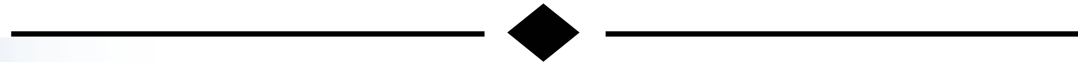
2004 Roadmap:
Environmentally Conscious Electronics



Mark Newton, Dell
Joe Johnson, Microsoft
Robert C. Pfahl, Jr., iNEMI

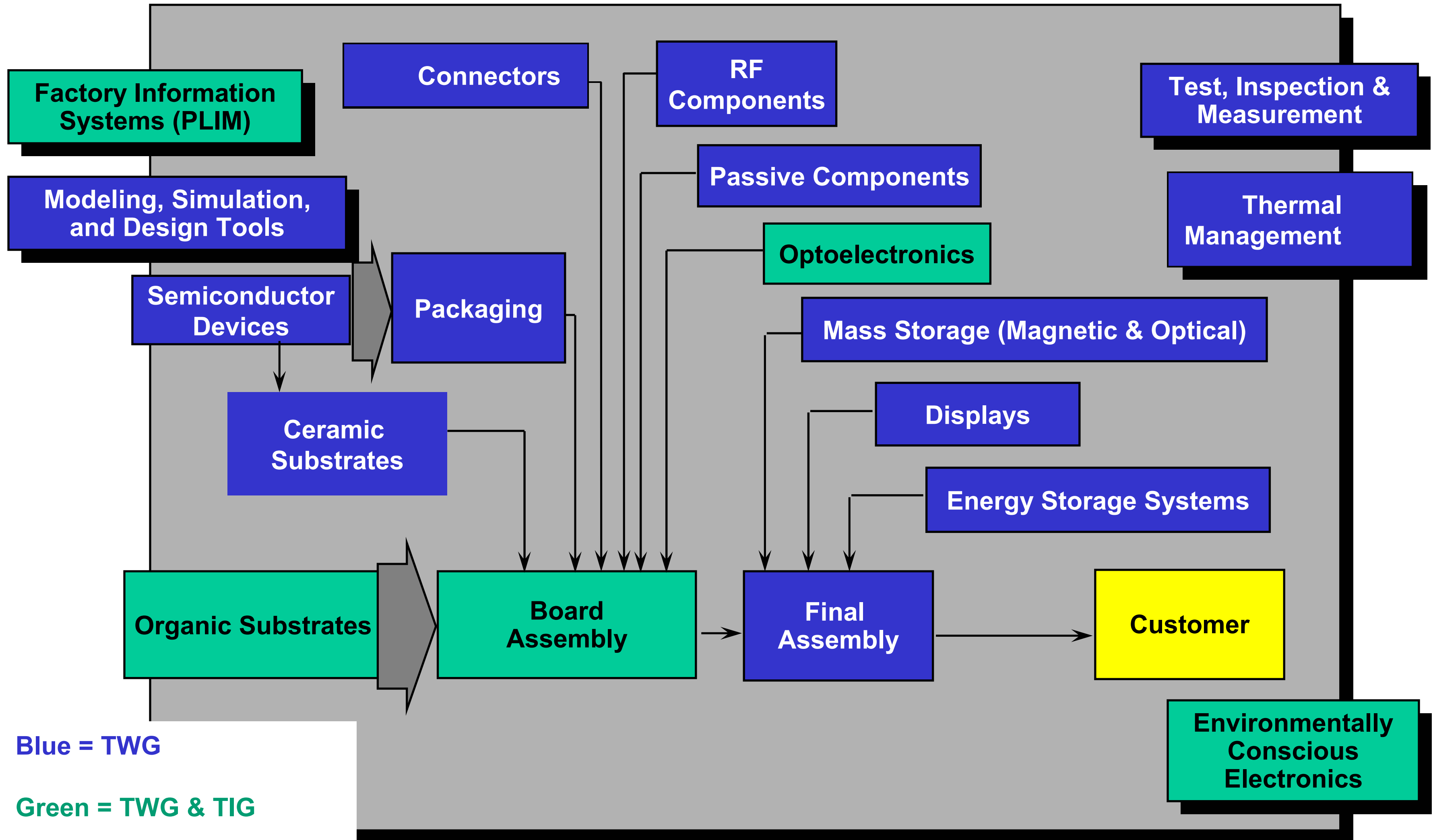
Topics to be Discussed

- International Electronics Manufacturing Initiative (iNEMI) overview
- The iNEMI Roadmap process
- 2004 Highlights from Environmentally Conscious Electronics (ECE) Roadmap
- Conclusion: Future Challenges

Some Definitions…

- **TWG - Technical Working Group**
  - Develops the roadmaps
- **TIG - Technology Integration Group**
  - Develops technical/strategic Plan
    - identifies research priorities:
    - based on roadmap findings and gap analysis meetings
- **PEG – Product Emulator Group**
  - "virtual product": future product attributes plus key cost and density drivers
    - Portable / Consumer
    - System in Package
    - Office Systems / Large Business Systems
    - Network / Datacom / Telecom Products
    - Medical Products
    - Automotive
    - Defense and Aerospace

NEMI TWG/TIG Overview and Interrelationships



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7 Product Emulator Groups (PEGs)

Provides Product Requirements for Roadmaps

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

CONNECT WITH AND STRENGTHEN YOUR SUPPLY CHAIN

iNEMI

2004 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
- Display
- Modeling, Simulation & Design Tools
- Thermal Management
- Test, Inspection & Measurement
- Product Lifecycle Information Management
- Sensors

Roadmap Affiliations

iNEMI

Interconnect Substrates—Ceramic

Semiconductors

iNEMI / ITRS Packaging TWG

iNEMI / IPC Interconnect TWG

Interconnect Substrates—Organic

iNEMI Roadmap

iNEMI Product Lifecycle Information Management TWG

Supply-Chain Council

Supply Chain Management

Displays

iNEMI Optoelectronics TWG

iNEMI Mass Data Storage TWG

INSIC

Magnetic and Optical Storage

OIDA

Optoelectronics and Optical Storage

iNEMI

Statistics for the 2004 Roadmap

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

Closing Gaps: Environmental Projects to Eliminate Pb Solder

- 1998 Roadmap identified the technology gap.
- Phase I project developed the alloy, process, components and reliability from 1999-2002.

Results:

  - The iNEMI efforts accelerated the establishment of SAC alloys as the standard and reduced the effort in each member company.

- Phase II projects have expanded the technology base to include assembly and rework of large complex PWB assemblies.

Closing Gaps: Environmental Projects to Eliminate Pb Solder

- 2002 Roadmap identified a number of business Issues to convert to a Pb-free supply chain.
- Five Phase III project teams have addressed these supply chain transition issues.
- Three new Phase IV projects are being established to close recently identified technology gaps:
  - Wave/selective solder
  - Mixed assemblies (Pb-free BGA's in a SnPb assembly process)
  - Pb-free surface finishes

The 2004 NEMI Roadmap

- Broader International Participation
  - –IEEE CPMT

- Released to public at Apex on February 22, 2005
- Preliminary Highlights from the 2004 Environmentally Conscious Electronics Roadmap
  - –New organization of the chapter
    - Design
    - Energy
    - Recycling
    - Materials
    - Sustainability

  - –Broader Input

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2004 NEMI Roadmap Goals

- Strengthen Product Emulators
- Begin globalizing Roadmap
- Work more closely with the International Technology Roadmap for Semiconductors
- Maintain strong linkages with other technology roadmaps.
- Expand emphasis on identifying market needs and business situation throughout roadmap.
- Clearly identify,prioritize and categorize gaps and R&D needs in all TWG chapters.
- Expand emphasis on disruptive events (business and technical)

Content Developed by Extended Teams

1. **Situation Analysis** - Describe state of the art, laws, initiatives, etc
2. **Critical Issues** - Identify key trends, especially paradigm shifts
3. **Technology and Business Needs** - Identify priorities for R&D and process development
4. **Gaps and Showstoppers** – Identify risks to business
5. **Recommended Alternative Technologies/Processes**

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2004 ECE Extended Teams

Topic	Key Legal and voluntary requirements	Trends/ emerging issues	R&D and process needs	Risks / show-stoppers	Enabling technologies and processes
Materials (RoHs, etc)					
Energy (E-star, etc)					
End of Life (WEEE, etc)					
Design (EuP, etc)					
"Sustainability"					
Cross-Cutting Coordination	Component Manufacturing Core Manufacturing Technology Crosscutting TWGs Product Emulator Groups				

2004 Roadmap Extended Teams

Chair: Mark Newton, Dell Co-chair: Joe Johnson, Microsoft

Materials Team

Leader: Holly Evans, Strategic Counsel LLC

Fern Abrams, IPC
Eric Austerman, Jabil
Brenda Baney, Delphi
Todd Brady, Intel
Dan Camarda, Centor
James Goeppinger, Storage Tek
Hansjorg Griese, Fraunhofer Inst.
Carol Handwerker, NIST
Tony Kingsbury, Dow
Becky Linder, AeA
Jutta Mulla, Fraunhofer Inst.
Mark Myles, Goodbye Chain
Scott O'Connell, Dell
Bob Pfahl, iNEMI
Fran Planinsek, Storage Tek

End of Life Team

Leader: Heather Bowman, HP

Eric Austerman Jabil
Reggie Cardill, NJIT
Tony Kingsbury, Dow;
Becky Linder AeA
Jason Linnell, EIA
Fran Planinsek, Storage Tek

iNEMI

2004 Roadmap Extended Teams

Energy Team

Leader: Todd Brady, Intel

H. Scott Matthews, CMU

Robert White, Dell

Design Team

Leader: Anne Brinkley, IBM

Bill Hoffman, Motorola

Patrick Eagan, U. Wisconsin

Larry Weinberg, Boeing

Sustainability Team

Leader: Todd MacFadden, Bose

Fern Abrams, IPC

Reggie Caudill, NJIT

David Dickinson, Consultant

Hansjorg Griese, Fraunhofer Inst.

Matt Kelly, Celestica

Tony Kingsbury, Dow

John Lott, Dupont

H. Scott Matthews, CMU

Mark Myles, Goodbye Chain

Bill Olson, Motorola

Dave Stangis, Intel

Harvey Stone, Goodbye Chain

Phil Trowbridge, AMD

Gaps and Needs: Materials

New trends in environmental regulation of materials: Challenges as well as opportunities for industry

- How to integrate cost-efficient materials compliance strategies across multi-tiered global supply chains
- RoHS: Defining 'homogeneous materials'; qualifying exemptions; Implementing documentation & testing
- Cd and Pb-free PVC cables
- Hg in CCLs
- Pb-free for high reliability requirement applications
- Halogen free: Plastics, laminates, components
- REACH risk assessment for chemical emissions

Gaps and Needs: End of Life

Globally, the electronics industry is being asked to take responsibility for products at end of life

- **Operational infrastructure to support WEEE**
  - Register/track/pay in regional markets
  - Financial guarantees
  - Logistics & reverse logistics
  - Electronic component recovery and reuse
- **Integration of business policies & procedures to meet compliance requirements**
  - Placed on the market; Producer vs. importer responsibility
- **Development of recycling technologies & markets**
- **Meeting EU product recycling targets**
  - IT products (Category 3): 65% recyclable, 75% recoverable

Gaps and Needs: Energy

Minimizing energy consumption: A major focus for electronic equipment manufacturers

- CA Appliance efficiency regs: Effective July 2006 for external power supplies
- Increasing market pressure from EuP & voluntary energy standards for PCs/TVs
- Cost efficient methods to improve energy efficiency of power supplies
- Enabling power management of IT equipment
  - Educating users on enhanced power management
  - Balancing standby power with network & usability demands

Gaps and Needs: Design

DFE: Integrated at beginning of Design Cycle

- Automated data management systems for materials declarations
- Product compliance & verification testing
  - Today: Regulated/non-regulated materials
  - Tomorrow: DfE attributes (need additional design team resources)
- Qualification of replacements for hazardous substances
- LCA / SLCA tools
- WEEE compliance verification process

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Gaps and Needs: Sustainability

The NEMI ECE TWG identified sustainability as a new focus area for the Roadmap

- **Definition of Sustainability**
  - **Operations: Consumption/emissions of materials & energy**
  - **Products: Minimizing ‘environmental footprint’ over the entire life-cycle**
- **Standard Sustainability Indicators and reporting protocols**

Future Challenges to the Industry

- **Green Electronics**
  - As we recover from implementing RoHS & WEEE, EuP/REACH/Halogen-free/IPP will continue to drive market/competitive pressure towards product sustainability metrics
  - The electronics industry must develop a strategic vision of sustainable electronics
- **Electronic Packaging**
  - Technology driver will be multifunctional system in packages (SiP)
  - Needs must be addressed through innovation using new processes and new materials made possible through emerging efforts such as nano-technology

Future Challenges to the Industry

- Opportunities For Leadership--
  - 2006 ECE Roadmap Team
  - Participate In ECE TIG Projects
- Thanks For Listening!
  - Bob Pfahl bob.pfahl@nemi.org
  - Mark Newton mark_d_newton@dell.com
  - Joe Johnson joejohn@microsoft.com