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The U.S. vs. China: Who Is Winning the Key Technology Battles?

China leads in 5G, but the U.S. has an edge in other crucial niches—for now

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In a world where geopolitical power is increasingly linked to technological advancement, the U.S. has long led its rivals. American companies make some of the world's fastest computers, deadliest jet fighters and most capable robots.

But China's growing economy—now the world's second largest—and huge government investments in technologies are eating away at that edge like never before.

Such progress has spurred President Trump's all-out trade and economic battle with Beijing, encompassing tariffs, export controls and a crackdown on Chinese scientists allegedly stealing American companies' secrets.

It's not clear yet how the economic devastation wrought by the coronavirus will change the rivalry, but one thing is certain: The disease hasn't done much to cool tensions. The Trump administration is weighing new curbs designed to hamper China's ability to make leading-edge semiconductors, according to people familiar with the matter. The chairman of Chinese telecom giant Huawei Technologies Co. warned last month that Beijing would impose its own restrictions if the U.S. moves forward with that plan.

The most visible technological battle has been over 5G, the superfast cellular networks that promise to be the foundation for tomorrow's technologies. The U.S. government has taken extraordinary measures to try to thwart Huawei, the cellular-technology leader that Washington considers a cybersecurity threat.

The battle has also extended to other technologies that, like 5G, are not life-altering today but could transform how we live, work and fight wars in the not-so-distant future. Artificial intelligence is often touted as the linchpin of a new industrial revolution, with applications such as augmented reality and remote surgery. Quantum computing could help discover new drugs and decipher encrypted data once thought uncrackable. Autonomous vehicles could fundamentally revamp our transportation systems and infrastructure and the way we all get around. Advanced computer chips act as digital brains that orchestrate it all.

Here is how the technology battle between the U.S. and China is shaping up in some of the most important areas of innovation.

5G

Attorney General William Barr made it clear where the U.S. stood in 5G in February by suggesting that Washington and its allies should consider taking a financial interest in Huawei rivals Nokia Corp. and Ericsson AB. Both are based in Europe.

The White House later dismissed the idea of buying either company, but Mr. Barr's remarks still emphasized how there is no American giant to challenge Huawei, the world's biggest maker of telecom equipment, such as the radio hardware that hangs on cellular towers.

After bad bets, what remained of onetime American champions Lucent and Motorola were acquired by Finland's Nokia and Sweden's Ericsson. They in turn have gone through layoffs and unprofitability while competing with Huawei, which gained nearly the combined market share of its European rivals via its cutting-edge products and low prices.

The U.S. has some 5G players. Cisco Systems Inc. is the largest maker of the behind-the-scenes routers and switches that connect to cellular equipment. Qualcomm Inc. and InterDigital Inc. are leading intellectual-property companies earning royalties for cellular-technology patents.

But those markets are comparatively small, and Huawei is a player in both. And more than 60% of a wireless carrier's 5G capital expenditures could go to cellular equipment, such as radios, a market Huawei leads. "All the money is in radio," says Dimitris Mavrakis, 5G research director at market-advisory firm ABI Research.

Huawei's technologically advanced cellular equipment, and its ability to churn it out quickly, helped China quickly roll out 5G, turning much of the nation into a potential lab for 5G-dependent technology, such as self-driving cars. Meanwhile, airwave restrictions have slowed the construction of U.S. 5G networks.

Still, it would be premature to declare China the winner in the 5G race, especially since Washington has further tools to slow Huawei's dominance in both the cellular-equipment industry and smartphone business, in which it is also a global leader.

"Federal agencies in Washington are currently debating whether and how to tighten sanctions on Huawei," says Dan Wang, a Beijing-based technology analyst at research firm Gavekal Dragonomics. "If they do, then Huawei's operations will be disrupted in major ways, such that it may have difficulty making smartphones and 5G equipment."

Edge goes to: China

Artificial intelligence

Three years ago, Beijing declared its intention to be the world leader in AI by 2030, envisioning a domestic industry alone worth some \$150 billion.

China's publicly traded tech giants, including Alibaba Group Holding Ltd. and Baidu Inc., have plowed billions of dollars into AI research and set up labs in China and Silicon Valley, taking advantage of the latter's openness. That has made them juggernauts, outshining global rivals in areas including e-commerce algorithms and facial recognition. China's huge population, surveillance infrastructure and more lax attitude on privacy rights generate huge volumes of data, which produces ever-smarter AI.

But while China may contribute more AI research and be ahead in some important subsets of AI, like facial recognition, it's not ahead in all of them. And when it comes to research into artificial general intelligence, or AI with broader, humanlike thinking abilities, the large U.S. companies—Microsoft Corp., Alphabet Inc.'s Google and others—are clearly leading, says Paul Triolo, an analyst at political-risk consulting firm Eurasia Group. American tech giants have untold amounts of money to spend on AI, which they're using in recommendation engines, targeted advertising and automatic filtering of obscene or otherwise banned pictures and videos,

among other areas. Some also sell AI services, letting companies, governments and police departments tap into the power of their algorithms.

The U.S. produces some of the world's best AI research and talent because of its combination of leading universities, deep-pocketed tech companies and an openness to ideas and people from across the globe—areas where the U.S. has a sustainable advantage, at least in the medium term. Not shutting down academic and commercial exchanges with Canadian, European, Israeli and even Chinese experts is crucial for the U.S. to maintain the advantages it has, Mr. Triolo says.

“In some sense the AI industry is still in its infancy, and many are contributing to its growth and maturity,” he says. “This may be more important than the level of funding in determining the success of U.S. companies in leveraging AI in new and important sectors like autonomous driving and health care.”

Edge goes to: U.S., but it's close.

Quantum Computing

Unlike today's computers, which use streams of ones and zeros to encode data, quantum computers use atom-scale quirks that allow particles to exist in more than two states. That added complexity gives them the ability to process more information more quickly, potentially far exceeding the power of supercomputers.

Harnessing that potential will probably take a decade or more. Today's quantum computers have a relatively small number of quantum bits, or qubits, with which to make calculations. It will not be easy to get to the point where there's enough of them to perform hard calculations quickly.

Because quantum computers eventually could be powerful enough to defeat current methods of encryption and run complex simulations to discover new drugs, the field has attracted a groundswell of investment from private capital sources and governments.

The U.S. is the clear world leader in the construction of quantum computers. Google last year claimed its 54-qubit machine, which excels at measuring probabilities in randomly outputted numbers, achieved “quantum supremacy,” making a calculation that wasn't possible—or, at least, not practical—on a classical computer. International Business Machines Corp., another American company that has a quantum computer rivaling Google's, disputed that result, saying the calculation actually could be performed with a supercomputer in a reasonable amount of time. Chinese scientists have built quantum computers, but analysts say they're years behind the U.S.

Quantum technology, however, goes beyond computers and extends into using quantum properties to communicate quickly and securely. That's where China may have the advantage. Led by Pan Jian-Wei, dubbed China's “father of quantum,” the country has pushed the envelope in quantum communications, sensors and radar—all areas with possible military applications. The country in 2016 launched a satellite, called Micius, that uses photon beams in a quantum state that makes transmissions impervious to interception. It's building a huge quantum-information-sciences lab in east China, a project with a \$10 billion price tag.

So the scorecard is split: The U.S. leads in quantum computing, and China leads in quantum communications and encryption. The future is hard to forecast because advances that will shape the field are likely still decades off, says Elsa Kania, a researcher at the Center for a New American Security, a think tank based in Washington, D.C.

“We’re at a relatively early stage of what I think can be more accurately characterized as a marathon,” she says.

Edge goes to: U.S. in quantum computing, China in quantum communications

Semiconductors

China has spent tens of billions of dollars over decades trying to get a leg up in semiconductors, essential ingredients in the race for faster computers and smartphones and more-sophisticated weaponry. Statistics from the Semiconductor Industry Association, based in Washington, D.C., suggest U.S. exports of chips to China have stayed around the same level for years, and that Chinese companies haven’t gained tremendous market share, even domestically. About 47.5% of chips sold in China were American as of 2018, according to SIA figures.

China’s neighbors have made a prominent place for themselves in the global semiconductor supply chain, with South Korea’s Samsung Electronics Co. becoming a dominant smartphone and chip supplier and Taiwan Semiconductor Manufacturing Co. becoming the world’s largest contract chip manufacturer.

That’s a model that China could never seem to replicate. The country’s leading chip maker, Semiconductor Manufacturing International Corp., isn’t able to produce the most cutting-edge chips with the smallest transistors. Some estimates suggest China is five to seven years behind the U.S. and Taiwan on chip technology, but it may take longer for China to catch up because cutting-edge chips are a moving target. By the time China is able to make chips that compete with the best available today, the rest of the industry will likely have taken another leap ahead.

That said, China has surprised U.S. officials by replacing American chips in many of its companies’ electronic devices with a combination of domestic chips and ones sourced from non-U.S. companies. Huawei’s newest phablets, launched last year, didn’t include any U.S. chips, according to a teardown of the devices commissioned by the investment bank UBS.

For the short term, China’s semiconductor strategy is focused on reducing reliance on the U.S., which often means finding other non-Chinese substitutes. In the long term, though, many industry observers think it’s a matter of when, not if, China’s huge investments in chip making finally pay off.

“If you’re willing to spend billions of dollars for dozens of years, eventually you’ll get there,” says Jim Lewis, a senior vice president at the Center for Strategic and International Studies, a Washington, D.C., think tank.

Edge goes to: U.S.

Autonomous vehicles

Silicon Valley businesses such as Google’s Waymo and General Motors Co.’s Cruise got a head start on testing driverless-car technology, helping give U.S. companies the early lead in sensor hardware, such as the cameras and radar needed to detect obstacles on the road. And the U.S. dominance of the semiconductor industry gives American companies the edge in making the chips that will essentially be the brains of such vehicles.

Chinese companies were two to three years behind international rivals in the important capabilities needed for self-driving cars, McKinsey & Co. said in a report last year.

But in the long term, China is poised to come out ahead. It is already the world's biggest car market, and the country's regulatory environment—such as restrictions on accessing maps on national-security grounds, as well as requiring foreign companies to partner with local ones—favors domestic champions trying to win the market there, which include Baidu, Didi Chuxing Technology Co. and Pony.ai. “It will be difficult for American companies to be competitive,” says Nikolaj Herskind, of Scandinavian consulting firm Qvartz.

China's huge population will give Chinese companies more data they can use to refine autonomous-vehicle technology. It also helps that the Chinese are more willing to try self-driving cars. While 48% of Americans said in a 2020 Deloitte survey that they thought autonomous vehicles were unsafe, only 35% of Chinese respondents thought the same thing.

China's lead in 5G infrastructure means its car companies can test, in real-world conditions, how the wireless technology can be used to beam map and traffic data to cars, or even remotely control vehicles in some situations.

But given how governments intensely regulate self-driving car tests and technology, says Andrey Berdichevskiy, director of Deloitte's Future of Mobility Solution Center, the most likely outcome of the autonomous-vehicle technology race is a bifurcated world—similar to how the U.S. and China are developing their own ecosystems for other hardware and software.

“I expect U.S. and Chinese players to first become successful in their home markets, but regulations and consumer perception makes it harder for either side to flourish on the other's territory without a local partner,” Mr. Berdichevskiy says.

The edge goes to: U.S., for now.