Deloitte’s Technology, Media, and Telecommunications (TMT) group brings together one of the world’s largest pools of industry experts—respected for helping companies of all shapes and sizes thrive in a digital world. Deloitte’s TMT specialists can help companies take advantage of the ever-changing industry through a broad array of services designed to meet companies wherever they are, across the value chain and around the globe. Contact the authors for more information or read more on Deloitte.com.
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Dear reader,

Welcome to Deloitte Global’s Technology, Media, and Telecommunications Predictions for 2019. The theme this year is one of continuity—as evolution rather than stasis.

Predictions has been published since 2001. Back in 2009 and 2010, we wrote about the launch of exciting new fourth-generation wireless networks called 4G (aka LTE). A decade later, we’re now making predictions about 5G networks that will be launching this year. Not surprisingly, our forecast for the first year of 5G is that it will look a lot like the first year of 4G in terms of units, revenues, and rollout. But while the forecast may look familiar, the high data speeds and low latency 5G provides could spur the evolution of mobility, health care, manufacturing, and nearly every industry that relies on connectivity.

In previous reports, we also wrote about 3D printing (aka additive manufacturing). Our tone was positive but cautious, since 3D printing was growing but also a bit overhyped. But time has passed. Reality has caught up to—or in some ways even surpassed—the earlier enthusiasm, and we now have new and impressive forecasts for that industry. We also wrote about eSports, which has evolved from a cult phenomenon to simply “phenomenon,” with big implications for media companies and advertisers.

In each of the last two Predictions reports, we discussed the truly exponential growth in machine learning, largely focusing on the chips that provided the processing foundation for that growth. We believe that machine learning will be the biggest and fastest-growing trend in technology again in 2019. We look at how machine learning is evolving rapidly from the domain of experts to a powerful technology any company can harness through the cloud. We also examine how China is growing its domestic chip industry, in part by leading with the artificial intelligence chip business.

We’ve had a prediction around TV, which is always worth writing about, every year for the last decade. In 2019, we focus on TV sports, young viewers, and TV sports watching’s surprising (and hitherto largely undocumented) connection with sports betting. To prove that even old (media) dogs can learn new tricks, we also write about traditional radio and its resilience ... even as it celebrates its 99th birthday this year! The first-ever commercial radio broadcast was November 2, 1920.

Of course, our report features new themes that will surely evolve. Smart speakers have rocketed onto the scene as one of the fastest-adopted new devices in history; where will they go from here? Finally, we look at the world of quantum computers, a technology so new that it is still damp behind its superposed and entangled ears. When will quantum computing be big, and how big will it be? Read to the last page to find out!
While there is continuity, the changes—often rapid changes—we track in this year’s report are new, important, and usually counter-consensus. TMT companies should understand and account for them as they evolve. We think they will matter to our readers in other industries as well, and they are important in all markets globally.

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DELOITTE GLOBAL PREDICTS that revenues for semiconductors manufactured in China will grow by 25 percent to approximately US$110 billion in 2019 from an estimated US$85 billion in 2018, to meet the increasing domestic demand for chipsets driven in part by the growing commercialization of artificial intelligence (AI). Deloitte Global further predicts that in 2019, a Chinese chip foundry will begin

China inside
Chinese semiconductors will power artificial intelligence
Chris Arkenberg
producing semiconductors specialized to support AI and machine learning (ML) tasks.

With China as the leading consumer of semiconductors (it consumes more than 50 percent of all semiconductors annually, both internally and for eventual exports),1 its growth has lifted the entire industry. And yet, Chinese manufacturers only meet around 30 percent of their own demand.2 Amidst shifting macroeconomics and the growing value of AI, the Chinese government and leading digital businesses have signaled that greater domestic self-supply of semiconductors is a vital component of their future. They are spending and hiring aggressively to create onshore manufacturing capabilities approaching those of the top global foundries.

Many Chinese companies are designing specialized semiconductors for AI and have designed chip architectures at the bleeding edge of the mobile smartphone industry. With strong coordination between the state and domestic manufacturers, China is wielding a great deal of capital and its massive market to advance its agenda. And while China has failed to expand its semiconductor industry in past decades, this time it may succeed. Its success might be further supported by the evolving relationship between computation and emerging technologies.

Mining for bitcoin

To better understand the modern Chinese semiconductor industry, it’s worth looking at public cryptocurrencies. In December 2017, the market value of a single bitcoin4 reached a historic high of US$17,900.4 It wasn’t an easy climb, and the value of bitcoin has fallen precipitously since, but the growth of cryptocurrencies has nonetheless captured headlines and, perhaps surprisingly, inspired Chinese semiconductor innovation.

Behind the headlines are the legions of bitminers running the computations that underlie the cryptocurrency economy. Each bitminer is potentially rewarded (in bitcoin) if he or she is the first to solve the mathematical puzzle within each transaction. Those with the most processing power are more likely to reach the solution fastest. In the early days of cryptocurrency, miners bought graphics processing units (GPUs), built server farms, and ran up large power bills to gain an advantage over each other. Their frenzy boosted GPU sales and consumed more power than small countries.5 But GPUs were expensive, power-hungry, and in short supply. The opportunity thus arose to introduce custom-designed chips that would be even better than GPUs for bitmining. The race was on to build application-specific integrated circuits (ASICs) that were optimized for bitmining.

The growth of cryptocurrencies has captured headlines and, perhaps surprisingly, inspired Chinese semiconductor innovation.

In 2013, Bitmain Technologies Ltd. was founded in Beijing to meet the growing computational needs of the young bitcoin economy.6 At the time, Chinese entrepreneurs were jumping on the bitcoin bandwagon, building server farms to help mine the cryptocurrency. Bitmain was one of the first chip designers to address this demand with specialized chip architectures. Instead of building general-purpose central processing units (CPUs) or GPUs, Bitmain developed single-use ASIC chips that could only do one thing: compute the proof-of-work calculations inside a bitcoin transaction. The popularity of its Antminer line of bitmining chipsets has earned Bitmain billions of dollars annually while stoking fears of an imbalanced cryptomarket.7 Other chip designers soon followed with their own bitmining solutions.

The design of Bitmain’s chips is advanced, with recent product lines using a 16-nanometer (nm) process (the measure of how small a transistor is), but they are still fabricated away from the Chinese mainland at Taiwan Semiconductor Manufacturing Co. (TSMC), the same foundry that produces iPhone...
chips for Apple Inc. This underscores the state of the Chinese semiconductor market: Local design has become competitive, but local fabrication is still behind that of global leaders.

**From bitmining to AI**

As China began to regulate cryptomarkets, and as these markets’ value has fallen, Bitmain announced its interest in supporting the computational needs of another emerging technology that will likely be larger over time. Like cryptocurrencies, AI has its own unique computational demands—demands that can be satisfied by general CPUs but whose execution can be accelerated by different architectures. Google’s Tensor Processing Unit, for example, is an ASIC for AI, and other companies are building ASICs for AI as well. The rise of GPU maker Nvidia has been driven in part by the demand for chips to perform ML training and inference, key tasks underlying today’s AI technologies. The massively parallel processing architectures of GPUs are better suited to common AI tasks than the serial designs of CPUs. Initially, gaming GPUs were exploited to drive ML tasks, but in the past few years of AI’s global ascent, Nvidia has delivered new hardware lines that directly support ML. Bitmain hopes the needs of AI might be better served by its ASICs than by GPUs.

Beijing’s Horizon Robotics, founded by the former head of Baidu’s Institute of Deep Learning, supplies embedded chips for machine vision. The chips include pre-trained data sets that can enable edge processors to run inference tasks (predicting how likely it is that an image matches its training set). Backed by Intel, Horizon is working with major automotive brands to provide edge processing with machine vision for vehicles. Although its chips are based on 10-year-old 40 nm processes, Horizon’s software enables it to be a strong competitor to much larger players in the embedded inference market. In this case, Horizon’s algorithms enable capabilities above and beyond the hardware.

Another notable Chinese chip player, Cambricon, also has a line of chips specialized to support ML tasks. Previously, Cambricon contributed design support for AI in Huawei’s Kirin smartphone chipset, then it delivered its own ML solution for data centers, the MLU100 line. This architecture leverages TSMC’s 14 nm process node for fabrication.

Of course, many non-Chinese providers are also trying to sell AI chips to the Chinese market, and foreign competition may grow fiercer as the country meets more of its own demand. The largest Chinese companies will likely buy from whoever supplies the best chips, foreign or domestic. It’s worth considering that, like many of the top digital platform businesses, China’s largest digital companies are also pursuing their own bespoke chip architectures to meet the needs of their hyperscale digital platforms.

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However, Chinese manufacturers often still lag in fabrication for the most advanced (i.e., smallest) processes. Foundries require enormous capital investments, as they need to build incredibly large industrial processes capable of making incredibly small circuitry. Top Chinese foundries such as Semiconductor Manufacturing International Co. (SMIC) are working to scale production at 14 nm, while AMD, TSMC, and others are reaching 7 nm. By this measure, Chinese foundries are two to three generations behind global leaders.

Despite this lag, the industry in China continues to advance. Revenues for semiconductors manufactured in China have grown steadily over recent
years, reaching around US$78 billion in 2017—a growth rate of about 19 percent over 2016. Over the past 15 years, this revenue curve shows more-than-linear growth, suggesting that the quality of Chinese semiconductors is getting better at meeting demand.

China meets the future

With the growth of AI and of purpose-built chips to support it, Chinese chipmakers may be able to capture more of that demand. Although China has failed to grow its own chip industry in the past, Chinese manufacturers have steadily developed greater capabilities over the years. Now, they are driven by a heavily funded state agenda, a strong domestic market, and their own hyperscale platform companies. As a result, China is perhaps better positioned now than ever before to become a globally competitive player in both semiconductors and AI. This could have very large implications.

Why is China better positioned than ever before? Five current conditions make China’s ascent in semiconductors more likely:

Domestic demand. China is now the largest global consumer of semiconductors, importing about US$200 billion worth each year. Its large population includes 800 million internet users. The size of China’s population and the growth of its economy support strong domestic demand, which drives the majority of foreign suppliers’ profits. And while much of the developed world is nearing saturation for PCs and mobile devices, China’s demand for chips has continued to grow. Indeed, the world economy has grown increasingly dependent on demand from China, and more global investors are underwriting its future. This shift has helped enable China to have more control over how foreign manufacturers can access its domestic market.

State sponsorship. Although China’s economy has cooled somewhat, it remains massive, and it has enabled the state and its industries to build significant war chests. Although China’s economy has cooled somewhat, it remains massive, and it has enabled the state and its industries to build significant war chests. And even though the Chinese state has been criticized for its tight relationship with its largest industries, state control affords the country much tighter market coordination. In 2014, the State Council of China announced the National Guidelines for Development and Promotion of the Integrated Circuit Industry. The plan addressed the technology gap between Chinese manufacturers and global leaders and was supported by a US$21.8 billion fund led by government-backed businesses. In 2015, China announced its Made in China 2025 plan, which aims to grow domestic production of core technological components—including semiconductors—to 40 percent by 2020 and 70 percent by 2025. More funds have since been raised to support these goals.

SMIC, the world’s fifth-largest contract chipmaker, expects its state subsidies for 2018 to near US$100 million. SMIC has placed an order with Holland’s ASML for extreme ultraviolet lithography (EUV) equipment, one of the most advanced chip production tools, for an estimated cost of US$120 million. The Shanghai manufacturer hopes to scale production of its 14 nm process by the end of 2019, although it costs billions to build a competitive foundry. It is not alone. The industry organization SEMI estimates that China will spend US$13 billion on fabrication equipment in 2018 to become the world’s second-largest buyer. At the end of 2017, China had plans to build at least 14 new chip foundries.

Growing demand for AI. In 2019, the global semiconductor industry will likely focus more support on the needs of AI. Advances in AI are one of the driving forces for the industry, with an anticipated 5–6 percent growth rate over the next
two decades. Computation itself is undergoing more specialization to meet the needs of AI. These trends are coming together with China’s strategic efforts to develop semiconductor independence and move AI into the center of its economic future. By 2018, the country led the world in patents for deep learning, though the overall value of those patents is unclear. China has loudly declared that its future is to be driven by advanced technologies, with AI as a key ingredient.

Many of China’s largest companies are hoping to win an edge in the market for AI. Baidu, Alibaba Group Holding Ltd., and Tencent (collectively known as BAT) have a combined market capitalization of over US$1 trillion, fielding global operations in numerous lines of business. They have invested billions in other companies, both domestically and overseas. Indeed, the trio holds positions in more than half of China’s 124 unicorn startups, including SenseTime, the world’s most valuable pure-play AI company. In some ways, the very existence of the BATs should be proof enough that the country can scale its technology companies to be globally competitive.

China has loudly declared that its future is to be driven by advanced technologies, with AI as a key ingredient.

Perhaps unsurprisingly, each of the BAT entities are bringing AI capabilities into their own product and service lines. Increasingly, each is making or planning to make its own custom chips for AI. Alibaba has announced a plan to build custom AI chips for inference at the edge, supporting its Internet of Things business lines in autonomous driving, smart cities, and logistics. This builds on its acquisition of Chinese chipmaker C-SKY Microsystems. For its part, Baidu’s Kunlun multicore chip solution is a field-programmable gate array chipset built specifically to support its expanding cloud computing platform. The chipset will likely find its way into Baidu’s ambitious autonomous driving platform, Apollo. Notably, Baidu isn’t getting its chips from China, at least not yet; it’s using Samsung’s 14 nm process.

In June 2017, China’s State Council published the Next Generation Artificial Intelligence Development Plan, which states China’s aim of becoming the world leader in AI by 2030. Along the way, the roadmap aims for parity with western capabilities by 2020 and seeks major breakthroughs in AI by 2025. The plan appears to be well aligned with the agendas of China’s top companies, the goals of some of its largest investment vehicles, and the aims of many of its municipal projects.

Onshoring foreign operations and hiring foreign talent. Autonomous vehicles sit at the intersection of robotics, AI, and semiconductors. They present very difficult design challenges, and Chinese startups and the country’s top hyperscale platform companies still look to Silicon Valley for expertise in driverless technologies. However, while expertise in autonomous cars may remain foreign, Chinese industries are pursuing the hardware and software to build the cars by investing in foreign manufacturers and aggressively hiring and onshoring market leaders. In June 2018, Japan’s SoftBank Group announced that it would sell a majority stake in the Chinese operations of Arm Holdings, a leading provider of semiconductor designs (including the Cortex line of chips for the iPhone), to a Chinese investment fund. Led by Hopu Investment Management Co. and backed by a Chinese sovereign wealth fund and Beijing’s Silk Road Fund, the group acquired 51 percent of Arm Holdings’ Chinese business for US$775 million. The move will give China more access to Arm’s designs. Notably, about a fifth of Arm’s 2017 earnings came from Chinese demand.

To continue developing their domestic chip supply, Chinese companies should also draw more talent to the mainland. On this front, Yangtze
Memory Technologies has invested US$24 billion to build China’s first advanced memory chip factory and has lured thousands of engineers away from foreign chipmakers. The company recently announced progress on its 32-layer NAND memory chip—a good sign, though still behind the state-of-the-art 64-layer chip that other memory manufacturers are achieving. Similarly, to advance its 14 nm efforts, SMIC hired a senior executive away from Taiwan’s TSMC, the world’s largest contract foundry and one that is considered to be two to three generations ahead of SMIC. Meanwhile, TSMC has begun constructing a foundry in Nanjing to gain a stronger foothold in the Chinese market.

**Chip design and intellectual property (IP).** Although Chinese companies’ ability to manufacture the most advanced semiconductors is still developing, Chinese designs and IP for chip architectures are now globally competitive. Huawei designed its new mobile chipset at 7 nm and claims that it performs better and uses less energy than its top competitor. The Huawei system-on-a-chip also boasts AI cores and claims to be the world’s fastest modem—in time for early 5G deployments. While Huawei relies on Taiwan’s TSMC for fabrication—similar to other top Chinese technology brands that showcase their domestic designs while manufacturing elsewhere—it signals that Chinese companies can produce specs at the bleeding edge of technology.

**Chinese startups and the country’s top hyperscale platform companies still look to Silicon Valley for expertise in driverless technologies.**
BOTTOM LINE

China is moving aggressively in its efforts to define the next phase of the digital economy, with its government, manufacturing, and hyperscale digital businesses all working together. If China meets its goal of growing its domestic chip production as a percentage of total chip consumption to 40 percent by 2020, it could significantly impact the global chip market. Recall that Chinese demand in 2018 accounted for more than half of the world's semiconductor demand. If Chinese chip manufacturers and the Chinese state can buy, hire, and develop enough advanced manufacturing capabilities while meeting the demands of AI, not only could these activities spark more domestic innovation, but China just might be positioned to have a larger impact on the next generation of cognitive technologies.

Leading foundries and chip designers outside China should accelerate their capabilities to remain competitive for Chinese demand. The development of newer architectures specialized for general and discrete machine learning (ML) workflows will likely become more important, with an increasing need for lightweight inference at the edge paired with high-performing training and modeling at the core. Leading AI providers may experience increasing pressure to offer greater capabilities at cheaper prices, which could lead to the commoditization of AI.

Current leaders in AI cloud services should continue to invest in research and development to find newer approaches to learning systems. The BATs are moving quickly, and they have an eye toward a greater presence in global markets. At the service level, they will likely exert more pressure on digital platform leaders and cloud providers, and they may find stronger footholds across logistics, industrial Internet of Things, and automotive sectors. Innovation, efficiency, and pricing will likely become more important to current leaders seeking to secure their competitive advantage. The greatest advantage for semiconductor incumbents, however, may be in staying close to their customers and continually advancing their own digital transformation. This requires sensing, rapid innovation, and the ability to learn and adapt quickly.

If China is even marginally successful in advancing its semiconductor agenda, it may be even better positioned to control access to its growing consumer market. If its progress in AI advances and weaves its way through both the state and commerce, the degree of data, analytics, and insights thus enabled could drive a feedback loop of optimization, enhancement, and innovation—and further reinforce the command-and-control nature of China's economy. To execute successfully on such broad change, however, the Chinese government and China's businesses will likely demand more consulting services and knowledge transfer from developed economies and current industry leaders. A big-picture view could be to see this as a sign of China's digital transformation becoming stronger.

Ultimately, for China, technological independence is about self-determination. Only a few decades ago, China was regarded as little more than the world's cheap manufacturing and assembly hub, and considered a somewhat minor global player. Since then, it has steadily moved up manufacturing's value chain. By learning from decades of manufacturing and by supporting its strongest digital businesses, China has bootstrapped its capabilities to produce some of the world's largest companies and most advanced products. It still faces considerable uncertainties due to the shifting winds of macroeconomics and the very real challenges at the edge of Moore's Law. And yet, it's harder now than ever to doubt China's potential.
China inside: Chinese semiconductors will power artificial intelligence

Endnotes

3. There are many other cryptocurrencies, but for the sake of simplicity, we refer here to bitcoin.
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24. Kubota, “China plans $47 billion fund to boost its semiconductor industry.”
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China inside: Chinese semiconductors will power artificial intelligence
Organizations and governments can take steps now to help capitalize upon—and protect themselves in—a quantum-computing world:

**Create a long-range quantum-safe cybersecurity plan.** It is definitely not too early to begin planning to fortify cyber defenses against a quantum future. The National Institute of Standards and Technology (NIST, part of the US Department of Commerce) recently assessed the threat of quantum computers and advised organizations to develop “crypto agility”—that is, the ability to swiftly switch out cryptographic algorithms for newer, more secure ones as they are released or approved by NIST. Organizations should pay attention to these developments and have roadmaps in place to follow through on those recommendations.

**For companies working at the atomic level, think about NISQ.** Single-task quantum devices of 50–100 physical qubits, though unsuited to most tasks, can be useful for modeling atomic behavior, and they will become available in the relatively near term. Companies in chemistry and biology will almost certainly benefit. Many companies in these fields are already investing in classical high-performance computing (HPC) computing resources; adding a NISQ initiative just makes sense.

**For companies working at the regular-size level, also think about NISQ.** More fields than chemistry and biology can use NISQ computers. In the financial sector, for instance, it is believed that these intermediate QCs can perform portfolio optimization, while other possible financial applications include trading strategy development, portfolio performance prediction, asset pricing, and risk analysis. The transportation industry is also looking at QCs: Some car companies are testing them for traffic modeling, machine learning algorithms, and better batteries. The logistics industry sees potential in QCs for route planning, flight scheduling, and solving the traveling salesman problem (a famously difficult task for classical computers). And, not unlike HPCs, NISQ computers are likely to find a place in both government and academia: for weather modeling and nuclear physics, to name just two examples.

**Update high-performance computing architectures.** Enterprises in industries that have already invested in HPCs, such as aerospace and defense, oil and gas, life sciences, manufacturing, and financial services, should familiarize themselves with the impact that quantum computing may have on the architecture of HPC systems. Hybrid architectures that link conventional HPC systems with quantum computers may become common. One company, for instance, has described an HPC–quantum hybrid for the simulation and design of a water distribution system; it uses quantum annealing, a restricted version of quantum computation, to narrow down the set of design choices that need to be simulated on the conventional system, with the potential to significantly reduce total computation time.

**Reimagine analytic workloads.** Many companies regularly run large-scale computations for risk management, forecasting, planning, and optimization. Quantum computing could do more than just accelerate these computations—it could enable organizations to rethink how they operate, and to tackle entirely new challenges. Executives should ask themselves, “What would happen if we could do these computations a million times faster?” The answer could lead to new insights about operations and strategy.
As observed earlier, companies may even be able to reap some benefits from quantum computing before the machines themselves are commercially available. Quantum computing researchers have discovered improved ways of solving problems using conventional computers. Some researchers are seeking to bring “quantum thinking” to classical problems. A startup that offers quantum-inspired computing technology for machine intelligence claims to be seeing increases in computational speed using this approach.

**Explore academic R&D partnerships.** Companies may find it worth allocating R&D dollars to collaborations with academic research institutions working in this area, as Commonwealth Bank of Australia is doing. An academic research partnership could be an effective way for an organization to get an early start on building knowledge and exploring the applications of quantum computing. Research institutions currently active in quantum computing include the University of Southern California, Delft University of Technology, University of Waterloo, University of New South Wales, University of Maryland, and Yale Quantum Institute.

Most CIOs will not be submitting budgets with line items for quantum computing in the next two years. But that doesn’t mean leaders should ignore this field. Because it is advancing rapidly, and because its impact is likely to be large, business and technology strategists should keep an eye on quantum computing starting now. Large-scale investments will not make sense for most companies for some time. But investments in internal training, R&D partnerships, and strategic planning for a quantum world may pay dividends.
Endnotes

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Quantum computers: The next supercomputers, but not the next laptops

24. This recommendation and the paragraphs that follow previously appeared in a Deloitte University Press publication: David Schatsky and Ramya Kunnath Puliyajodil, From fantasy to reality: Quantum computing is coming to the marketplace, Deloitte University Press, April 26, 2017.


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