



International Electronics Manufacturing Initiative

Overview of 2004 Technology Roadmaps

HDP '05

Jim McElroy & Bob Pfahl

- **Overview**
- **Situation Analysis**
- **Highlights from a Product Emulator Group**
- **Highlights from the Individual Roadmaps**
- **Closing identified Gaps**
- **Trends and Challenges**

iNEMI is a member-driven consortium whose mission is to assure leadership of the global electronics manufacturing supply chain.





Consultants, Government, Organizations & Universities



Développement
économique
et régional

Québec 

Virginia's Center for
Innovative Technology

- **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**

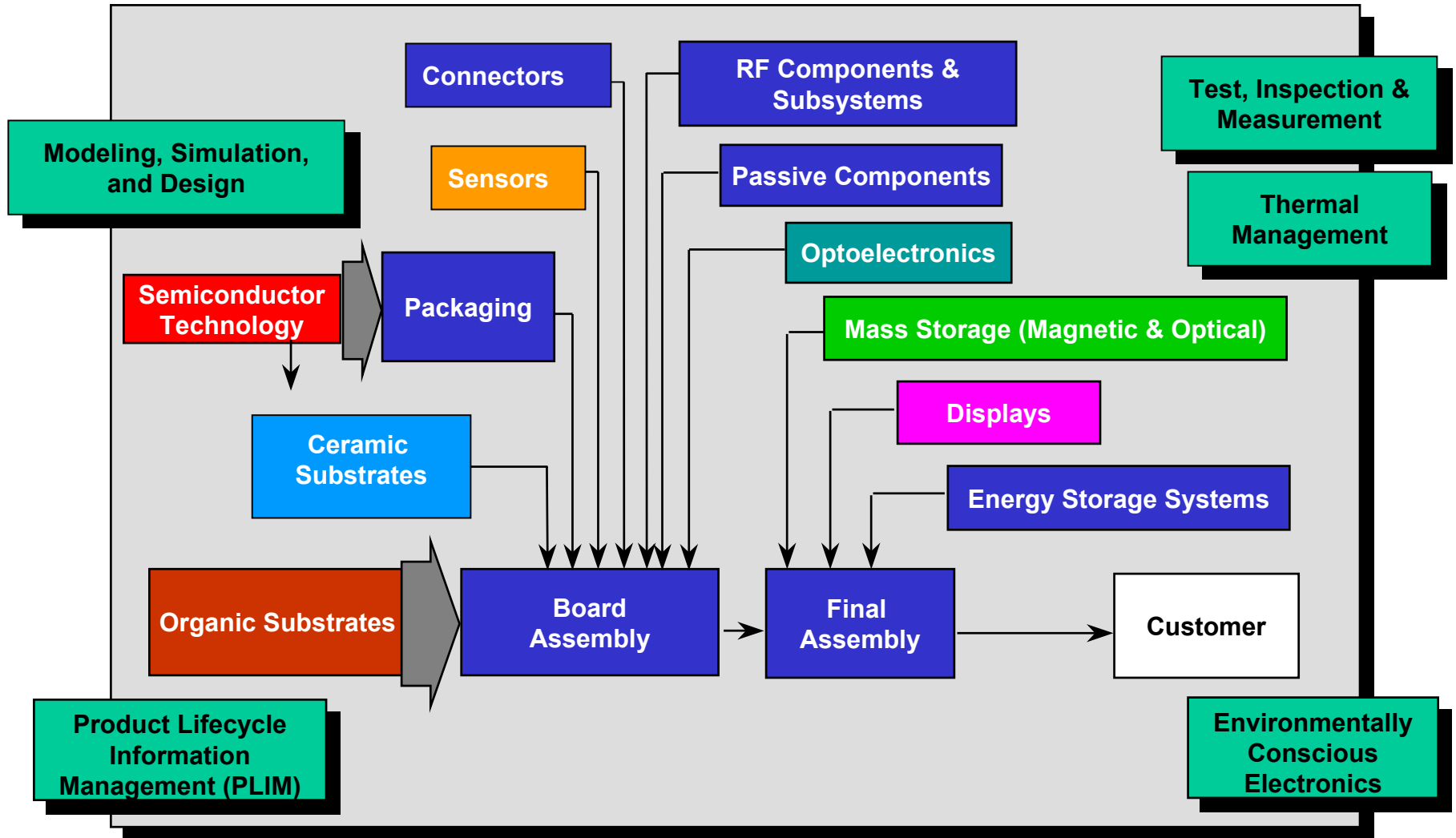
- iNEMI Roadmap is **customer need driven**, not technology driven.
- OEM driven Product Emulator Groups (PEGs) start roadmapping process by presenting what they need to remain competitive in the world market.
- Focus of Roadmaps is on process and technology rather than end products.
- Technology Working Groups (TWGs) respond and identify gaps and showstoppers. They do not provide solutions.
- iNEMI Technical Committee prioritizes gaps and forms Technology Integration Groups (TIGs) to close them.

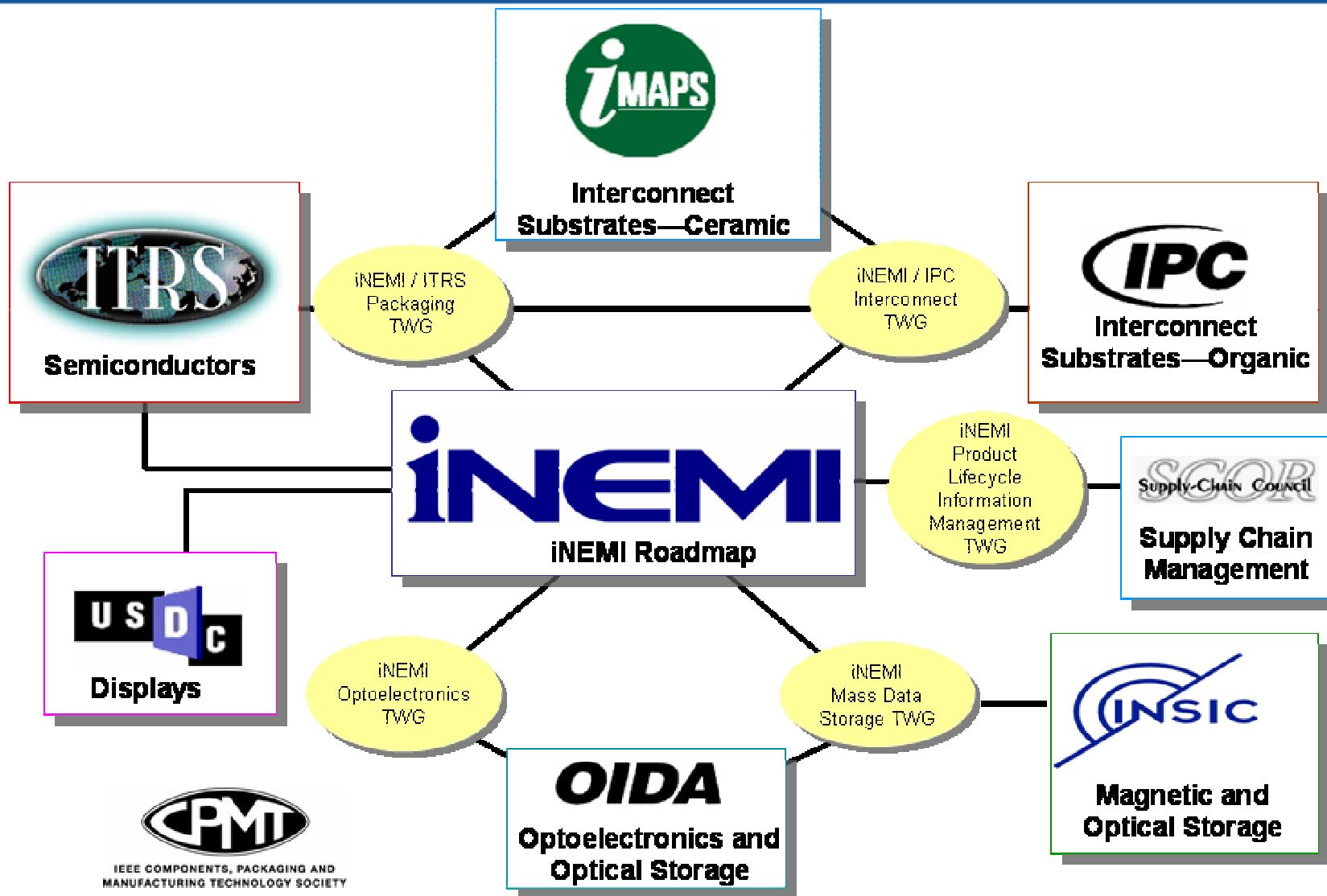
- **> 470 Participants**
- **> 220 Companies/organizations**
- **11 Countries from 3 Continents**
- **19 Technology Working Groups (TWGs)
(added Sensors)**
- **7 Product Emulator Groups (PEGs)**
- **Over 1200 Pages of Information**
- **Roadmaps the needs for 2005-2015**

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







International Electronics Manufacturing Initiative

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:
 - 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 at the backplane level
 - Innovative Packaging for:
 - Nano size devices
 - Giga-function System in Package (SiP)
- Innovation must begin soon to meet the 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:

- 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.

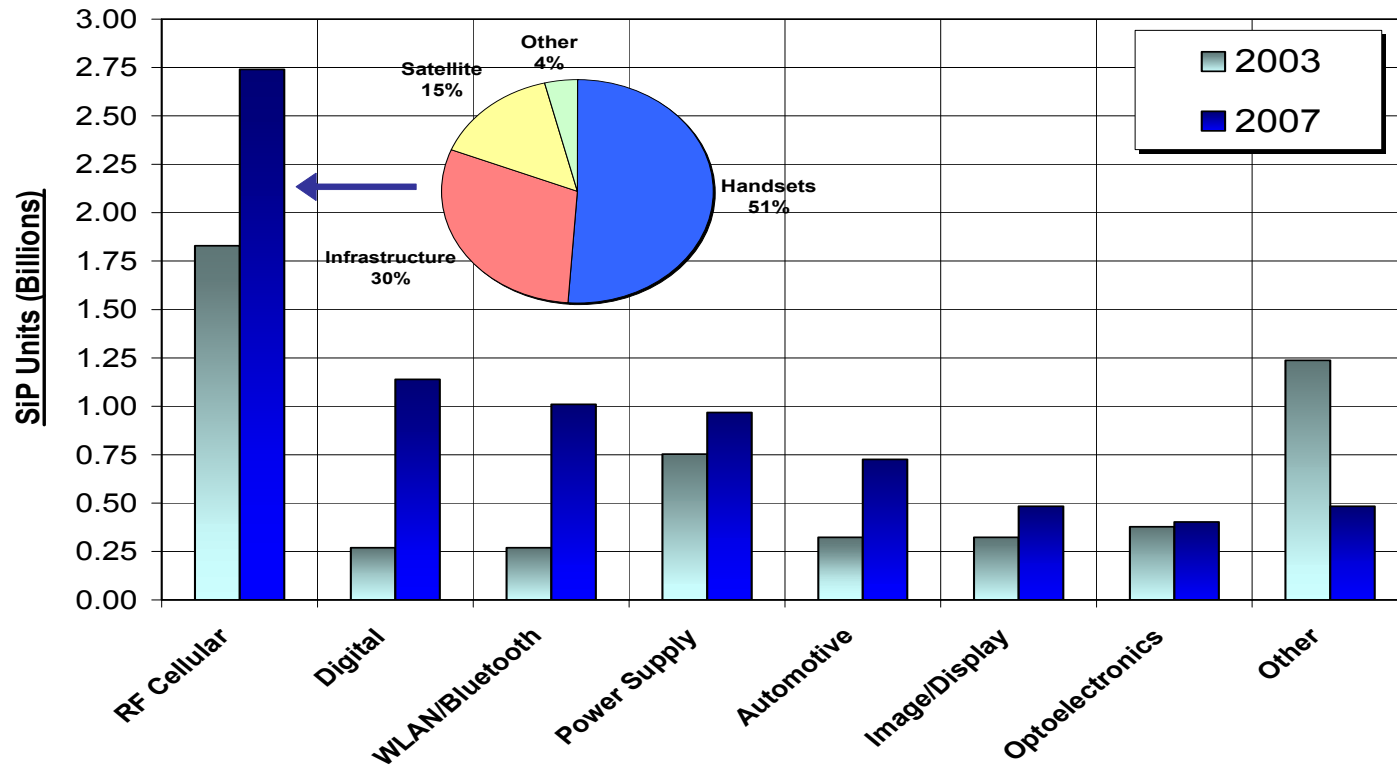


International Electronics Manufacturing Initiative

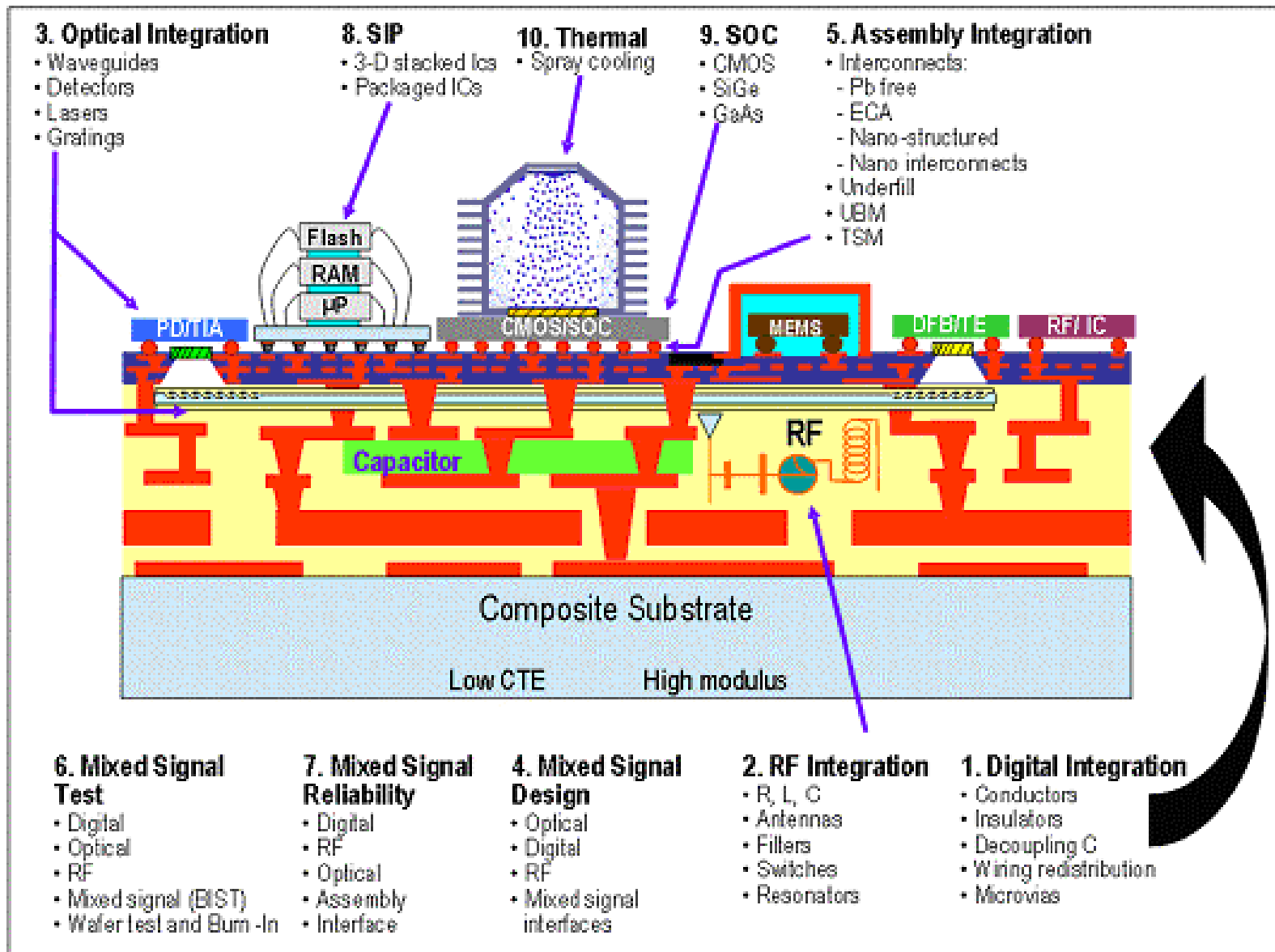
**Highlights from the SiP
Product Emulator Group
(PEG)**

- **Broadest adoption of SiP has been for stacked memory/ logic devices & small modules (integrate mixed signal devices & passives for mobile phones).**
- **SiP provides more integration flexibility, faster time to market, lower R&D cost, & lower product cost for some applications (vs. SOC).**
- **Infrastructure issues facing SiP implementations include:**
 - **Need for low cost higher density substrates**
 - **High speed simulation tools for electrical & mechanical analysis**
 - **Wafer level packaging**
 - **Lower cost assembly equipment**
 - **Improved materials for encapsulation**
 - **Skill set and business models vary for EMS/SAS (Semiconductor Assembly Services)**

Overall SiP Market: 2003 vs. 2007



Sources: Prismark (primary), Deutch Bank, Credit Suisse First Boston, Allied Business Intelligence.



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



International Electronics Manufacturing Initiative

Highlights from Individual Roadmaps

- 1. Board Assembly**
- 2. Environmentally Conscious Electronics**
- 3. Packaging**

- **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**
 - **Set up times & adoption of factory information integration with real time optimization**
 - **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 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

- **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**
- **Design:**
 - **LCA / SLCA tools and data**
- **Sustainability:**
 - **Standard Sustainability Indicators**

- **Packaging costs have become a larger part of I/C costs**
- **Impact of packaging is increasing, but R&D investment is not**
- **Packaging has become a major competitive factor due to:**
 - **rapid growth in wireless**
 - **complex consumer products**
- **Emerging device technologies driving new packaging requirements**

- **Major challenge: modeling/simulation of mechanical, thermal & electrical performance of the entire chip, package & heat removal structures as a system.**
- **Improved organic substrates**
- **Reliable packages for Cu/low k devices**
- **Pb, Sb, Halogen free packaging materials**
- **Improved Materials for:**
 - **Thermal Performance**
 - **High frequency performance > 2 GHz**
 - **Smaller packages and tighter I/O pitches (exceeding today's capabilities).**



International Electronics Manufacturing Initiative

Closing Gaps Identified in Roadmap

**Emerging TIGs and Projects for
iNEMI Member Participation**

- **New Pb-free Nano-solder Project:**
The Application of Nanotechnology to Suppress Non-Lead Solder Reflow Temperature.
- **NEW - SiP TIG:**
To address process, materials, equipment, and reliability gaps identified in the 2004 roadmap.
- **NEW – Heat Transfer TIG:**
To address thermal management gaps identified in the 2004 roadmap (focused on high performance systems).
- **New Medical Products Reliability Standards Project:**
The Development of Medical Reliability Standards to gain broader agreement as to what constitutes a “Medical” component rating.



International Electronics Manufacturing Initiative

Trends & 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**

Order your roadmap today!

www.inemi.org

Email contacts:

Jim McElroy

jmcelroy@inemi.org

Bob Pfahl

bob.pfahl@inemi.org