

**“The number of people predicting the death of Moore’s Law doubles every two years.”**

*Peter Lee, Vice President at Microsoft Research, [LINK](#)*

Less than a decade ago, to watch TV, you’d go to your lounge room and turn it on.

You could only watch what was on at the time. From the lounge room.

Today, you can pick up your phone, anywhere, and watch almost anything you like. How quickly we forget and how much we take for granted.

Over a decade ago, Marc Andreessen famously declared, “*Software is eating the world*”, trumpeting the transformative power and accelerating importance of software, not only to information technology, but to life.



Yet, without hardware, software is useless - it does nothing. Is it Netflix or Disney software alone that delivers the magic? How is it possible that we can go from standard-definition to high-definition video, from 4G to 5G, or from GPT-2 to -3 to -3.5 to -4 so seamlessly?

Each step up requires massive increase in performance, processing power and bandwidth ..

.. in **hardware!**

This month we feature IT hardware, coincidentally only days after the government’s major announcement to recast its multi-billion dollar defence investments into long-range missiles and other military hardware.

It’s unfortunate that military hardware has taken such prominence when IT hardware is such an integral, critical, strategic, yet almost forgotten foundation of the modern economy and humanity’s well-being.

*Previous Newsletters, including this one, are available on our site in pdf [HERE](#)*

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## Hardware – the forgotten son

Usage of Australia’s national broadband network (nbn) peaked at 24 terabits per second (Tbps) on the evening of 10<sup>th</sup> March this year, fuelled by the release of a massive patch for the online game Fortnite.



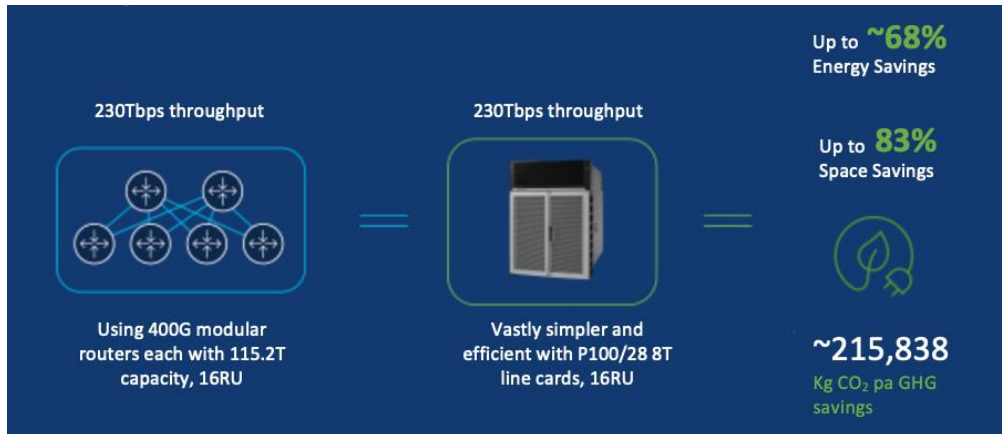
Coincidentally, this month Cisco announced a new 28.8 Tbps line card, built on Cisco’s Silicon One P100 ASIC. [LINK](#)

Although not a direct comparison, *Cisco’s single line card ‘today’ can support the peak of Australia’s bandwidth demand.*

As spectacular as Fortnite may be, without decades of continual innovation and improvements in hardware performance, neither Fortnite nor any of the over-the-top (OTT) services such as Netflix, Disney+, Zoom,

Microsoft Teams, Cisco Webex, ChatGPT etc, would be what they are today, used daily by billions of people globally.

The benefits of hardware innovation go beyond simply supporting massive data throughput and new advanced OTT services.



*Potential Sustainability/Operational Benefits Example*

Source: Cisco

Hardware innovation is having a massive impact on other factors including energy savings and climate change. For example, as shown above, instead of six Cisco 400Gbps modular systems, one 800Gbps eight-slot modular system can achieve 230Tbps with up to 83% space savings, up to 68% energy savings, or about 215,838 kg CO<sub>2</sub>e/year (greenhouse gases) savings.

***“To put it in perspective, these carbon savings are the equivalent of recycling 115 tons of waste a year instead of going into landfills”***

*Satish Surapaneni, Cisco*

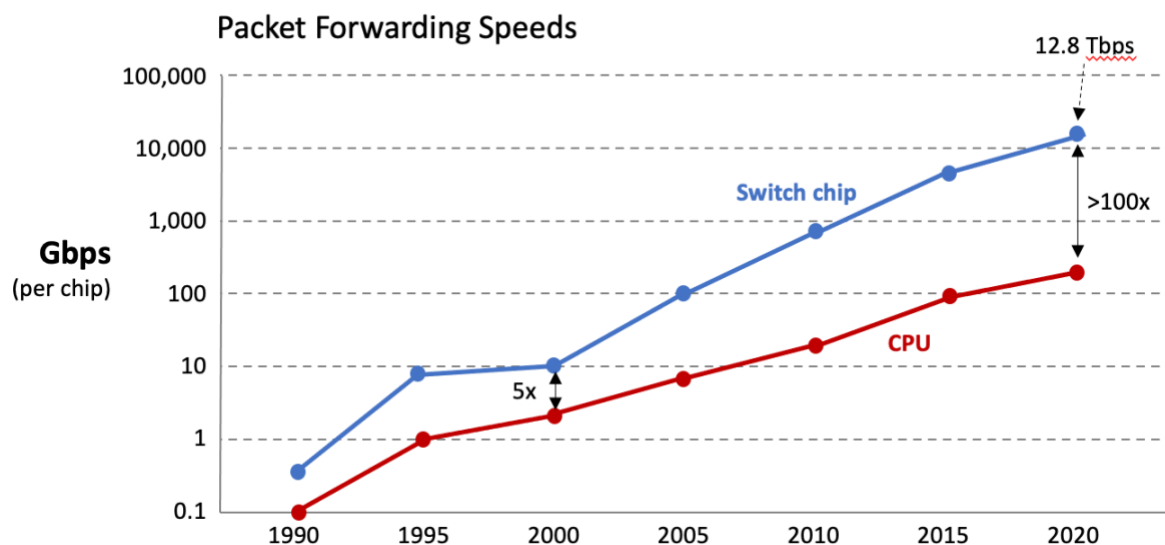
## Hardware - Technology Innovation

Hardware innovation has accelerated in several directions.

**CPUs**, central processing units, have seen spectacular improvements by companies such as Intel and ARM. But the next wave of disruption is already here. Quantum computing is gradually moving out of the laboratory and getting set to transform computing as we know it.

In 2019, Google claimed it had passed a milestone known as "quantum supremacy" executing a calculation in 200 seconds that would have taken a conventional supercomputer 10,000 years to complete. Such a massive leap inevitably forces the industry to re-examine what is possible and could potentially eliminate obstacles previously thought permanent. [LINK](#)

**Network Processors, application-specific integrated circuits, ASICs:** Back in the nineties, it was well understood that the type of hardware required for communications was different to that required to process applications.



Purpose-designed switch chips demonstrated 5x performance improvements over CPUs in 2000. In 2020 they show 100x improvements. [LINK](#)

In his 2020 keynote, Nick McKeown, professor of Engineering, Stanford University, presented the graph above to illustrate how switch chips (ASICs) continue to outpace traditional CPUs for packet forwarding.

Besides performance superiority, an ASIC and CPU each supporting 10 Tbps, required 400W versus 25,000W respectively. *Takeaway:* Switches will be ASICs for the foreseeable future.

**GPUs**, graphics processing units, were originally built to tackle the challenge of high-resolution graphics for gaming, that required highly scalable parallel processing. Due to this important capability, GPUs from companies like Nvidia, have found their way into other adjacent markets including machine learning, AI, and crypto mining enabling applications such as ChatGPT and blockchain.

**DSPs**, digital signal processors, have also advanced significantly in undertaking complex mathematical calculations and filtering operations on digital signals for audio and video – core to every mobile phone. Qualcomm's Snapdragon processors can be found today in almost every mobile phone on earth.

**TPUs**, tensor processing units, are specialised chips designed specifically for AI and machine learning workloads. Google's TPUs have been widely used in their data centres to accelerate machine learning workloads and their third generation TPUs are up to eight times faster than the previous generation. Microsoft is rumoured to be close to announcing its own equivalent, competitive processor.

Advancements in hardware such as CPUs, GPUs, DSPs, TPUs, and ASICs, have played a critical role in enabling digital and global transformation. These improvements have enabled faster processing and connection speeds, improved power efficiency, and more specialised hardware. While consumer applications and software may have taken centre stage, it is the hardware, the quiet achiever, that has enabled them to deliver.

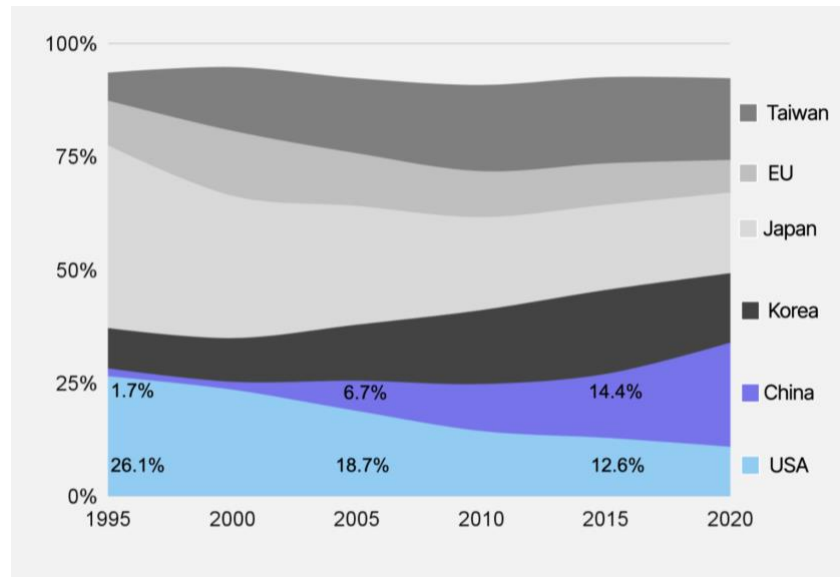
Perhaps Marc Andreessen's quote is due for an update, something like:

**“Software is eating the world, but without hardware it does nothing”.**

## Geopolitics – Semiconductor wake-up call

The significance of hardware and more broadly, the semiconductor industry, goes well beyond the technology. It has become a strategic geopolitical priority such the battle between leading nations has become fierce.

Over the past 25 years, China's share of semiconductor capacity has grown to exceed that of the US, as shown below.



*Twenty-five years of China's expanding share of semiconductor capacity  
World wafer fab capacity by country / region  
Source: European Semiconductor Industry Association, SEMI*

Only recently have the US and Europe recognised the inherent risk of losing control of the hardware supply chain (perhaps distracted by their focus on military hardware!). Both have made significant announcements to boost hardware investments in their local markets.

**US:** In July 2022, the U.S. government voted to pass the CHIPS and Science Act of 2022 [LINK](#).

The principal aim of the CHIPS Act is to:

- Onshore domestic manufacturing of semiconductors
- Substantially increase government funding for science and technology development programs impacting the networking and telecommunications fields.

The legislation provides over US\$136 billion in total appropriations for CHIPS and Public Wireless Supply Chain Innovation (also known as ORAN) and other related research.

**Europe:** The European Chips Act, announced in April 2023, is aimed at strengthening European competitiveness and resilience in this strategic sector. It targets doubling global market share of semiconductor manufacturing to 20% by 2030. [LINK](#)

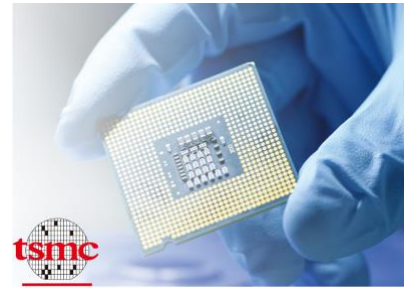
The initiative includes investment of public funds of around € 8.8 billion and is expected to spur an estimated € 43 billion in public and private investments in manufacturing for chipmakers and their suppliers.

**Taiwan:** It's not just about the US and China. Have you ever wondered why the tiny island of Taiwan has attracted so much attention?

Taiwan is home to TSMC, who accounts for more than half of the world's output of semiconductors and more than 90 per cent of the world's most advanced chips, used in artificial intelligence and high-end surveillance. [LINK](#)

Taiwan's semiconductor sector accounted for US\$115 billion, around 20 percent of the global semiconductor industry. [LINK](#)

Unfortunately, until the US and China cede themselves from their dependence on Taiwanese semiconductors, tension is expected to continue.



## Five Megatrends: By Ray Dalio

[LINK](#)

***“The existing world order is changing rapidly in challenging ways and people who are living on the assumption that things will work in the orderly ways that they have gotten used to will be shocked and hurt by these changes to come”.***

Most would agree that the world today can be confusing and sometimes challenging. With the short-term outlook so difficult to read, perhaps we need to take a step back and look at the bigger picture. There is a plethora of predictions and perspectives from within the technology industry, so it is useful to go beyond.

One view that resonated was from billionaire investor Ray Dalio, founder of hedge fund giant Bridgewater Associates, and self-styled historian of financial markets and political regimes. The following is a summary of his five megatrends that he says will end what he has called the “big cycle”.



- 1. The build-up of debt:** According to Dalio's historical research, the current high levels of debt are colliding with the need to raise interest rates to fight inflation, which may result in the need for major restructuring. Other economists, such as Nouriel Roubini, argue that high debt levels may cause central banks and governments to not effectively fight inflation, leading to a higher level of inflation that the world will have to adjust to. The uncertainty surrounding inflation, economic growth, and high debt levels means that the market remains unclear.
- 2. Conflicts within countries:** Dalio predicts that the increasing internal division within countries, exemplified by rising populism due to increased inequality, will worsen heading into the 2024 US election season. He warns that the fight over the US debt ceiling, which is expected to be a big election issue, will likely split the country and not go as smoothly as expected, adding to investor nervousness. BlackRock's vice-chairman Philipp Hildebrand has also warned that a US debt default would threaten the global financial system.
- 3. Conflicts between countries:** Dalio notes that the rising tensions between China and the US, which are unlikely to subside as both sides engage in "China-bashing" during an election year, have ramifications beyond just the threat of cold or hot wars. US Treasury Secretary Janet Yellen's recent declaration suggests that building more resilient domestic supply chains in strategic industries (like semiconductors) will be prioritized over economic interests, which may lead to higher inflation.

4. **Natural disasters:** Dalio suggests that natural disasters, which have often been important catalysts in hastening the end of a long-term cycle, pose a clear risk due to their increased intensity caused by climate change. While difficult to predict, the likely inflationary pressures created by the need to speed up the energy transition and resilience measures, add another layer to the current inflation question that markets are grappling with.
5. **Technology changes:** Dalio identifies technological changes, such as the development of artificial intelligence, as the fifth megatrend that can end a long-term cycle. While he is less certain about the potential level of disruption AI will bring, its development, potential costs, and economic benefits are adding to the current uncertainty that markets are facing.

On their own, each of Dalio's megatrends are important to consider. But his key point is that at least four of the five are in play at the same time.

***"When these forces come together in the magnitudes that we are now seeing, history has shown that it is likely that we experience seismic shifts in financial orders, domestic orders, and world orders".***

Stay connected.

Kevin