



International Electronics Manufacturing Initiative

R&D Requirements
from the
2004 iNEMI Roadmap

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Dr. Robert C. Pfahl, Jr.
VP of Operations, iNEMI

- **Overview of iNEMI and the 2004 Roadmap**
- **Situation Analysis**
- **Highlights from the Individual Roadmaps**
- **Identified Needs**
- **Paradigm Shifts and Disruptive Technologies**
- **Key Recommendations**
- **Major Trends and Future Challenge**

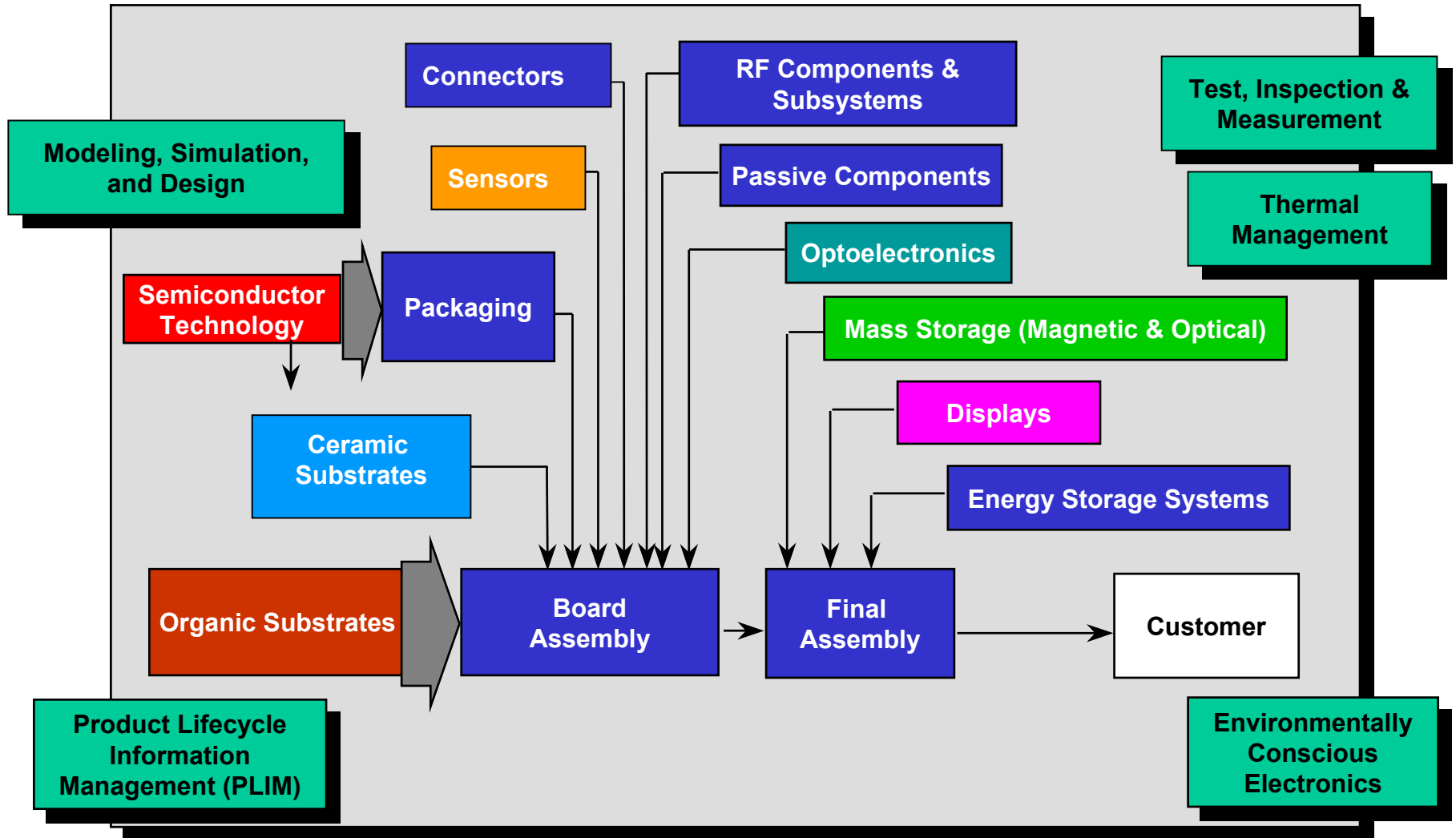
- **iNEMI roadmaps the global **needs** of the electronics industry**
 - **Evolution of existing technologies**
 - **Prediction of emerging/innovative technologies**
- **iNEMI identifies gaps (both business & technical) in the electronics infrastructure**
- **iNEMI stimulates research/innovation to fill gaps**
- **iNEMI establishes implementation projects to eliminate gaps**
- **iNEMI stimulates worldwide standards to speed the introduction of new technology & business practices**

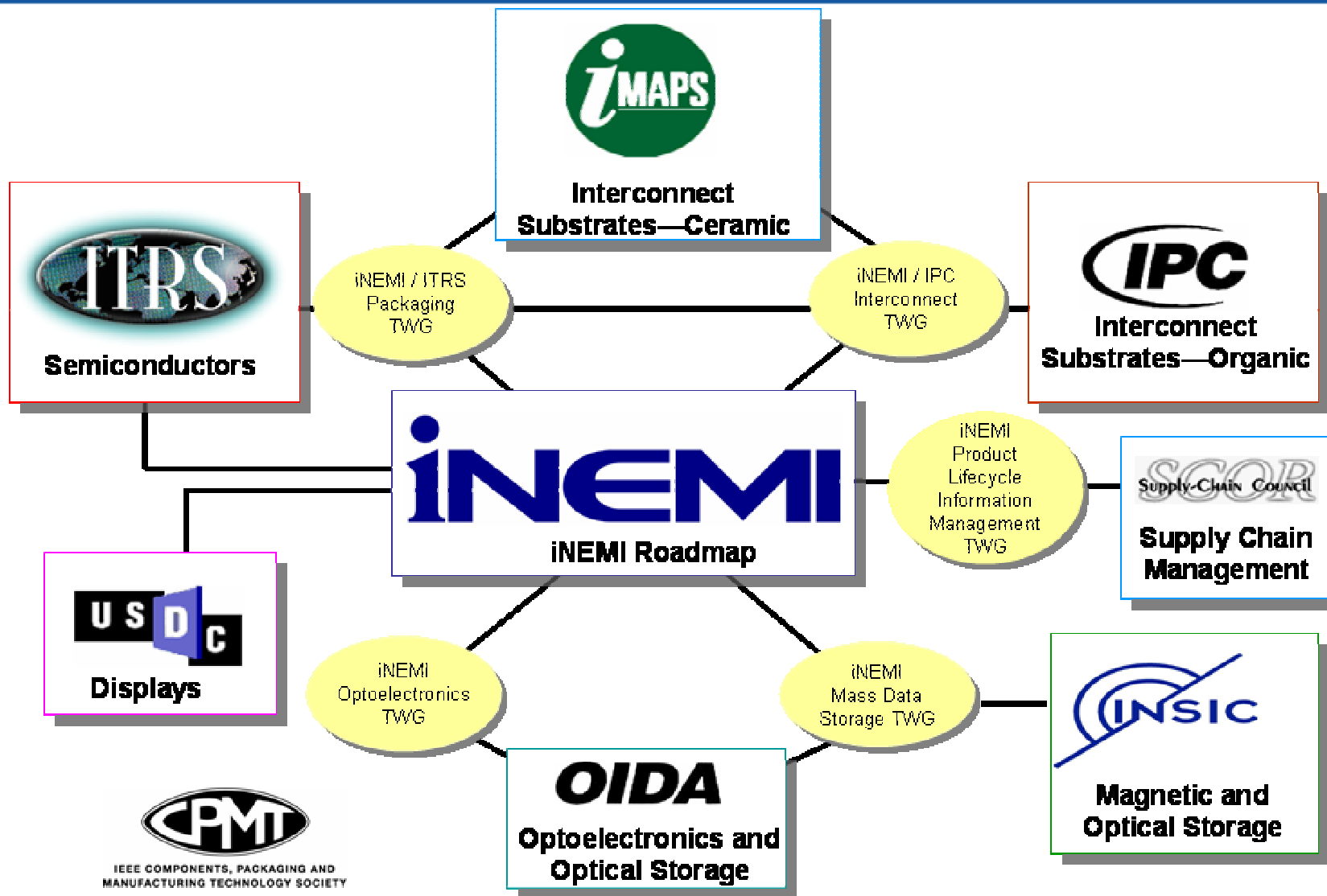
- **> 470 Participants**
- **> 220 Companies/organizations**
- **11 Countries from 3 Continents**
- **19 Technology Working Groups (TWGs) (added Sensors)**
- **7 Product Emulator Groups (PEGs)**
- **Over 1200 Pages of Information**
- **Roadmaps the needs for 2005-2015**

Emulators	Characteristics
Portable / Consumer	High volume Consumer Products for which cost is the primary driver including Hand held, battery-powered products driven by size and weight reduction
System in a Package	Complete function provided in a package to system manufacturer
Office Systems / Large Business Systems	Products which seek maximum performance from a few thousand dollar cost limit to literally no cost limit
Network / Datacom / Telecom Products	Products that serve the networking, datacom and telecom markets and cover a wide range of cost and performance targets
Medical Products	Products which must operate within a highly reliable environment
Automotive	Products which must operate in an automotive environment
Defense and Aerospace	Products which must operate in extreme environments

Yellow = Completely new Emulator

Green = Broadened focus







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Situation Analysis:

Market

Technology

Legislation

New products, enabled by new technologies, are creating a pronounced **market shift in the industry:**

- Blurring of the lines: personal entertainment, computers & communications**
- Emergence of Wireless Products**
- Automotive electronics (add functionality of home & office to your car plus added safety features)**

- **The anticipated end to semiconductor scaling c. 2015 will create a major **technology** shift in the industry:**
 - **Implementation of advanced, non-classical CMOS devices with enhanced drive current**
 - **Identification, selection, and implementation of advanced devices (beyond-CMOS)**
 - **Increased need for improved cooling**
 - **Potential need for high speed optical communications**
 - **Innovative Packaging for:**
 - **Nano size devices**
 - **Hetro systems**
- **Innovation must begin today to meet these needs**

- **Growth in silicon device size is slowing**
- **SiP applications have become technology driver for:**
 - **small components**
 - **packaging**
 - **assembly processes**
 - **high density substrates**
- **MEMS technology is making new capabilities feasible in old and new markets**

Legislation impacting the design and recycling of electronic products is being enacted throughout the world (including China):

- Environmental legislation in various product segments requires the electronics industry to **share** detailed material content data of products and components.
- To meet regional legislative requirements, manufacturers must **remove** environmental “Materials of Concern,” such as lead.
- The electronics industry is facing producer responsibility (**recycling**) legislation.



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Highlights from the Individual Roadmaps

Board Assembly

&

**Environmentally Conscious
Electronics**

Black items require R&D
Gray items require implementation

- Board assembly incurs most of the direct-material costs for electronics products
- Identified areas for improvement:
 - Efficiency and utilization of high mix/low volume lines
 - Shorter set up times
 - Ramps to volume and line flexibility
 - **Qualification processes for materials & process development**
 - DPMO leverage to understand package performance
 - DFX tools integrated with factory data systems
- **Board assembly is being impacted by MEMS, optoelectronics and wireless communications packaging technology development**

Parameter	Definition	2003	2005	2007	2009	2015
Digital Terminals	Maximum number of terminals to the board. That are carrying a digital signal per package	800	2900	3200	3500	3500
RF Terminals	Maximum number of terminals to the board. That are carrying a RF signal per package	100	200	200	200	200
Maximum Body Size	(L x W)- mm	40	52.5	70	70	70
Minimum Terminal Pitch BGA	Pitch of the I/O (mm)	1.27	0.80	0.80	0.65	0.50
Minimum Terminal Pitch CSP	Pitch of the I/O (mm)	0.65	0.50	0.40	0.40	0.30
Number of stack die	Maximum number of stacked die in a package	4	7	8	8	8
Number of die in SiP max	Maximum number of stacked or unstacked die in a package	8	10	12	12	12
Minimum Component size	Minimum component size used in a Package by Type	0201	0201	0201	0201	0201
Embedded Passives		Few	YES	YES	YES	YES
MSL Level	Moisture sensitivity level per IPC that packages are qualified	3	2	2	2	2
Max Reflow Temperature	Common reflow temperature for multi die packages. – deg C	250	260	260	260	260
Die Attach Materials	Thermal conductivity critical	80%	85%	90%	90%	90%
	Low temperature capability	<5%	<5%	<5%	<5%	<5%
	Pre-applied	<1%	3%	5%	20%	30%
	Matched CTE capability	0%	5%	7%	15%	25%

Key

Current Capability

In Development

Research Needed

- **Design:**
 - **LCA / SLCA tools and data**
- **Materials:**
 - **Pb-free for high reliability requirement applications**
 - **Cd and Pb-free PVC cables**
 - **REACH risk assessment for chemical emissions**
- **Energy:**
 - **Cost effective methods to improve power supply efficiency**
 - **Enabled power management of IT equipment**
- **Recycling:**
 - **Compliance to diverse regional Recycling requirements**
- **Sustainability:**
 - **Standard Sustainability Indicators**



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Identified Needs

Design & simulation tools are main roadblocks to more rapid introduction of new technologies:

- Mechanical & reliability modeling**
- Thermal & thermo-fluid simulation**
- Co-design of mechanical, thermal & electrical performance of the entire chip, package & associated heat removal structures**
- Simulation tools for nano devices & materials**
- Improved design tools for emerging technologies like embedded passives & optoelectronic PWBs**
- Integrated design & simulation tools (circuit, EM, thermal, mechanical, manufacturing, etc.) for higher functionality in mixed-mode wireless chips & modules.**

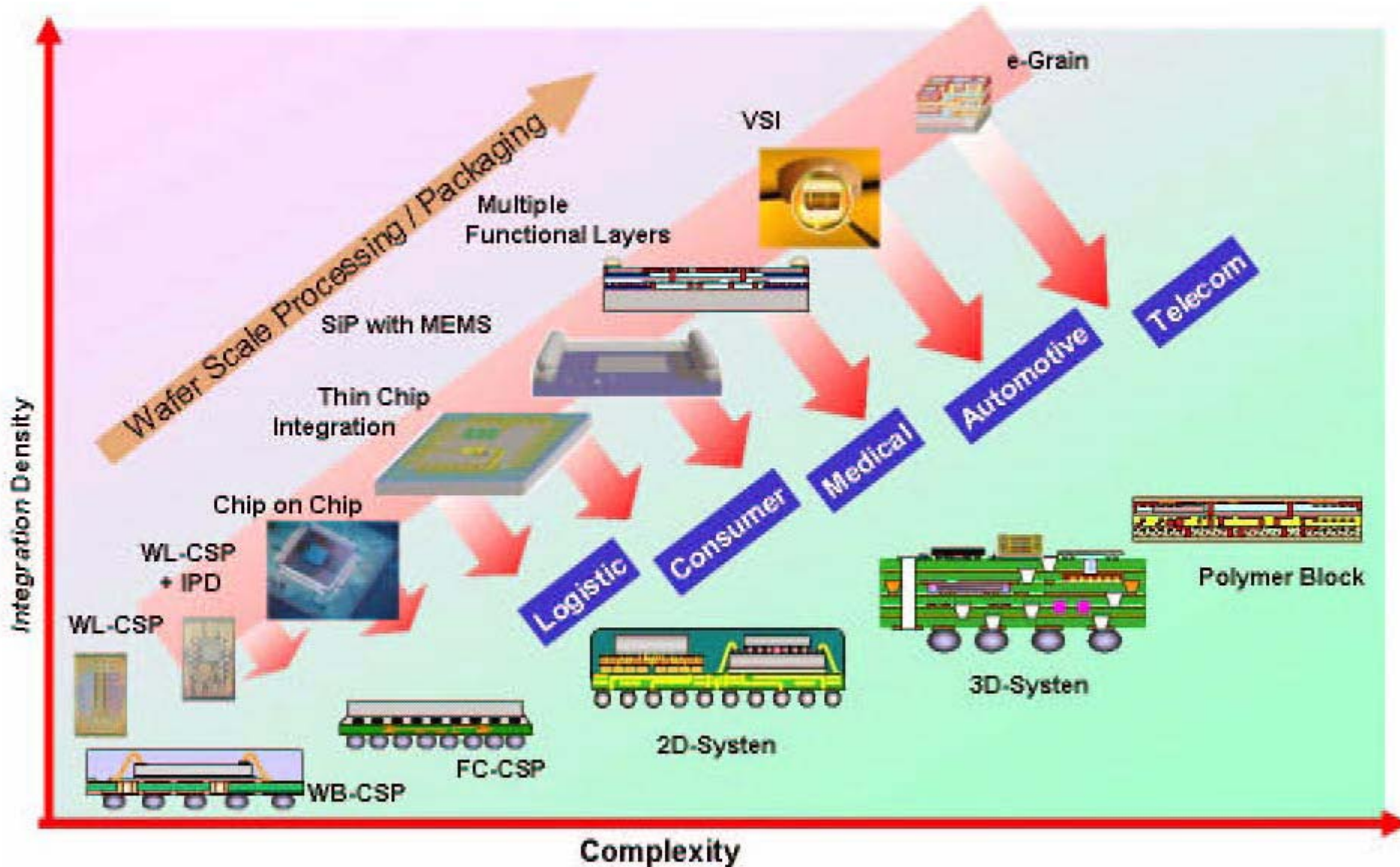
- **Material Traceability through Product Life Cycle for:**
 - Environmental and Medical Regulations
 - Automotive and Military Requirements.
- **Further Integration of design chain/supply chain to reduce costs and improve performance throughout the product life cycle:**
 - Understanding customer needs (moving target)
 - Critical information flow
 - Timely decisions that optimize performance of entire chain rather than one node.



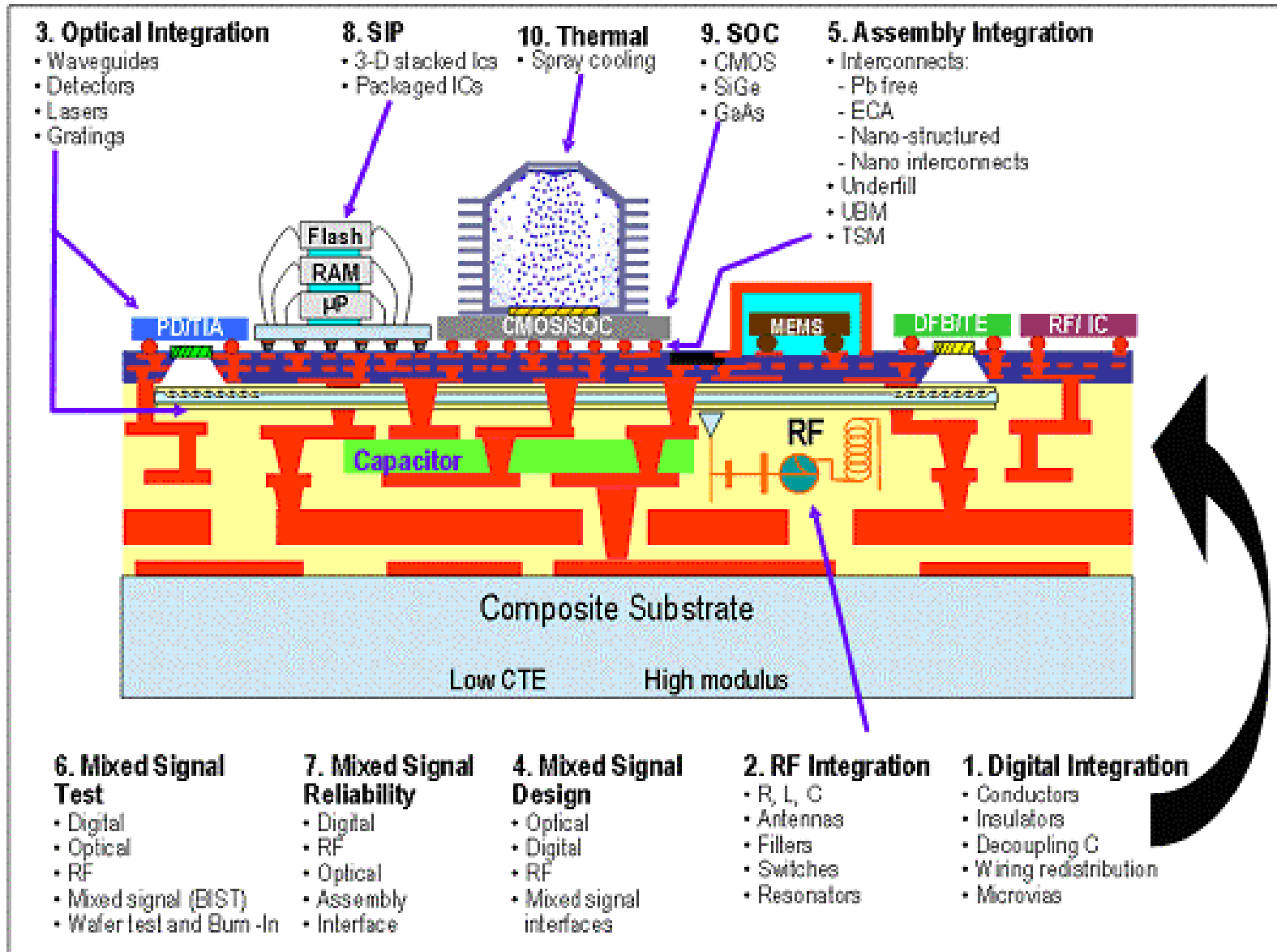
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**Paradigm Shifts &
Disruptive
Technologies**

- **Convergence of personal entertainment, computers & communication products because of digital and broadband communications technology has increased product opportunities while creating uncertainty in marketing.**
- **Rapid introduction of complex, multifunctional new products to address converging markets favors development of functional, modular components (e.g. SiP)**
 - **Increases flexibility & shortens product design cycle & places test burden on module producers**
 - **This architecture allows for MEMS device construction with a variety of new applications in fuel cells & life sciences (DNA/blood testing)**



Source: Professor Dr. Reichl, Fraunhofer IZM, Berlin Germany



Source: Professor Rao Tummala, Georgia Institute of Technology-Packaging Research Center.

- **New energy technologies that may cause disruptive opportunities include fuel cells and high power batteries for hybrid electric vehicles**
- **Nanotechnology has the potential to be a very disruptive technology during the period covered by the roadmap**



Nano Composites: stronger, tougher, stiffer, lighter materials (adhesives, structural, thermal, electronic, optical functionality)

Nano displays: Large, lower cost and brighter displays based on embedded carbon nanotubes

Nano sensors: smaller, more sensitive Nano scale sensors for bio, optical, chemical and physical sensing

Nano antennas: Nano scale fractal antennas for multiple spectra and broadband

Nano power: High capacity power sources (storage, conversion, advanced fuel cells, photonic energy), parasitic energy harvesting, nanobiotech related functionality



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**Key
Recommendations**

iNEMI Technical Projects

- **Establish a SiP Technology Implementation Group (TIG) to address process, materials, equipment, & reliability gaps.**
- **Establish a research project on new organic materials with improved dimensional and RF properties for electronics packaging.**

Design

- **Develop co-design capabilities of mechanical, thermal, and electrical performance of the entire chip, package, & heat removal structures.**
- **Develop improved design tools for emerging technologies like embedded passives and optoelectronic PWBs.**

Manufacturing Technology

- **Develop automated printing, dispensing, placement, and rework equipment capable of the pitch requirements for SiP package assembly at current process speeds.**

Materials Development

- **New interconnect technologies utilizing nano-materials to enhance material properties**
- **Characterize & improve reliability of material systems**

Energy and the Environment

- **Development & implementation of scientific methodologies to assess true environmental impacts of materials and potential trade-offs for alternatives**
- **Develop a common, straightforward definition of sustainability**

Technology Development

- **Thermal Management of high power densities**



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**Major Trends
&
Future Challenges**

- **Environmental considerations will expand**
 - RoHS/WEEE is the beginning
 - Defensive posture has reduced industry's influence on regulations
 - Significant impact to supply chain/information needs
 - Design for Sustainability
- **SiP is a major trend in portable products**
 - Manufacturing infrastructure issues need attention
 - Could find use in other sectors where mixed IC technologies are used
- **Lack of integrated design/simulation tools is:**
 - Delaying new technology adoption
 - Impacting product time to market

- **The predicted end of semiconductor scaling could have major implications:**
 - **Non classical CMOS**
 - **Beyond CMOS**
 - **Increased thermal challenges**
 - **Significant impact to packaging/interconnect**
- **Nanotechnology has the potential to dramatically effect electronics:**
 - **Materials**
 - **Displays**
 - **Sensors**
 - **Power**

- **Electronic Packaging**
 - **The Technology Driver will be multifunctional system in packages (SiPs)**
 - **These needs must be addressed through innovation using new processes and new materials made possible through emerging efforts such as nano-technology**
- **Green Electronics**
 - **As we recover from the recession and from implementing RoHS and WEEE, the electronics industry needs to develop a strategic vision of sustainable electronics**



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www.inemi.org

Email contact:

Bob Pfahl

bob.pfahl@inemi.org