iNEMI

International Electronics Manufacturing Initiative

iNEMI Heat Transfer TIG

Liquid Cooling Symposium

May 31, 2006, 7:00-9:00 p.m.
Executive Center 3
Sheraton San Diego Hotel & Marina

iNEMI

International Electronics Manufacturing Initiative

Introduction

Michael K Patterson, Intel Corporation

Agenda

TIME:	TOPIC:	
7:00 - 7:10 pm	Introduction iNEMI Overview	Michael K Patterson, Intel Corporation David Godlewski, iNEMI
7:10 – 7:25 pm	Experimental performance of high performance, low cost,water- cooled, copper micro-channel heat sinks	Ralph. L. Webb, Hasan Nasir Omega Piezo Technologies, Inc.
7:25 – 7:40 pm	A integrated cost-effective liquid cooling technology for CPU cooling	Ketan R. Shah, Intel Corporation
7:40 – 7:55 pm	Cold Plate Manufacturing - Factors that Drive Up Production Pricing	Kathryn Whitenack, Lytron, Inc.

Agenda

TIME:	TOPIC:	Presenter
7:55 – 8:10 pm	Passive Two-Phase Liquid Cooling as an Alternative to Aqueous Forced Convection	Phil E. Tuma, Application Development Specialist, 3M Electronics Markets Materials Division
8:10 – 8:25 pm	Artech Integrated Liquid Cooled Heatsink	Gregg Kloeppel, Artech Inc.
8:25 – 8:40 pm	Cost Effective Design and Manufacture of Liquid Cooling Systems	Michael Lee, Ph.D. Director of R&D, Thermaltake Technology Co., Ltd.
8:40 -	Forum Discussion	

iNEMI

International Electronics Manufacturing Initiative

Heat Transfer TIG

Liquid Cooling Project

Michael K Patterson

iTHERM/iNEMI Liq Cooling Symposium

May 31, 2006

- # TIG Overview

  Newly created and organized in Q3 2005

  First Technical Report created and submitted Q4 2005

  First Projects identified Q1 2006

  - **6 projects prioritized to select 2**

  Two projects in development

Heat Transfer TIG Participants

TIG Chair: Michael Patterson, Intel

Al Ortega, NSF
Alan Lyons, Lucent
Avi Bar-Cohen, U. Maryland
Bahgat Sammakia, U. Binghamton
Bruce Myers, Delphi
Cam Murray, 3M
Chad Hawkinson, PTC
Charles Minning, JPL
Chia-Pin, Intel
Chuck Richardson, iNEMI
Darvin Edwards, TI
Dereje Agonafer. UTA
Gaurang Chocksi, Intel
Greg Chrysler, Intel
Greg Horning, Tyco
James Maveety, Intel
Jim Shields, Dell
John Buchowski, PTC
Kathryn Whitenack, Lytron
Martin Bayes, Rohm & Haas
Michael Heatly, Dell
Nate Breese, Rohm & Haas
Paul Kolodner, Lucent
Rajiv Mongia, Intel
Ravi Mahajan, Intel
Rick Culham, U. Waterloo
Steve Davidson, Northrup Grumman
Yogendra Joshi, Georgia Tech.

Heat Transfer TIG Premises

- The cost of thermal management technologies must keep pace with the reductions in overall package and system cost per function which are being realized in virtually all product sectors.
- Traditional thermal solutions have addressed the immediate level of concern with little concern about the impact of that design upon the subsequent higher level assemblies.
- Thermal challenges need to be considered early in the system design process.
- The only way to satisfy the cost/performance requirements is to integrate the electrical, mechanical, and thermal design processes at a higher level.

Suggested Projects

Based on the TIG's gap analysis the following projects were suggested for consideration:

- **Limits of air-cooling in Data Centers**
- **Impact of liquid cooling**
- **Quiet, high performance fans**
- **Reliable, low cost pumps - for liquid cooling systems**
- **3D package cooling technologies - best known methods and current capability review**
- **Low and transitional turbulence modeling assessment in cooling design CFD modeling**

Liquid Cooling Next Steps

- **Symposium Today**
  - Thanks!!! to iTHERM organizers
- **Liquid Cooling Project Team Meeting**
  - Friday, June 2, 2006, 7:00 a.m. - 8:00 a.m.
  - Marina 5 Room
  - Sheraton San Diego Hotel & Marina

  - Review seminar results
  - Highlight good news
  - Identify Gaps
  - Develop path forward to “Best Practices” document

iNEMI

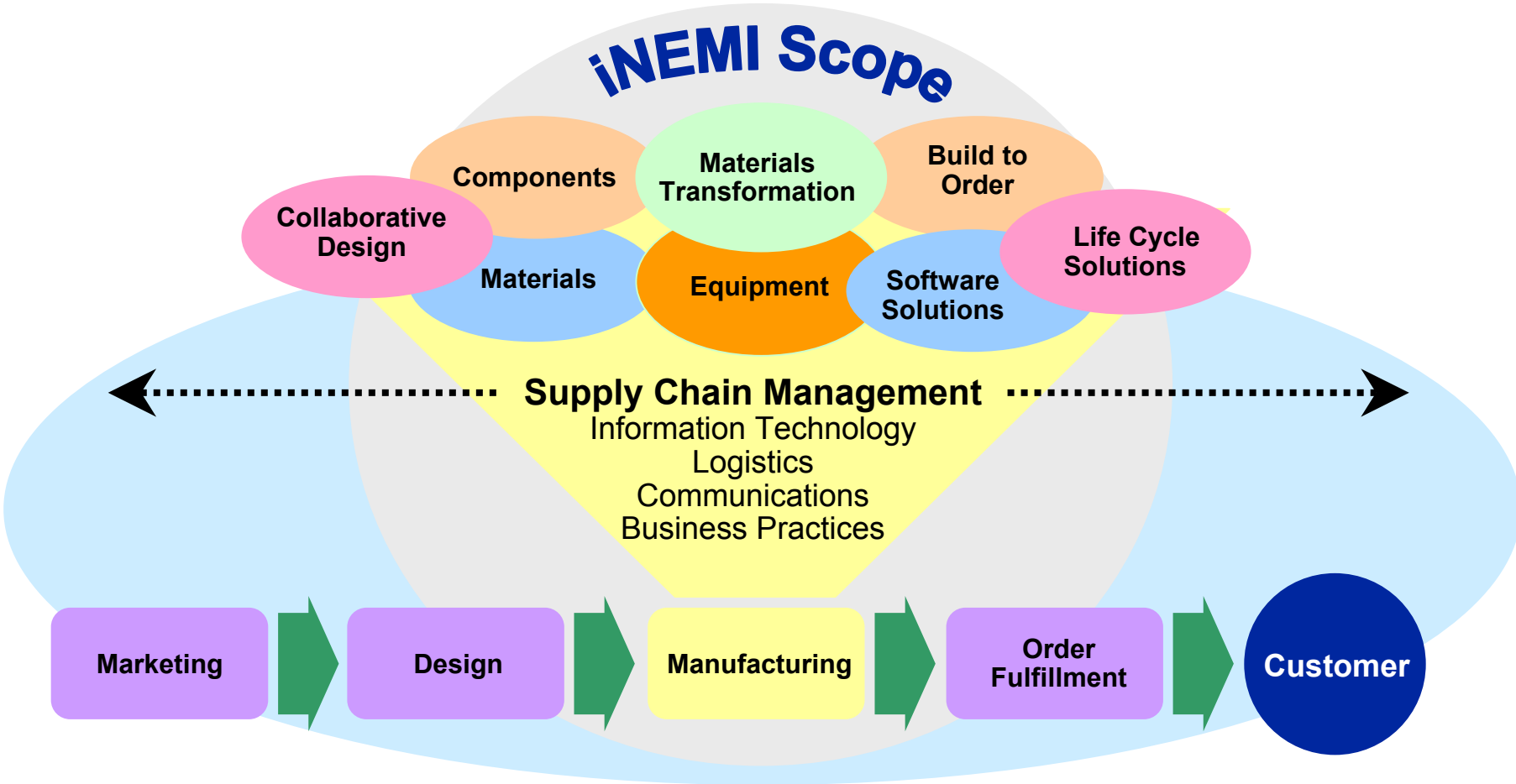
International Electronics Manufacturing Initiative

iNEMI Overview

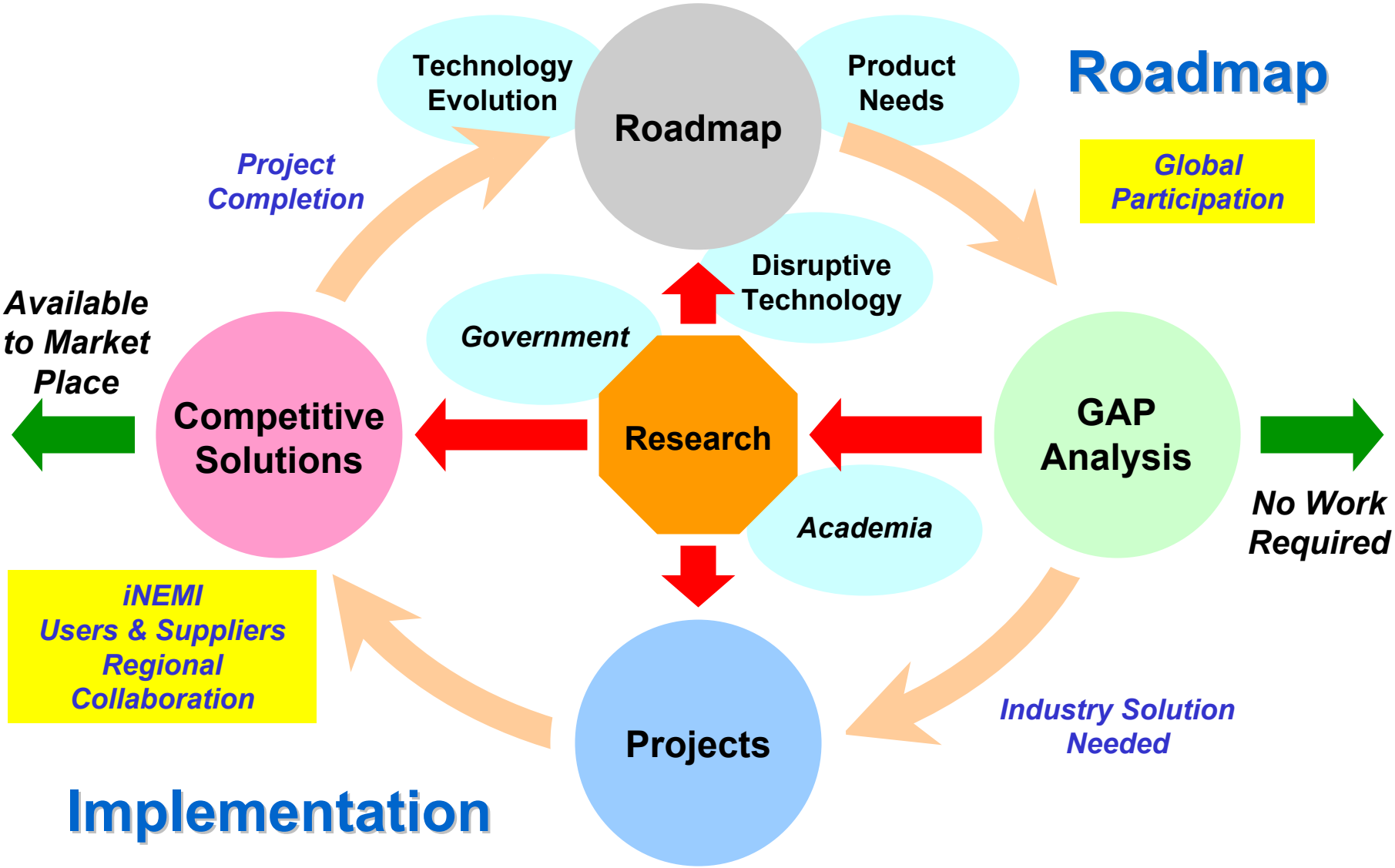
David Godlewski, iNEMI

Mission

Assure Leadership of the Global Electronics Manufacturing Supply Chain for the benefit of members and the industry



Methodology



Value Proposition

"Connect with and Strengthen Your Supply Chain"

- **iNEMI offers the opportunity to collaborate with the entire supply chain in an efficient manner**
  - **To understand and accelerate strategic directions**
  - **To define future needs and opportunities**
  - **To jointly create industry standard solutions.**
- **Today's increasingly distributed supply chain makes this more important than ever.**
- **iNEMI is a member driven organization that adapts to industry changes quickly and provides timely leadership.**
- **iNEMI provides important deliverables:**
  - **Technology roadmaps**
  - **Forums on key industry issues**
  - **Deployment projects.**

What Does iNEMI Do?

Leverage the combined power of member companies to provide industry leadership

- **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 works with other organizations to ensure that government policy recommendations are aligned with our mission.**

Industry Leaders belong – OEM/EMS

Industry Leaders belong – Suppliers

Industry Leaders belong

Consultants, Government, Organizations & Universities

AeA

AMR Research

EIA Electronic Industries Alliance

IPC Association Connecting Electronics Industries

CMAP Centre for Microelectronics Assembly and Packaging

IEEC

METAGROUP

Georgia Institute of Technology

MIT

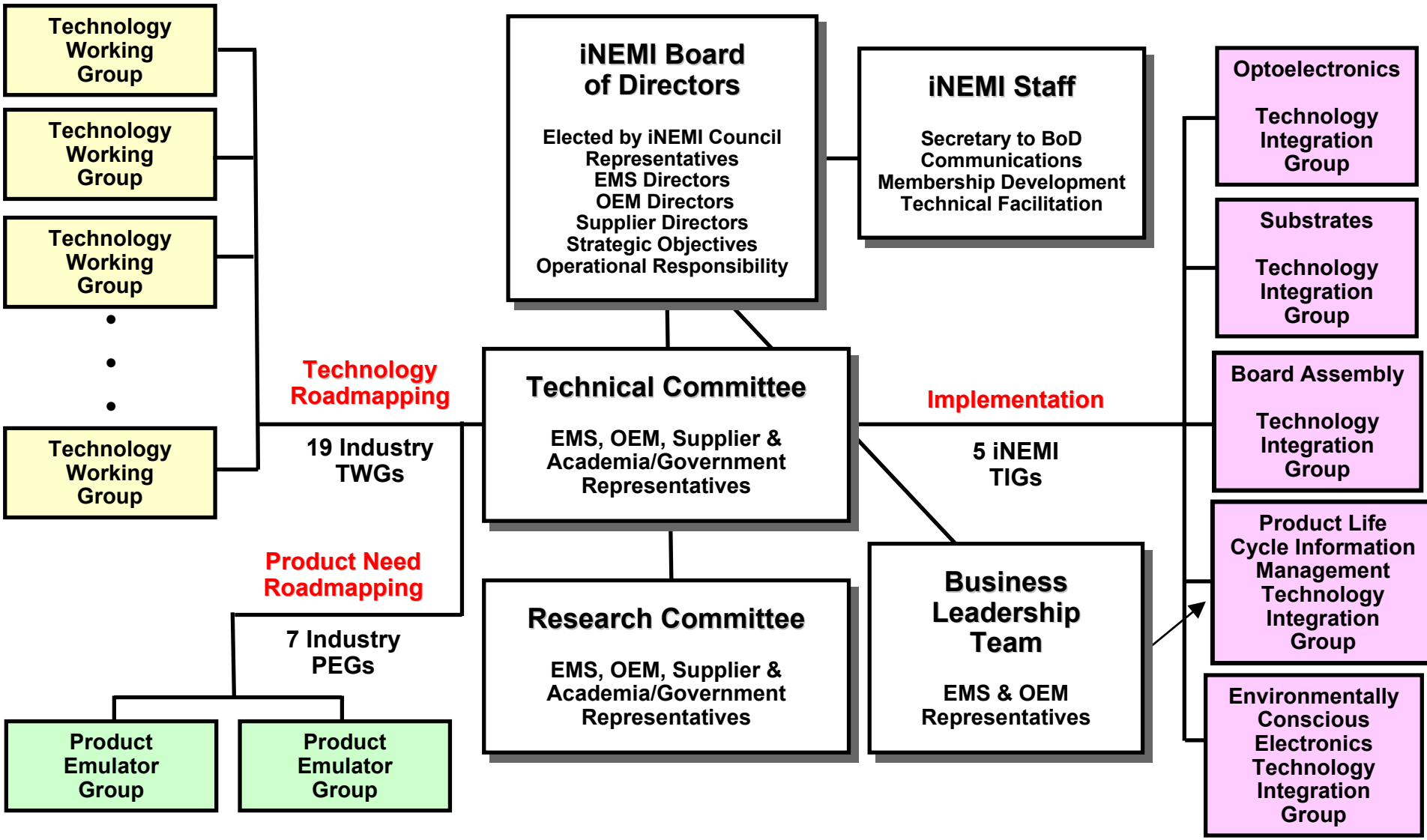
NCMS

Virginia's Center for Innovative Technology

Développement économique et régional Québec

NIST

Organization



Key Elements in Value

- The companies represented
  - OEMs who are market leaders in innovative products
  - EMS providers who are global leaders in manufacturing
  - Leading suppliers for manufacturing equipment, materials, components, and software.
- The specific participants within those companies
  - Board of Directors
  - Technical Committee
  - Council Members
- Reputation of iNEMI as an industry leader, through activities such as:
  - Roadmapping
  - Industry forums
  - Collaborative projects to close identified gaps
    - Lead-free interconnect
    - Distributed manufacturing software standards

Why do Companies Join?

- Collaboration with their key customers (at multiple levels)
- Collaboration with their key suppliers
- Leverage their resources
  - Reduce investment
  - Increase accomplishments
- Help influence and create industry-standard solutions that lead to competitive products.
- Understand direction of industry & competition
- Understand & exploit new business opportunities
- Help influence innovation and funded research
- Improve probability of “right solution at right time”
- Improve return on investment

www.inemi.org

Email contacts:

Jim McElroy

jmcelroy@inemi.org

Bob Pfahl

bob.pfahl@inemi.org

iNEMI
International Electronics Manufacturing Initiative

Experimental performance of high performance, low cost,water- cooled, copper micro-channel heat sinks

Ralph. L. Webb, Hasan Nasir Omega Piezo Technologies, Inc.

iNEMI
International Electronics Manufacturing Initiative

A integrated Cost-effective Liquid Cooling Technology for CPU Cooling

Ketan R. Shah, Intel Corporation

iNEMI
International Electronics Manufacturing Initiative

Cold Plate Manufacturing - Factors that Drive Up Production Pricing

Kathryn Whitenack, Lytron, Inc.

iNEMI
International Electronics Manufacturing Initiative

Passive Two-Phase Liquid Cooling as an Alternative to Aqueous Forced Convection

Phil E. Tuma, Application Development Specialist, 3M Electronics Markets Materials Division

iNEMI
International Electronics Manufacturing Initiative

Artech Integrated Liquid Cooled Heatsink

Gregg Kloeppel, Artech Inc.

iNEMI

International Electronics Manufacturing Initiative

Cost Effective Design and Manufacture of Liquid Cooling Systems

Michael Lee, Ph.D. Director of R&D, Thermaltake Technology Co., Ltd.

iNEMI
International Electronics Manufacturing Initiative

Forum Discussion