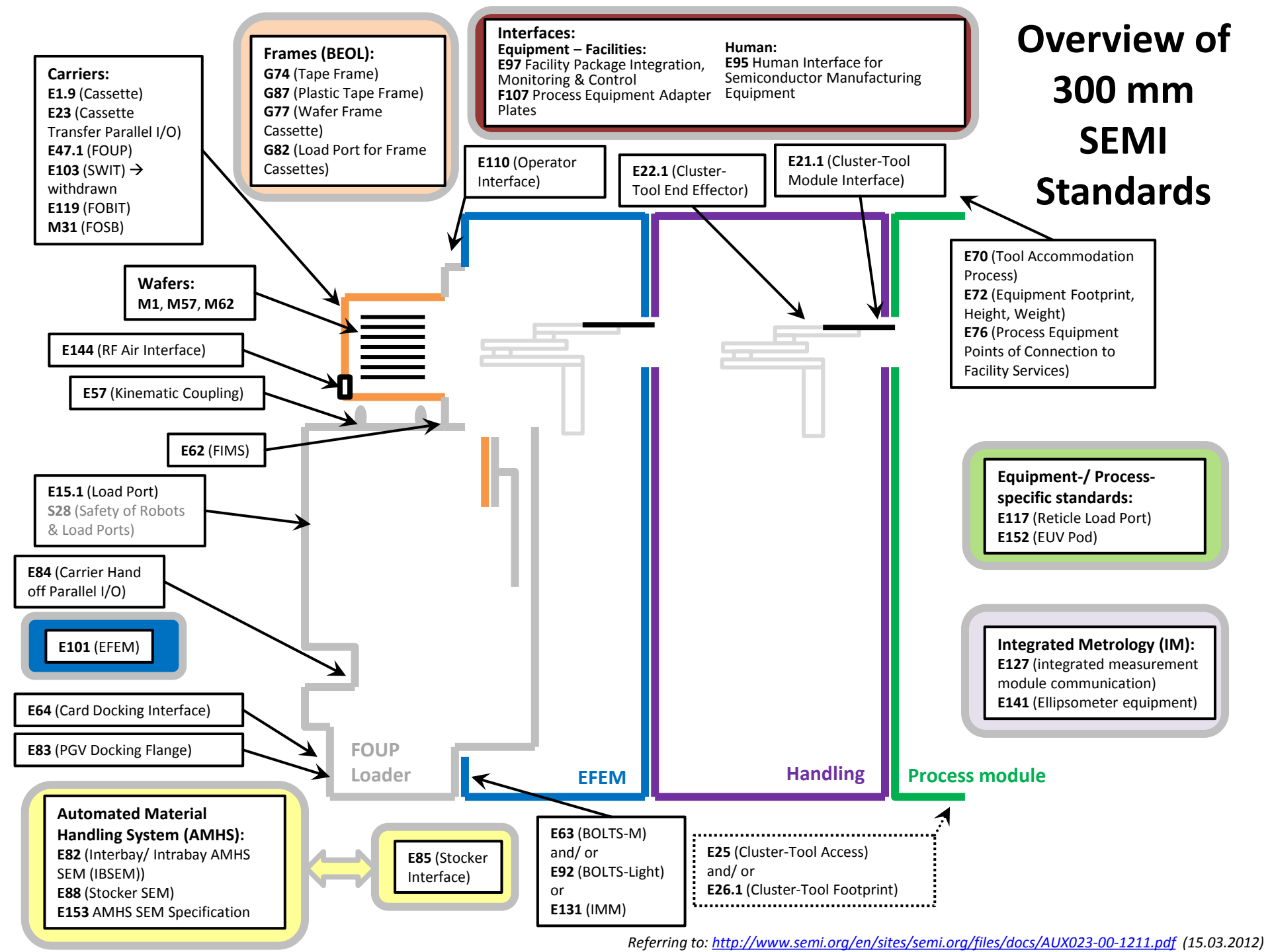
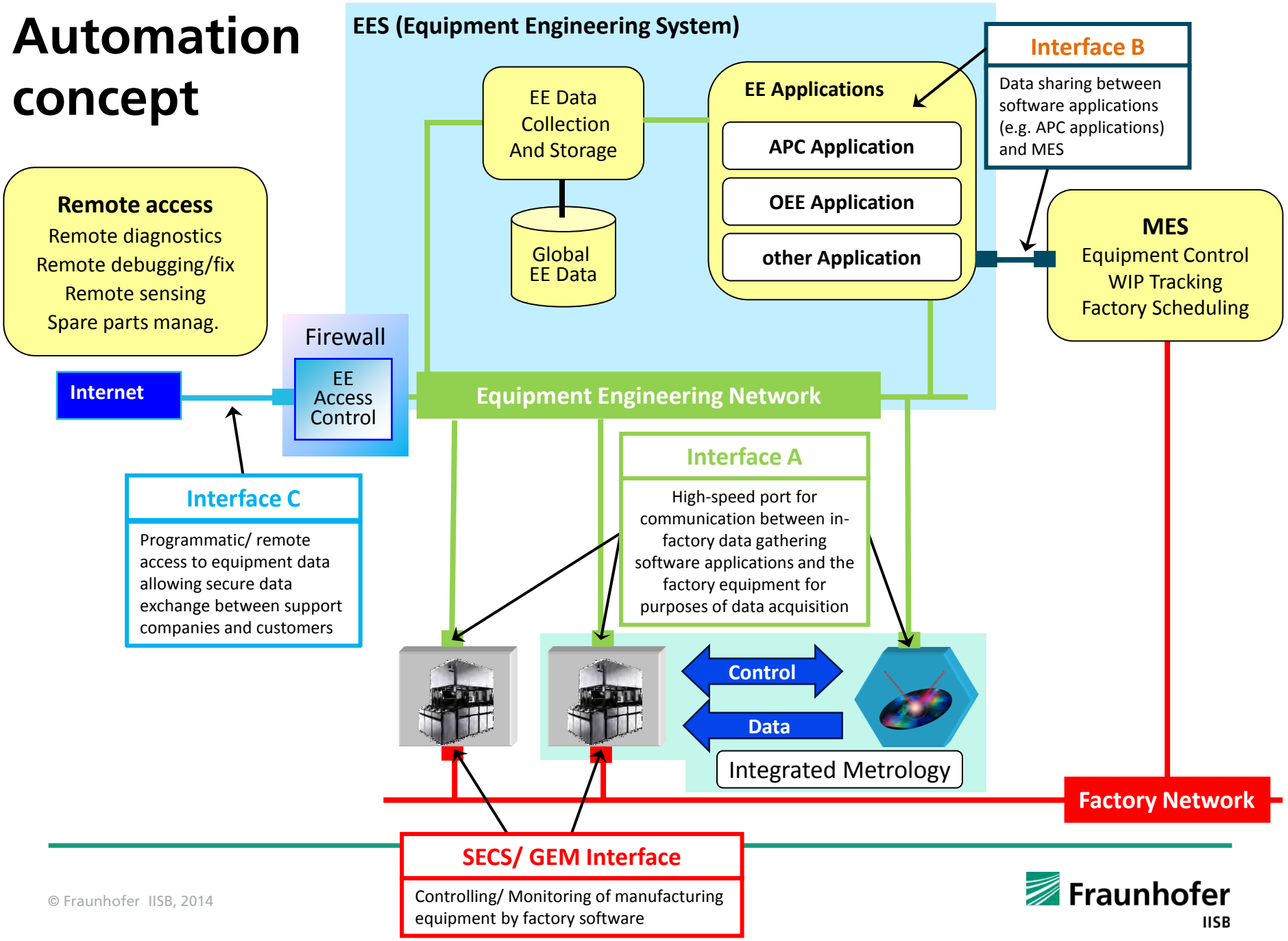
Overview of 300 mm SEMI Standards



Referring to: http://www.semi.org/en/sites/semi.org/files/docs/AUX023-00-1211.pdf (15.03.2012)

Automation concept



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Potential for other Industries

Categories of SEMI standards

- 3D-IC (3D)
- Equipment Automation Hardware (E)
- Equipment Automation Software (E)
- Facilities (F)
- Flat Panel Display (D)
- Gases (C)
- HB-LED (HB)
- Materials (M)
- MEMS (MS)
- Microlithography (P)
- Packaging (G)
- Photovoltaic (PV)
- Process Chemicals (C)
- Safety Guidelines (S)
- Silicon Materials & Process Control (MF)
- Traceability (T)

For other industries:

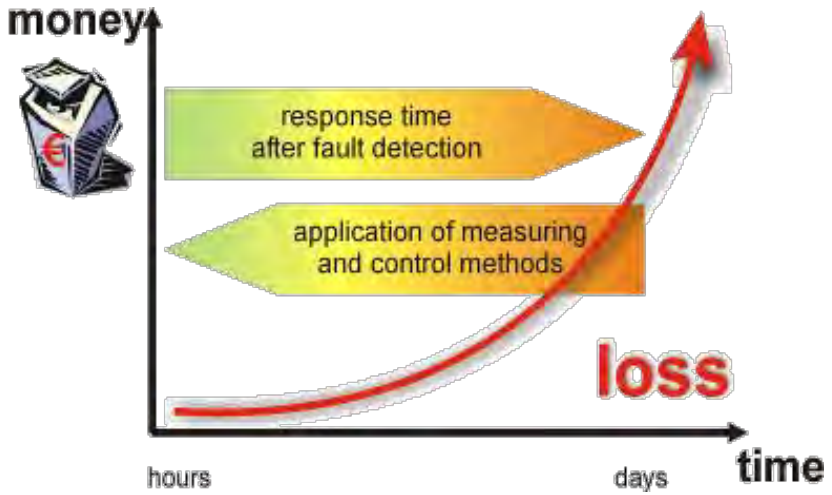
"Put everything to the test.
Hold on to what is good."

(The Bible)

Potential for other Industries

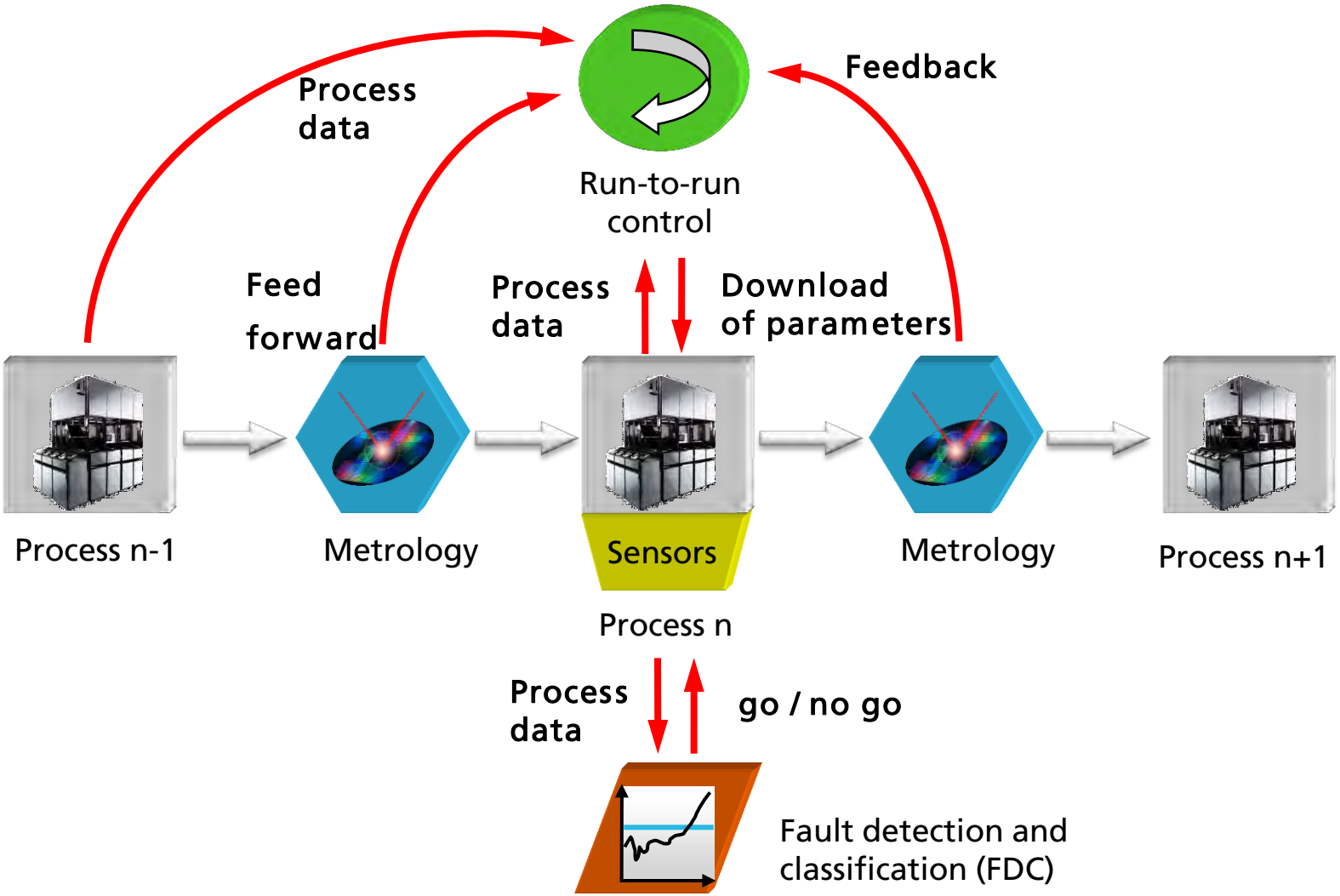
„Big data“ and Advanced Process Control

- Objective: Ensure high quality productivity
- Fundamental goals of APC
  - to obtain measures for process control closer to the process
  - to automate control actions
- Typical APC methods (SEMI E133):
  - SPC, FDC, FP, RtR, VM, PdM
- Basis for APC:
  - Metrology data
  - Data from equipment & processes
  - Logistics data



Potential for other Industries

Interaction of APC elements



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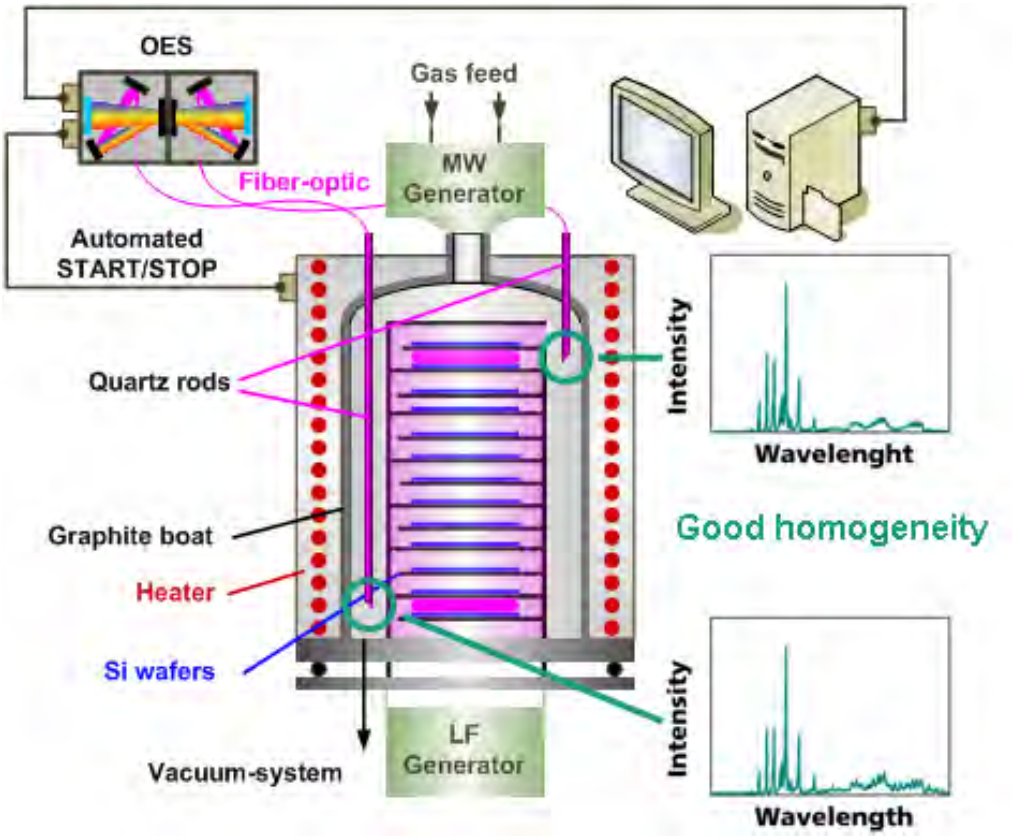
Potential for other Industries

Examples for productivity enhancement by APC

Real-time control of plasma processes by integrated OES



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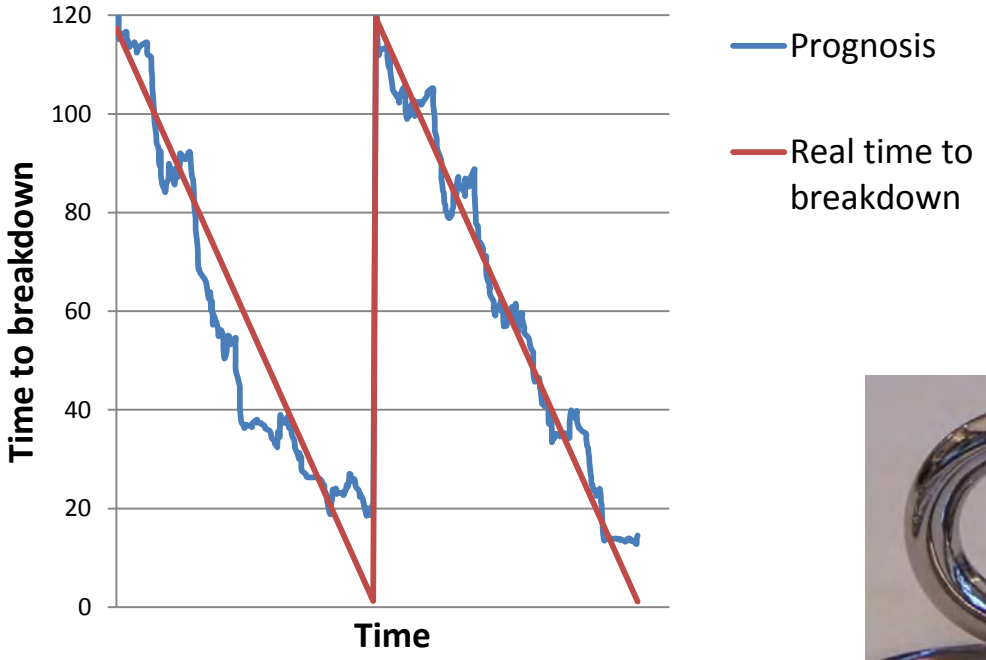
Potential for other Industries

Examples for productivity enhancement by APC

Prediction of maintenance events by PdM



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Potential for other Industries

Examples for productivity enhancement by APC

From an ENIAC project on productivity enhancement - IMPROVE

- 9 European Semiconductor manufacturing sites
- Requirement: **Integration by utilizing standards**!
- Generic framework based on SEMI standards
- Increase of equipment availability in the range of 1%-5%
- Equipment Health Factor (EHF) and the capability to predict equipment failure improve the cycle time by reducing unexpected failure.
- Knowledge of equipment behavior from the modelling work provided a better diagnosis capability and therefore an additional improvement of the equipment availability in the range of 1%.

Potential for other Industries

Lessons learned from APC in semiconductor manufacturing

1. Know your process
2. Make use of standards
3. Use data you already have
4. Take care of data quality
5. Keep things simple and inexpensive
6. Go for low-hanging fruits

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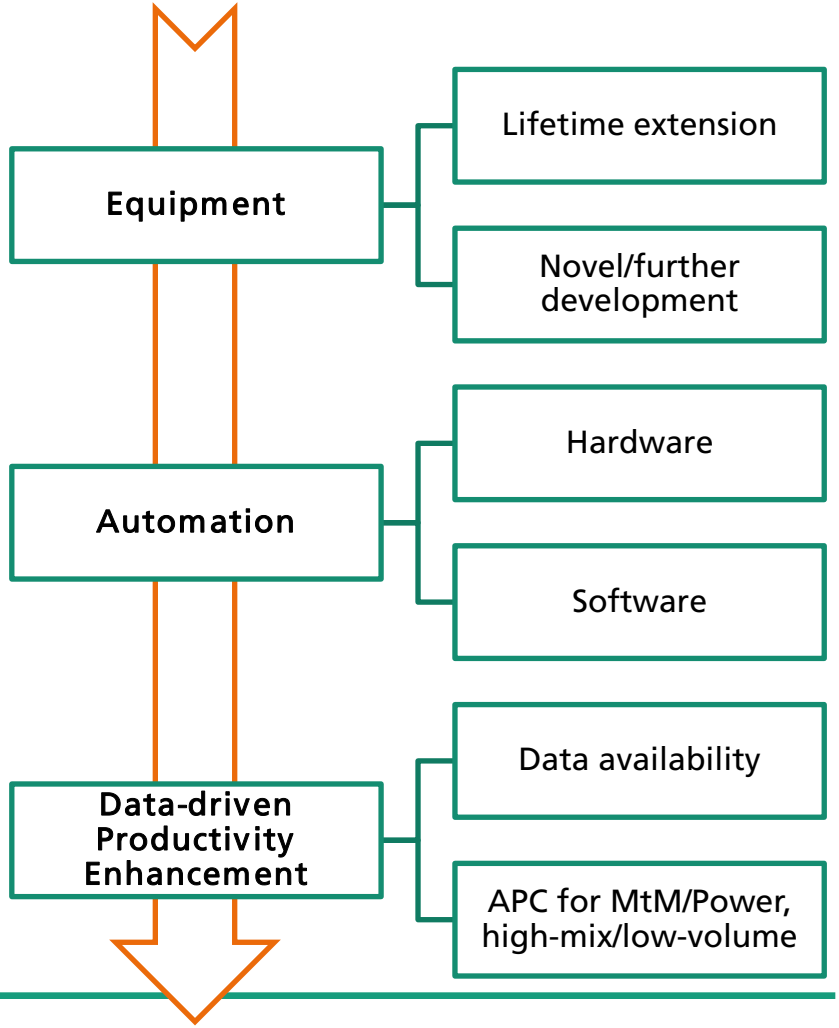
- **The chance of working together**

The chance of working together

Results from a study amongst German IC manufacturers

Main challenge:

- How to enhance productivity in a “More than Moore” production environment!



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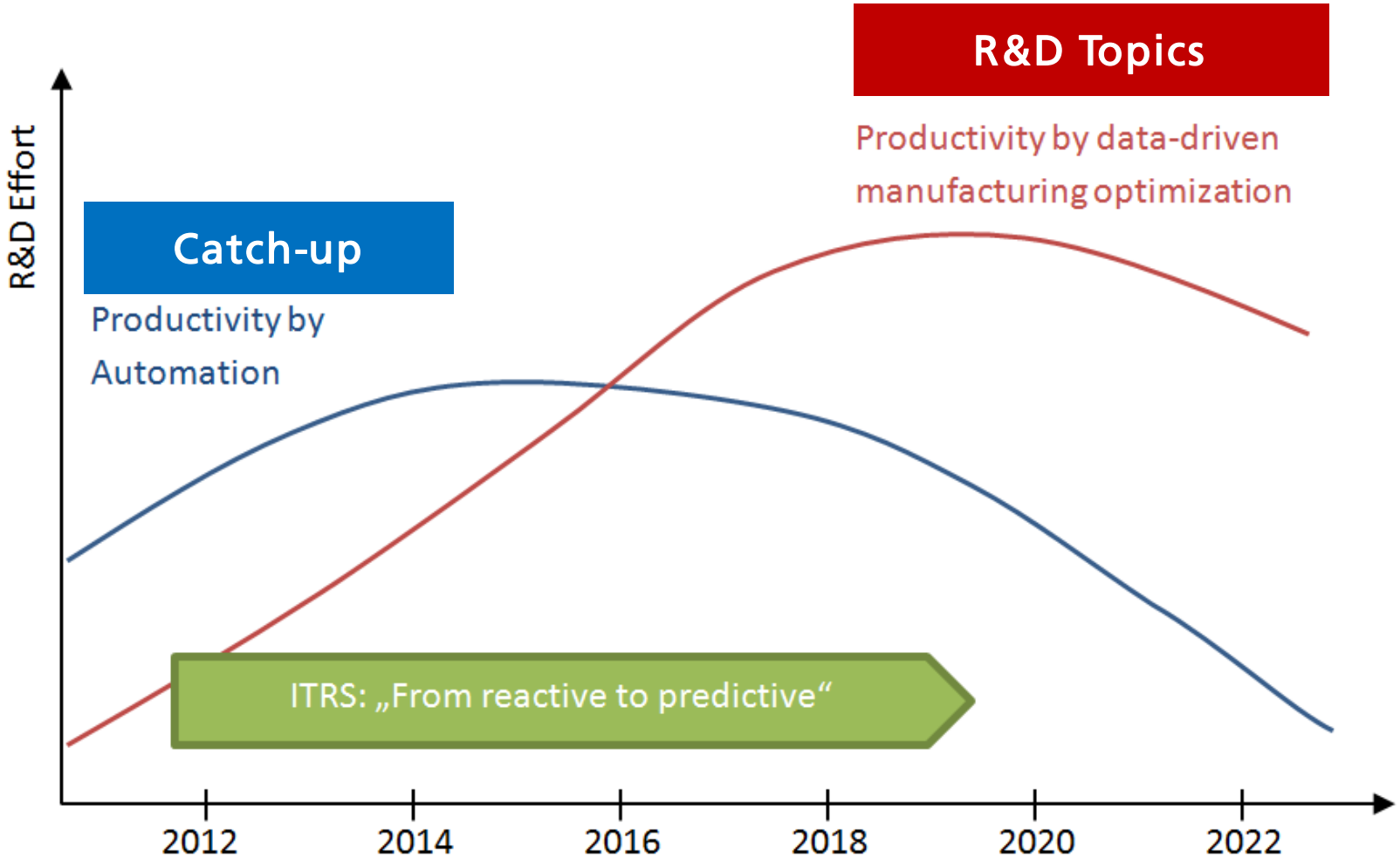
The chance of working together

Results from a study amongst German IC manufacturers



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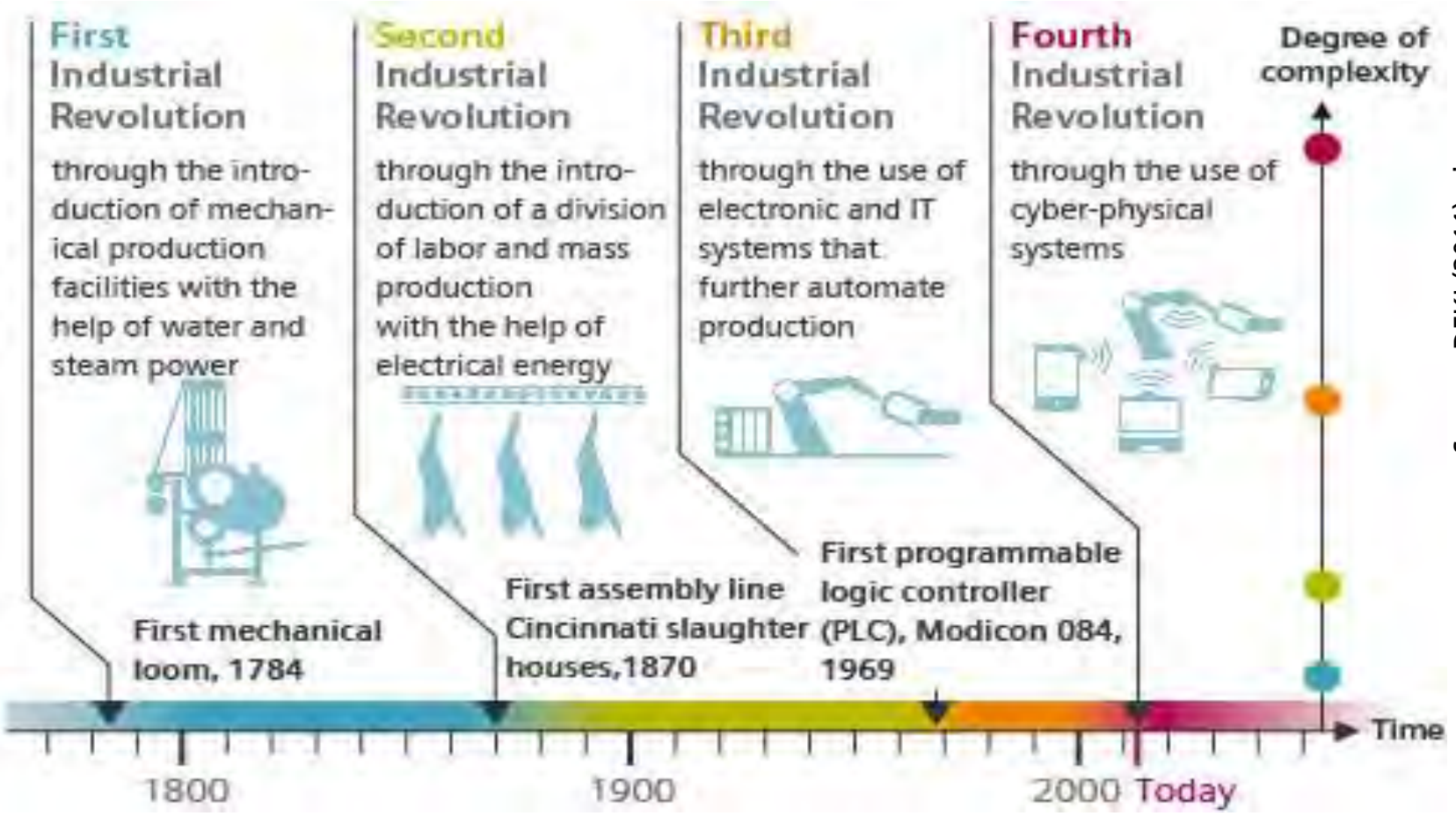
The chance of working together

Starting points towards “Industry 4.0”



Source: DFKI (2011), siemens.com

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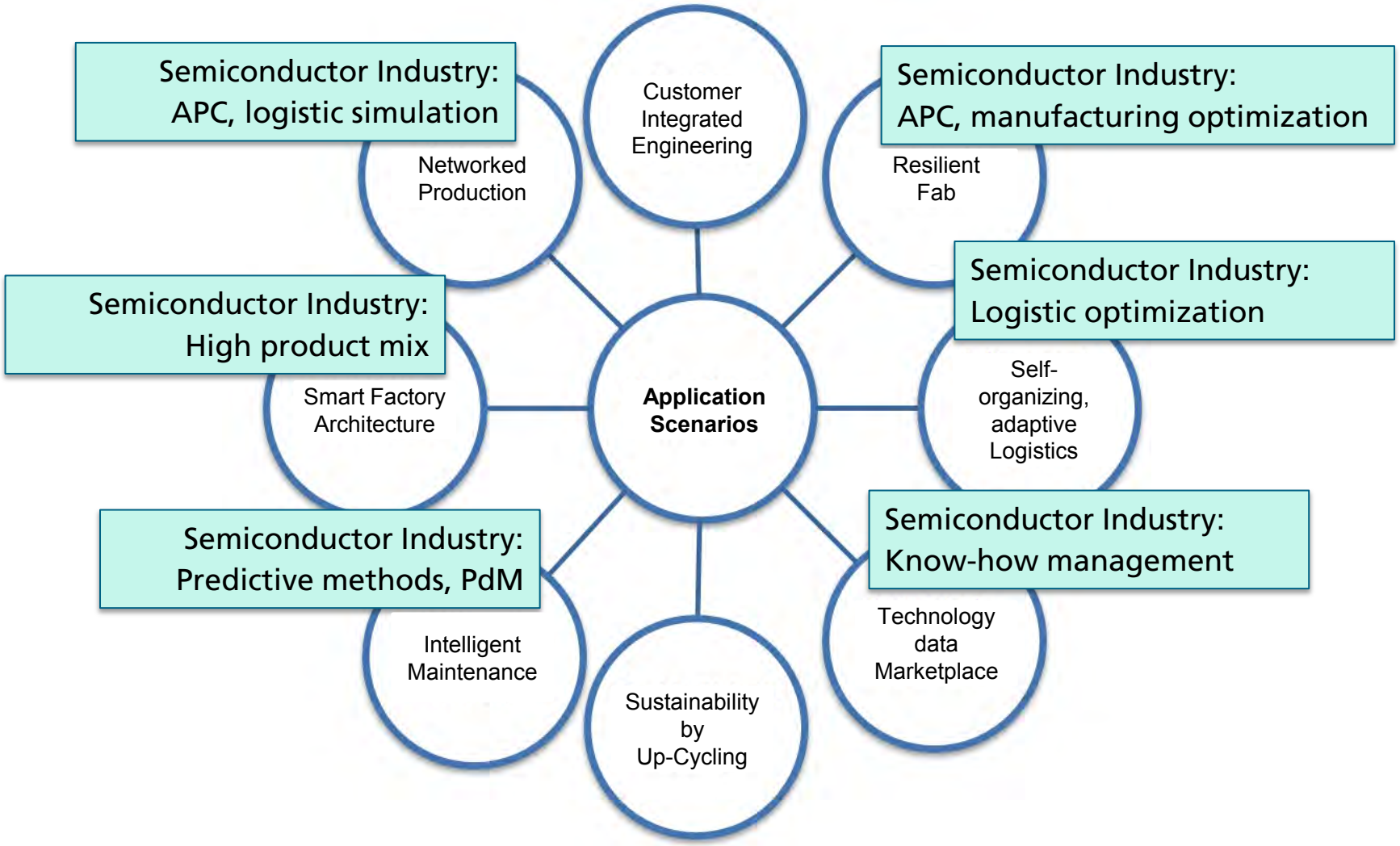
Starting points towards “Industry 4.0”



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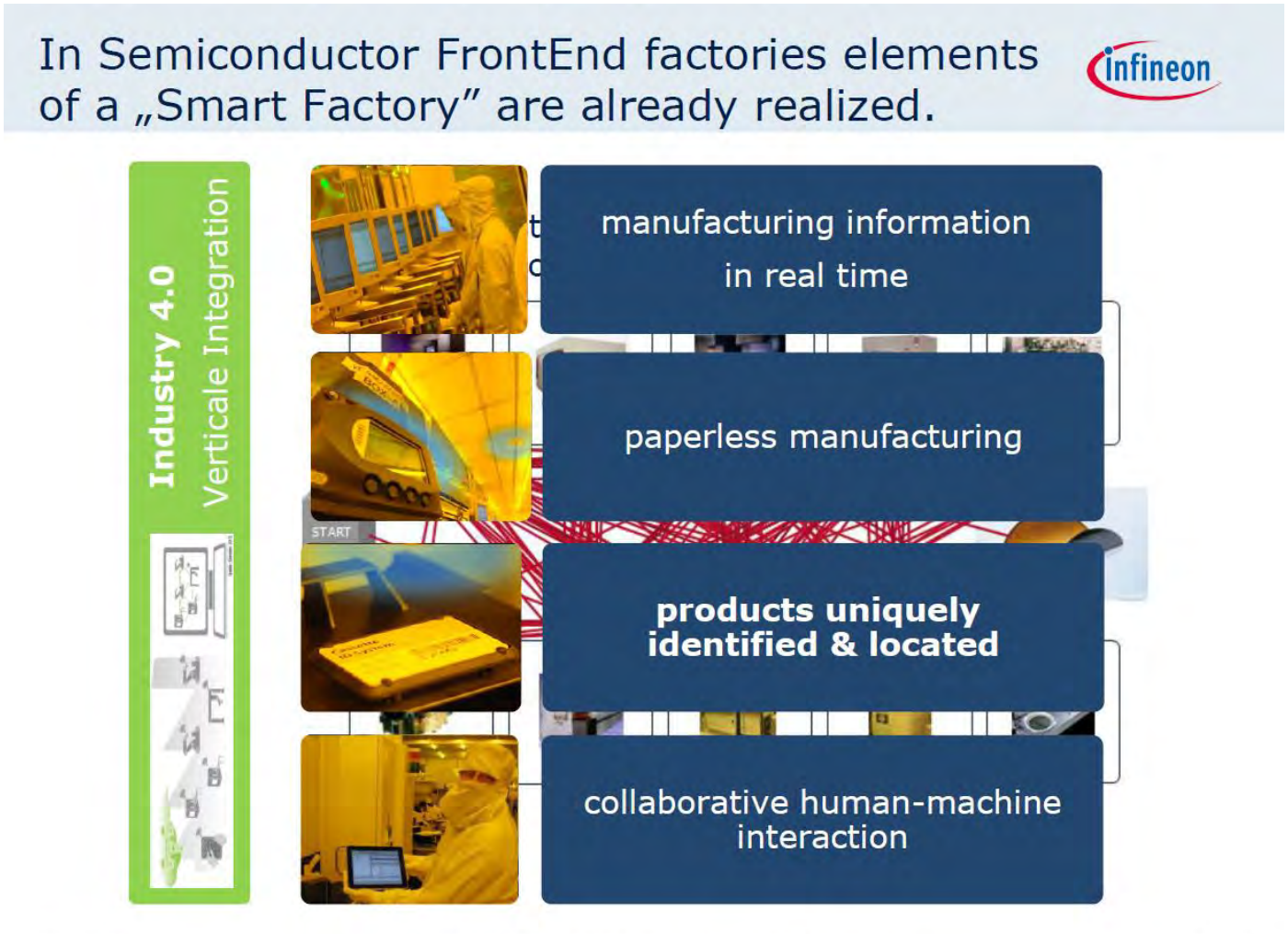
The chance of working together

A semiconductor view on “Industry 4.0”



Dr. T. Kaufmann, Infineon

11th Innovationsforum for automation, 2014, Dresden

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The chance of working together

Summary

Achievements in semiconductor manufacturing

- Standards and automation concepts evolved over more than 35 years
- Proven as basis for improved productivity

Potential for other industries

- “Hold on to what is good” – knowledge and definitions
- Well experienced R&D and suppliers available

The chance of working together

- From APC-enhanced equipment to cyber-physical systems
- Semiconductor manufacturing: strategic partnerships with other industries, spearheading with products and “manufacturing science”

Acknowledgment

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Thanks

for your attention!