# Title: The Status of the U.S. Integrated Circuit Design and Manufacturing Industry: Capabilities and Challenges

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**Abstract**

**The U.S. Department of Commerce, Bureau of Industry and Security (BIS) is the focal point within the Department for assessing the capabilities of the U.S. industrial base to support the national security. In 2017 BIS completed a comprehensive survey of the health and competitiveness of the U.S. Integrated Circuit (IC) Design and Manufacturing Industry, with extensive survey responses covering effectively the entire U.S. industry: 143 organizations representing 401 individual facilities (see Figure 1)**

**This presentation provides aggregated results of this survey, with a focus on U.S. industry capabilities and challenges. Among these challenges is the Chinese Government's announced plan to dominate the future IC industry and restrict their market to primarily Chinese-manufactured ICs. BIS examines the potential effects of these actions as well as a broader set of issues facing the U.S. industry.**

## Introduction

In late 2016, with the support of the Secretary of Commerce and request of the International Trade Administration, the Bureau of Industry and Security (BIS) undertook an assessment of the U.S. integrated circuit (IC) design and manufacturing industrial base.

The principal goal of this effort was to gain a better understanding of the capabilities of U.S.-located companies engaged in the design and manufacture of ICs and related products. In addition, with an eye on the longer term health of the U.S. industry, BIS gathered data on the industry supply chain, financial health, trade and intellectual property issues, and competitiveness.

Using mandatory data collection authority under Section 705 of the Defense Production Act of 1950, BIS distributed an extensive survey to all known designers and manufacturers of ICs. The resulting assessment covers 401 facilities from 143 different organizations.

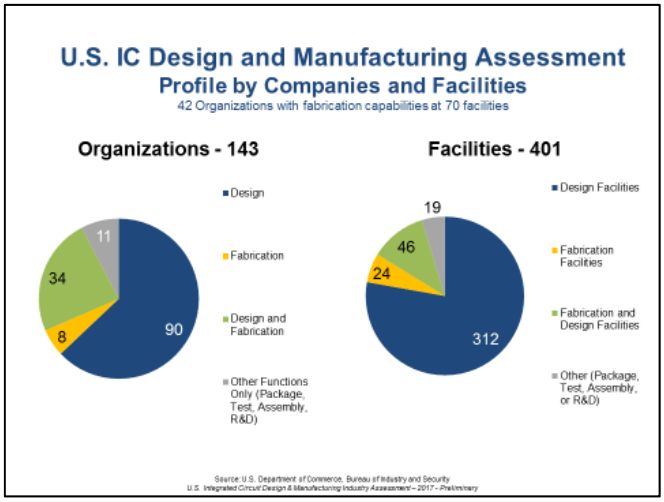


Figure 1. Survey responses types

## Industry Capabilities

Respondents design and manufactured ICs at all technology nodes possible, from 10,000 nanometers to under 7 nanometers, with multiple respondents designing and fabricating in each node category except below 7 nm, a level at which there was no fabrication capability (see Figure 2).

Design capabilities were skewed toward smaller technology nodes than manufacturing capabilities. The number of facilities designing ICs peaked in the 130-180nm range, whereas for manufacturing facilities this peak was in the 500-800nm range, with relatively few respondents capable of fabricating ICs below 90nm.

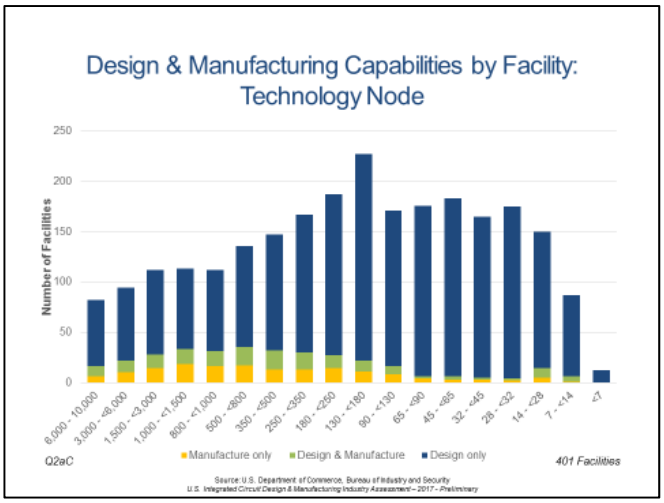


Figure 2. Design and manufacturing capabilities by technology node

## Workforce and Employment Challenges

A total of roughly 200,000 people worked on IC-related activities at the 401 respondent facilities, with a vacancy rate of 2.5 percent. While vacancies are currently low, one-third of facilities expected over 10% of their workforce would retire in the next five years, creating a potential shortage of qualified and experienced workers.

Indeed "finding qualified workers" was by far the most common primary workforce issue expected among respondents, with nearly half of all facilities listing it as their number one workforce challenge in the next five years. "Finding experienced workers" was the next most frequent area of concern (see Figure 3).

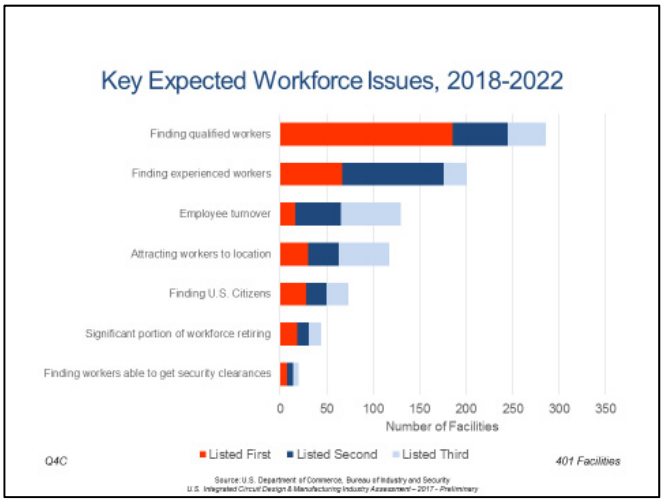


Figure 3. Key workforce issues expected in next five years

For specific occupational categories of concern, respondents reported by a large margin they had both the most vacancies and the most difficulty hiring Electronic Engineers and RF/Analog Engineers. Among the occupations with the largest differential between vacancies and hiring difficulty was Silicon Design Architect, for which respondents had the 10th most vacancies but 3rd most difficulty hiring.

## Outsourcing/Offshoring

Among the concerns for the U.S. IC industry as a whole is an increasing tendency to rely on non-U.S. sources for materials, equipment, and production processes. In microelectronics, as in many industries, proximity of production to suppliers and customers is important for cost savings and ability to quickly meet requirements. As a result, changes in supply chain locations can develop a momentum of their own.

While most suppliers of inputs for IC fabrication in the U.S. are based in the U.S., for some input types this is increasingly not the case. Nearly half of the primary sources of Wafers and of Raw Materials were from non-U.S. locations, and over half of the primary sources of Assembly Materials were from non-U.S. locations.

In the design area, among respondents who outsourced design function, nearly as many outsourced it to India-based organizations as to U.S.-based organizations. More respondents said they outsourced fabrication to organizations in Taiwan, China, or Singapore than to those in the U.S.

Trends away from the U.S. also show up in corporate investments (see Figure 4). While overall capital expenditures grew by 15 percent from 2013 to 2016, capital expenditures in the U.S. actually fell by 27 percent, with expenditures outside the U.S. more than doubling, and surpassing U.S.-based investment.

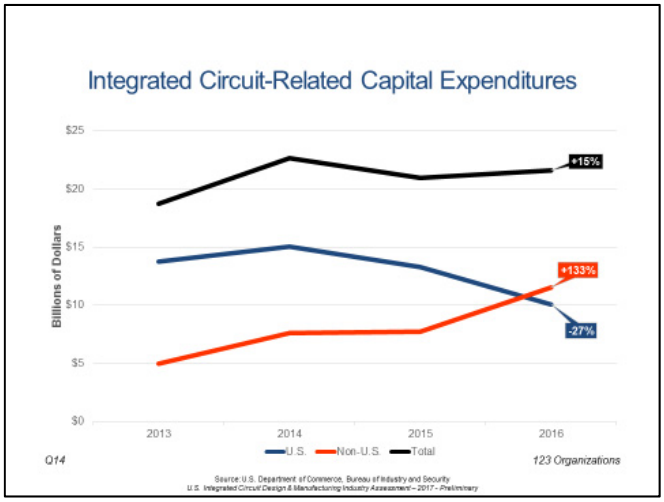


Figure 4. IC-related capital expenditures, U.S. and abroad

## Corporate Challenges

BIS provided respondents with a list of 30 challenges, and asked them to indicate which applied to their organizations, both in the past five years and expected in the next five years. Respondents also ranked their five most significant challenges.

Competition—both foreign and domestic—led the list, as might be expected from a healthy industry. The next most common concerns were "Labor Availability/Costs" and "Worker/Skills Retention", in line with the previously noted expected workforce issues. These were followed by R&D costs, which were also the third most common challenge listed as respondents' primary concern.

The ability to adequately invest in the future is significant, particularly in light of some promising advanced technologies, the Chinese Government's announced plans to invest heavily in IC capabilities and R&D, and U.S. structural approaches to R&D. Basic research was by far the least invested in by U.S. IC organizations, and grew at just 10 percent from 2013 to 2016, while applied research grew at 26 percent and product/process development at 53 percent.

This R&D investment structure raises concerns about short-sighted behavior by U.S. industry, with investment focused more heavily on short-term solutions than longer-term ones. Indeed, the percent of respondents performing R&D on advanced IC technologies fell rapidly as the expected readiness date of technologies grew (see Figure 5).

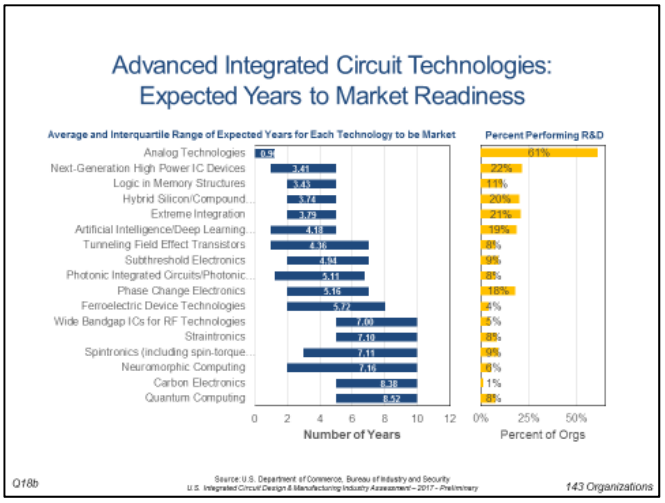


Figure 5. Advanced IC technologies and R&D

## Potential Solutions

BIS developed a list of 20 potential U.S. Government policy actions and asked respondents to rank which would be the most beneficial to the U.S. IC industry (see Figure 6). The most commonly selected action—lowering federal corporate tax rates—has occurred since the survey's completion, but nearly as frequently identified was "Increase funding for research in IC-related disciplines", reflecting an understanding of the need for both more R&D.

Also toward the top of the potential actions were those aimed at solving expected workforce problems, like "Increase federally funded scholarships for college-level U.S. students in key IC-related disciplines" and "Increase green-card and H1-B employment visa caps".

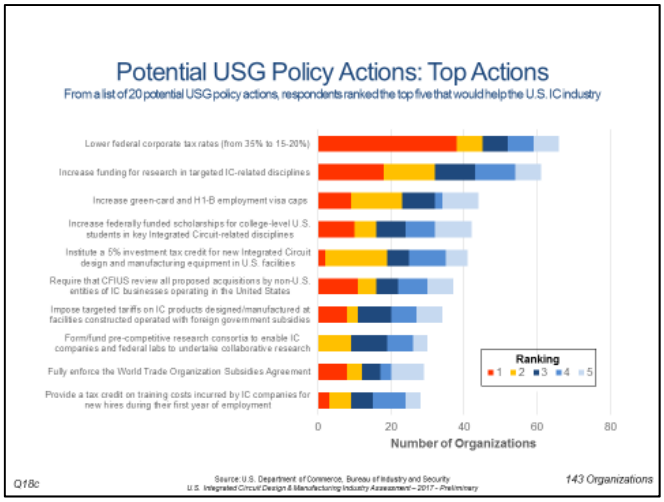


Figure 6. Top potential U.S.G. policy actions

Other frequently favored potential policy actions included more aggressive USG intervention to protect U.S. IC companies, including an enhanced CFIUS review process, tariffs targeting foreign subsidized firms, and stronger enforcement of current trade policies.

## Conclusions

The U.S. IC industry is currently in strong shape, but the challenges it faces are expected to expand in the next five to ten years, as possible workforce shortages, changes in supply chain structure, Chinese Government intervention, and weak U.S.-based investment combine to threaten the long term growth of U.S. industry. It is necessary for both industry and the USG to take action now to ensure the U.S. IC industry remains at the cutting edge.