



**iNEMI**

International Electronics Manufacturing Initiative

**2007 iNEMI  
Research  
Priorities and  
2009  
Roadmap**

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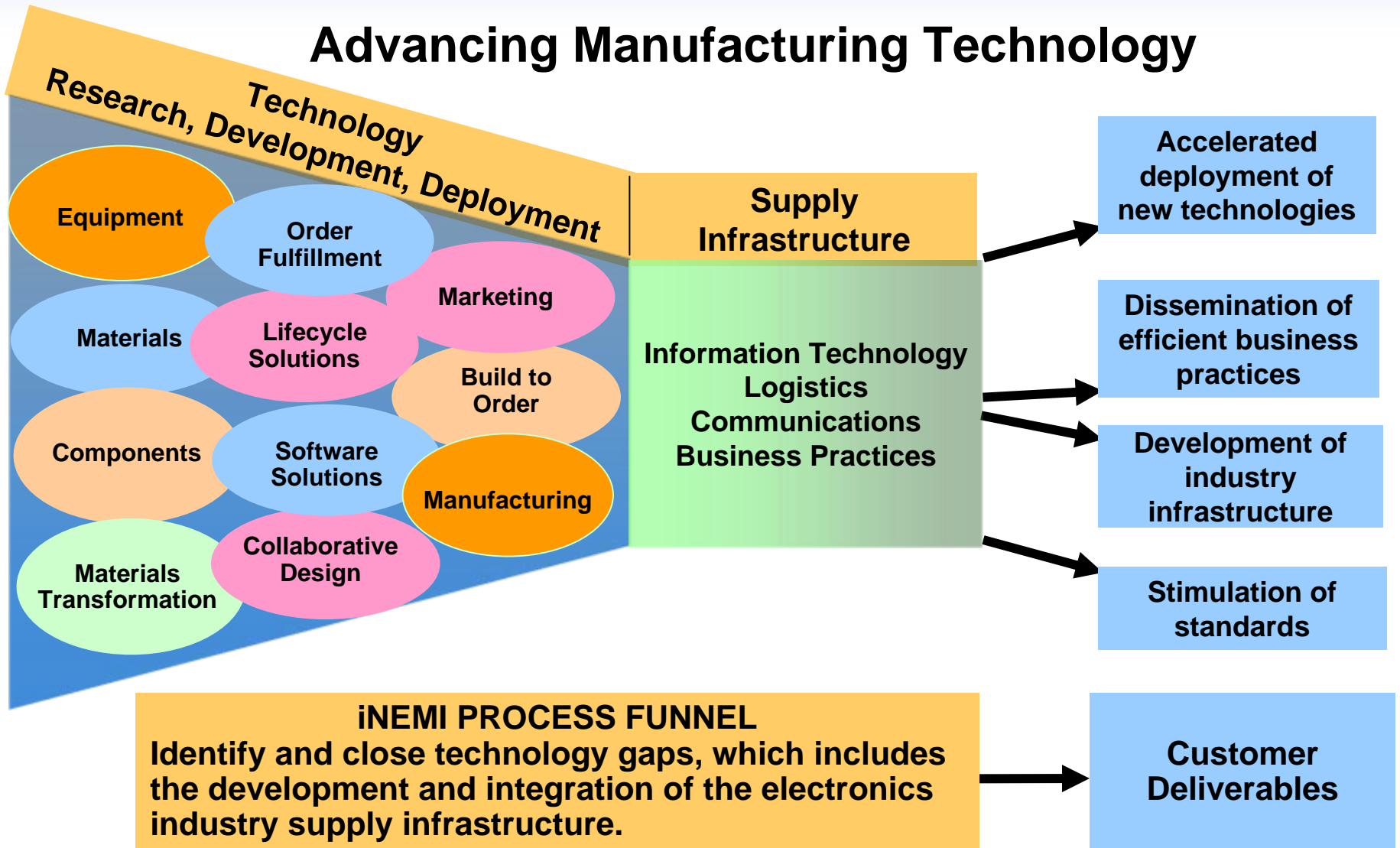
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# Topics

- **iNEMI Overview**
- **2007 iNEMI Roadmap**
- **2007 Research Priorities**
  - **Key Gaps**
    - **By Roadmap Areas**
    - **By Research Areas**
  - **Projects to address iNEMI Strategic Thrusts**
  - **Pb-free Conversion: Current Situation**
- **2009 iNEMI Roadmap**
- **Conclusions and Summary**

# The iNEMI Mission:

## Advancing Manufacturing Technology





# **iNEMI**

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## **2007 iNEMI Roadmap**

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# Statistics for the 2007 Roadmap

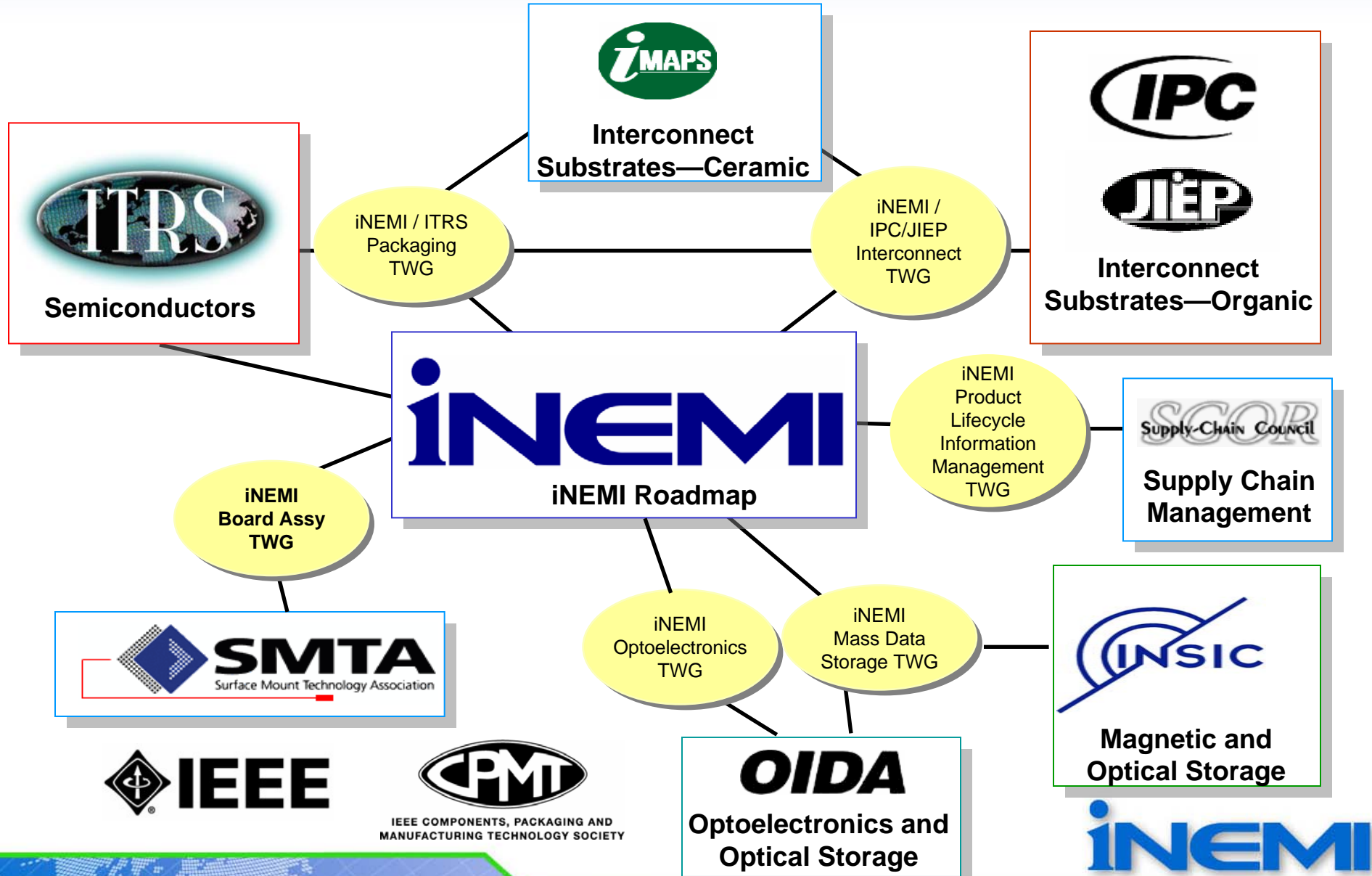
- **> 500 Participants**
- **> 265 Companies/organizations**
- **17 Countries from 4 Continents**
- **19 Technology Working Groups (TWGs)  
(added Organic & Printed Electronics)**
- **5 Product Emulator Groups (PEGs)**
- **Over 1300 Pages of Information**
- **Roadmaps the needs for 2007-2017**

# 2007 Roadmaps

## 19 Individual Roadmap Chapters

- Semiconductor Technology
- Packaging
- Mass data storage
- Board Assembly
- Final Assembly
- Environmentally Conscious Electronics
- Interconnect Substrates Organic
- Interconnect Substrates Ceramic
- Connectors
- RF Components & Subsystems
- Optoelectronics
- Passive Components
- Energy Storage Systems
- Organic & Printed Electronic
- Modeling, Simulation & Design Tools
- Thermal Management
- Test, Inspection & Measurement
- Product Lifecycle Information Management
- Sensors

# 9 Contributing Organizations

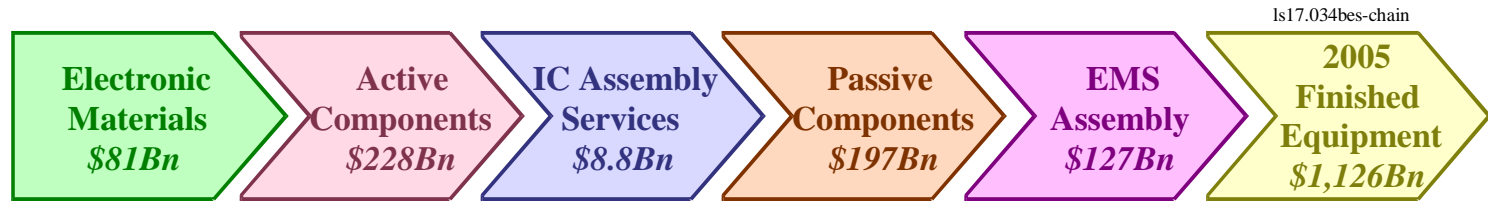


# The Changing Industry

- **Consumers are concerned about the impacts that electronics products may exert regarding safety, energy usage, and environmental impact.**
- **There has been a dramatic movement of manufacturing and manufacturing support to China from North America, Europe, and other Asian countries because of:**
  - **A low-cost, highly skilled workforce**
  - **A massive market opportunity.**
- **The increasing scope of outsourced operations requires loosely coupled business processes spanning multiple companies and continents.**
- **Business models in the electronics industry have changed - leading to significant shifts in roles and responsibilities across the supply chain.**

# Strategic Concerns

## Value Creation in the Supply Chain



### Typical Companies

Sumitomo Bakelite, DuPont, Ablestik	Intel, STMicro, LSI Logic	Amkor, ASE, SPIL	Tyco, Molex, AVX, Sharp	Solectron, Sanmina-SCI, Flextronics	Dell, HP, Cisco, Nokia, Teradyne, Visteon, Siemens
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<b>Gross Margin</b>	<b>30%</b>	<b>45%</b>	<b>17%</b>	<b>25%</b>	<b>6%</b>	<b>30%</b>
<b>Operating Margin</b>	<b>10%</b>	<b>15%</b>	<b>8%</b>	<b>8%</b>	<b>2%</b>	<b>8%</b>
<b>R&amp;D</b>	<b>7%</b>	<b>15%</b>	<b>2%</b>	<b>5%</b>	<b>&lt;1%</b>	<b>8%</b>
<b>Margin Value</b>	<b>\$8Bn</b>	<b>\$34Bn</b>	<b>\$0.7Bn</b>	<b>\$16Bn</b>	<b>\$3Bn</b>	<b>\$90Bn</b>
<b>R&amp;D Value</b>	<b>\$6Bn</b>	<b>\$34Bn</b>	<b>\$0.2Bn</b>	<b>\$10Bn</b>	<b>\$1Bn</b>	<b>\$90Bn</b>
<b>% Total R&amp;D</b>	<b>4%</b>	<b>24%</b>				<b>64%</b>

Source: Prismark Partners



# Market Growth

- **Worldwide production of computers and office equipment is expected to reach \$431Bn in 2006, and grow at an average rate of 5.4% per year to reach \$532Bn in 2010.**
- **Global production of communications equipment is expected to reach \$176Bn in 2006, representing about 15% of the electronics industry.**
- **Portable and consumer electronics production will reach \$267Bn in 2006, following several years of exceptional growth.**
- **Medical electronics equipment production will be \$53Bn in 2006, accounting for about 4% of the global electronics industry.**
- **In 2006, over 3Bn SiPs were assembled. By 2010, this number is expected to reach 6.65Bn, growing at an average rate of about 17% per year.**

# Converging Markets

- **Medical-Consumer**
- **Automotive-Entertainment**
- **Communication-Entertainment**
- **Computing-Entertainment**

# Emerging Technology

- **The end of traditional semiconductor scaling.**
- **Reduction of emphasis on the microprocessor frequency metric, and the corresponding increase in importance of the system's throughput metric.**
- **Higher bandwidth to and from the microprocessor.**
- **Increased need for improved cooling & reduced power.**
- **Minaturization including 3D Packaging.**
- **Disruptive technology offers opportunity for innovation. In order to ensure success, the supply chain must be willing to invest with a long-term perspective in mind.**
- **The 2007 roadmap did not identify a major need for optical transmission within high performance printed wiring boards during the next decade.**
- **Growth in silicon device size is slowing.**



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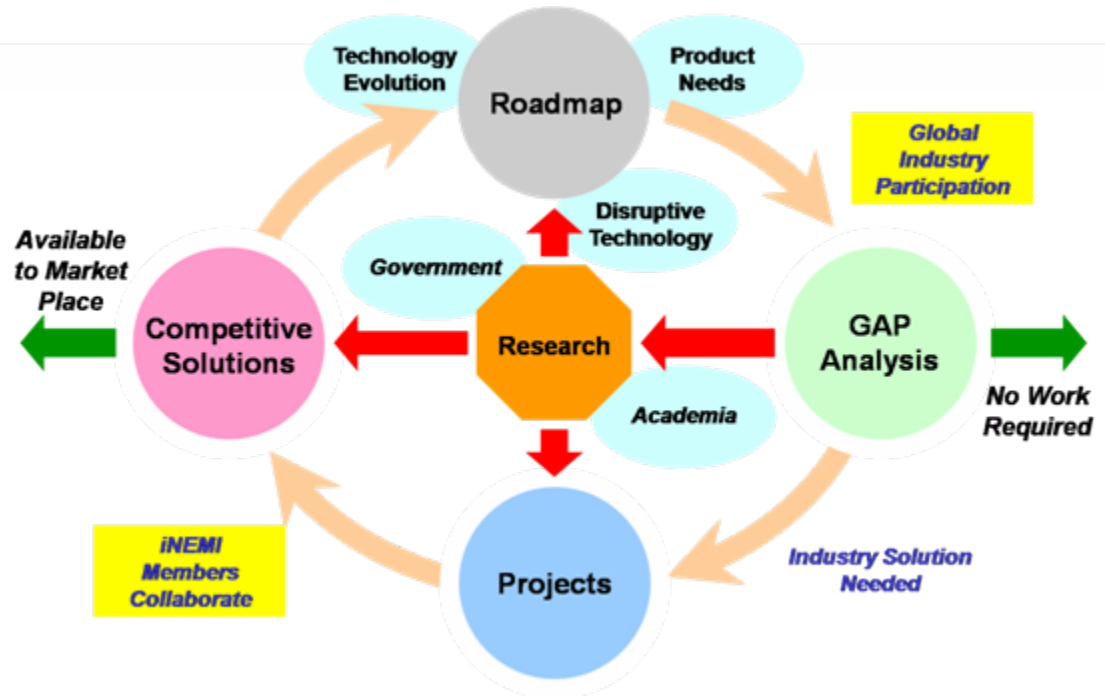
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# 2007 Research Priorities

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# Leadership through Innovation

- A research vision with three major thrusts:
  - Energy & the Environment
  - Miniaturization
  - Medical Electronics



# Research Priorities

- 2007 Research Priorities Released in Sept.
- 10 year R&D priorities identified
- Available at <http://www.inemi.org/cms/ri/>
- Contents:
  - Technology Research Needs by Product Sector
  - Priorities Summarized by Research Area
    - *Manufacturing Processes*
    - *System Integration*
    - *Materials & Reliability*
    - *Energy and the Environment*
    - *Design*
  - Significant Gaps and Issues from Roadmap
  - Options for Innovation



# Key Gaps by Roadmap TWG Area

- **Board Assembly**
  - Low cost fine line/via PCB Technology
  - Inspection and test capability
  - Board flex standards
  - Design for Manufacturing standards
- **Environmentally Conscious Electronics**
  - Alternatives to Cd, Hg, CrVI, PBB, and PBDEs
  - Industry involvement in policy making on material restrictions
  - Scientific methodologies to assess environmental impact of materials
  - Effective basic energy efficiency metrics
- **Substrates**
  - Low cost, fine line/via PCB Technology
  - Moisture reliability
  - High Tg
  - Low cost, low loss tangent materials

# Key Gaps by Roadmap TWG Area

- **Medical**
  - Component reliability standards and standard test methods
  - Standardized characterization process for RoHS-compliant components
  - Development of advanced printed circuit board and flexible printed circuit technologies
  - Safety study of clinical and home-health wireless environment.
- **Thermal Management**
  - Closed Loop, Liquid Cooling Solutions
  - Cooling of 3-D Stacked Dies
  - Data Center cooling strategies
  - Reliable low-cost pumps
- **Board & System Test**
  - Test access for miniaturized products
  - Increased adoption of boundary scan in digital and analog devices
  - Tools to determine defect coverage.
  - Standards for board flexure of lead-free BGAs
  - Test solutions for High Density Interconnect

# Key Gaps by Research Area

## Manufacturing Processes

- There is a need for a new methodology/strategy for R&D to be conducted in the global outsourcing environment
- The infrastructure to produce high volume, low cost, high density interconnect substrates for portable electronic products
- Inspection/test technologies need to keep up with density of board designs and component packages

The top priority shifted from development of reduced cost manufacturing processes that support rapid miniaturization to development of a new methodology/strategy for R&D to be conducted in the global outsourcing environment

# Key Gaps by Research Area

## Energy and the Environment

- **Accepted and sound scientific methods to evaluate environmental impact of materials that are also accepted by regulators, NGOs and industry**
- **New innovative energy sources**
- **R&D to develop a sustainable infrastructure and viable recycled materials**

**The top two research priorities essentially remain the same**

# Key Gaps by Research Area

## Materials and Reliability

- Improved Pb-free alloys for better area array shock, lower cost, lower temperature and reduced copper dissolution issues
- Halogen free material for substrates and PCBs
- Second level underfill solution needed that is reliable / reworkable and cost effective
- Need for sensor specific material standards - especially thin films

The top research priority in this area was identified as the number four priority in 2005. The number two research priority for 2007 did not show up during the 2005 process.

There was a significant increase in the number of materials gaps identified.

# Key Gaps by Research Area

## System Integration

As disparate technologies continue to be combined into product architectures, integration challenges face the industry that will limit the ability to improve cost, size and reliability. While there is still a need to continue improvements to the IT infrastructure (the top system integration research priority in 2005), the top research needs identified in 2007 are:

- **3D interconnect structures with associated thermal management**
- **Standardized test methods / figures of merit for printed electronics**
- **The capability to do system level comparisons (performance, power, and cost) between optical and RF technology from the device level to the system level.**

# Key Gaps by Research Area

## Design

- Improved, integrated and standardized DfX tools for compatibility across supply chains
- Low cost solutions for carrying >10Gb/s signal rates between components on a PCB
- Better tools for concurrent design of packages and PCB for better system optimization.
  - Includes metrology and
  - Methodologies for:
    - Materials characterization and
    - performance validation

Neither of the first two topics were identified in the 2005 Research Priorities.



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## **iNEMI Projects to address Strategic Thrusts**

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# Emerging Scenario for iNEMI Projects

- **Meet needs of members (both users & suppliers) in key segments:**
  - **High volume/portable**
    - Expand & strengthen miniaturization projects
  - **Medical electronics**
    - Complete initial Medical Electronics Project & build momentum for this segment
  - **High reliability (Telecom, Computing)**
    - Establish “End Game” for High Reliability segments for Pb-free conversion:
      - Close remaining knowledge gaps
      - Work source of supply issues (BGAs) in the interim
    - Advanced Thermal Management Technologies

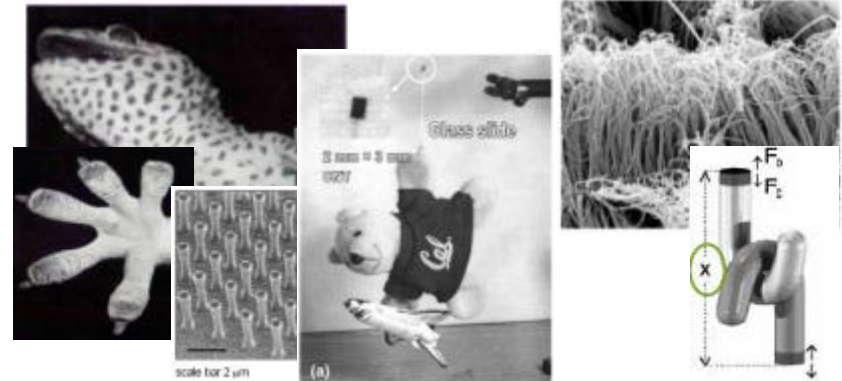
# Miniaturization

- **Established Projects**
  - Nano Attach Project
  - Pb-free Nano-solder Project
- **New Project**
  - **Functional Test Coverage Assessment Project – Launched July 2007**
- **Initiatives**
  - High Temperature Co-planarity Requirements for Components and PWBs
  - RFID Item Level Tag Roadmap and Gap Analysis

**Goal: Develop low-temperature or room temperature assembly processes that have the potential to improve field reliability, streamline manufacturing, and reduce cost**

## Strategy:

- Use nanotechnology based dry adhesive technologies, e.g., nano-velcro or biomimetic systems (“gecko foot”) to replace high temperature solder attach systems
- Project Lead: Hope Chik (Motorola)



## Tactics

- **Phase 1: Discovery and Concept Development** - Define requirements necessary to adapt nano-structure attachment schemes in electronic assembly
- **Phase 2: Evaluation and Proof of Concept** - Identify and evaluate currently available nano-attach technologies and explore these approaches
- **Phase 3: Demonstration and Prototype** - Proof-of-concept material evaluation and fabrication of assembled prototypes

## Milestones & Issues

- **Phase 1 – Discovery** .....Q407
- **Phase 2 – Evaluation** .....Q208
- **Phase 3 – Demonstration** .....Q408
- **Issues:**
  - ✓ Is the technology mature enough to have a high probability of success in Phase 2 and 3

# Printed & Organic Electronics Roadmap

**Goal: Develop industry-wide Printed & Organic roadmap to establish supply chain**

## Strategy:

- Publish internationally accepted printed and organic electronic roadmap.
- Project Lead: Motorola



## Tactics

- Phase 1: Agree to partner with Organic Electronics Association to deliver a combined iNEMI and OEA Roadmap
- Phase 2: Initiate roadmap drafting effort and agree to outline for combined document

## Milestones & Issues

- Phase 1.....Q407
- Phase 2 .....Q108
- P&O Roadmap issued .....Q109
- ISSUES:

# Medical Electronics

- **Established Project**
  - **Medical Grade Component Reliability Specifications**
- **Initiative**
  - **iNEMI Substrates for Medical Devices**

# Medical Electronics Thrust Area

**Goal: Provide the patient and medical community with seamless end-to-end solutions for improved health management**

## Strategy:

- Wirelessly connect implantable devices, portable devices and diagnostic imaging tools for clinical and home-health monitoring.
- Increase substrate and component packing density for producing small, easy to use, cost effective medical devices
- Increase device reliability for long term product life cycles



## Tactics

- Develop modeling tools to understand RF traffic issues in the wireless clinical and home-health environment.
- Develop advanced PWB technologies that address the performance & I/O density requirements of medical devices.
- Develop component reliability standards & test methods that address the unique performance requirements and use environments that characterize the medical products sector
- Create & disseminate industry roadmaps to drive technology development

## Impact

- Reduce paperwork and recording errors between patient and care-giver
- Enable new cost effective device designs, products and treatments
- Reduce time investment for medical approvals by governmental agencies
- Establish efficient supply chains to meet industry growth rates

# Energy & the Environment

- **Established Projects**
  - Tin Whisker Phase II Project
  - Lead-Free Rework Optimization Project
  - Pb-free Wave Soldering Assembly Process Project
  - Lead-Free Rework Optimization Project
  - Pb-free BGAs in SnPb Assemblies Project
- **New Project**
  - Halogen-Free Project Phase II – Launch June 2007
- **New Initiatives**
  - BGA Metallurgy Proliferation
  - Advanced Thermal Management Technologies (under discussion)
- **High Reliability Task Group**
  - Prioritization of remaining Pb-free knowledge gaps
  - Strategy for closing gaps
  - Industry coordination for Pb-free transition

# High Reliability RoHS Task Force

**Goal: Safeguard the dependability of high reliability RoHS-exempt products as the supply chain converts to Pb-free components and materials.**

## Strategy:

- Develop recommendations and guidelines that communicate the needs of the High Reliability manufacturers to this segment of the supply chain and relevant standards groups that address these needs.
- Understand and close remaining knowledge gaps that must be closed to allow Pb-free conversion for High Reliability manufacturers.
- Project Lead: Mike Davisson (Agilent Technologies), Thilo Sack (Celestica), Joe Smetana (Alcatel-Lucent)



## Tactics

- Phase 1: Publish position statements:
  - "Recommendations to Electronics Industry Component Supply Base"
  - "Pb-Free Manufacturing Requirements for High-Complexity, Thermally Challenging Electronic Assemblies"
  - "RoHS5 & RoHS6 Subassembly Modules"
- Phase 2: Influence supply base for SnPb BGAs
  - Hold workshop and publish results
- Phase 3: Prioritize knowledge gaps and spawn projects as needed.

## Milestones & Issues

- Phase 1..... Complete
- Phase 2 ..... On going
- Phase 3..... On going
- ISSUES:



# **iNEMI**

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## **2009 iNEMI Roadmap**

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# 2009 Roadmap

- **20 Technology Working Groups (TWGs)**  
(New Roadmap on Solid State Illumination)
- **5 Product Emulator Groups (PEGs)**
- **Roadmaps the needs for 2009-2019**

# 2009 Roadmap Schedule

- **November 13, 2007 – Roadmap kick-off Europe, Productronica**
- **February 20-21, 2008 PEG Workshop/TWG Kick-off, Santa Clara, CA:**
- **May 14, 2008 – North American Roadmap Workshop, Herndon, VA**
- **June 2008 – European Roadmap Workshop**
- **June 2008 – Asian Roadmap Workshop - China**
- **August 6-7, 2008 – TC Review with TWG Chairs, Liberty Lake, WA**
- **September 22, 2008 – Final Chapters of Roadmap Due**
- **December, 2008 – Roadmap Released to iNEMI Members**
- **April, 2009 – Industry presentation at APEX**



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# Conclusions & Summary

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# Conclusions

- **Consumer Electronics has become the major driving force for our industry:**
  - **New Technology to enable miniaturization**
  - **Relentless cost reduction**
  - **Volume manufacturing capability**
- **Disruptive technology offers opportunity for innovation. To ensure success, the supply chain must invest with a long-term perspective in mind.**

# Summary

- **The 2007 iNEMI Research Priorities identifies R&D needs that must be met.**
- **Given the limited resources that industry, academia, and governments can apply, it is crucial that we focus our R&D efforts on these high priority knowledge gaps.**

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