International Roadmap for Devices and Systems (IRDS)

Industry Connections Activity Initiation Document (ICAID)

Version: 3.0, 16 February 2018

IC16-006-03 Approved by the IEEE-SASB 8 March 2018

Instructions

- Instructions on how to fill out this form are shown in red. It is recommended to leave the instructions in the final document and simply add the requested information where indicated.
- Shaded Text indicates a placeholder that should be replaced with information specific to this ICAID, and the shading removed.
- Completed forms, in Word format, or any questions should be sent to the IEEE Standards Association (IEEE-SA) Industry Connections Committee (ICCom) Administrator at the following address: industryconnections@ieee.org.
- The version number above, along with the date, may be used by the submitter to distinguish successive updates of this document. A separate, unique Industry Connections (IC) Activity Number will be assigned when the document is submitted to the ICCom Administrator.

Version 3.0 of this ICAID is a request to renew this activity for another two year period.

1. Contact

Provide the name and contact information of the primary contact person for this IC activity. Affiliation is any entity that provides the person financial or other substantive support, for which the person may feel an obligation. If necessary, a second/alternate contact person's information may also be provided.

Name: Dr. Paolo Gargini
Email Address: paologargini1@gmail.com
Phone: 1-650-847-8564
Employer: Consultant / Stanford University
Affiliation: IEEE EDS

Name: Dr. Thomas M. Conte
Email Address: tom@conte.us
Phone: 1-404-385-7657
Employer: Georgia Institute of Technology
Affiliation: IEEE Computer Society

2. Participation and Voting Model

Specify whether this activity will be entity-based (participants are entities, which may have multiple representatives, one-entity-one-vote), or individual-based (participants represent themselves, one-person-one-vote).

Entity based

3. Purpose

3.1. Motivation and Goal

Briefly explain the context and motivation for starting this IC activity, and the overall purpose or goal to be accomplished.

The electronics industry has benefitted from identifying technical trends since Moore's Law was first published in 1965. Since then, road mapping long-term trends has allowed industry to identify challenges and possible solutions early on that have guided the research of academia, consortia, industry, and national laboratories.

The continuous improvements in transistor density and performance had driven "bottom-up" the electronic industry until the end of the previous century. In the past 10 years, smart phones, data centers, tablets, and enhanced interconnectivity via the Internet (e.g., Internet of Everything), just to mention a few, have revolutionized the electronics industry and changed it to a "top driven" industry.

This Industry Connections activity will continue its focus on an International Roadmap for Devices and Systems ("IRDS") via continuation of an interest group closely aligned with the new electronics industry ecosystem. Activity members will continue to collaborate in the development of this roadmap, as well as engaging with other segments of the IEEE in complementary activities (e.g. conferences, standards) that help assure alignment and consensus across a range of stakeholders.

The IRDS will continue to identify key trends related to devices, systems, and all the related technologies by generating a roadmap with a 15 years horizon. The supporting participants shall cooperate to identify generic devices and systems needs without regard to particular products of individual companies.

The IRDS will continue to identify challenges and include recommendations on possible solutions.

IRDS produces roadmaps in odd-numbered years and updates to roadmaps in even-numbered years. IRDS will update its 2017 roadmap in 2018. It will produce a new roadmap in 2019.

3.2. Related Work

Provide a brief comparison of this activity to existing, related efforts or standards of which you are aware (industry associations, consortia, standardization activities, etc.).

The IEEE Rebooting Computing Initiative (RCI) is a NIC-funded initiative that studies fundamental new ways to compute. IRDS is funded in part through this initiative. Also TAB has several related roadmapping activities (e.g., the 5G

Roadmap). IRDS continues to welcome participation from and collaboration with these efforts. IRDS continues to seek "standards-related" activities which may lead to future standards proposals. Furthermore, roadmapping is a pre-competitive activity that shares many similarities with standards activities. Thus IRDS seeks to continue to operate as an IC in SA.

3.3. Previously Published Material

Provide a list of any known previously published material intended for inclusion in the proposed deliverables of this activity.

The International Roadmap for Devices and Systems 2017 edition (published in Q1 2018). Prior to this, the International Technology Roadmap for Semiconductors (ITRS) was published in 1999, 2000 Update, 2001, 2002 Update, 2003, 2004 Update, 2005, 2006 Update, 2007, 2008 Update, 2009, 2010 Update, 2011, 2012 Update, 2013, and 2015

Emerging Research Devices Workshop Reports on:
Beyond CMOS 2008
Emerging Logic Devices 2010, 2014
Emerging Memory Devices 2010, 2012, 2014
Emerging Information Processing Architectures 2008, 2012, 2014

3.4. Potential Markets Served

Indicate the main beneficiaries of this work, and what the potential impact might be.

Potential Market	**Potential Impact**
Computer Manufacturers	New components to accelerate information collection, analysis, and action.
Integrated Circuit Manufacturers Logic ASIC Memory	Higher performance lower power logic New logic architectures with higher information analysis and throughput Higher density lower cost memory
Semiconductor Process Equipment Manufacturers	New process equipment needed to support future logic and memory needs
Semiconductor Material Suppliers	New materials markets identified to support future logic and memory needs
Integrated Circuit CAD Vendors	New design CAD tools required to analyze and design new logic architectures. New design CAD tools required to analyze and design products with diverse integrated components
Process and Device Modeling Companies	New process and device models required

	to simulate and optimize new devices for emerging logic and memory
MEMs and NEMs Manufacturers	New sensors and transducers to support future applications
Photonics Components Manufacturers	Demand for more compact, integrated, lower power photonic circuits
IC & Device Test Equipment Suppliers	Demand for testing of novel architecture logic and memory components Demand for testing of products with integrated logic, memory, sensors and transducers
Integrated Circuit Packaging Companies	Identification of technology and manufacturing requirements for integrating diverse components into a single package.
Process and Device Researchers	Identification of high value research needed to enable devices to support new architectures
Architecture and Circuit Researchers	Identification of high value research to analyze performance of different implementations of new architectures to support emerging applications

4. Proposed Deliverables

Outline the anticipated deliverables and output from this IC activity, such as documents (e.g., white papers, reports), proposals for standards, conferences and workshops, databases, computer code, etc., and indicate the expected timeframe for each.

The primary output of this IC activity is the development and delivery of a roadmap document outlining recommendations for the electronics industry, as described above in the scope. The first IRDS roadmap was delivered in Q1 of 2018.

5. Funding Requirements

Outline any contracted services or other expenses that are currently anticipated, beyond the basic support services provided to all IC activities. Indicate how those funds are expected to be obtained (e.g., through participant fees, sponsorships, government or other grants, etc.). Activities needing substantial funding may require additional reviews and approvals beyond ICCom.

Industry Connections staff continue to will provide standard support as made available to all IEEE_SA IC activities. Activity members will provide any needed support for hosted meetings, marketing activities that exceed basic IC support.

It is envisioned that IRDS will continue to hold 3 plenary meetings per year. The responsibility of supporting the cost of IRDS meetings will be shared by the supporters in an equitable manner. Other events and initiatives supporting IRDS will be addressed through collaboration with IEEE Societies and other IEEE means, depending on nature of the funding needs.

IRDS requires one technical writer / roadmap coordinator. Currently, Linda Wilson fills this role as a contractor. She served in the same role for ITRS for many years and is uniquely well suited for the position. We request that her employment be continued.

6. Management and Procedures

6.1. IEEE Sponsoring Committee

Indicate whether an IEEE sponsoring committee of some form (e.g., an IEEE Standards Sponsor) has agreed to oversee this activity and its procedures.

Sponsors of the IRDS ICAID are the current IEEE Societies and Councils participating in the Rebooting Computing Initiative* with the Computer Society as the Lead representative.

(*These are the *Solid-State Circuits Society, Computer Society, Circuits & Systems Society, Council on Nanotechnology, Council on Superconductivity, Reliability Society, Electron Devices Society, Magnetics Society* and *Council on Electronic Design Automation*)

Has an IEEE sponsoring committee agreed to oversee this activity?: Yes

If yes, indicate the sponsoring committee's name and its chair's contact information.

Sponsoring Committee Name: IEEE Computer Society
Chair's Name: Hironori Kasahara (2018 President, IEEE Computer Society)
Chair's Email Address: kasahara@waseda.jp
Chair's Phone: Please use point-of-contact individual (below)

Point-of-Contact: Dr. Thomas M. Conte (2015 President, IEEE Computer Society)
POC Email Address: conte@gatech.edu
POC Phone: 404-376-2267

6.2. Activity Management

If no IEEE sponsoring committee has been identified in 6.1 above, indicate how this activity will manage itself on a day-to-day basis (e.g., executive committee, officers, etc).

The activity is managed by an executive committee comprising the participants (see below), and society representatives from EDS, ComSoc and the CS*. Officers are Chair, Vice Chair and Secretary and are renewed annually. Current 2018 officers are:

Dr. Paolo Gargini, Chair
Dr. Thomas Conte, Vice-Chair
Dr. Fernando Guarin, Secretary

(*A society representative from EPS has been invited to serve as well.)

6.3. Procedures

Indicate what documented procedures will be used to guide the operations of this activity; either (a) modified baseline *Industry Connections Activity Policies and Procedures,* (b) Sponsor policies and procedures accepted by the IEEE-SA Standards Board, or (c) Working Group policies and procedures accepted by the Working Group's Sponsor. If option (a) is chosen, then ICCom review and approval of the P&P is required. If option (b) or (c) is chosen, then ICCom approval of the use of the P&P is required.

Will use the baseline Industry Connections Activity Policies and Procedures.

7. Participants

7.1. Stakeholder Communities

Indicate the stakeholder communities (the types of companies or other entities, or the different groups of individuals) that are expected to be interested in this IC activity, and will be invited to participate.

Industry associations:
Since 1998 researchers from Europe, Japan, Korea, Taiwan and the USA have participated in the ITRS and have expressed their intention to continue their participation in IRDS through organizations equal or similar to the ones listed below:

The European Semiconductor Association (ESIA)
The European SiNANO Institute (ESI)
The Society of Applied Physics of Japan (JSAP)
The Korea Semiconductor Industry Association (KSIA)
The Taiwan Semiconductor Industry Association (TSIA)

IEEE TAB Initiatives:
IEEE Rebooting Computing Initiative

IEEE Societies and Councils:
Solid-State Circuits Society
Computer Society [lead society]
Circuits & Systems Society
Council on Nanotechnology

Council on Superconductivity
Reliability Society
Electron Devices Society
Electronics Packaging Society
Magnetics Society
Council on Electronic Design Automation

7.2. Expected Number of Participants

Indicate the approximate number of entities (if entity-based) or individuals (if individual-based) expected to be actively involved in this activity.

Typically over 1000 researchers contribute to the ITRS
See list of 2013 ITRS participants (attached at end of this document)

7.3. Initial Participants

Provide a list of the entities or individuals that will be participating from the outset. It is recommended there be at least three initial participants for an entity-based activity, or five initial participants (each with a different affiliation) for an individual-based activity.

The European SiNANO Institute (ESI)
The Society of Applied Physics of Japan (JSAP)
The Korea Semiconductor Industry Association (KSIA)
The Taiwan Semiconductor Industry Association (TSIA)
IEEE Rebooting Computing Initiative

ATTACHMENT: Past Participants

2013 ITRS TECHNOLOGY WORKING GROUP KEY CONTRIBUTORS

Cross TWG Study Group (Technology Pacing)—Alan Allan, Dave Armstrong, An Chen, Mustafa Badaroglu, Joel Barnett, Roger Barth, Herbert Bennett, Bill Bottoms, Juan-Antonio Carballo, Carlos Diaz, Alain Diebold, Paul Feeney, Mike Gaitan, Paolo Gargini, Mike Garner, Hidemi Ishiuchi, Dan Herr, Hirofumi Inoue, Scott Jones, Andrew Kahng, Leo Kenny, Rich Liu, Jürgen Lorenz, Steve Moffat, James Moyne, Mark Neisser, Kwok Ng, George Orji, Lothar Pfitzner, Gopal Rao, Thomas Skotnicki, Hitoshi Wakabayashi, Mike Walden, Linda Wilson, Osamu [Sam] Yamazaki, Victor Zhirnov, Paul Zimmerman

Cross TWG Study Group (More than Moore)—Herbert Bennett, Bill Bottoms, Michel Brillouët, Juan-Antonio Carballo, Patrick Cogez, Erik DeBenedictis, Michael Gaitan, Mart Graef, Bert Huizing, Andrew Kahng, Reinhard Mahnkopf, Grace O' Malley, Chuck Richardson

System Drivers and Design—Yoshimi Asada, Valeria Bertacco, Colin Bill, Ralf Brederlow, Yu Cao, Juan Antonio Carballo, John Darringer, Wolfgang Ecker, Dale Edwards, Paul Franzon, Masaharu Imai, Kwangok Jeong, Bill Joyner, Andrew Kahng, Masaru Kakimoto, Jong Ho Kang, Victor Kravets, Frederic Lalanne, Jingwei Lu, Vinod Malhotra, Masami Matsuzaki, Alfonso Maurelli, Nikil Mehta, Katsutoshi Nakayama, Sani Nassif, Nobuto Ono, Sam Pa, Ralf Pferdmenges, Shishpal Rawat, Wolfgang Rosenstiel, Toshitada Saito, Jean Pierre Schoellkopf, Gary Smith, Peter Van Staa, Leon Stok, Shireesh Verma, Maarten Vertregt, Alfred Wong, David Yeh, Hak soo Yu, Ichiro Yamamoto

Test and Test Equipment—Kenichi Anzou, Dave Armstrong, John Aslanian, Roger Barth, Yi Cai, Krishnendu Chakrabarty, Tapan Chakraborty, Sreejit Chakravarty, Wendy Chen, William Chui, Steve Comen, Zoe Conroy, Adam Cron, Al Crouch, Ted Eaton, Stefan Eichenberger, Bill Eklow, Paul Emmett, Ira Feldman, Francois-Fabien Ferhani, Shawn Fetterolf, Paul Franzon, Piergiorgio Galletta, Anne Gattiker, Sandeep Goel, Kazumi Hatayama, Hirokazu Hirayama, Hisao Horibe, Shuichi Ito, Hongshin Jun, Masahiro Kanase, Rohit Kapur, Toshiaki Kato, Brion Keller, Ajay Khoche, Satoru Kitagawa, Marc Knox, Masashi Kondo, Ken Lanier, Lenny Leon, Marc Loranger, Anthony Lum, Erik Jan Marinissen, Peter Maxwell, Cedric Mayor, Teresa McLaurin, Milanjan Mukherjee, Takeshi Nagasaka, Masaaki Namba, Naoaki Narumi, Phil Nigh, Akitoshi Nishimura, Hermann Obermeir, Jayson Park, Mike Peng-Li, Frank Poehl, Chris Portelli-Hale, Bill Price, Jeff Rearick, Herb Reiter, Mike Ricchetti, Michael Rodgers, Mark Roos, Tomonori Sasaki, Keno Sato, Masayuki Sato, Yasuo Sato, Ryuji Shimizu, Yoichi Shimizu, Fumio Sonoda, Hiroyoshi Suzuki, Tetsuo Tada, Satoru Takeda, Steven Tilden, Erik Volkerink, Adam Wright, Yervant Zorian

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Microelectromechanical Systems (MEMS)—Steve Bart, Raji Baskaran, Steve Briet, Asif Chowdhury, Alissa Fitzgerald, Koji Fukumoto, Michael Gaitan, Buzz Hardy, Brian Jamieson, Akihiro Koga, Ron Lawes, Karen Lightman, Pete Loeppert, Erik Jan Lous, Mary Ann Maher, Jianmin Miao, Takashi Mihara, Arthur Morris, Yasutaka Nakashiba., Goro Nakatani, Fumihiko Nakazawa, Rob O'Reilly, Mervi Paulasto-Kröckel, Sasha Revel, Philippe Robert, John Rychcik, Tetsu Tanaka, Steve Tilden, Hiroshi Toshiyoshi, Joost van Beek, Chris van Hoof, Randy Wagner, Marcie Weinstein

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