STRATEGIES FOR CLOSING THE ITRS FUNDING GAP[#]

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For over 35 years, each generation of integrated circuits (ICs) has doubled the transistor count while cutting the cost per function in half. This progress, described by Moore's Law, has resulted primarily from scaling device dimensions and wafer size. In reality, 'Moore's Law' is not a law; it is not based on physical principles, and is thus not assured of continuation. For each generation, it works only if *the cost per function can be reduced* in the face of increasing process complexity.

In light of the critical importance of continuing semiconductor progress:

- Adequate We must adequately fund the long term funding is required forresearch needs of the International Technology Roadmap for Semiconductors (ITRS) which are critical to extending Moore's Law for another 15 years and "Beyond CMOS".
- The semiconductor industry needs to find creative ways to close the $1.1 – 1.5B research gap, first noted in 2003, between the funding being applied and the research needed to support the goals of the ITRS.

Figure 1 shows the evolution and funding sources of ITRS needs for the past 10 years. The gap between the funding needs and the total funds available is growing exponentially; the NEEDS curve is growing at the rate of ~16 % compounded annually [1].

The high rate of growth of new technology development NEEDS derives, at least in part, from the many ITRS research efforts that are unfunded or under-funded and carried over each year hoping for "better funding cycles." In the 2007 edition of the ITRS Roadmap, 147 of 204 topics, totaling $3.2B, were ***continuations*** of those already in place in 2003. There are also 57 topics, requiring $1.389B of new research funding.

Without adequate and stable R&D funding the semiconductor industry will not meet the projected targets set forth in the current edition of the ITRS roadmap. For example, the past four years have confirmed the serious difficulties due to the incorporation of many new materials and methods into the traditional CMOS process.

In some areas, serious delays have crept into the ITRS timeline, specifically, EUV patterning continues to be substantially behind schedule, low-K interlayer dielectrics have been delayed several years, and high-K dielectric/metal-gate stacks have been shifted 2-3 years to 45 nm.

Many of the ongoing and most of the new topics require the development of new fundamental metrology infrastructure; whereas industry funding has grown, total worldwide government funding appears to have decreased in 2007.

In 2007, for the first time, industry's funding for the long-term ITRS development needs is currently larger than public funding. Figure 2 shows the evolution of industry's contribution to the long-term ITRS development funding. While industry funding for the long term ITRS development needs is currently much larger than public funding, industry actually spends only ~2 % of their R&D budget on long-term ITRS needs. They spend the bulk of their R&D funds on tactical research to benefit their current and near-term product offerings. So, how does the Semiconductor Industry get the

semiconductor industry to increase in their funding for ITRS needs?

Clearly, the public funding of strategic infrastructure identified by the ITRS roadmap is drastically underfunded. The net result is that the ongoing semiconductor-related development work is chronically underfunded. Therefore, the need to find alternative sources of funds to sustain the evolution of the semiconductor industry is essential.

One possible solution is the creations of a Public-Private Partnership (PPP) to leverage various sources of non-federal funds to supplement public funding. Specifically, a possibility is the creation of a not-for-profit foundation, similar to the Foundation for the National Institutes of Health (FNIH). The proposed foundation couldwill, among other things, raise private sector funds and stimulate and facilitate the formation of public-private partnerships focused on supporting long-term research needs identified by the ITRS roadmap.

A PPP is often defined as an agreement where the public sector enters into long-term contractual agreements with private sector entities for the construction or management of public sector infrastructure. PPP projects can appear in a variety of different structures but are usually characterized as large, long-term agreements between the public and the private sector where the private consortia builds, designs, constructs, operates, maintains, and/or finances a particular facility or the provision of service. [2]

By shifting these responsibilities, public agencies are also able to transfer a substantial amount of risks and costs to the private firms. PPPs have been shown to reduce the whole life costs of the projects due to the private sector's concerns for profit and reduced costs [2].In addition, PPPs can aid in generating additional revenues (as the private partner may be able to obtain additional funding sources from third parties) and result in greater innovations in the delivery of service and technologies used. PPPs also provide opportunities for improvements in risk management strategies; they optimize risk allocation by transferring the risks to the party best able to manage them. [1]

A secondary function for the proposed foundation will be to serve as a Technology Transfer Organization (TTO) to facilitate the transfer of semiconductor technology from government laboratories, as well as to referee the transfer of novel enabling technologies from small start-up companies to well established companies. The sole purpose of this function is to accelerate the market introduction of enabling emerging materials and device technologies into the rapidly changing semiconductor market space. The central role of the TTO in technology transfer is illustrated by Figure 3, the "Hylton Model", as a PPP. The proposed TTO function of the foundation will, among other activities [3]:

- coordinate intellectual property
- facilitate access to product development infrastructure
- provide small business services
- manage the relationships between the various participants in the technology transfer process
- help with market strategy coordination and road mapping
- monitor / coordinate competition & globalization (interface with IMEC, SELETE, etc.)
- foster global / international consortia (facilitate small company participation in such consortia such as the Albany NanoTech Center, Sematech, etc.)
- encourage conversations on new financing frameworks

Several existing PPP entities in other areas can serve as precedents and benchmarks for the proposed PPP foundation to support the research necessary to meet ITRS objectives. Of these, we propose to model the new semiconductor specific PPP foundation after the Foundation for the National Institutes for Health (www.FNIH.org).

References

[1] James Hutchby "The ITRS Research Needs vs. Funding: A 2007 Update", Semiconductor Research Corporation, Research Triangle Park, North Carolina

[2] Dorothy Morallos and Adjo Amekudzi "A Review of Value for Money (VfM) Analysis for Comparing Public Private Partnerships to Traditional Procurements," TRB 2008 Annual Meeting CD-ROM

[3] Dr. Todd L. Hylton's testimony before the U.S. Senate Committee on Commerce, Science, and Transportation concerning developments in nanotechnology, February 15, 2006. http://www.commerce.senate.gov/pdf/hylton-021506.pdf

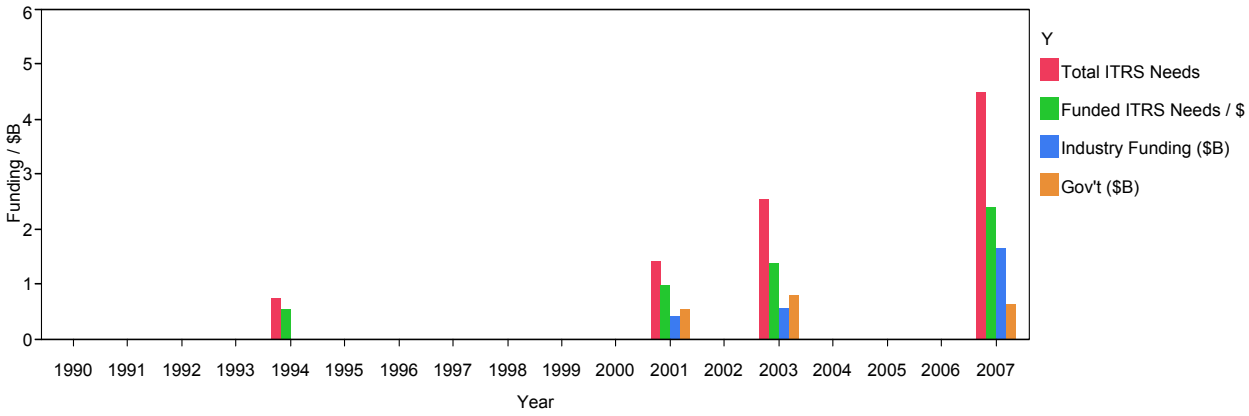

Figure 1: Evolution of Term ITRS Development Funding Needs and Funding Sources
Reference

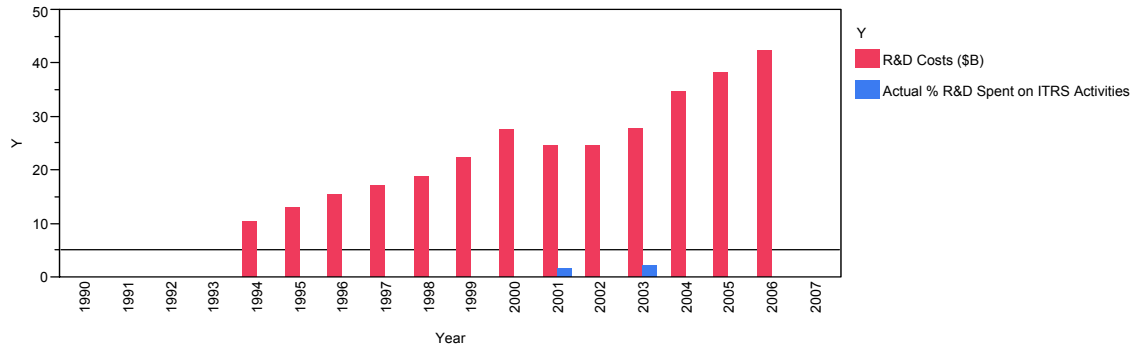

Figure 2: The evolution of Industry's Contribution to the Long Term ITRS Development Funding

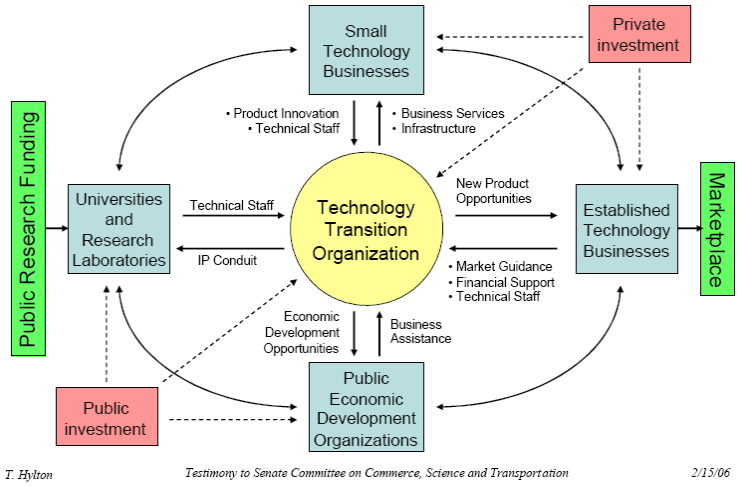

Figure 3: The "Hylton" Model of Facilitated Technology Transfer (from reference # 3)