

The New Arms Race: Supply Chains, Data and National Security

The CDC 6600 is thought to be the world's first supercomputer. It was developed by the Control Data Corporation in their labs near Chippewa Falls, Wisconsin in 1964. That was before most people had even heard of a computer. It stood 6 feet tall, weighed in at more than 5 tons, and sold for around \$7 million. This remarkable machine had memory capacity of around 2 megabytes. That's a tiny fraction of the typical smartphone we carry in our pockets every day. A single microchip in our modern devices contains billions of transistors, while the CDC 6600 was limited to just a handful. And just as Moore's Law predicted at the time, that number of transistors would double every year or so, transforming information technology and leading to the dot-com bubble. Today, the technology sector is laser-focused on artificial intelligence. The applications for generative AI and machine learning seem endless. But the projected computing power needs are also growing at astonishing rates. Around 20% of data center capacity is now used for generative AI. And global demand for all data center capacity is growing at around 20% per year. How can investors identify the next wave of AI investment opportunities, including data centers and digital infrastructure? And how will data sovereignty, supply chains, and other security concerns shape both the opportunity set and risk outlook? To understand today's investment landscape, it's important to know how we got here. This is *The Outthinking Investor*, a podcast from PGIM, that examines the past, the present-day opportunities and future possibilities across global capital markets. Chris Miller is a professor at the Fletcher School of Tufts University and author of the book *Chip War: The Fight for the World's Most Critical Technology*. Bill Reinsch is the Sholl Chair and Senior Advisor at the Center for Strategic and International Studies in Washington, DC. Morgan Loughlin is Global Head of Data Center Investments at PGIM Real Estate. The artificial intelligence landscape has gone through a massive evolution over a short period of time with far-reaching implications. Chris Miller has some observations.

I think the biggest challenge at first with the boom in investment in artificial intelligence was actually just building out the infrastructure. If you listen to the world's biggest technology companies, from Microsoft to Meta, Alphabet to Amazon, they have all spent the last couple of years trying to build out the infrastructure that AI requires. They've all been surprised by the demand for AI products, which means that they've all had to more rapidly build out data centers than they expected. And this has not just meant more data centers, it's meant more of all the stuff that makes data centers possible. Like the semiconductors inside, like all of the components that go into the servers, like the transformers that make possible the powering of these data centers, all the way down the computing and data center supply chain, there's been unexpected demand. And this has, I think, caused AI to have had impacts in places you would not have expected. If you look, for example, at the manufacturing of gas turbines that go into natural gas powerplants, you probably wouldn't think those are connected to artificial intelligence. But it's because AI is requiring more electricity that there's more demand than expected for gas turbines causing lead times for turbines to be much longer than expected. And I think that's a great anecdote that explains already just how deeply this AI investment boom is reaching into different segments of the economy. And to really understand the AI supply chain, you've got to actually not just look at who are the AI engineers in San Francisco thinking up the algorithms, but also who's building out the infrastructure that makes all this computing possible. Elon Musk said in 2024 that the chip rush is greater than any gold rush. And I think many investors have adopted a similar logic in trying to invest in what they describe as the picks and shovels of AI. And the logic behind this has been that you can't know or it's hard to know which AI model or which AI application is going to win in the long run. But you definitely know that more AI will require more computing power. And so, building up the data centers and buying the chips and supplying the power has been seen by many investors as a better bet, or at least a higher confidence bet in terms of the early stages of this artificial intelligence boom.

Not all data centers are created equal. Most of the existing data centers are on the enterprise side of the spectrum, housing a company's servers, storage and network systems, and the rest of their IT infrastructure. On the other end of the spectrum are hyperscale data centers which provide the massive power needed for AI applications. Morgan Laughlin is focused on the investment opportunity for hyperscale from a real estate perspective.

Hyperscale is really defined more as a group of users than anything else. And the names that most people know when you talk about hyperscale are Microsoft, Amazon, AWS, Oracle, Google and Facebook as large US-centric hyperscalers. And then globally, you have Tencent, Alibaba and others. Those are probably the best-known names of the hyperscale sector on the customer side. The hyperscale business really grew out of the transition from on-prem technology resources where all of your technology and your infrastructure for your technology was resident within your company. Starting around about 2010, as AWS, Microsoft and Google began launching cloud-based systems, the hyperscale business grew rapidly from there. And what those cloud-based systems allowed was companies to stop housing all of their own computer infrastructure on a proprietary basis. Effectively within their office spaces, it allowed them to outsource those data services. Since 2010, you started seeing an upward

trajectory of demand within that hyperscale space driven purely by that movement towards cloud from proprietary architecture. If you look back now, November 2022, you get the launch of ChatGPT and the launch of AI as a meaningful element within our lives and within the data center industry. You're now seeing a further ramp up in demand for hyperscale, as all of that compute requirement necessary for both the training of AI and also the application of that AI has created a huge new demand driver within space, all of which falls into that hyperscale bucket.

The US was an early adopter of digitization and then artificial intelligence. That's provided a tremendous economic advantage which has continued along with the development of hyperscale data centers.

The growth of cloud began in the United States and the United States has been the leader in the adoption of cloud. And so, the growth of the hyperscale industry is greatest within the United States. And interestingly and not purely coincidentally, the growth of AI demand, the growth of the machine learning, AI learning requirements, the computer capacity, the compute capacity, the data center capacity required, that's also been concentrated within the United States market. The US is by far and away the biggest and at the moment, due to the AI, the fastest-growing market globally. If you look purely at the cloud component and take out the AI and machine learning training aspect of it, then Asia Pacific is the fastest growing. It's been slower than the United States and Europe in adopting the cloud, but is now at this point growing the most rapidly within that more traditional cloud infrastructure perspective. Europe was kind of falling on the heels of the United States, smaller market, not quite as deep a penetration and not as rapid a growth rate as Asia Pacific. The hyperscale component of the data center industry is projected to grow, depending on the source, anywhere from 23 to 28% compounded annual growth for the next three to five years.

An important aspect of the link between the growth of artificial intelligence and the investment opportunity of hyperscale data centers relates to geopolitical issues and concerns about national security. Tensions between China and the US are at center stage.

Both Beijing and Washington believe that artificial intelligence will be important, not just for chatbots or for tech companies, but also because governments are already using it for strategic purposes. If you listen to the US defense secretary or China's leaders or most of the world's key powers, they're already talking about the application of artificial intelligence for defense and intelligence collection purposes. And so, there's a direct linkage between the contest for the future of AI and the geopolitical contest between the United States and China to define the world's political landscape and its future technological balance. And I think it's fair to say that for all of their disagreements, both American and Chinese leaders believe that AI will be a critical component of the future political balance in the world.

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When it comes to complicated issues like artificial intelligence, governments tend to over-control or under-control. Bill Reinsch considers how this will play out for questions on national security.

It's a constant struggle to walk a very fine line between under-controlling and over-controlling. If you under-control, the bad guys get things you don't want them to have and it enhances their military capabilities. If you over-control, to put it simply, you end up kneecapping your own guys. Because particularly in the high-tech sector, the dilemma that our high-tech companies face, frankly, is that China is simultaneously the best customer and the biggest threat. And they have to figure out how to deal with that. And frankly, I don't think they've done a very good job over the years. They struggle with it. They want and need the short-term revenue that comes along with it. Wall Street tells them to focus their planning on quarterly earnings reports and share price. That makes big customers very important. And it has a practical consequence. If you forego lots of revenue, you cannot reinvest in the development of next technology products. And in the high-tech area where technology has a short shelf life, that matters a lot. When I was in the government, I had an eye-opening conversation with a colleague from the Defense Department who was lamenting the fact that the life cycle of things they were buying was shorter than their procurement process, which meant that they were always out of date. And he was talking mostly about software. And to their credit, they developed ways to deal with that. So, it's a dilemma and it really ends up being case by case. And the government kind of decides, what do we want to do about this chip? What do we want to do about that chip? What are we going to do about quantum? What are we going to do about different elements of AI? What are we going to do about data? And can we parse data into different categories of risk or not? What are we going to do about the cloud? Each of these are very specific questions. All of them are complicated. And it's a challenge to sort through it. One of the reasons it's a challenge is there's an enormous amount of political pressure that shows up on both sides of any decision.

Another reason it's a challenge is the complexity that supply chains add. Risk can be obscured at any point of a product supply chain. Case in point was the shocking news of exploding pagers and walkie-talkies in Lebanon during September of 2024.

Governments have always tried to use supply chains to achieve their strategic interests, particularly during times of war. I think what's different now is that supply chains have gotten so complex and so internationalized that it's much harder than ever for governments to verify that the products their consumers are buying, or even that they're buying themselves, are designed and manufactured in the way they expect. Today, a typical product, especially electronics products, will cross borders dozens of times in their manufacture. It will be designed. The software will be written by many different groups in many different countries. And so, this question of verification is getting harder and harder as time passes and as products become more complex. And the Hezbollah pagers are a great example of this. The pagers were marketed as being Taiwanese in origin. In reality, it was a Taiwanese brand and the Israelis did all of the design and manufacturing themselves. Governments are concerned about this dynamic, but I also think they don't really know what to do because it's implausible that we're going to be undertaking a teardown of every phone or pager we buy. It's just not economically possible. And companies themselves don't have the methods or the capabilities to undertake this type of analysis themselves. I think the right analogy to think of where we are is in the early days of the push towards taking cybersecurity seriously. If you think back 20 years, there really weren't that many companies that were specialized in cybersecurity. You might have a single antivirus software downloaded in a computer, but it was not very sophisticated. And it took decades as well as many billions of dollars of investment to build up the capabilities to really analyze software systems and try to find vulnerabilities. And even still, we're still in the process of getting better at that. We're at stage one when it comes to hardware verification and security. And I think over the next decade, we're going to see a lot more investment, a lot of new tools being developed to provide some of the assurance that not only governments but also companies and consumers want and today can't really provide themselves.

As the use of AI continues to expand, so do concerns of potential risks. How might data centers and cloud computing be impacted by national security issues?

Overall, I think that this is going to lead to greater data localization, which is not going to be a good thing. But you can see that happening first on the part of authoritarian governments who have their own reasons for doing it. But I think what you're going to see is companies doing it themselves for other reasons. I'd suggest I think three areas to look at. One, heightened security concerns in the cloud and in data centers may slow down the adoption of cost-cutting cloud computing capabilities and may instead scare companies into sticking with older computing technologies. That's ironic because the older systems may be less secure and more vulnerable. But what you do if you're nervous about something new is you stick to the old. The Government Accountability Office conducted a survey in 2023 that concluded that some government agencies are still using legacy computing technologies that are decades old. And some of them are even currently reducing their use of cloud computing and cloud services for security reasons. It makes everybody more cautious and more conservative. I think cloud computing also raises data sovereignty concerns which leads to localization efforts. Governments are increasingly viewing data as a strategic national asset. We certainly are. That leads them to be interested in heightened security over whoever owns and operates data centers, and particularly those that store sensitive data. So, you're seeing enhanced privacy regulations and enhanced localization requirements on the part of I think a growing number of governments, unfortunately. What that ends up meaning sometimes is forcing the prioritization of service providers that are less efficient and possibly less secure, but which are domestic. And that is the world that we may be heading towards is more localization. And finally, one of the cloud computing elements is creating backups of all data stored in a data center, backing it up in a duplicate center somewhere else, co-location of the words. That creates uncertainty if there is a problem about what the source of the breach was, where it was, and how it happened.

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The infrastructure needs for cloud computing and data centers also adds to national security concerns. That includes the vast energy requirement and specialized semiconductor chips.

To build and power big data centers, you need a lot of electricity. And electricity requires engagement with the government for environmental reasons, for permitting reasons, because if you want to be attached to the electricity grid, you've got to engage with electricity regulators. And today, basically every major tech company in the United States is now also a tremendous buyer of electricity and they are going to be even larger buyers of electricity in the future. We're already I think seeing the United States, but also in the Middle East and Japan, a realization that there's got to be a lot of thinking done about how to find the right balance between permitting dynamics, between environmental protection, and between the provision of power that data centers require. Because if your country doesn't do that, it will not get the data centers that are required, both for economic growth, but also for the AI capabilities that are seen to be strategically important. The second is that the chips that go in AI data centers

today are controlled by the United States for national security reasons. So, they can't be exported to certain countries. China, first and foremost, but also sending advanced AI chips to countries in the Middle East generally requires a license from the US government. And the US is doing this because it wants to make sure that the most advanced AI systems are trained and largely deployed first in the US and in close allies, like in Europe, Japan, Canada, Australia, before they spread to other countries. And this is having a major impact on the investments that big US tech firms are making. There's been a lot of discussion, for example, in the media about Microsoft and its partnership with a company in the United Arab Emirates which had wanted to build a very large, powerful set of data centers and has had to roll back some of its plans because the US government wouldn't approve the initial plan for importing very large numbers of these AI chips. So, I think we're about to see a period in which data centers are an increasing focus of national security policymakers, really around the world. And this is something that would have been a surprise to anyone five years ago, but today they're really front and center. And it's not just the US and China. It's India. It's Europe. It's Japan. All of these countries want some degree of sovereign AI capabilities, the ability to build and deploy AI systems in their territory. They don't want to be reliant on other countries to provide them with the computing power they need.

Concerns for national security further underscore the massive scale of the investment opportunity in data centers worldwide.

AI requires huge amounts of data processing and storage capabilities. And that demand profile is greater than what we can reasonably expect to be able to build to. The result is you now get a shortage of supply, shortage of capacity within the data center space, which is causing an increase in value for those data centers which can be built, which is the fundamental thesis of why we think this space is such an interesting investment opportunity for both institutional and individual investors.

This technology-related investment opportunity just happens to fall within the real estate bucket of a portfolio. And it comes at a time when many institutional investors may be looking to diversify their real estate exposure.

We began looking at data centers as one of those sectors where we wanted to invest within Asia Pacific almost 10 years ago. I started spending an increasing amount of time on it as the opportunity became more and more clear to me as to the future potential for it. And it's more from being something which I was kind of looking at when I had a few free moments into today as 100% of my job as the global head of our business. And that's a reflection of the scale and the breadth of the opportunity that I see within the space. The way we're approaching this industry and the opportunity around AI is not by trying to pick who's going to be the winner or the loser within the development of AI applications. It's by providing the capacity that all of those companies need in order to execute on their business strategies. Our initial focus in this space has been on the development side. And we see the opportunity created by that differential between demand and supply is driving very attractive development yields which we believe are outsized relative to the risk involved. We also think there's really interesting opportunities in owning stabilized data centers, owning data centers long term. And this is particularly the case in what we call low-latency locations.

Latency is a key concept in data centers and cloud computing. It represents the amount of time it takes for information to move between the data center and the end user. Even the tiniest lags can have an impact because of the enormous amounts of data going back and forth. Generally speaking, the closer the data center to the end user, the faster the data transmission. So, low-latency locations are typically found near dense populations.

We have a very strong view that the low-latency data centers are going to continue to increase in value because there is continued growth in demand for cloud services. And as AI moves more and more into everything we do, that's also going to be heavily dependent on having low-latency data center processing capability. And it's much more difficult to find powered land, again, in close proximity to major metros than it is to find powered land in the middle of nowhere. So, we believe that the greatest value growth is going to occur over the long term in those low-latency data centers.

The level of planning, infrastructure, and capital commitment required to build data centers makes it clear why companies prefer to lease rather than own.

The scale of infrastructure that the underlying hyperscale customer would have to put in on the development side in order to meet that growth within their business model is really beyond what is practical for them. Keeping in mind, at the end of the day, these companies are technology companies, not real estate developers. And so, while there is some economic benefit to them at an operational level, total cost perspective of self-owning versus leasing from a third party, that is not a viable solution for them for the majority of their requirements. Where we are seeing probably the greatest growth in self-build by the hyperscale customers is in the AI and machine learning area because they have more flexibility around where they can locate those facilities.

That need for flexibility only strengthens the case for investing in data centers and gaining exposure to the AI boom. Thanks to Chris Miller, Bill Reinsch and Morgan Laughlin for their insights on the growth of data centers and their impact on the global economy and national security. The Outthinking Investor is a podcast from PGIM. Follow, subscribe, and if you like what you hear, go ahead and give us a review. If you enjoyed this episode and want to hear more from PGIM, tune into our Speaking of Alternatives podcast. See the link in the show notes for more information.

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