



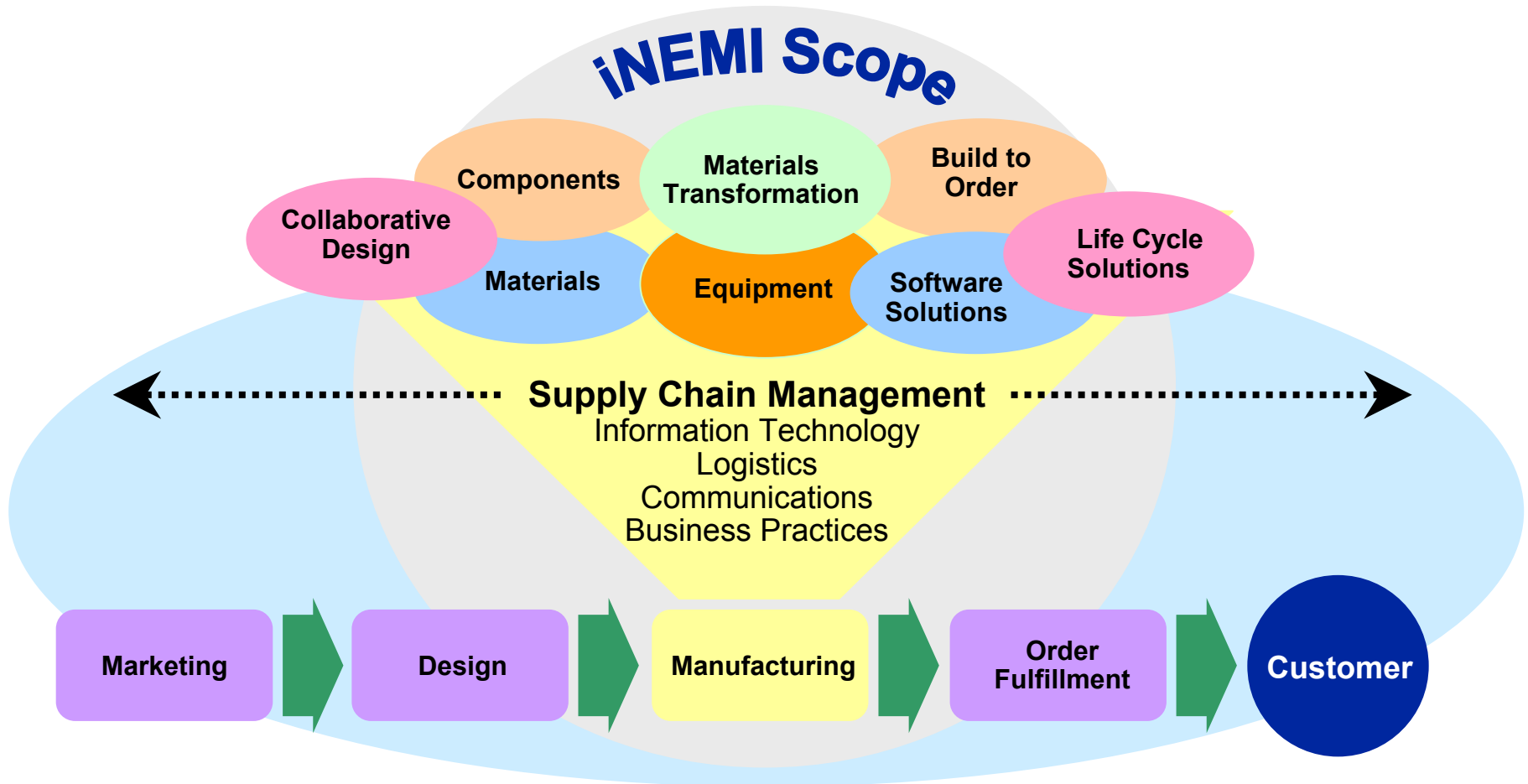
International Electronics Manufacturing Initiative

# Industry Gets Ready for RoHS



*Roger Han*  
*Vitronics-Soltec*

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



***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.**

- **iNEMI roadmaps technology in 19 different areas.**
- **Each roadmap chapter is created by a Technology Working Group (TWG).**
- **From the Roadmap, iNEMI identifies the need for deployment activities and forms Technology Integration Groups (TIG).**
- **iNEMI currently has TIGs in 7 different areas.**
- **Each project is organized within a TIG.**
- **Roadmap and project groups are made up of industry people (including leadership).**

- **A gap is defined as a technology need that will not be satisfied without additional action by industry.**
- **Projects typically:**
  - **Develop/evaluate processes and/or protocols**
  - **Evaluate alternative technologies**
  - **Identify equipment needs**
  - **Identify/evaluate communication schemes**
  - **Determine component requirements**
  - **Develop standards proposals**

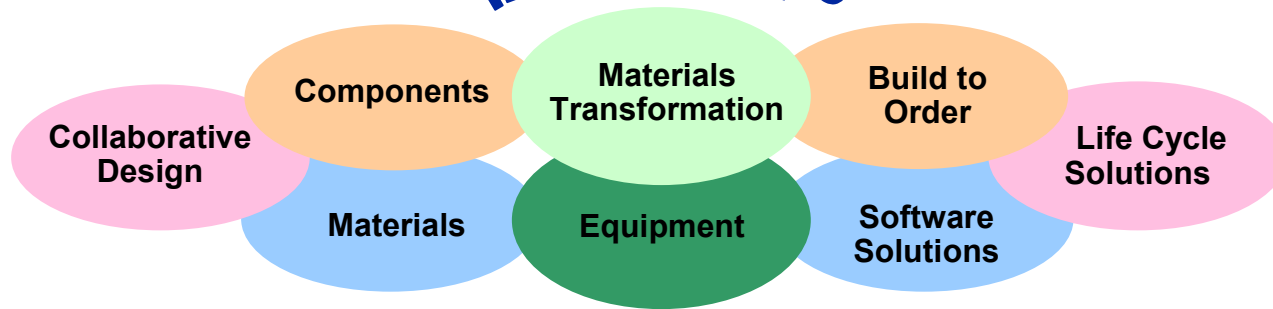
Currently we have standards alliances with the following organizations:



- IPC
- IEEE
- EIA/JEDEC
- RosettaNet



## iNEMI Scope



### Substrates TIG Projects:

- High Frequency Materials Effects on HDI
- Optoelectronics for Substrates

### Board Assembly TIG Projects:

- Pb Free BGA's in SnPb Assemblies
- Substrate Surface Finishes for lead free
- SMT Reel Labeling
- Pb-free BGAs in SnPb Assemblies
- Lead-Free Nano-Solder

### Product Life Cycle Information Management TIG Projects:

- PDX Extensions & Updates
- Materials Composition Data Exchange
- Offspring Industry Adoption (IPC 2581)

### Optoelectronics TIG Projects:

- Fiber Optic Splice Loss Measurement
- Fiber Connector End-Face Inspection

### Environmentally Conscious Electronics TIG Projects:

- Lead-Free Assembly & Rework
- Tin Whisker Accelerated Test
- Tin Whisker Modeling
- Tin Whisker User Group
- Lead-Free Wave Soldering Assembly
- RoHS Transition Group
- Lead-Free Rework Optimization
- High Rel RoHS Compliance

### System in Package TIG:

- Just being defined
- Address equipment, process, & standards

### Heat Transfer TIG:

- Just being defined
- Address process, & standards

**Co-Directors of Planning: Leslie Guth, Lucent Technologies; Bill Barthel, Plexus**

- **Board Assembly**
  - **Chair: Tom Pearson, Intel**
- **Environmentally Conscious Electronics**
  - **Chair: Joe Johnson, Cisco**
- **Heat Transfer**
  - **Michael Patterson, Intel**
- **Optoelectronics**
  - **Chair: Peter Arrowsmith, Celestica**
- **Product Lifecycle Information Management**
  - **Co-Chair: Barbara Goldstein, NIST**
  - **Co-Chair: John Cartwright, Intel**
- **System in Package (SiP)**
  - **Chair: Joe Adam, Skyworks**
- **Substrates**
  - **Chair: Hamid Azimi, Intel**

- **1998 Roadmap identified the gap.**
- **Phase I project developed the alloy, process, components and reliability from 1999-2002.**
- **Phase II project is expanded the technology base to include rework, high I/O devices and large complex PWB's.**
- **2002 Roadmap identified a number of business Issues to convert to a Pb-free supply chain.**
- **Phase III project teams were established to address these supply chain transition issues.**
- **Phase IV projects now underway for remaining issues.**

### **Results:**

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

# Environmentally Conscious Electronics (ECE) Technology Integration Group (TIG)

## Pb-Free Assembly

Chair: Edwin Bradley, PhD Motorola  
Co-Chair: Rick Charbonneau

*Complete*

## Pb-Free Assembly & Rework

Chairs: Jerry Gleason, HP  
Charlie Reynolds, IBM  
Team Leaders: Jasbir Bath, Solectron  
Quyem Chu, Jabil Circuit  
Mathew Kelly, Celestica  
Ken Lyjak, IBM  
Patrick Roubaud, HP

*Complete*

## RoHS Transition Task Group

Chair: Dave McCarron, Dell  
Projects:  
Component Supply Chain Readiness  
Chair: John Oldendorf  
Component and Board Marking  
Chair: Vivek Gupta, Intel  
Assembly Process Specifications  
Chair: Frank Grano, -SCI  
Materials Declarations  
Chair: Nancy Bolinger, IBM

*Complete*

## Tin Whisker Accel. Tests

Chair: Valeska Schroeder, HP  
Co-Chairs: Jack McCullen, Intel  
Mark Kwoka, Intersil

## Tin Whisker Users Group

Chairs: Joe Smetana, Alcatel  
Richard Coyle, Lucent

## Tin Whisker Modeling

Chair: George Galyon, IBM  
Co-Chair: Maureen Williams, NIST

## Pb-free BGAs in SnPb Assy.

Chair: Robert Kinyanjui, Sanmina-SCI

## Pb-free Wave Soldering

Chair: Denis Barbini, Vitronics Soltec  
Co-chair Paul Wang, Sun Microsystems

## Pb-free Substrate Finishes

Chair: Keith Newman, Sun Microsystems  
Co-chair: Charan, Gurumurthy, Intel

- **Solder Alloy**
  - Recommended Tin-Silver-Copper (SnAgCu) alloy for reflow and Tin-Copper alloy for wave soldering (more work on wave needed)
  - Backwards compatible with lead based systems
- **Components**
  - Maximum component temperatures of 240C for large ICs, 250C max for small ICs on boards  $\leq 0.92$ " thick were achieved
  - JEDEC revised J-STD-020B standard 250°C  $-5/+0$
- **Process**
  - Manufactured with existing assembly process equipment
  - Performance of Pb-free pastes and fluxes are adequate
- **Reliability**
  - Demonstrated Pb-free joints are more reliable than tin-lead

## –NEMI declares victory for lead-free alloy

- In 2000, NEMI team recommended Sn3.9Ag0.6Cu for reflow solder
- Many other compositions have been proposed, but debate has shifted from a wide variation of materials to discussion of best SnAgCu alloy
- Although compositions vary, the NEMI-recommended alloy is representative of the acceptable range of lead-free alloys
  - Provides a model system for industry that has been extremely well-characterized by NEMI and NIST
  - Members are using the alloy in production
- NEMI's focus on a single lead-free alloy helped accelerate industry convergence on standard solder formulations and manufacturing processes



**Objective:**

**Develop baseline manufacturing process for medium to high-end IT products in time to meet EU RoHS requirements**

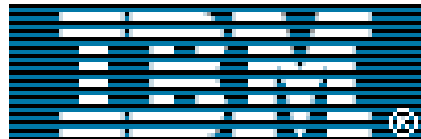
**Scope:**

**Extend the previous project's work (based on SnAgCu solder) into new areas:**

- High I/O count packages**
- Large thick PWBs**
- Rework**
- MSL limits (for large complex PWBs)**

**Status:**

- Indications are that existing rework process needs additional development to meet maximum temperature requirements for lead-free packages and laminates**
- Group has revised process and tools to stay under the maximum temperature goal of 260°C**
- Reliability testing complete**
- Final report released to members.**



- **Solder Alloy**
  - All work based on iNEMI SAC Alloy
- **Components**
  - Component temperatures of 230C - 260C max on boards 135 mil. thick were observed
  - PWB material selection is critical (for thick, complex boards)!
  - JEDEC revised J-STD-020C standard (260°C max. component temp.)
- **Process**
  - Manufactured with existing assembly process equipment
  - Developed rework capability for SAC (more effort needed)
- **Reliability**
  - Demonstrated reliability of high I/O count devices on complex boards (with & without rework)
  - No impact – electrolytic NiAu vs. Immersion Ag

## Three NEMI Committees Related to Tin Whiskers

- **Accelerated Test Project** – Investigating Standardized Test Methods
- **Modeling Project** – Investigating Fundamental Mechanisms of Initiation & Growth
- **User Group** – Developing Mitigation Strategies & Acceptance Criteria

**Objective:**

Devise industry standard tests for predicting tin whiskers

**Status:**

–The group has carried out three factorial experiments looking for test methods involving

:

- Temperature
- Humidity
- Thermal cycling

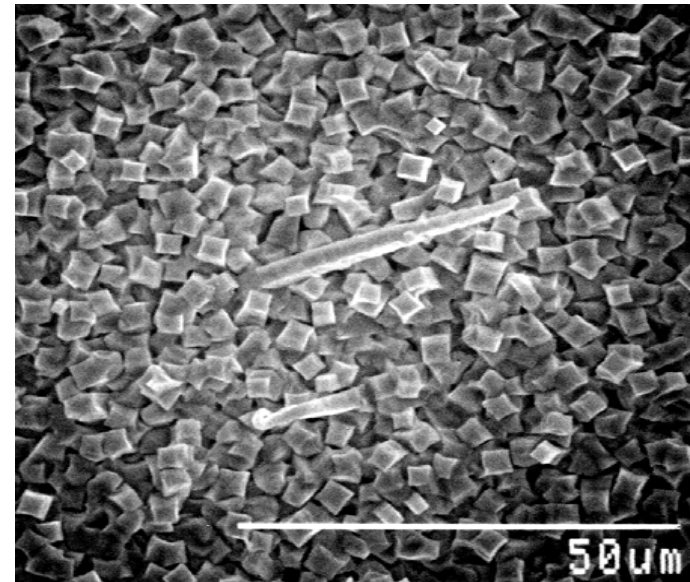
–Third test completed 10,000 hrs. Reported at ECTC May 31, 2005

–Fourth test underway to verify voltage bias effect (completed 3,000 hrs.)

–Fifth test to gain better understanding of temp./humidity underway

–Developed and submitted tin whisker “test protocol” to IPC/JEDEC for consideration as an industry standard:

- INEMI project chair drove standard JESD 22-A121, released May, 2005
- Group is coordinating with JEITA (Japan) and ITRI/E4 (Europe) to establish unified whisker test methods worldwide.



*Example of tin whisker*



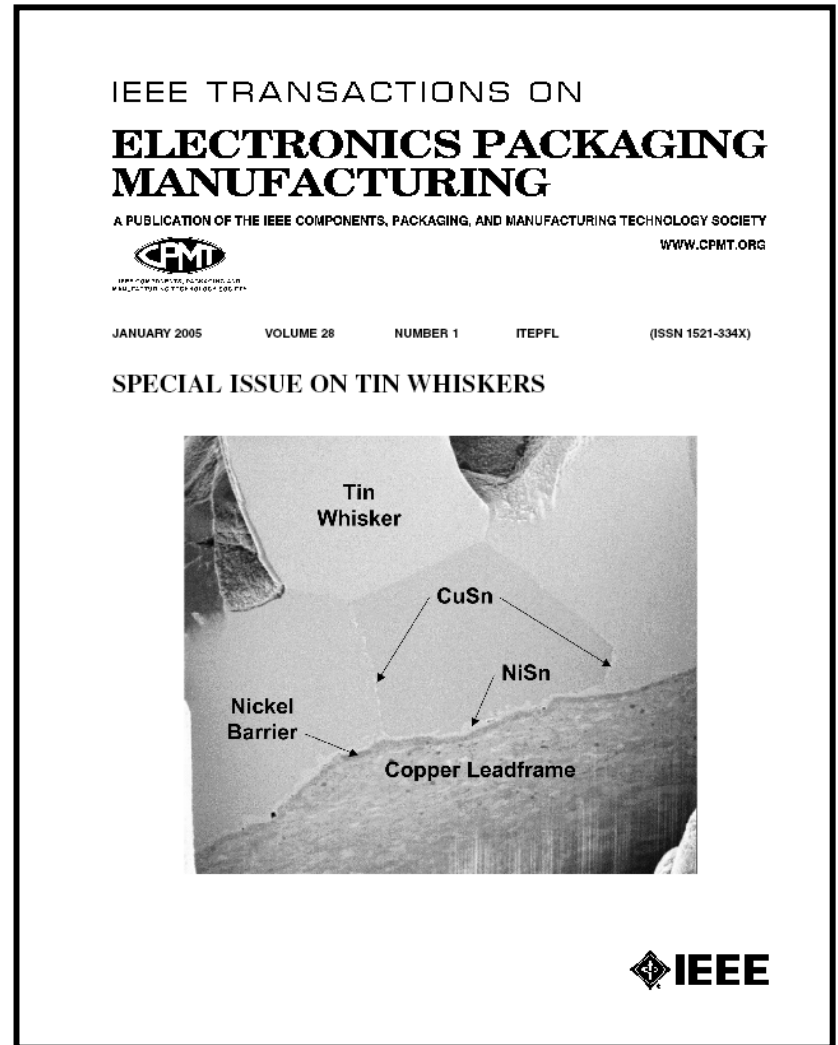
- ITRI Soldertec
- Micro Semi
- Soldering Tech.

## Objective:

To determine the mechanism of tin whisker formation and growth in order to predict behavior, design mitigation methods, and develop acceleration tests.

## Status:

- 1<sup>st</sup> Workshop (iNEMI/NIST/TMS) at Metals, Minerals and Materials Society conference San Diego (6/03)
- Interim report produced (6/03).
- 2<sup>nd</sup> Workshop (iNEMI/CPMT/ECTC) held at ECTC in Las Vegas (6/04).
- IEEE Mfg. Transactions special edition published.
- 3<sup>rd</sup> Workshop (iNEMI/ECTC) held at ECTC in Orlando (5/31/05).
- Provided guidance to test project and User Group on Whisker Theory





**Objective:**

**Develop recommendations for lead-free surface finishes on components that would minimize risk of failures from tin whiskers in high-reliability electronic applications.**

- **11 large corporate users of components**
  - Concerned with long-term reliability (>8 years)
- **Developed recommendations for Acceptance Testing & Mitigation Practices for tin whiskers on high-reliability products**
  - Rev. 2 sent to JEDEC/IPC recommending joint standard (8/04)
  - Rev. 3 released (5/05)
- **Working with JEDEC/IPC on Acceptance Test and Guidance Specifications**
  - JESD 201 (Acceptance Test) sent out for vote April 2005 and voted down. Revised and sent out for vote on Sept. 1, 2005.
  - Current Tin Whisker Theory and Mitigation Practices Guideline sent out for vote jointly by JEDEC and IPC August, 2005.
- **Cooperating with JEITA on IEC Specification**



## **Objective:**

**The RoHS Transition Task Group is working to address a number of supply chain and logistics issues related to the transition away from banned substances.**

## **Status:**

**Four projects working to address the following:**

- Component and Board Marking (including product number change management and labeling standards) – Project Complete: standards recommendations made.**
- Assembly Process Specifications – Project complete: Standards recommendations made.**
- Supply Chain Readiness (focusing on component issues) – Survey complete. Analysis shows component areas of concern.**
- Materials Declarations – Project complete. Standards effort moved to IPC/RosettaNet.**

## Objectives:

- **Work with the appropriate international standards bodies to help define and validate standards for the exchange of Material Composition data between all elements of the value chain**
  - **Support requirements of the WEEE and RoHS Directives**
  - **Work closely with the Materials Declarations Project**

## Scope:

- **Create a roadmap to identify standards, as well as the IT infrastructure, required to support the B2B exchange of material composition data.**

## Status:

- **The Materials Composition Data Exchange Project was launched on July 17, 2004.**
- **Transitioned to an IPC standards committee.**
- **Draft standard IPC-1752 out for feedback on June 10, 2005.**
- **Completed 60 day comment period & resolving feedback.**



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## New Projects



**New Pb-Free/RoHS Projects to date 2005:**

- **Board Assembly TIG:**
  - **Pb-free BGAs in SnPb Assemblies Project**
  - **Pb-Free Nano-Solder**
- **ECE TIG**
  - **Pb-free Wave Soldering Assembly Process Project**
  - **Pb-Free Rework Optimization**
  - **High-Reliability RoHS Compliance**
- **Substrates TIG:**
  - **Evaluation of Substrate Surface Finishes for Pb-free Assembly Project**

**Objective:**

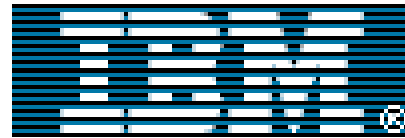
- **Understand process parameters for assembly of Pb-free BGA's in a PbSn reflow/wave environment. Companies that have exemption from RoHS face this alternative due to supply chain transition to lead-free**

**Scope:**

- **Provide the general industry with a “generic” process guideline and risk assessment for assembling lead-free BGAs in a SnPb assembly process**

**Status:**

- **May 2005, this project officially Started**



**Objective:**

- **Explore and demonstrate the feasibility of melting point temperature reduction of a non-lead solder system, based on melting point depression of nano-scale metal particles**

**Scope:**

- 1. Develop and Demonstrate a Nano-Solder Paste**
- 2. Demonstrate Manufacturability of a Solder Joint Based on a Nano-Solder System**
- 3. Nano-Solder System Joint Reliability**
- 4. Manufacturing Equipment**

**Status:**

- **Project Group released the project's SOW & PS in July 2005 – Membership sign-up in underway**

## **Objective:**

- **Characterize the impact lead free alloys exert on the wave and/or selective soldering process as well as identifying the impact this has on product reliability**

## **Scope:**

- **Develop an appropriate wave soldering test vehicle with a number of board level parameters which includes through hole components and surface mount devices**

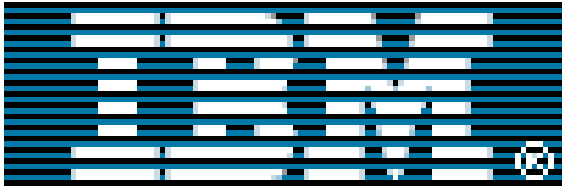
## **Status:**

- **May 2005, this project officially started**
- **Phase 1 Results**
  - **Test Vehicles designed**
  - **Boards delivered**
  - **TV Built**
  - **Testing in process**



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**Vitronics Soltec**

**Objective:**

- **Evaluate and recommend best practices, rework equipment requirements, and procedures for best of breed lead-free rework processing in a manufacturing environment**

**Scope:**

- 1. Rework tolerances and repeatability (Rework equipment manufacturers)**
- 2. Optimized heat transfer into reworked boards (Rework equipment manufacturers)**
- 3. Work to reduce adjacent (top and bottom) component temperatures with development from rework equipment suppliers**

**Status:**

- **July 2005, this project officially started**



## **Objective:**

- **Work with components supply base to insure that High Rel product needs are met.**
- **These companies are taking advantage of Lead exemptions and therefore expect to continue to use SnPb assembly for some time.**

## **Scope:**

- 1. Address availability of SnPb compatible BGA's for High Rel segment.**
- 2. Communicate clear requirements for Tin Whisker mitigation and testing practices.**

## **Status:**

- **Position paper addressing these two areas released.**
- **Now working on second document to cover mfg. issues with thermally complex assemblies.**

## **Objective:**

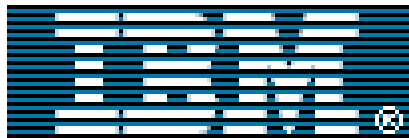
- **Evaluate the effects of alternative surface finishes for circuit boards and package substrates on Pb-free solder joint reliability during mechanical stress testing – do comparative reliability testing on Pb-free components assembled on test boards**

## **Scope:**

- **Group plans to provide the general industry with a “generic” process guideline and risk assessment for assembling lead-free BGAs in a SnPb assembly process**

## **Status:**

- **May 2005, this project officially started**
- **PWB Design & Fabrication of the Test vehicle is complete with PWB Fixtures, Set-up & Assembly scheduled with Temperature Cycle (0<>100C) scheduled to start in Third Quarter 2005**



### **ECE TIG's - iNEMI Halogen-Free Initiative**

#### **Objective:**

- **Establish Printed Circuit Board Standards for both materials and test criteria based on the viability of various flame retardants being proposed from both the environmental and process ability / material properties stand points**

#### **Status:**

- **“Call for Participation” Teleconference scheduled for Wednesday, August 24, 2005**

### **Board Assembly TIG's – iNEMI Pb-Free DPMO initiative**

#### **Objective:**

- **Due to the ROHS compliance transition - develop Pb-Free DPMO data - this project will build on the results and processes developed during iNEMI's DPMO project, now complete**

#### **Status:**

- **Development of a project statement of requirements is in process, which will lead to a membership “Call for Participation” Teleconference**



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# Collaboration in China

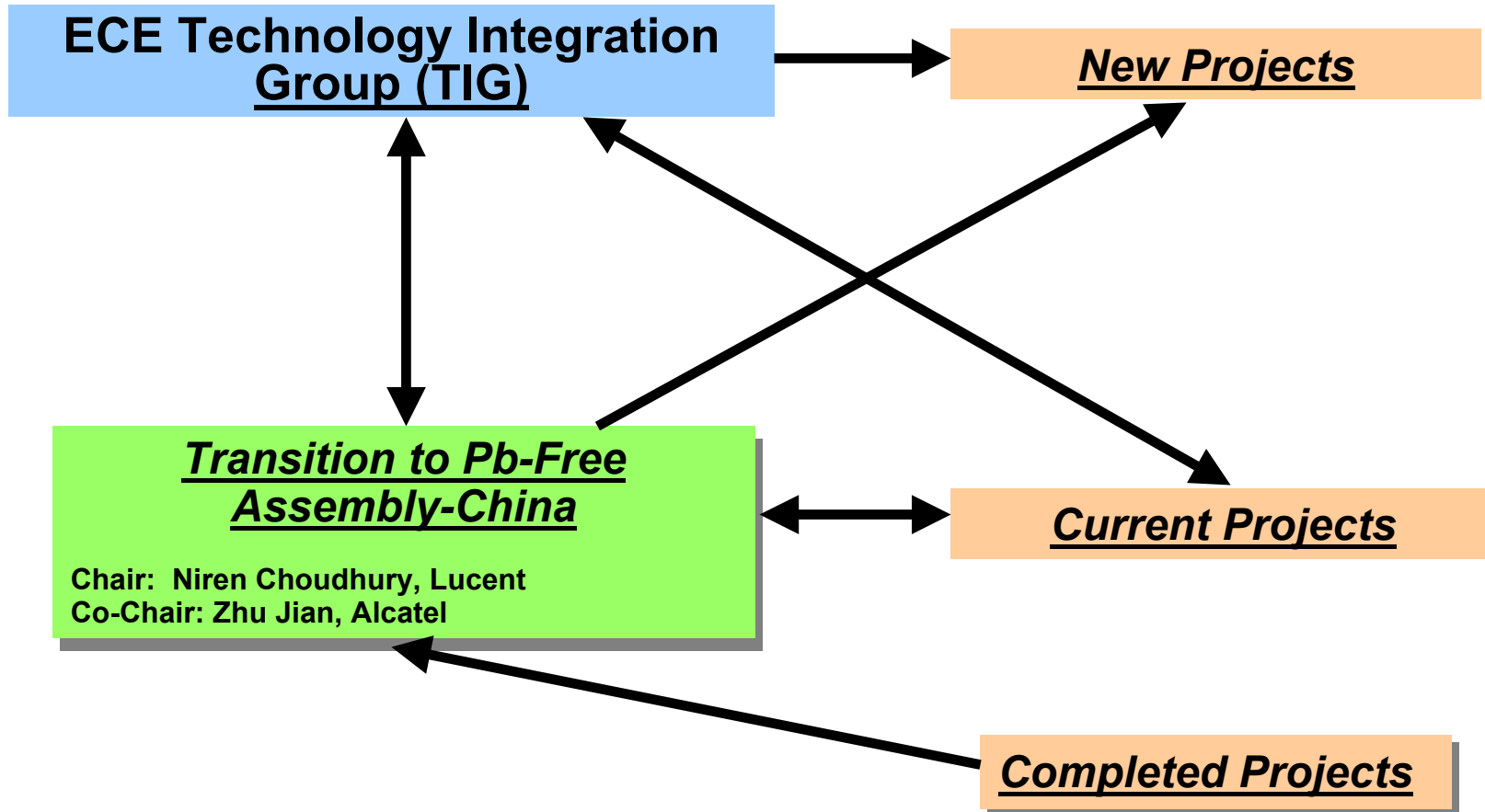


*Addressing Common Challenges for iNEMI  
Member Companies in China*

- **Charter:**
  - **Address technology deployment issues of iNEMI member companies within China.**
  - **Provide a forum for sharing of best practices for member companies within China.**
- **Organizational progress:**
  - **Team is being coordinated by Jack Zhong, Intel and Niren Choudhury, Lucent.**
  - **3 monthly meetings held (June, July, August).**
  - **For further information contact: Niren Choudhury [niren@lucent.com] or Jack Zhong [Jack.Zhong@intel.com]**

- **Agilent Technologies**
- **Alcatel**
- **Asymtek**
- **Celestica**
- **Delphi**
- **Intel**
- **Lucent Technologies**
- **Motorola**
- **Rohm & Haas**
- **Solectron**
- **Sun Microsystems**
- **Vitronics-Soltec**

- **Transition to Pb-Free Solder Assembly in China**
- **Focus: Regional Transition Issues**
  - Technical
  - Infrastructure
- **Leadership:**
  - Chair: Niren Choudhury, Lucent
  - Co-Chair: Zhu Jian, Alcatel
- **Next steps:**
  - Engage OEM Members in China
  - Identify members through North American Pb-Free participants



- **Two major areas of Discussion for sharing of experiences and Best Practices**
  - **Human Resources**
    - Training
    - Retention
  - **Supply Chain Management**
    - Developing supply base
    - Logistics

- **iNEMI roadmaps/gap analyses help set the agenda for electronics industry.**
- **iNEMI is providing the Leadership required to work emerging technologies/opportunities.**
- **iNEMI is Leveraging R&D investments (academia & government) to address industry's agenda.**
- **Projects lead to improved deployment (faster, better, lower cost) created across supply chain.**
- **Standards efforts (with IPC, EIA, IEEE, and RosettaNet) are encouraging broad utilization of emerging technologies/solutions.**

**[www.inemi.org](http://www.inemi.org)**

**Email contacts:**

**Jim McElroy**

**[jmcelroy@inemi.org](mailto:jmcelroy@inemi.org)**

**Bob Pfahl**

**[bob.pfahl@inemi.org](mailto:bob.pfahl@inemi.org)**