New features for 2013

- “Stewardship” section provides expanded content and scope, emphasis on true sustainability

- Explanation of new business models. Expectations of OEMs, ODMs, EMS providers, & fabricators. The rise of contractor specialists

- Coverage of the printed electronics industry as it matures into a truly viable option

- Increased use of shared information. Contributions from the best sources of electronic knowledge
**About IPC:**

Since 1957, IPC — Association Connecting Electronics Industries® has been guiding the electronic interconnection industry through its dramatic changes. A global trade association dedicated to the competitive excellence and financial success of its more than 3,300 member companies, IPC represents all facets of the industry including design, printed circuit board manufacturing and electronics assembly. As a member-driven organization and leading source for industry standards, training, market research and public policy advocacy, IPC supports programs to meet the needs of an estimated $2.02 trillion global electronics industry. IPC maintains additional offices in Taos, N.M.; Arlington, Va.; Stockholm, Sweden; Moscow, Russia; Bangalore, India; Bangkok, Thailand; and Shanghai, Shenzhen and Beijing, China.

**Our Mission**

IPC is a global trade association dedicated to furthering the competitive excellence and financial success of its members, who are participants in the electronics industry.

In pursuit of these objectives, IPC will devote resources to management improvement and technology enhancement programs, the creation of relevant standards, protection of the environment, and pertinent government relations.

IPC encourages the active participation of all its members in these activities and commits to full cooperation with all related organizations.

Adopted May 5, 2008
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PART A – SECTION 1: ROADMAP OVERVIEW

INTRODUCTION

What is the purpose of this roadmap?

The purpose of the IPC International Technology Roadmap for Electronic Interconnections is to provide the target audiences with a benchmark comparison for their current needs and capabilities, but more importantly, help them understand what they might need to compete over the near (1-3 years), mid-range (~5 years) and "long" term (~10 or more years) periods. The goal is to provide that user with information that they can use to plan their staffing, equipment, and training investments to address those portions of the predicted market in which they plan to compete.

There are many different organizations providing technology or market roadmaps, each aimed at specific “kind” of user, or covering a particular segment of the market place, over a particular time frame. The IPC concentrates on the “operational” segment of the electronic interconnect market, only reporting the very broad (overall major corporate strategic plan, i.e. iNEMI and Prismark) and very narrow (Japanese consumer electronics needs, i.e. JISSO) as much as needed for our constituents planning purposes. We ALWAYS recommend that users consider the input from other roadmaps where it may pertain to their specific situation.

Run properly, this Technology Roadmap (like any good, ongoing roadmap activity) is continuously updated to reflect the changes in technology, market, external influences AS THEY MAY AFFECT THE TARGETTED USER. Each ‘release’ is a snapshot of an evolving body of information. This “evolutionary” process includes the methodology of data collection and generation of the roadmap itself. Recognizing the changes in our constituency's ability to travel, demands from many sources made on some key subject matter experts, and overall “leaner” operational staffing, we are in a transition to a more “distributed processing” model, with major chapter leaders running their own sections as best fits their contributor’s schedules and methods. There is a much greater emphasis on shared data sources between organizations that may all need the same basic facts or numerical projections, in some cases from a very small number of "experts", but may make very different use of the information based on their user’s needs. The IPC and iNEMI (just as one example) are sharing the same basic facts as the basis for 3 chapters /sections in each of their roadmaps. The implications of those facts mean quite different things to their target audiences, and what’s done with the basic underlying facts is quite different in each roadmap.

Done properly, the Roadmap is a “living” document, with the market dictating shifts in emphasis depending on the user’s needs.

More information from international sources will be incorporated in the 2013 release than in previous roadmaps, and this relative proportion is likely to increase further in the 2015 release.

Who uses it? Who is the intended audience?

The “stereotypical” users of the IPC International Technology Roadmap can be oversimplified into three general groupings;

- Chief technical officer of an operational unit of a company engaged in the fabrication or assembly of one or more of the categories of electronic interconnect structures addressed in this roadmap. This could be the chief engineer of a single plant, or the CTO of a family of operations on several continents. Their likely uses of this information will be deciding where/if/how/what equipment upgrades will be needed to address the projected technologies over the next few years, and what technical skill sets (including design tools and skills) will need to be in place through training or hiring to address those needs. Both paths will be needed to prepare their budget submittals (capital and expense).
• Chief operating officer (VP-Operations and the like) of a company engaged in the fabrication or assembly of one or more of the categories of electronic interconnect structures addressed in this roadmap. Overlapping the CTO in some regards, but more concerned with operational level work flow and processes, operator skill sets needed over the next few years, budgeting for the time and funding to achieve those skill sets, etc.

• Mirroring those positions are the persons tasked with sourcing the technologies predicted over the time covered. Will the technologies their corporate business direction demands be readily and widely available, or are they likely to be still struggling at the cutting (or “bleeding”) edge of producibility, with the accompanying risks to schedule, high and variable costs, etc. Will their current supply base be capable, or do they need to find or develop new sources for the projected technologies?

We hope we can do a better job of using the knowledge coming out of the roadmapping activity to identify gaps or shortfalls in existing standards or committees (or skills within those committees) and identify specific barriers to progress which need to be resolved before specific improvements may be widely implemented. This 2013 release will do a better job of that than in the past, and we hope to do a better job yet in the 2015 release.

ROADMAP OVERVIEW

The electronic interconnection supply chain rests on three basic elements: 1) the design and fabrication of semiconductors and their associated packaging; 2) the fabrication of the interconnecting substrate for both the semiconductor package and the product printed board; and 3) multiple levels of assembly and test. In the past, the predominant model was one of a more-or-less vertically integrated enterprise (commercially-organized or state-directed). Increasingly these functions are accomplished in a fluid arrangement of business relationships with partners that may be anywhere on the planet. This shift in the business model, developed through outsourcing many of the activities to entities specializing in the individual steps, requires that success will be achieved in direct proportion to the degree that the links between the three elements are strengthened through clear and unambiguous communication. It is also important that each player in the supply chain understands their contribution, technical and contractual to the product reliability. It must be stressed that many operating models to accomplish the end result exist simultaneously, generally with the “brand-holder” [OEM??] choosing from a broad spectrum of business models depending on their needs, the product, the market, etc. This will be discussed at greater length in section A-2, “OEM/Integrator Expectations.”

In many cases, the EMS provider participates in (and in some cases, controls) the design function. Using the tools at their disposal, they are responsible for the documentation and for procuring component parts as well as printed boards. As the agent of the OEM, the EMS provider also faces the challenges of requirements to meet new legal directives ¹ to remove hazardous substances from the electronic products, implement more robust processes and face greater density packaged in smaller form factors. Another supply chain challenge directed toward the printed board manufacturing is keeping up with the integration of functionality within or supplied as pre-assembled with the printed board. The circuit board increasingly contributes to the electrical function; thus, changes in material and mounting structure can dramatically change the electrical performance of the final product.

An area where consortia, made up of users and suppliers, have been successful is in the area of hazardous material properties. Since the EU and other national and international bodies have generated directives that identify materials that are restricted from or controlled in the electronic product market, companies have banded together to look for alternatives, in part to provide a common industry voice to the sometimes conflicting requirements imposed. These issues have become a global problem, even for companies that have no intention of placing their product in any of the restricted market areas. Component suppliers have already changed termination finishes from the traditional tin-lead to new alloys that do not contain lead in excess of the permitted allowance. Therefore many of the assembly processes have been reviewed and revised to handle the attachment requirements for the

¹ Although the “brand holder” [generally, the OEM] retains ultimate legal responsibility for this and essentially all other product liabilities.
new finishes. Nevertheless, there are still product markets that have yet to fully embrace the idea of using lead-free solders, citing the lack of reliability data.

This 2013 roadmap identifies some of the difficulties members of the supply chain are facing as well as the research needed. A great deal of focus is placed on the timing necessary to meet the new global hazardous material elimination directives as well as the sustainability of the product over its life cycle. Since companies are dealing with regulations in several different markets, it has become paramount to be aware of the different requirements in each global sector and the manner in which the supply chain must be prepared to provide documentation indicating compliance. The energy and focus of technology drivers has been to define, educate and recommend how to meet these regulatory requirements. Figure A1-1 shows the different technology sectors leading to the final product.

**Figure A1-1 – Technology Sector Manufacturing Flow**

**SCOPE**

The IPC Technology Roadmap for Electronic Interconnections describes those characteristics that are important to advances in technology and industrial competitiveness. The roadmapping processes used by the high technology sectors can be effective and productive in spurring new innovation. Technology roadmaps drive collaborative R&D and provide critical guidance to the industry supply chain. Various government agencies throughout the world have important roles in technology roadmaps, particularly during the early stages of industry/technology development.

**CURRENT STATUS**

The IPC Technology Roadmap provides value to those companies, agencies and individuals that participate in the process as well as the industries involved in general. The roadmapping process identifies key technology requirements and develops strategic industry information in a timely fashion, which is particularly of value to the manufacturing supply chain. Suppliers can obtain a significant short term benefit by receiving an industry consensus of specific requirements and timing. Without this guidance, suppliers run the risk of missing a technology generation if they introduce their products too late or invest too early, resulting in an inadequate return.

Consensus is obtained on the key elements of the roadmaps using several different approaches. Some industries use historical models to project future progress; others use “product emulators” to identify requirements. In either case, they find ways to overcome competitive barriers to achieve a useful end product. By building a consensus on priorities for R&D, they help plan more efficient use of industry resources.

Technology roadmaps influence technology projects and industry advances. In the electronics sector in particular, the U.S. for a time recovered a competitive position by “compressing Moore’s Law,” i.e., by