Smart Manufacturing:
Convergence, Co-Design & Co-Optimization Improve Performance, Sustainability and Yield across Microelectronics Supply-Chain

Tom Salmon
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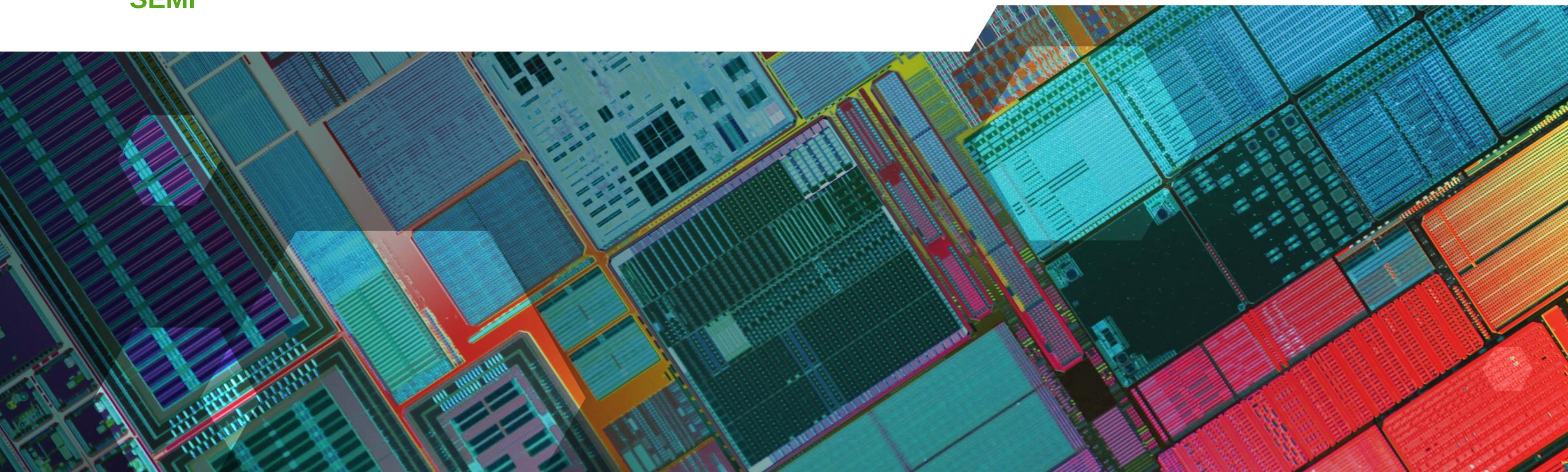
SEMI



Talking Points

- SEMI and Our Industry: Connect – Collaborate – Innovate
- How We Got Here
- The New Imperative
- Connecting the Supply Chain
- Data, What Data?

SEMI Connects to Advance a Global Industry

Mission

SEMI provides industry stewardship and engages our members to advance the interests of the global electronics manufacturing supply chain.

Vision

SEMI promotes the development of the global electronics manufacturing supply chain and positively influences the growth and prosperity of its members. SEMI advances the mutual business interests of its membership and promotes a free and open global marketplace.

SEMI is the place to connect, collaborate, and solve problems in a pre-competitive forum. Platforms for regions and special interest groups are connected to global common interests.

From Monolithic Demand Drivers to an Explosion in Applications

Mainframe Computers

1970s

Personal Computers

1980s

Internet "The Web"

1990s

Mobile & Social Networking

2000s

IoT & Big Data & …

2010s

This is the ***most interesting*** time to be in the electronics manufacturing industry

- IoT/wearables
- Big Data
- New Memory/Server Farms
- Virtual and Augmented Reality
- Autonomous Vehicles
- Artificial Intelligence
- Smart Manufacturing
- Digital Medicine

nest IoT thermostat

Google TPU v2

SEMI Connects the Electronics *Manufacturing* Supply Chain for Collaboration

Collaboration segments

IOT

SMART TRANSPORTATION

SMART MANUFACTURING

SMART MEDTECH

SMART DATA

semi | FOA fab owners alliance

semi | FlexTech

semi | ESDA Electronic System Design Alliance

semi | MEMS & Sensors Industry Group®

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How We Got Here

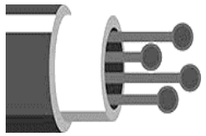
Evolution of SEMI Standards to Enable Smart Manufacturing

SECS II / GEM

- Data exchange
- Point to Point communication
- Message structure
- Data types
- Units

HSMS

- Bandwidth
- High-speed communication
- TCP/IP protocol
- Timeouts



GEM 300

- Full factory automation
- Substrate tracking
- Job management

EDA

- Authentication
- Multi-client data collection
- Equipment metadata

FUTURE

- Intelligent robotics
- Cloud based
- Advanced modeling

1980 **Addressing Industry Trends** 2020 +

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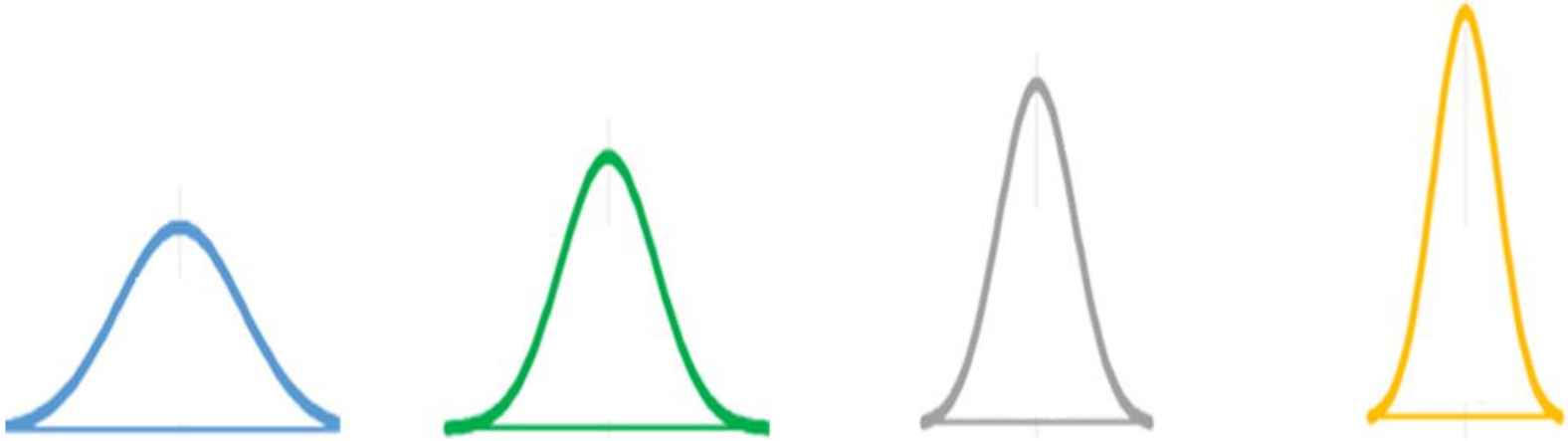
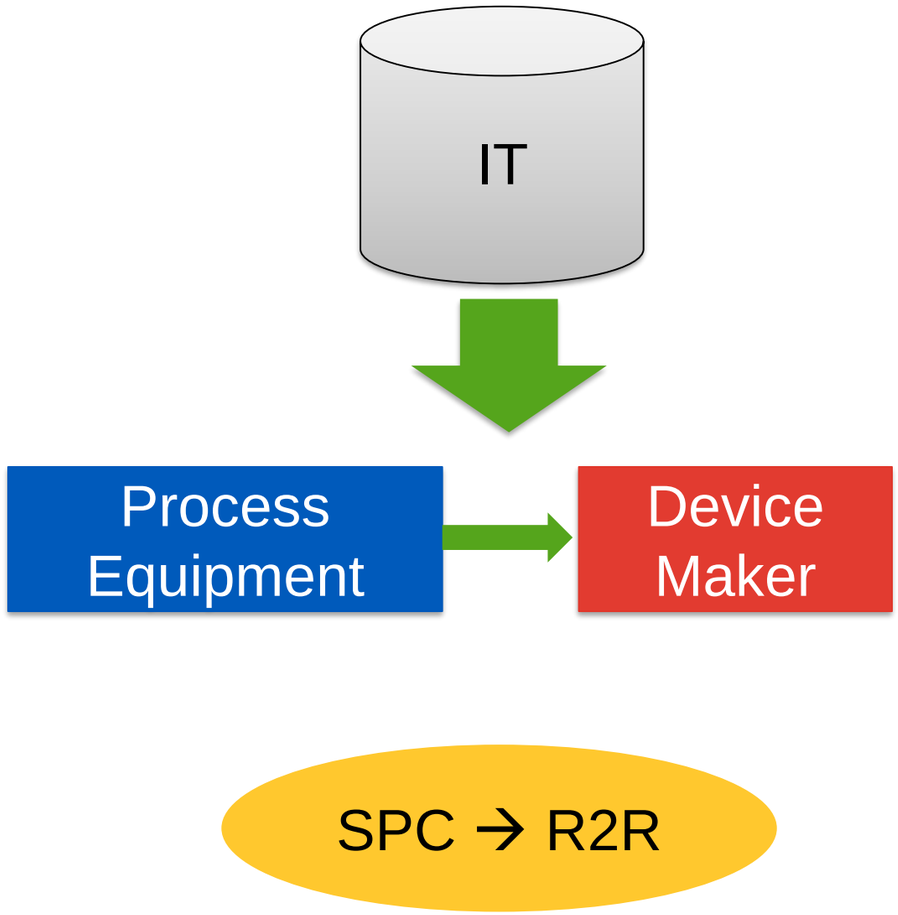
Smart Manufacturing
and the evolution supporting SEMI Standards

Node (nm)	800	600	350	250	180	130	90	45	32	22	14	10	7
Process Window (C_{pk})													
Key Applications	SPC		R2R		FDC		VM		PDM		Big Data		Artificial Intelligence Machine Learning
Data Generated (MB/sec)	0.016		0.3		2.4		18		110		500		1200
Supporting SEMI Standards	SECS-II		GEM		GEM300		EDA I		EDA II		E164		TBD…

Courtesy: Alan Weber, Cimetrix

Changes in Complexity, Supply-Chain and Markets

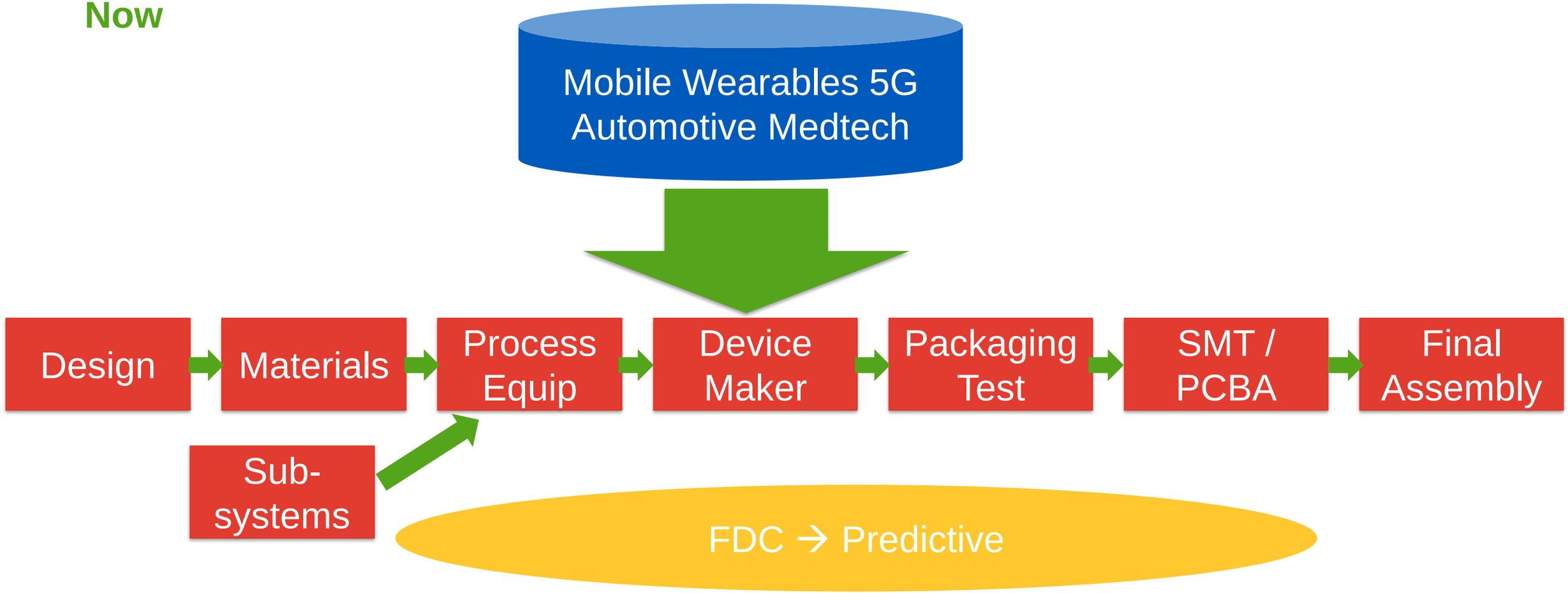
Before



The New Imperative

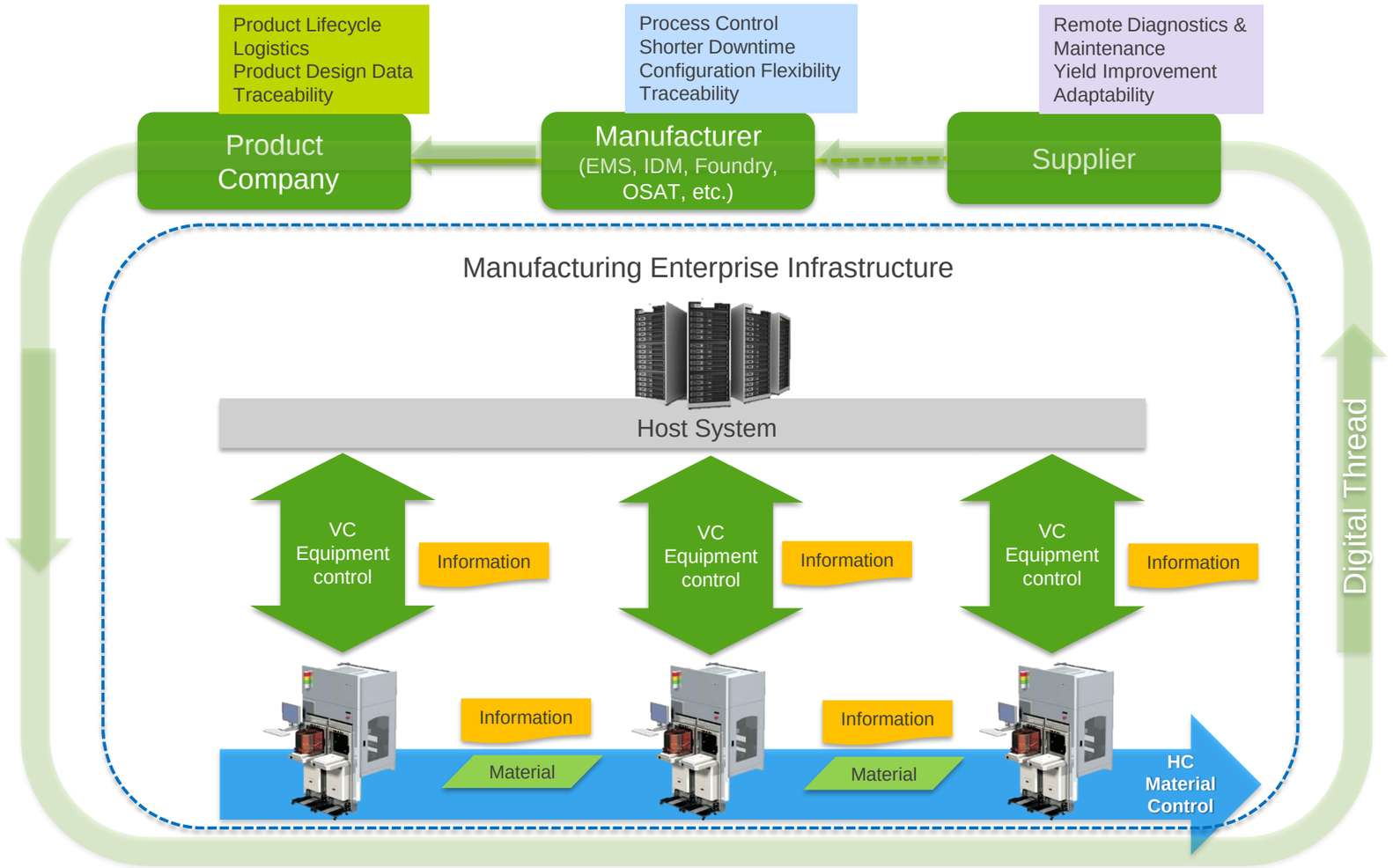
Changes in Complexity, Supply-Chain and Markets

Now

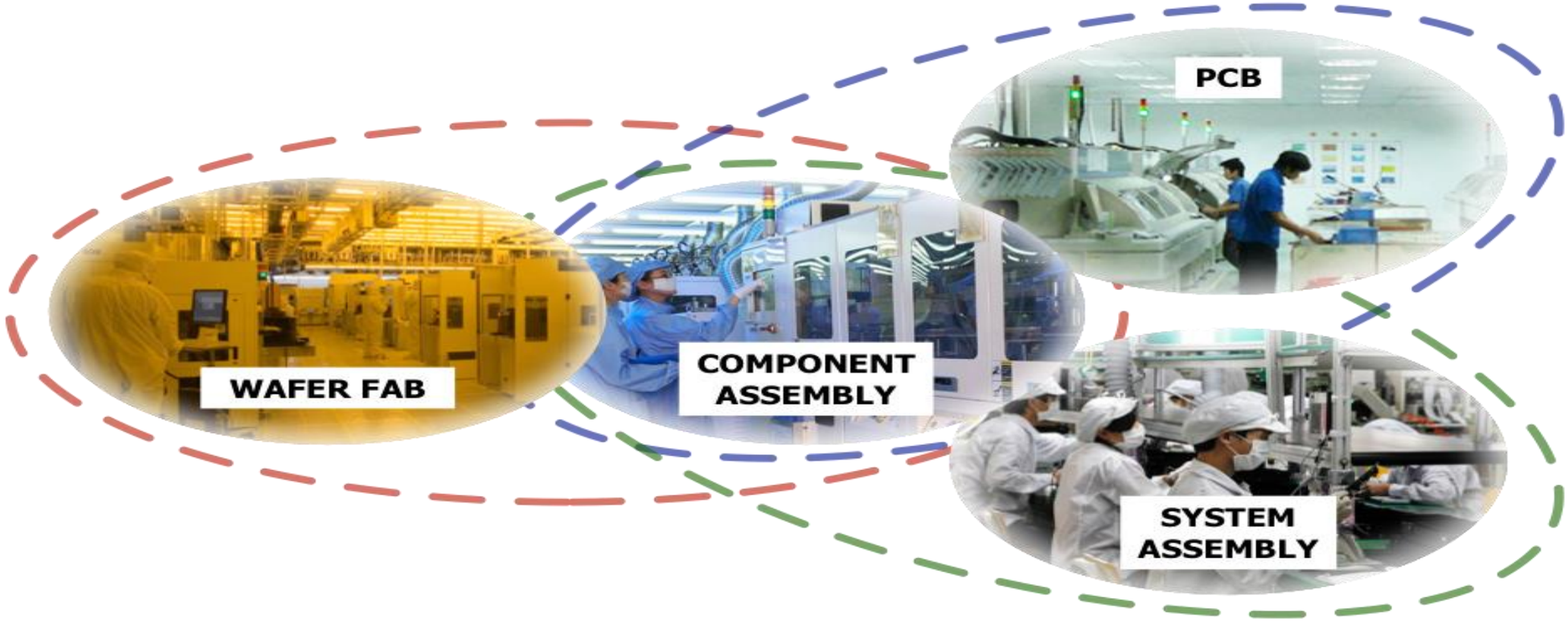


Connecting the Supply Chain

Smart Manufacturing and the Microelectronics Ecosystem - Future State Digital Thread



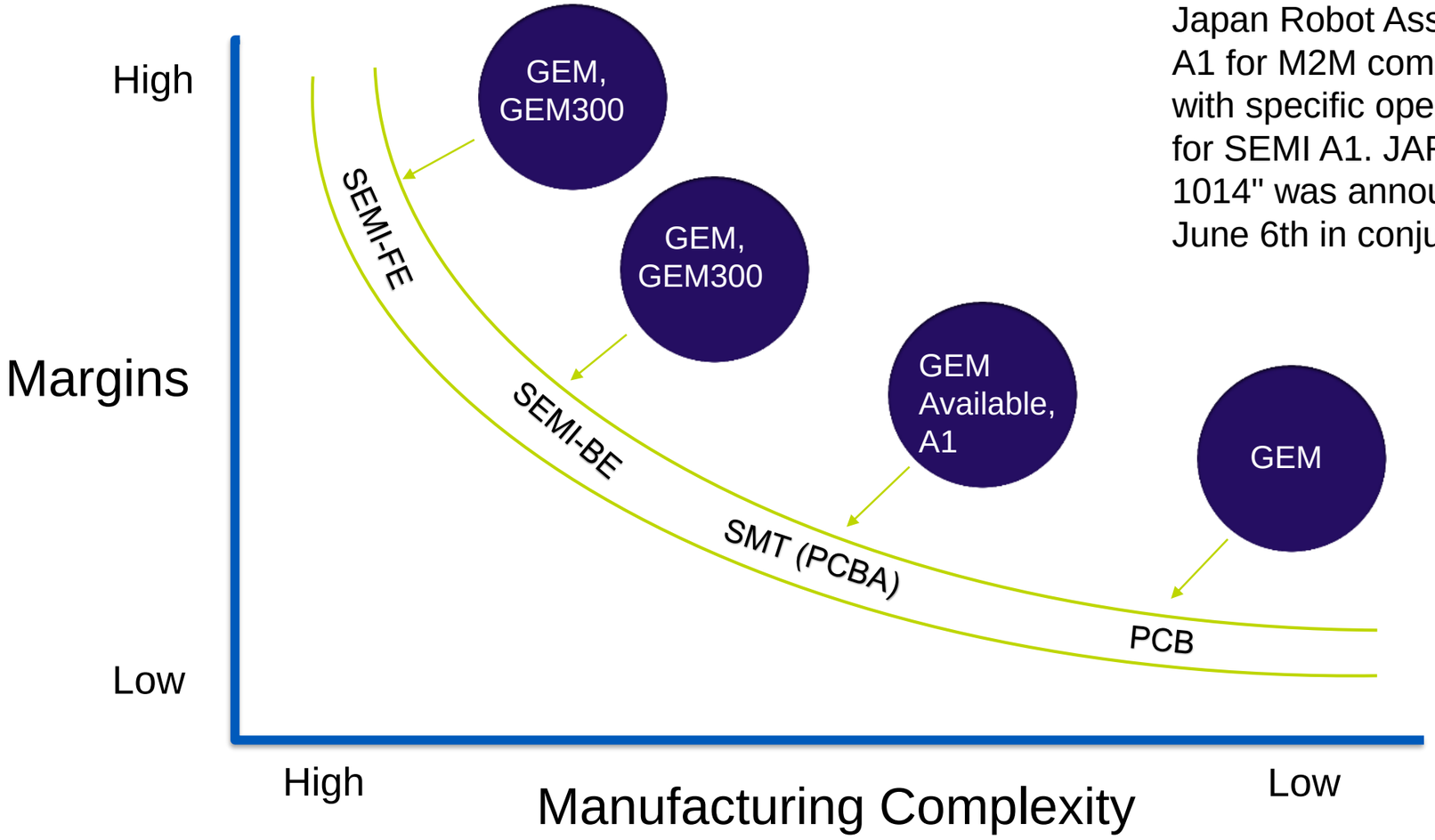
Observation: Convergence of Industry Segments



- Competition from EMS companies in System-in-Package (SiP) assembly
- PCB and substrate makers compete with embedded components etc.

Source: TechSearch International

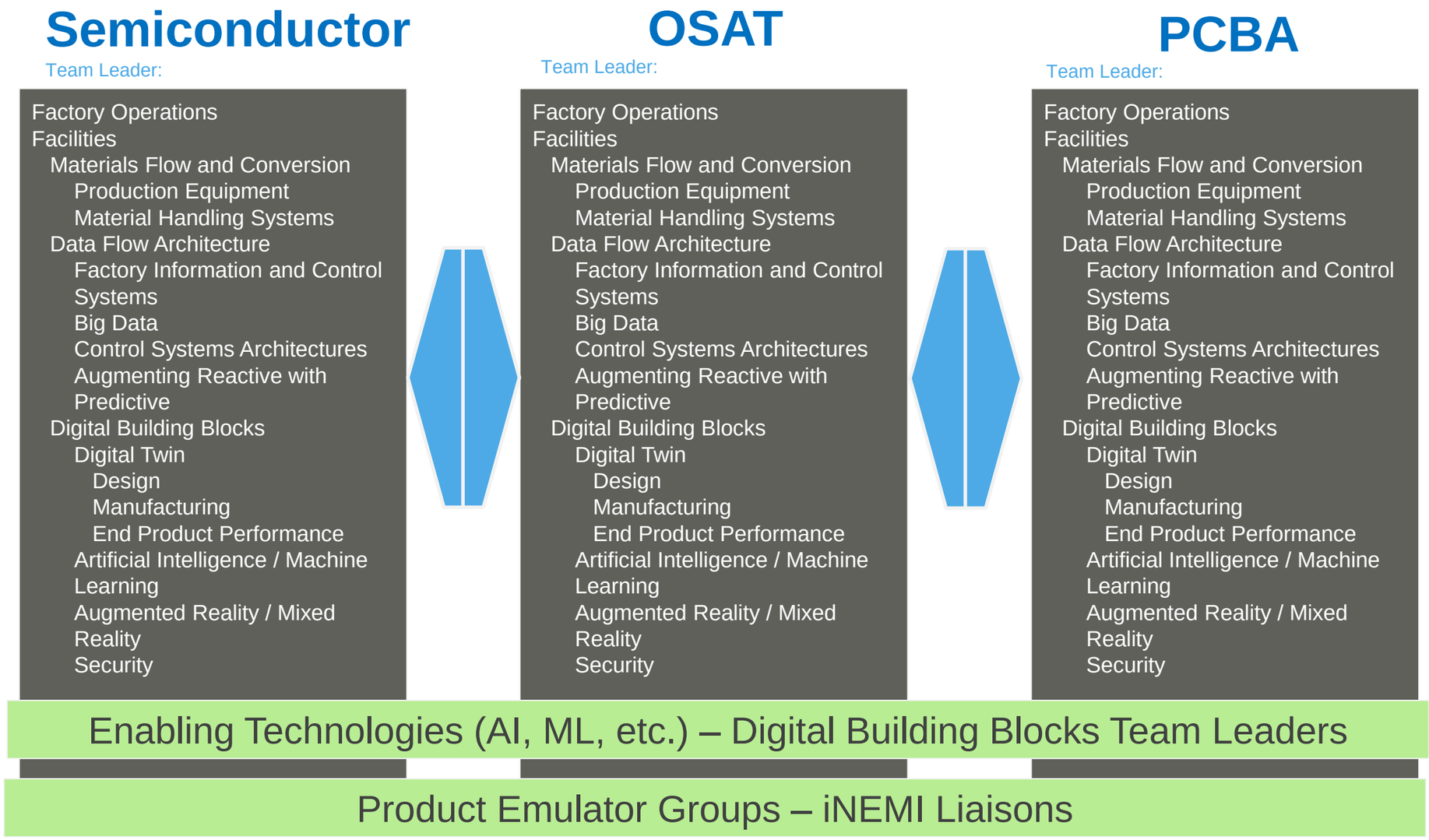
The Machine Communications Adoption Curve



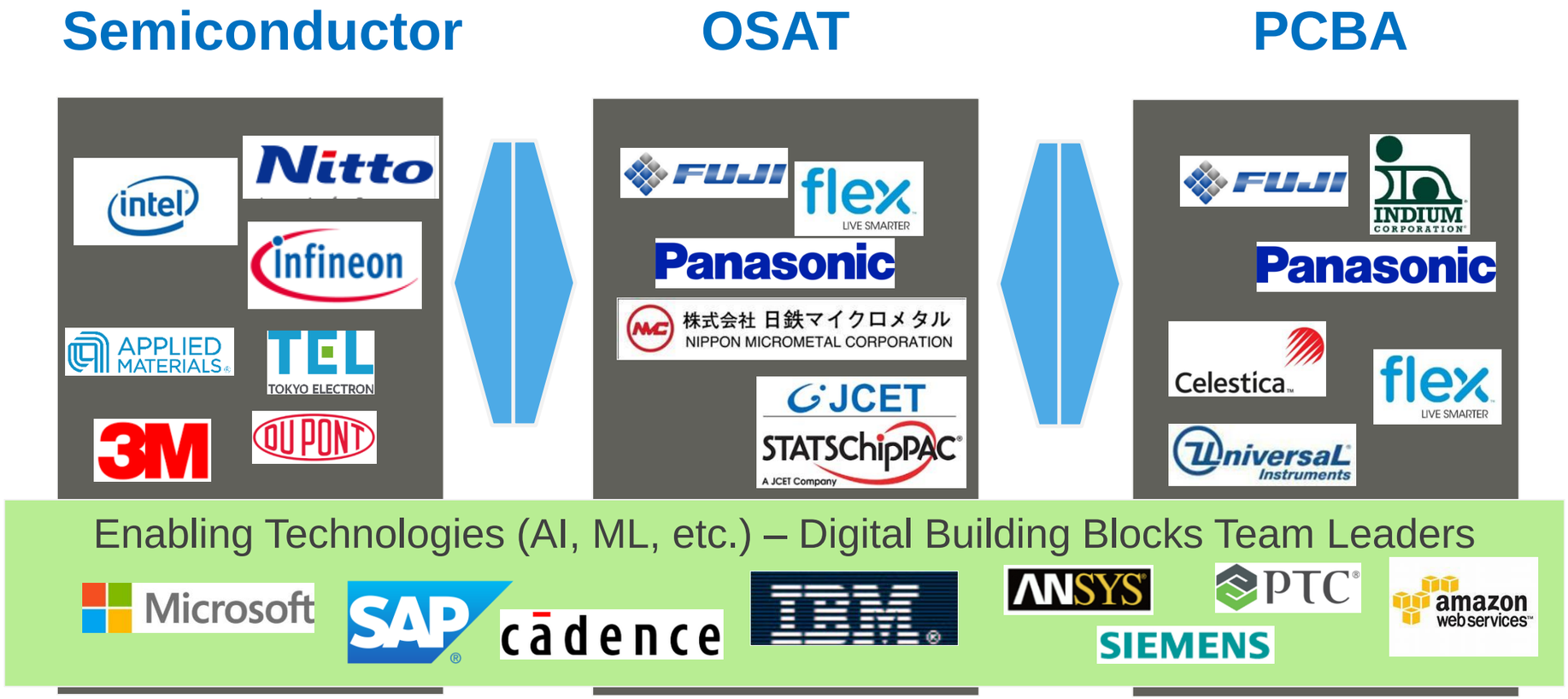
Japan Robot Association (JARA) adopted SEMI A1 for M2M communication in the SMT industry with specific operation and message definitions for SEMI A1. JARA Standard, named "JARAS 1014" was announced at a special session on June 6th in conjunction with JISSO PROTEC.

http://www.semi.org/en/industry-collaboration-smart-factories

Smart Manufacturing Roadmap



Smart Manufacturing Roadmap Participants



Data, What Data?

Smart Manufacturing Successes and Challenges in Semiconductor

- Successes
  - Analytics and Applications
    - FDC, R2R control, virtual metrology and PdM, etc.
  - Process digital twin
    - R2R control, PdM, Real-time Dispatch, etc.
  - Big data environment conversion

- Challenges
  - Data and IP Security; leveraging the Cloud
  - Supply chain integration
  - Structured incorporation of Subject Matter Expertise (SME)
    - Realizing that “big data” is really many clusters of “small data”
  - Enabling the human in all aspects of SM
  - Data quality given complexity and dynamics

Courtesy: James Moyne

Digital Building Blocks for Optimization & Connectivity

Data Analytics

aws SIEMENS IBM ORACLE Microsoft

Data Conditioning – selection, IP mgmt., formatting, etc.

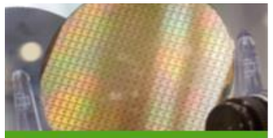
SMART DATA

Data Acquisition – from PLC, Sensor, Camera, TCP/IP, MES/ERP, etc.

SMART MANUFACTURING

Smart Manufacturing Standards, Guidelines & Best Practices

SEMI® International Standards



Substrates
Materials
Components
Subassemblies

Equipment

IP
Design
Fabless

Device Manufacturing
Packaging
Test

System Integration

Applications

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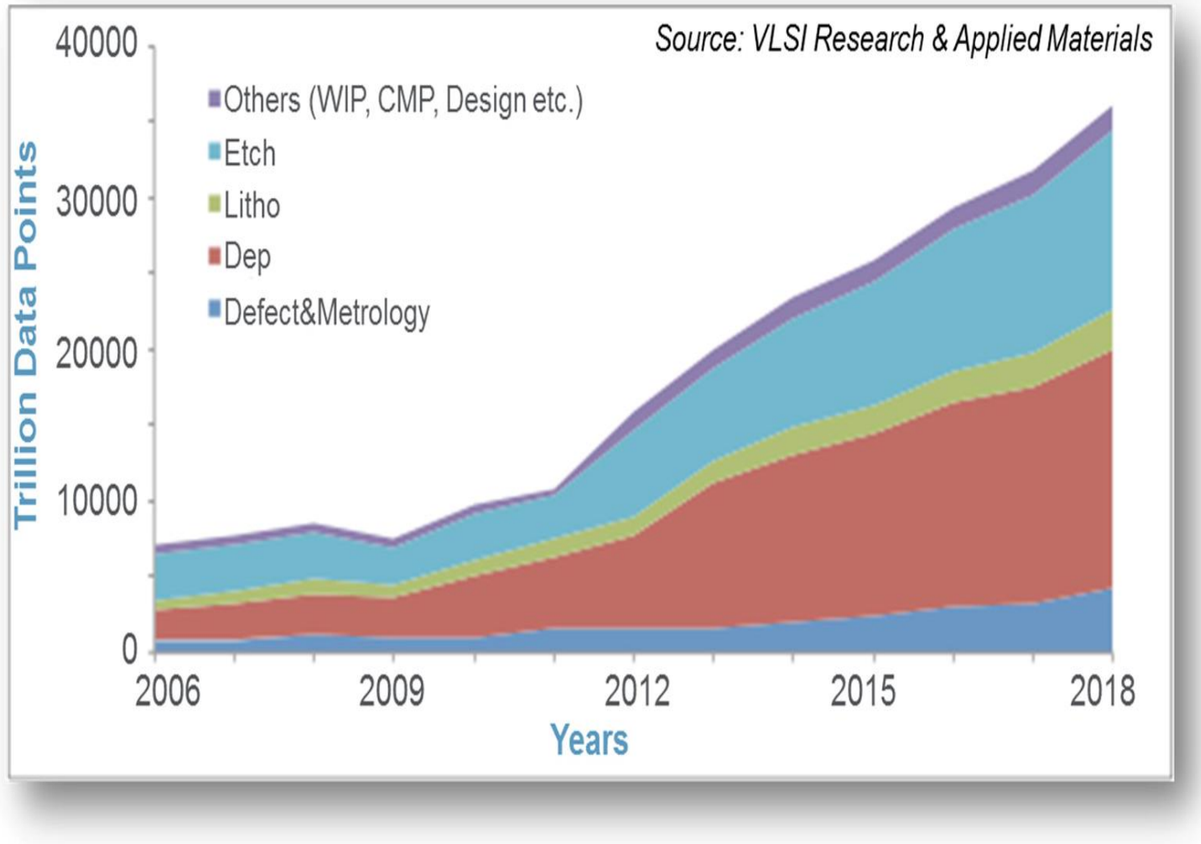
AI & Data Offers Opportunities to Improve Operational Efficiency in Semiconductor Manufacturing & Supply Chain

"AI-enabled root cause analytics can improve yield, and AI-optimization can minimize equipment maintenance required, reduce testing cost and lead to higher throughput. Overall, the use of AI can lead to a reduction in yield detraction by up to 30%.
--Mckinsey & Co. "Smartening up with Artificial Intelligence (AI)" April 2017

"Machine learning and analytics to improve predictive maintenance, and process/quality optimization is predicted to increase 35% in the next five years."
-Price Waterhouse Coopers, "Digital Factories 2020" April 2017

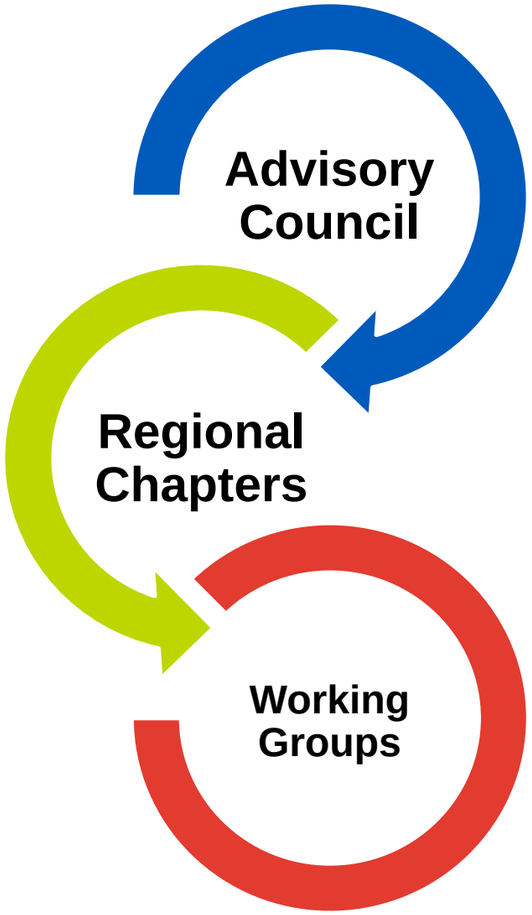
"Adoption of Blockchain in supply chains currently stands at five percent, but is projected to rise to 54% over the next five years"
– MHI (Material Handling, Logistics & Supply Chain Association) and Deloitte Consulting, 2018 Annual Industry Report

Increasing data generation creates new opportunities to improve efficiency using AI & data analytics



SEMI Smart Manufacturing Global Technology Community

Driving Global Objectives and Effort



Current Projects or Issue Management

- Standards
- Cost of Ownership
- PCBA Toolkit
- Smart Manufacturing Benchmark

Chapter Development Progress

- Europe, Americas, Japan, Taiwan, China

Other Activities

- FlowShop Group in Japan
- Working groups and projects will vary

Constraining the Opportunity

Initial Focus

Proof of Concept (POC)

- **Demonstrate Feasibility**
- **Identify Additional Areas of Focus**
- **Define IP guidelines for any Potential POC invention**

Data Transfer

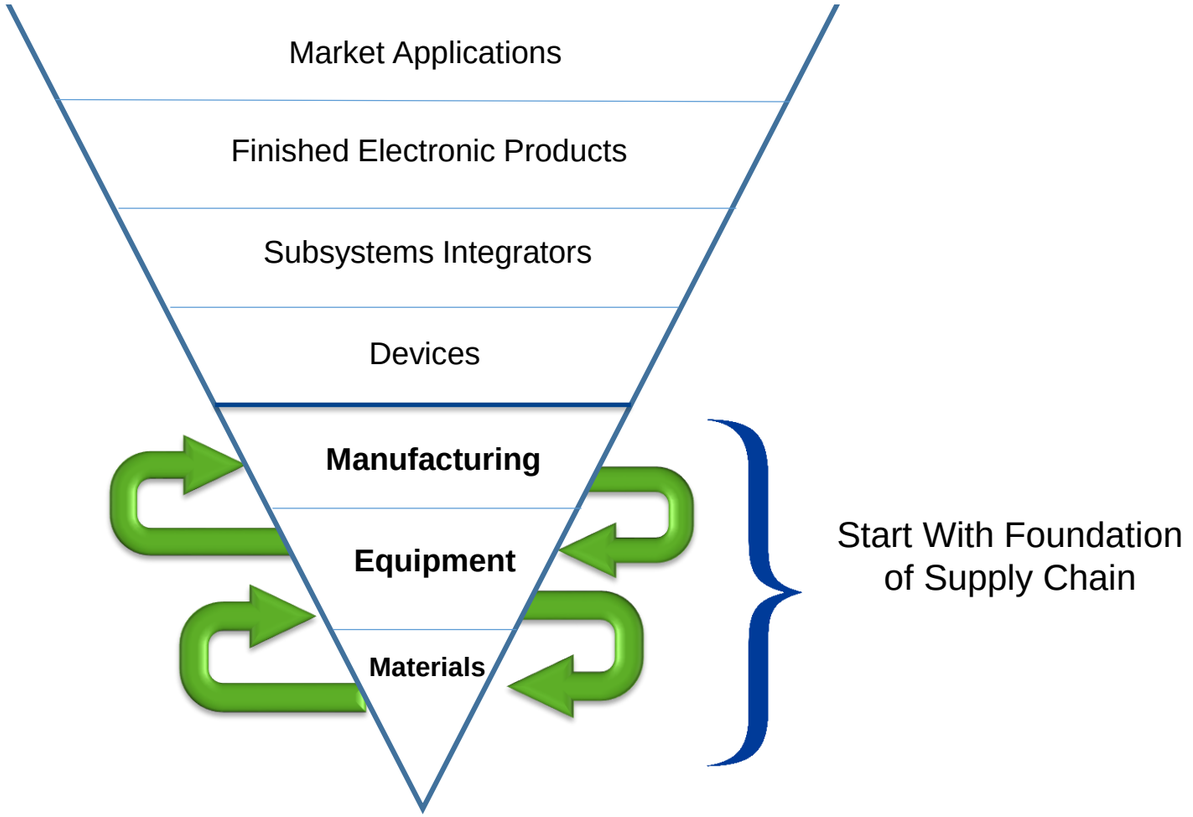
- **Consistent Format**
- **Exchange Protocols**
- **Transfer Node Identification**
- **Standards Requirements**
- Precision Level
- Security & Encryption (privacy, authentication, integrity, non-repudiation)
- Distillation Level

Future Considerations

IP Concerns

- AI Output Ownership
- AI Output Value Assignment
- Data Ownership
- Information Sharing Protocols
- No Legal Precedence

Semiconductor Manufacturing Supply Chain



SEMI Smart Manufacturing Initiative

SEMI Smart Manufacturing Information Hub

SEMI Global Smart Manufacturing Contacts

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Connecting Members To

Issues, Research, Services, Information and Resources Manufacturing Peers, Thought Leaders, and Customers

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