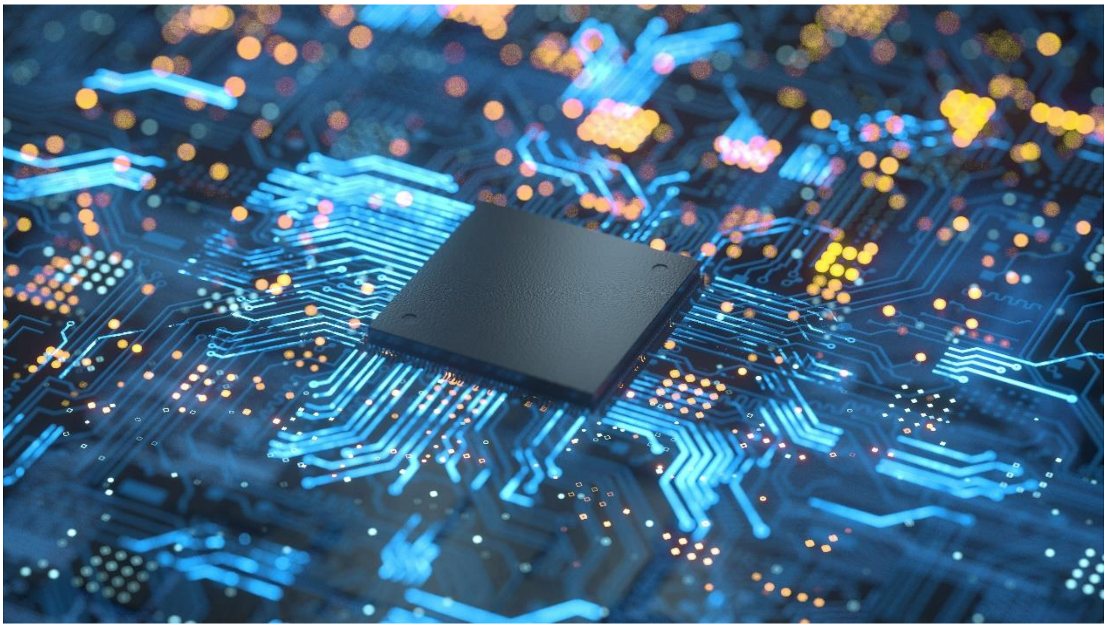
What makes the world's 4th most traded product critical to industry today?



According to a Wall Street Journal report, semiconductors are the lifeblood of many industries — ranking as the world's fourth-most traded product (counting imports and exports), after crude oil, refined oil and cars. As per a Boston Consulting Group survey, no other industry has the same high level of investment in both R&D (22% of annual semiconductor sales to electronic device makers) and capital expenditure (26%).

Their useful electrical properties make semiconductors a critical component of electronics manufacturing. With an almost unlimited lifespan, semiconductors lend themselves to integration into complex microelectronic circuits. They provide functions such as operations control, data processing, storage, input and output management, sensing, wireless connectivity and power management, with improved efficiency and at a viable cost.

Types of semiconductors

Most semiconductors are tiny integrated circuits, packing billions of electronic components in a few square millimeters. Comprising sets of miniaturized electronic circuits, they consist of active discrete devices, such as transistors and diodes, passive devices, such as capacitors and resistors, as well as the interconnections between them. These are layered on a thin wafer of semiconductor material- typically silicon.

While more than 30 types of categories of semiconductors have been detailed by industries, they can be classified into three broad groups:
1. Logic – 42% of industry revenues
2. Memory – 26% of industry revenues
3. Discrete, Analog and Other (DAO) – 32% of industry revenues

Semiconductors in everyday life

Semiconductors are used in all kinds of electronic devices across multiple applications. They bestow 'state-of-the-art' status to everyday electronic devices, ranging from household appliances and smartphones to ATMs and eCommerce, among countless other applications.

Semiconductors also play a key role in a host of industrial applications in the electronics and manufacturing industries, agriculture, healthcare, telecommunications, transportation, energy management, military systems, space… to name just a few.

Further, almost all the emerging technologies - such as autonomous self-driving vehicles, AI, 5G, IoT, gaming and wearables are all powered by discrete, yet highly sophisticated semi-conductors.
Semiconductors during the pandemic era. In the present pandemic that has been battering the globe for more than a year and a half, technology, powered by semiconductors has often been the succor, coming to the rescue of individuals, organizations and even governments, offering myriad solutions.

Today, as the world grapples with this unprecedented crisis, here is a quick look at how semiconductors are driving some of the most critical sectors and services today.

Healthcare: Starting with machines used to test samples from patients for signs of infection, to Patient Vital Signs Monitors, which measure blood pressure, heart rate, pulse oxygen and temperature using IR thermometry, almost every Covid-care support system is reliant on semiconductors to work. This also includes the disbursal of vaccines across countries, receiving app-based certifications, delivery of life supporting medicines, a steady flow of data to the Covid 19 war rooms – they are all riding on these wafers of silicon.

Remote working and online learning: Semiconductors underpin the technology infrastructure necessary for maintaining communication networks between colleagues, clients, classmates and coordinators outside of a traditional brick and mortar setting. Businesses have been able to smoothly move their operations online and allow staff to work remotely and safely without interruption thanks to semiconductors.

Manufacturing: This "essential' e-sector is dependent on semiconductor chips to establish cleanroom operations that minimize the risk of virus transmission through higher levels of automation and cleanroom environments.

Semiconductors and emerging technologies

According to Juniper Research's latest report, the number of IoT devices by the end of 2021 will reach 46 billion. Each one of these devices is powered by semiconductors.

With AI applications gaining traction across sectors, the need for specialized sensors, integrated circuits, improved memory, and enhanced processors is increasing. These are yet some applications where semiconductors will play a key role.

Many Smart Cities and towns around the world are committed to vastly improving city services and critical civic infrastructure for its citizens. To do that, they need to connect almost aspect of civic infrastructure with a wide range of devices, which in turn will be connected with individuals. This inter-connected infrastructure will be powered by semiconductors.

The 5th generation mobile network is designed to connect virtually everyone and everything, i.e., machines, objects and devices; deliver peak data speeds; achieve ultra-low latency; more reliability; massive network capacity; increased availability and a more uniform user experience. At the core of this next gen technology, cutting edge semiconductor chips with smaller nodes and greater efficiency will provide critical, speedy, high-performance computing.

The evolution of semiconductors

The evolution of semiconductors can be traced back to the invention of the transistor in 1947, followed by the invention of the integrated circuit in 1958. Next, the invention of the microprocessor in 1970 enabled the development of the microcomputer, as well as a host of small devices like numerically controlled lathes and one-armed robotic devices for spot welding for instance. This is when semiconductors as we know them today came of age.

Semiconductors are now defined by their nodes, which refers to its specific manufacturing process and design rules. The smaller the node, the smaller is the feature size, which means smaller the size of the transistors, which in turn, means they are faster, more power-efficient and packed with greater performance capabilities.

The driving force behind the downscaling in the size of process nodes is defined by Moore's Law. In 1965, Gordon Moore observed that the number of transistors on an integrated circuit has been doubling every two years, for more than 50 years. This phenomenon was named Moore's law and the singular focus and drive of the semiconductor universe has been to reduce transistor size and to integrate more, smaller transistors on each chip.

Further, 'More Moore' techniques, an attempt to continue to meet the growing demands of new applications, targeted more performance at constant power and cost. Today, chip designers and foundries are also getting into 'More than Moore' techniques. 'More than Moore' represents a new, functional change, in which digital meets analog. Unlike 'More Moore', 'More than Moore' focuses on meeting the new demands and applications by using existing semiconductors. In these cases, while size is still important, manufacturers do not need the cutting-edge technologies of the most advanced nodes. Therefore, these semiconductors can be fabricated by selectively enhancing tools and processes originally developed for older, larger nodes with new technologies. This technology is likely to grow with the coming of age of phenomena such as 5G connectivity, the internet of everything, and other path-breaking applications.

In the 1990s, incremental shrinkage of semiconductors, or 'chips' as they are more commonly called, was easily achievable. Today, shrinking has become more complex, requiring more capital, expertise, and resources. Therefore, the number of companies capable of providing leading edge fabrication has been steadily dropping. As of 2020, only three companies are capable of fabricating integrated circuits on the most cutting-edge process. These three companies are Intel, Samsung and TSMC.

The semiconductor supply chain

The semiconductor industry has built a global supply chain with deep technical knowhow and scale. It is this global supply chain, in which all the member countries are inter-dependent and rely on free trade to move materials, equipment, IP and products to optimal locations to perform each activity that has made possible the exponential growth in information technology and digital services over the last three decades, through performance enhancements with increased cost savings in designing these highly complex products.

In the current global scenario, while the US provides most of the R&D-intensive activities, such as electronic design automation, core intellectual property, chip design and advanced manufacturing equipment, thanks to its world-class universities and engineering talent as well as its market-driven innovation eco-system, it is the expertise of countries in East Asia, like Taiwan and South Korea that leads the way in wafer fabrication, which requires huge capital investments, robust infrastructure and skilled manpower. Then there is China, which looks after the assembly, packaging and testing functions of semiconductors – services that are relatively less skill- and capital intensive.

The global chip shortage crisis

It is clear that semiconductors are changing the game in our modern, fast-moving world. It is also clear that change is nothing new for the semiconductor industry. What is even clearer is that with government after government being on crisis management mode at present, it is a given that semiconductors will receive the status of "critical infrastructure', in every country, in the near future.