Testimony of Dr. Eric Schmidt

U.S. House of Representatives Committee on Science, Space, and Technology

Hearing Titled: "Losing Ground: U.S. Competitiveness in Critical Technologies"

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Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, thank you for the opportunity to testify on the importance of U.S. competitiveness in critical technologies. I appear today as a long-time advocate for federal government investments in technology research and development, having seen first hand how these investments can bolster America's competitiveness in the global economy. I am proud to have been CEO of Google, and recall how the National Science Foundation helped fund the scientific advances that Google co-founders Larry Page and Sergey Brin commercialized so successfully to build the first broadly adopted search engine. I have also focused on understanding the role of new technology in protecting our national security, as chair of two government panels -- the National Security Commission on Artificial Intelligence and the Defense Innovation Board. Today, however, I am speaking not as a representative of these organizations, but as a private citizen.

I commend the Committee for the breadth of this hearing. The range of technologies discussed today must be understood as interconnected opportunities. Advances in quantum computing will spur developments in AI, progress in AI will help accelerate discoveries in biotechnology, 5G networks will open up new opportunities to leverage AI applications, and so on. We must find an integrated approach to federal investments across emerging technologies. Doing so requires a comprehensive national strategy, to set and reinforce priorities and to reconcile budget tradeoffs. This Committee has a central role in that urgent project.

My central argument is this: If we do not make serious investments now, we stand to lose our global leadership position in critical technology areas by the end of this new decade, with significant consequences for our country's prosperity and security.

I will offer my view on the imperative of global technology leadership and our complex technology competition with China, and then offer a series of proposals for this Committee's consideration. I will focus mainly on AI and associated issues such as advanced computing, but many of my points are applicable more broadly. Based on my recent experience working with the defense and intelligence communities, I also want to emphasize the national security dimensions of these issues. The AI Commission's recently published Interim Report expands upon some of these points, and I have attached it here for the Committee's reference.

Global Technology Leadership

Holding a global leadership position in emerging technology is both an economic and a national security imperative. Innovation is the foundation of the U.S. economy, as well as the

source of the military advantage that protects us and our allies and deters aggressors. Leadership gives our security agencies access to the best available technologies, and puts the United States in the best position to secure them against vulnerabilities and develop standards for their responsible use.

Because the commercial sector vastly outspends the government on R&D, the government must partner more closely with private companies to shape technology development. The commercial sector alone will not meet every or even most of our economic competitiveness or security needs. The U.S. government must prioritize and catalyze. The government's responsibility is to steer advancements in ways that protect Americans, preserve a robust basic research environment, and fill gaps where commercial enterprises have not focused their attention or resources.

The United States now faces an economic and military competitor in China that is aggressively trying to close our lead in emerging technologies. Many Americans still have an outdated vision of China. In three generations China transformed from having a per capita income of about $90 in 1960 to about $10,000 today.[1] China has already passed the United States in GDP based on purchasing power parity. China poses a larger economic challenge than the Soviet Union did. As a leading historian recently noted, "the Soviet Union could never draw on the resources of a dynamic private sector. China can."[2] Now, the Chinese government has ambitions -- and specific plans, with promises of billions of dollars in funding -- to surpass the United States in areas such as quantum communications, supercomputing, aerospace, 5G, mobile payment, new energy vehicles, high-speed rail, financial technology, and AI.

With AI in particular, where do we stand today? By most estimates the United States is the global leader in 2020. There are many different metrics and I won't go into them here. But consider the most recent attempt to do a comprehensive assessment, called the Global AI Index, which measured 150 indicators. It found the United States is the "undisputed leader" in AI development, with a score almost twice that of China, which placed second.[3]

But now consider how fragile that lead is. The same study projected that based on current AI trends, China will overtake the United States in only five to ten years. From my own experience, which includes frequent interaction with China's technology community, I think that's about right.

Many data points and observations lead me to such a projection. Here are just a few. Today, China has almost twice as many supercomputers as the United States. It has approximately

[1] World Bank, "GDP per capita (current US$) - China." (2018), https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=CN.
[2] Niall Ferguson, "The New Cold War? It's With China, and It Has Already Begun," New York Times (Dec. 2, 2019), https://www.nytimes.com/2019/12/02/opinion/china-cold-war.html.
[3] Tortoise Media, "The Global AI Index" (Dec. 2019), https://www.tortoisemedia.com/intelligence/ai/.

15 times the number of deployed 5G base stations as the United States.[4] By 2025, Chinese researchers are expected to overtake American researchers in the one percent of most-cited scientific papers in AI.[5] By 2030, China is expected to spend more than the United States on overall R&D, in absolute terms.[6] Sometime after 2030, the Chinese economy likely will become larger than ours.[7]

In other words, unless trends change, we will be competing with a country that has a bigger economy, more R&D investments, better quality research, wider application of new technologies, and stronger computing infrastructure. As the 2020s begin, we should be gearing our policy and legislation to compete effectively in a 2030s world that may look very different.

Complex Competition with China

The technology competition with China is not straightforward or zero sum. Speaking of an arms race is too simplistic. We should not only compete with the Chinese but also work with them. Many breakthroughs in one country will benefit researchers in the other, because they are openly available -- or were produced through cooperation. In the AI field, for example, the number of research papers published with American and Chinese co-authors has doubled in the last decade.[8] Chinese nationals are important contributors to U.S. universities and research institutes. There are many areas where cooperation would have clear mutual benefits, for example in AI-based approaches to climate challenges, disaster relief, and health care. We should also engage in collaborative discussions on AI safety -- that is, ensuring AI systems only do what they are designed to do.

Simple decoupling is unwise because it would significantly harm the United States. Still, there are aspects of the U.S.-China technology relationship that need to be recalibrated. China's well-documented espionage, intellectual property theft, and talent recruitment programs are disadvantaging our companies, our universities, and our military. The findings of a recent Senate investigation into China's methods to unfairly exploit U.S. taxpayer-funded research for its own benefit is a case in point.[9] I commend the intense focus in Congress on these issues.

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[4] Stu Woo, "In the Race to Dominate 5G, China Sprints Ahead," Wall Street Journal (Sept. 7, 2019), https://www.wsj.com/articles/in-the-race-to-dominate-5g-china-has-an-edge-11567828888

[5] Field Cady and Oren Etzioni, "China May Overtake US in AI Research," Allen Institute AI2Blog (Mar. 13, 2019), https://medium.com/ai2-blog/china-to-overtake-us-in-ai-research-8b6b1fe30595.

[6] "2018 Global R&D Funding Forecast," R&D Magazine (Winter 2018).

[7] See James Manyika and William McRaven, "Innovation and National Security," Independent Task Force Report No. 77, Council on Foreign Relations (Sept. 2019), https://www.cfr.org/report/keeping-our-edge/pdf/TFR_Innovation_Strategy.pdf.

[8] Sarah O'Meara, "AI Researchers Want to Keep Global Sharing Culture Alive," Nature (May 29, 2019), https://www.nature.com/articles/d41586-019-01681-x.

[9] "Threats to the U.S. Research Enterprise: China's Talent Recruitment Plans," Staff Report, U.S. Senate Permanent Subcommittee on Investigations (Nov. 2018), https://www.hsgac.senate.gov/imo/media/doc/2019-11-18%20PSI%20Staff%20Report%20-%20China's%20Talent%20Recruitment%20Plans.pdf.

But as we find areas for prudent disengagement, we should bear in mind that unwinding the complex web of connections between our countries -- people, hardware, supply chains, investments, research -- will have costs, and possibly consequences we don't foresee, for our economy and research system. We should take careful stock of our choices.

The way to technology leadership is a dual path: better protect our innovations, and out-innovate our competitors. The best outcome is having U.S. tech firms out-compete their global competition on a more level playing field to win greater market share, and to integrate that world-leading technology into our government agencies to use in national security missions.

We also need to reframe the bilateral disputes in a more global context. Technology developments, especially in AI applications and 5G infrastructure, are pointing toward a world that risks becoming divided into technological and ideological spheres of influence. This world would have American and Western technologies predominant in some regions and Chinese systems more established in others. We do not seek a divided world, but neither do we want to live in a world shaped by China's view of the relationship between technology and governance.

For example, Chinese companies already supply AI surveillance technology to 63 countries, according to a recent study.[10] China's so-called "digital silk road" initiative could provide technology infrastructure to enable more governments to impose the authoritarian norms found in China -- including the disappearance of individual privacy under state surveillance, and the repression of speech and expression through state censorship.

My concern is that as China tries to fulfill a vision of high-tech authoritarianism, that governing model will appeal to other governments searching for a foundation on which to exercise their power. It is incumbent upon our country and other free societies to present a model of high-tech democracy that is even more compelling and economically viable, because it preserves foundations of individual freedom.

So U.S. technology leadership is imperative not only for our economic competitiveness and for our military advantage -- it is also imperative to uphold the democratic model of governance and prove its resilience in the face of technological changes that could be used to threaten it.

What To Do Now

Let me turn to some nuts and bolts of what the U.S. government -- and this Committee in particular -- can do to change current trends and extend U.S. technology leadership. The past year has seen several positive steps, such as the National Quantum Initiative, progress in the Energy

[10] Steven Feldstein, "The Global Expansion of AI Surveillance," Carnegie Endowment for International Peace (Sept. 2019), https://carnegieendowment.org/2019/09/17/global-expansion-of-ai-surveillance-pub-79847.

Department's exascale supercomputer project, and NSF's new initiative to build a series of AI research institutes. Here are six proposals that would have a broad impact on new technology development in the United States. They focus on civilian investments, given the jurisdiction of this Committee, but they could also benefit military competitiveness. Many are described with more context or detail in the AI Commission's report.

1) Funding: Overall federal R&D spending has not kept pace with technological change. Simply put, we need to place big bets. U.S. government funding for R&D has seen a decades-long decline, and is now at pre-Sputnik levels as a percentage of GDP.[11] For AI, the scale of investment should be multiple times current levels. In computer science in particular, more research funding is critical to help stabilize academic research and mitigate a brain drain from academia to industry. Student enrollment in computer science classes has skyrocketed, but universities aren't retaining enough faculty to teach this next generation.

2) Nationwide Infrastructure: Given the interconnected nature of emerging technologies, we must invest in foundational infrastructure. This includes supporting a competitive and secure global alternative to Huawei in 5G, ensuring the U.S. microelectronics supply chain is resilient and assured, and investing in next-generation and high-performance computing. Congress should consider national models that have worked well, such as the National Nanotechnology Initiative. Launched in 2000, that effort integrated the work of 20 government bodies and prompted huge growth in the nanotech field, including a network of labs and research centers across the country.

3) Flexible Grants: The United States graduates the largest number of science and engineering doctorates of any country. We need new mechanisms to accelerate expert research. Congress should consider models for multi-year investments in promising individuals, not just specific projects, as is done at the Howard Hughes Medical Institute and through the Defense Department's Vannevar Bush faculty fellowships.

4) Government–Industry–Academia Collaborations: Partnerships can help researchers overcome technical and financial barriers, as NSF is doing through its CloudBank initiative to connect NSF-sponsored researchers to cloud computing resources. This could expand into a nation-wide National Research Cloud. Congress should also explore tax incentives for companies to share data and provide computing capabilities to research institutions, and accelerate efforts to make government datasets more widely available.

[11] In 1953, the U.S. spent 0.72 percent of its GDP on R&D. In 1957, when the then-Soviet Union launched Sputnik, it had grown to 1.3 percent. R&D spending peaked at 1.86 percent in 1964. In 2017, it declined below 1953 levels to 0.61 percent. Federal R&D Budget Dashboard, American Association for the Advancement of Science, https://www.aaas.org/programs/r-d-budget-and-policy/historical-trends-federal-rd.

5) Talent Development: The United States needs major new STEM education initiatives at the K-12, college, and graduate levels. This includes expanding the existing STEM scholarship programs and designing new ones. We also need to attract more global expertise to America. Around 80% of computer science PhD students who come from abroad to study end up staying in the United States after graduation.[12] Students all over the world want to study here, and we should make it easier for them to stay. That helps our competitiveness. But more countries are trying to recruit science and technology experts -- not just China, but also friends like Canada -- through immigration and work incentives. Experts in fields like AI have highly-specialized skills and are in demand. The more competitive our talent retention policy, the better our chances to lead.

6) Public Confidence: If we do not earn the public's trust in the benefits of new technologies, especially AI, doubts will hold us back. An international survey found that China has a huge lead in public confidence in AI: 70% of Chinese said they trust AI technology, compared to 25% of Americans.[13] Legislators, researchers, and tech companies need to confront the concerns Americans have, while also communicating the great potential to improve lives. That means, among other things, enhancing privacy rules, investing in security research, developing technical standards, and preparing for workforce impacts from more automation.

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In sum, U.S. global technology leadership is an imperative, and there are near-term steps this Committee can take to extend our leadership in new technologies beyond what many experts currently predict. The Defense Innovation Board has published many other recommendations, and the AI Commission is preparing more detailed prescriptions, and will provide them on a rolling basis as they are developed, leading up to a final report next year. Thank you again for the chance to appear today, and I look forward to your questions.

[12] Remco Zwetsloot, Roxanne Heston, and Zachary Arnold, "Strengthening the U.S. AI Workforce: A Policy and Research Agenda," Center for Security and Emerging Technology at iii (Sep. 2019), https://cset.georgetown.edu/wp-content/uploads/CSET_U.S._AI_Workforce.pdf; see also Science & Engineering Indicators 2018, National Science Board (2018), https://www.nsf.gov/statistics/2018/nsb20181/assets/901/tables/tt03-27.pdf.

[13] Ipsos, "The Emergence of Social Entrepreneurialism to Compete with Business Entrepreneurialism," (Nov. 12-18, 2018), https://www.ipsos.com/sites/default/files/ct/news/documents/2018-10/entrepreneurialism-2018-global-report.pdf.

Biography of

Dr. Eric Schmidt

Eric Schmidt is Founder of Schmidt Futures.

Eric is also Technical Advisor to Alphabet Inc., holding company of Google Inc, where he advises its leaders on technology, business and policy issues.

Eric was Executive Chairman of Alphabet from 2015-2018, and of Google from 2011-2015.

From 2001-2011, Eric served as Google's Chief Executive Officer, overseeing the company's technical and business strategy alongside founders Sergey Brin and Larry Page. Under his leadership, Google dramatically scaled its infrastructure and diversified its product offerings while maintaining a strong culture of innovation, growing from a Silicon Valley startup to a global leader in technology.

Prior to joining Google, Eric was the chairman and CEO of Novell and chief technology officer at Sun Microsystems, Inc. Previously, he served on the research staff at Xerox Palo Alto Research Center (PARC), Bell Laboratories and Zilog. He holds a bachelor's degree in electrical engineering from Princeton University as well as a master's degree and Ph.D. in computer science from the University of California, Berkeley.

Eric was elected to the National Academy of Engineering in 2006 and inducted into the American Academy of Arts and Sciences as a fellow in 2007. Since 2008, he has been a trustee of the Institute for Advanced Study in Princeton, New Jersey. Since 2012, Eric has been on the board of the Broad Institute and the Mayo Clinic. Eric was a member of the President's Council of Advisors on Science 2009-2017. In 2013, Eric and Jared Cohen co-authored The New York Times bestselling book, *The New Digital Age: Transforming Nations, Businesses, and Our Lives*. In September 2014, Eric published his second New York Times bestseller, *How Google Works*, which he and Jonathan Rosenberg co-authored with Alan Eagle. In April 2019, Eric published his third New York Times bestseller, *Trillion Dollar Coach: The Leadership Playbook of Silicon Valley's Bill Campbell*, which he co-authored with Jonathan Rosenberg and Alan Eagle.

Eric became the Chairman of the Department of Defense's Innovation Board in 2016 and was awarded the Department of Defense Medal for Distinguished Public Service in January of 2017 by Secretary of Defense Ashton Carter. He is Chairman of the US National Security Commission for Artificial Intelligence. He is a member of NASA's National Space Council User Advisory Group which is chaired by the Vice President. Eric is an MIT Visiting Innovation Fellow, member of the Advisory Board for MIT IQ, member of the MIT Commission on the Work of the Future, member of the MIT CEO Advisory Board, and member of the MIT Schwarzman College of Computing Advisory Council. Eric is founder of Schmidt Futures which helps exceptional people do more for others by applying science and technology thoughtfully and working together across fields.