Industry Roadmap

iNEMI Roadmap Overview

Steve Payne, iNEMI
EIPC Winter Conference
February 13, 2020
Rotterdam, The Netherlands

Advancing manufacturing technology

What is iNEMI?

The International Electronics Manufacturing Initiative (iNEMI) is

- a not-for-profit,
- industry-led,
- highly efficient

R&D consortium of approximately 90 leading electronics manufacturers, suppliers, associations, government agencies and universities.

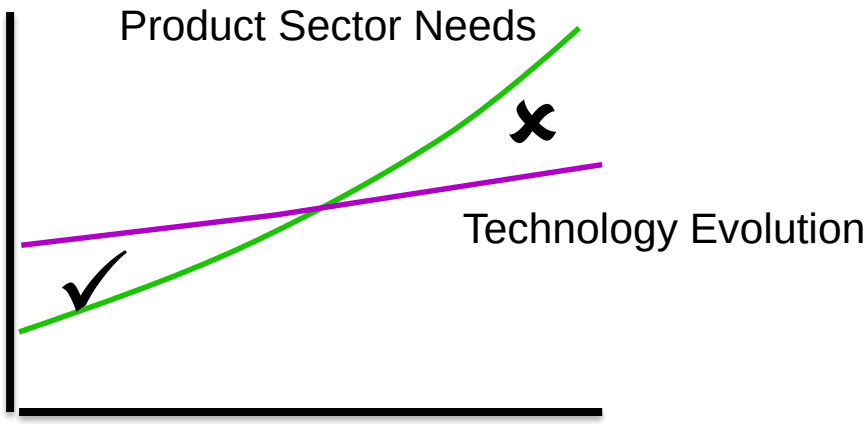
iNEMI

- roadmaps the future technology requirements of the global electronics industry
- identifies and prioritizes technology and infrastructure gaps
- facilitates eliminating those gaps through timely, high-impact collaborative projects

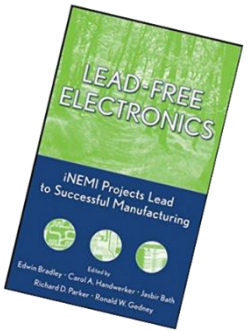
iNEMI Roadmap

- Full electronics manufacturing design/supply chain scope
- Open to industry participation
- 10 year outlook
- Broad global, cross-industry participation
  - > 500 participants
  - > 350 companies/organizations

Product Sector Needs vs Technology Evolution



Collaboration instrumental in addressing a shared gap

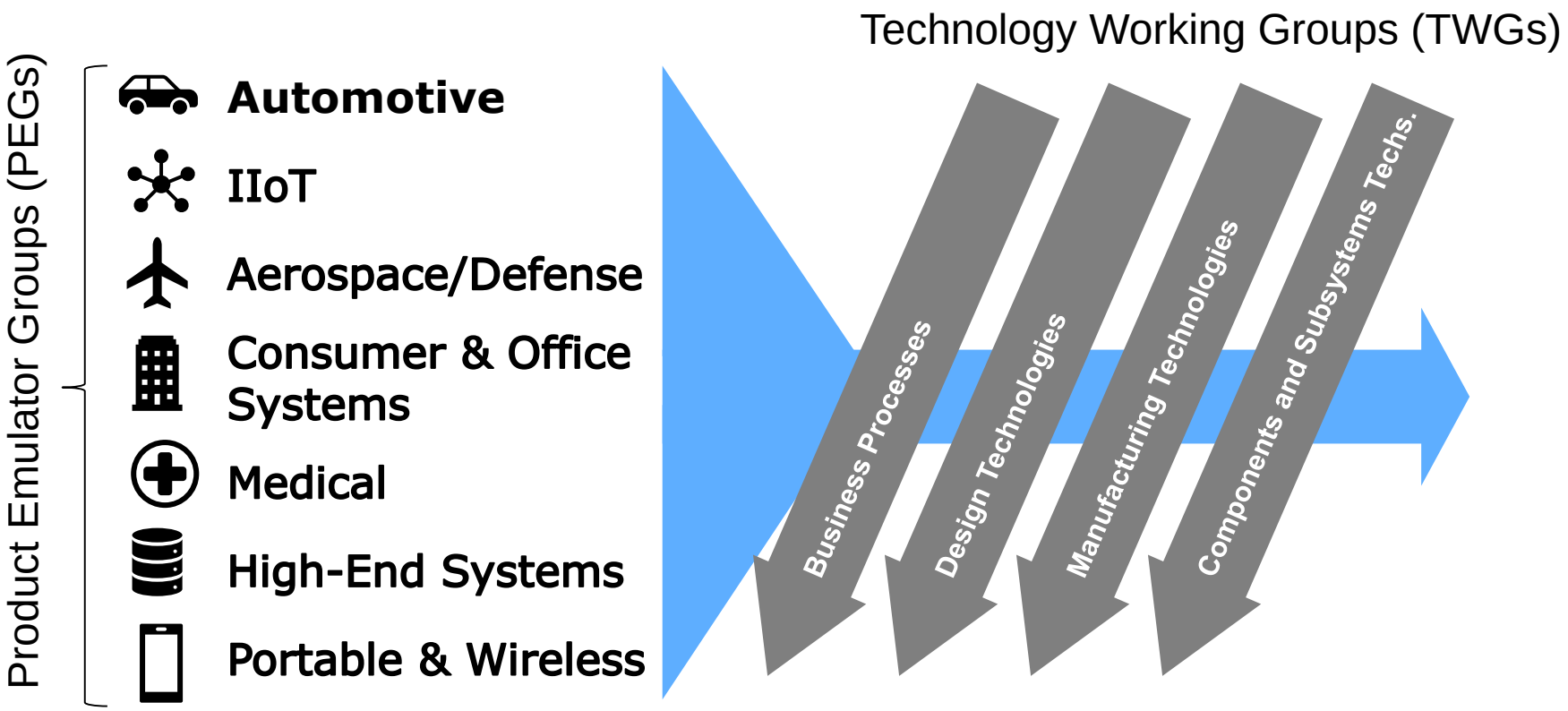


✓Technology Evolution ≥ Product Sector Needs – No Gap

✘Technology Evolution < Product Sector Needs - Gap

- Collaborative Project opportunity?
- Research Project opportunity?
- IP / Differentiation opportunity?

Product Sector Needs vs Technology Evolution



Technology Working Groups (TWGs)

Board Assembly	Smart Manufacturing	RF Components & Systems
Connectors	Sustainable Electronics	Solid State Illumination
Flexible Hybrid Electronics	Thermal Management	Energy Storage Systems
Interconnect PCB – Organic	Modeling, Simulation & Design Tools	Test Inspection & Measurement
Interconnect Substrates – Ceramic	Optoelectronics	Final Assembly
Mass Data Storage	MEMs & Sensors	
Power Conversion Electronics	Packaging & Components	
Semiconductor Technologies	Passive Components	

Roadmap Highlights

Key Trends & Themes

- Convergence
  - Markets, applications, supply chain
- Big Data Management
  - ML, AI, etc.
- Security
  - digital, physical, geo-political
- IoT / Smart Everything
  - Ubiquitous connectivity
- 5G – solution and/or disruptor

- Harsh – it's relative
  - unexpected → expected
- Virtualization
- Circular Economy
  - + material restrictions & availability
- Energy Consumption
  - Green + OpEx
- Thermal Management

Not all mutually exclusive and many both drivers and enablers

Organic PCB Chapter

The chapter draws on information from the iNEMI 2019 Roadmap Product Emulator chapters, which define the future needs for

- High-End Systems (such as Mainframe computers and Data Centers)
- Aerospace,
- Automotive,
- Medical,
- Office & Consumer,
- Portable & Wireless

Automotive Product Emulator Chart

Parameter	Descriptions	Metric	2017	2019	2021	2029
PCB Costs	FR4 Unless Otherwise Stated					
6 layer conventional	State of the Art (production volume)	$ per cm2	0.014	0.012	0.009	0.009
6 layer, blind/buried	State of the Art (production volume)	$ per cm2	0.038	0.034	0.032	0.032
8 layer	State of the Art (production volume)	$ per cm2	0.025	0.023	0.019	0.015
Reliability	**Typical Product Family**					
Temperature Range	State of the Art (production volume)	Deg C - Deg C	-40 to 115	-40 to 125	-40 to 125	-40 to125
Number of Cycles	State of the Art (production volume)	Cycles to Pass	1200	1300	1500	2000
Vibrational Environment (PWB leve	State of the Art (production volume)	G^2/Hz	4.06	4.06	4.06	4.06
Use Shock Environment	1 meter drop on concrete	Gs & ms to Pass	25G, 15ms	25G, 15ms	25G, 15ms	25G, 15ms
Humidity Range	State of the Art (production volume)	% - %	95-100	95-100	95-100	90-98
PCB / Substrates	**PCB = Mother/Daughter & Substrate = Module**					
PCB Board Size (Min)	State of the Art (production volume)	sq. cm	0.52	0.52	0.52	0.52
PCB Board Size (Max)	State of the Art (production volume)	sq. cm	991	991	991	991
Substrate Lines/Spaces	Minimum (Production volumes)	µm	100	75	50	40
Substrate Pad Diameter	Minimum (Production volumes)	µm	150	100	75	70
PCB Minimum Plated-thru-via (PTV	State of the Art (production volume)	mm	0.2	0.15	0.15	0.1
Substrate Material	State of the Art (production volume)	Type	FR4 +	FR4 +	FR4 +	FR4 +
PCB Lines And Spaces	Minimum (Production volumes)	µm	100	75	50	40
Substrate uVia Diameter	Minimum (Production volumes)	µm	100	100	100	80
Use Ambient Operating Temperatu	State of the Art (production volume)	Deg C - Deg C	-40to125	-40to125	-40to145	-40to145
Use Relative Humidity	State of the Art (production volume)	% - %	95-100	95-100	95-100	95-100
Note: NA for "not applicable" and UA for unavailable						

PCB Chapter – Key Drivers

Miniaturization with increasing functionality

Increase data volumes and transfer speeds
Higher speed processors

Increasing complexity of components (fine pitch area arrays)

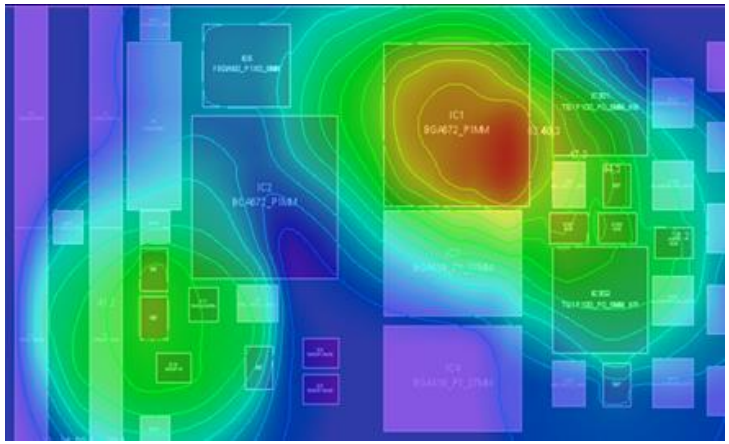
Form and flexibility of interconnects (e.g. stretchable circuits)

Environmental

- Reducing energy consumption
- Reducing / eliminating effluent discharge
- Water recycling
- End-of-life recycling

PCB Chapter – Development Needs

- HDI technology improvement (e.g. mSAP)
- Microvia improved plating for higher aspect ratio blind vias
- Continued development of design and modelling tools for
    - embedded actives and passives
    - optoelectronic PCBs.
    - Thermal management tools



PCB Chapter – Development Needs cont.

- Improved layer registration
- Finer line and space development in imaging techniques
- High-speed alternatives to back-drilling (e.g. additive build-up)
- Continuous cycle time reduction for rigid and flexible circuits
- Adoption of Industry 4.0 /smart manufacturing for
    - enabling traceability
    - continuous processing lines

PCB Chapter – Identified Challenges and Gaps

Collaborative projects are being undertaken or being planned in iNEMI to address some of these challenges, such as:

- Durability under harsh environments
- Reliability: stacked via's, pad cratering, CAF failures
- Laminate materials:
  - Signal losses through copper foil surface treatment
  - Hybrid Build characterization (e.g. FR4 + high performance dielectrics)

PCB Chapter - Summary

Specific future product demands will drive the development of new materials and manufacturing methods.

Advanced technologies used for organic semiconductor packaging substrates are now being adapted for advanced high-density interconnect (HDI) PCBs. (e.g. SLPCB)

PCB fabricators must prepare for these demands driven by miniaturization and increased functionality of products.

In 10 years, we will likely be at 6G, or whatever it will be called, and artificial intelligence (AI) may be the next boundary to cross.

Steve Payne
Project Manager
International Electronics Manufacturing Initiative
email:steve.payne@inemi.org

www.inemi.org
Follow iNEMI on LinkedIn

Advancing manufacturing technology