President's Council of Advisors on Science and Technology

Ensuring Long-term U.S. Leadership in Semiconductors

January 2017

PCAST Study on Semiconductors

1. **Overview**
2. Challenges
3. Influencing China
4. Creating a More Supportive Business Climate
5. Innovation Strategy for Continuing U.S. Leadership

Context and Motivation

Context:

- Semiconductors have important implications for the U.S. economy and for national security
  - The semiconductor industry creates foundational technologies that enable innovation
  - Semiconductors are important in defense and cybersecurity-related applications

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Motivation:

- Industry is approaching technological and economic inflection points
  - Slowing of "Moore's Law" and other scaling patterns
  - Rising cost of designing and fabricating high-performance chips
- New large-scale Chinese industrial policy is targeting semiconductor industry
  - Raises questions regarding consequences for economy, security, and innovation

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Goals of Study:

- Sharpen understanding of core challenges facing the semiconductor industry and implications for the U.S. economy and national security
- Identify actions the Federal government, industry, and academia could pursue to address challenges and strengthen semiconductor innovation

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Output:

- Report that sharpens understanding of challenges and offers 9 recommendations

Working Group Members

Co-Chairs: John Holdren (Assistant to the President for Science and Technology; Director, Office of Science and Technology Policy; PCAST Co-Chair, Paul Otellini (Former President and CEO, Intel)

Members:

1. Richard Beyer (Former Chairman and CEO, Freescale Semiconductor)
2. Wes Bush (Chairman, CEO, and President, Northrop Grumman)
3. Diana Farrell (President and CEO, JP Morgan Chase Institute; Former NEC Deputy Director)
4. John Hennessy (President Emeritus, Stanford University)
5. Paul Jacobs (Executive Chairman, Qualcomm)
6. Ajit Manocha (Former CEO, GlobalFoundries)
7. Jami Miscik (Co-CEO and Vice Chairman, Kissinger Associates; Former CIA Deputy Director for Intelligence)
8. Craig Mundie (President, Mundie and Associates; Former Senior Advisor, Microsoft)
9. Mike Splinter (Former CEO and Chairman, Applied Materials)
10. Laura Tyson (Distinguished Professor of the Graduate School, UC Berkeley; Former CEA Chair and NEC Director)

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Two Key Challenges

Shifts in Technology and Markets

- Slowing of "Moore's Law" and other scaling patterns
- Increase in range of major semiconductor applications beyond traditional computing
- Rising industry concentration

Chinese Industrial Policy

- Use of $150 billion in public and state-influenced private funds over 10 years
- Problematic policies are in the form of subsidies, market restrictions, and other forms of market manipulation

Six Guiding Principles

1. Win the race by running faster
2. Focus principally on leading-edge semiconductor technology
3. Make the most of U.S. strengths rather than trying to mirror China
4. Anticipate Chinese responses to U.S. actions
5. Do not reflexively oppose Chinese advances
6. Enforce trade and investment rules

Enhance Technological and Business Insight

Recommendation 1.1 Create new mechanisms to bring industry expertise to bear on semiconductor policy challenges.

The U.S. government could benefit from expertise on cutting edge technology and markets. One option is creating a standing external technical group with broad membership– including expertise from within semiconductor producing and consuming industries. Another option is to take steps to make it easier to access industry expertise on an *ad hoc* basis.

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Overview of Issues

- The United States has a range of tools (formal trade agreements, informal trade and investment norms, CFIUS and export controls) available to respond directly to Chinese activities
- The current set of strategies pursued by the Chinese government through its policies brings the effectiveness of these tools into question
- The U.S. government should revisit its tools to ensure that they are sufficiently able to protect against actions that may unacceptably harm the country's economic and security interests

Boost Transparency and Reshape Tools

Recommendation 2.1 Boost the transparency of global advanced technology policy. The United States should attempt to influence Chinese behavior by identifying specific areas where greater transparency could be mutually beneficial, and press for progress there through discussions in bilateral and multilateral forums. In doing so, the United States should also be open to increasing transparency around its own activities.

Recommendation 2.2 Reshape the application of national security tools, as appropriate, to deter and respond forcefully to Chinese industrial policies. In doing so, U.S. export and investment controls should continue to focus on national security concerns rather than be expanded to pursue economic goals. This should include considering individual Chinese acquisitions in the context of the broader national security impact of Chinese policy.

Work with Allies on Tools

Recommendation 2.3 Work with allies to strengthen global export controls and inward investment security.

The semiconductor supply chain and market are global. The United States should work with like-minded partners to develop common principles (insofar as possible) for acceptable and unacceptable market behavior, and to help build their administrative capacity to effectively implement appropriate controls and pursue needed investigations, since many countries are currently far less capable than the United States in this regard.

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Overview of Issues

- U.S.-based business benefits from a robust innovation ecosystem
- A supportive U.S. business environment thus boosts innovation
- Recommendations are areas in which many U.S. companies and policymakers have long called for action
  - Areas are particularly important to sustaining semiconductor innovation

Secure the Talent Pipeline and Invest in Pre-Competitive Research

Recommendation 3.1 Secure the talent pipeline. Global businesses invest where the talent exists. U.S. government should strengthen its home-grown talent by investing in STEM education and needs to attract talented scientists and engineers from abroad to live and work in the United States through immigration reform.

Recommendation 3.2 Invest in pre-competitive research. The U.S. government should increase its R&D spending, focusing in particular on collaborative pre-competitive R&D in science and technology areas outside the health sciences (which have received large increases in recent years). We recommend targeting a doubling of Federal non-health R&D spending.

Enact Corporate Tax Reform & Responsibly Speed Facility Permitting

Recommendation 3.3 Enact corporate tax reform.

Specific actions recommended:

1. Create an internationally competitive corporate tax system.
2. Recognize the importance of manufacturing through the tax code.
3. Strengthen R&D tax credits.

Recommendation 3.4 Responsibly speed facility permitting.

Improving permitting could yield a meaningful change in the pace of U.S. semiconductor foundry innovation. Specific actions recommended:

1. Create additional “fast track” permitting options within EPA and review existing ones to ensure that they are operating as intended.
2. Provide funds to increase staff capacity at EPA and other relevant agencies to handle the permitting process.
3. Identify important areas where regulations or procedures are redundant with state rules and might therefore be modified or removed.

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Overview of Issues

- There is often a strong temptation to respond to the challenges outlined in this report by focusing centrally on attempting to slow China down.
- The United States will not remain a semiconductor leader if it confines its efforts to making it cheaper and easier to build today's semiconductors and opposing damaging Chinese industrial policy.
- To maintain a strong and globally competitive semiconductor industry, the United States needs to keep the U.S. industry at the technological frontier through transformative innovation.

Overview of Moonshots

- We propose a series of "moonshots"—such as developing cutting-edge medical technologies and game-changing biodefense detection systems—that have independent merit and would, if achieved, also deliver radical semiconductor advances of much broader applicability.
- These would require a mix of public and private participation.
  - Government role could include convening, procurement, and catalytic investment in innovative, pre-competitive technologies

Sample Moonshot

Development of a zero-day bio-threat detection network

- Goal: identify previously unknown threats (for example, some unexpected types of biological or chemical agents)
- Innovation required: (i) design of advanced and low-cost bio-sensors, (ii) real-time data analytics based on classic and machine learning algorithms to detect threats and anomalies, (iii) ultra-secure and encrypted communications including methods such as post-quantum cryptography, and (iv) real-time communications through this sensor network for rapid dissemination of threat information
- Sponsors: DHA, NIH, DARPA
- Challenge: Engaging with established and startup companies through prizes and procurements of products for both domestic and battlefield monitoring of bio-threats
- General Purposes: Technologies can be applied more broadly in healthcare, battlefield sensing and communications, and population health surveillance activities

Execute Moonshot Challenges

Recommendation 4.1 Execute moonshot challenges.

The National Science and Technology Council (NSTC) should form a Subcommittee on Semiconductor Moonshots under its Committee on Technology to coordinate the selection, development, and execution of moonshot challenges.

- This interagency group would coordinate the selection and prioritization of the moonshots across the U.S. government.
- In addition, for each moonshot, an advisory group across industry, government, and academia should be established.
- The Subcommittee, along with the lead agency, would determine the appropriate government tools for achieving the moonshot.