

Global Semiconductor Shortage – Key Drivers and Outlook

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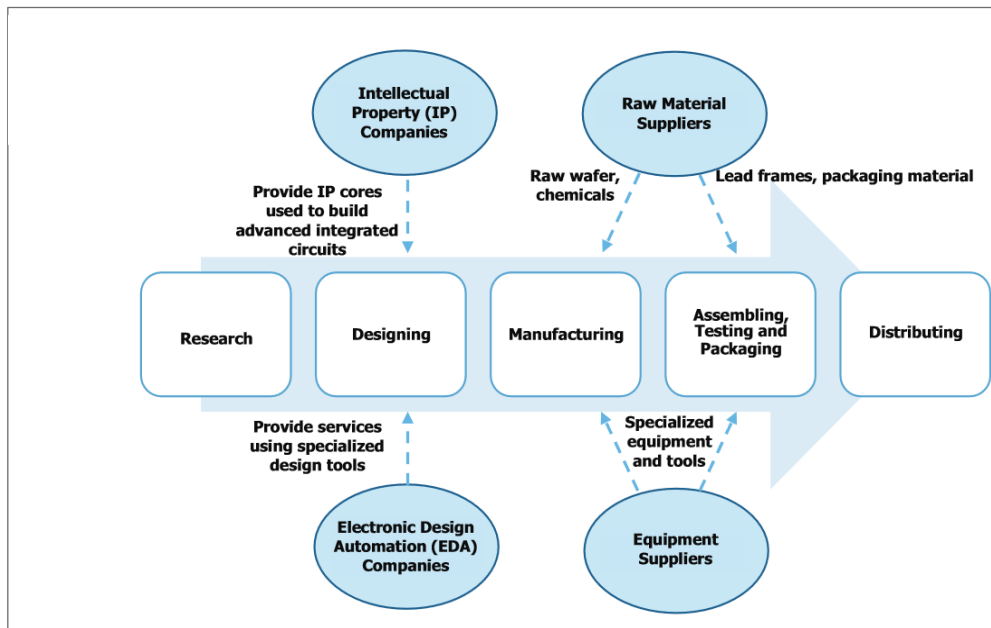
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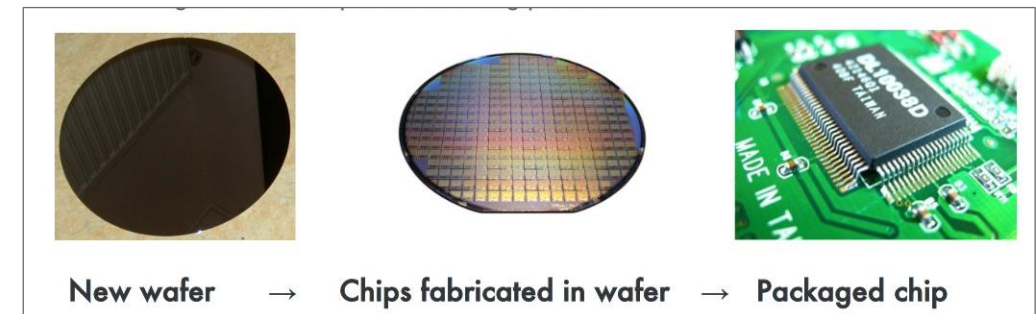
Background

- Currently semiconductor supply chain is highly complex global ecosystem with some geo heavily influencing supply chain than others
- Semiconductor supply chain includes different partners for R&D, Design, Manufacturing, Assembly, Test, Packaging and Distribution
- Semiconductor manufacturing also relies on raw material, software and manufacturing equipment suppliers
- Any electrical/electronic thing that we use today comes with a semiconductor chip
- Ongoing supply chain shortages has affected all of us in some or the other ways



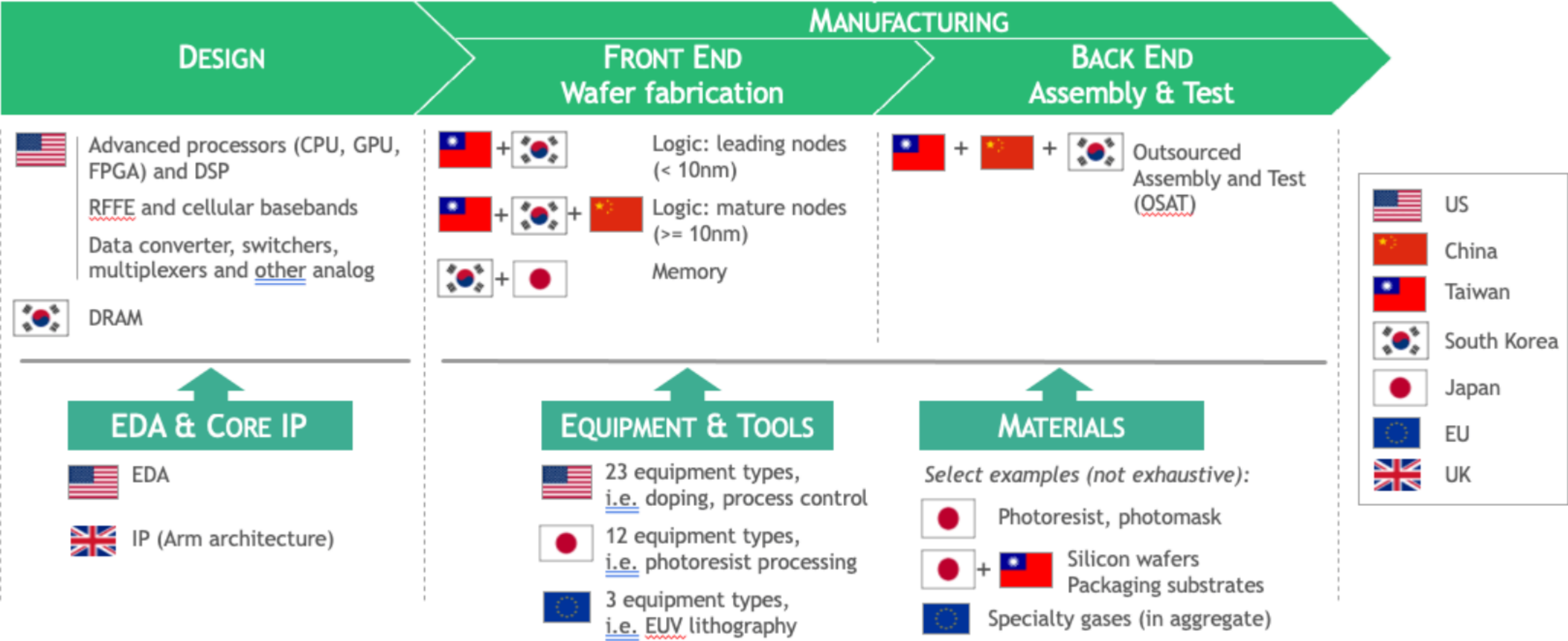
Semiconductor Ecosystem

Ref: <https://www.semiconductors.org/wp-content/uploads/2018/06/SIA-Beyond-Borders-Report-FINAL-May-6-1.pdf>



Chip Fabrication process

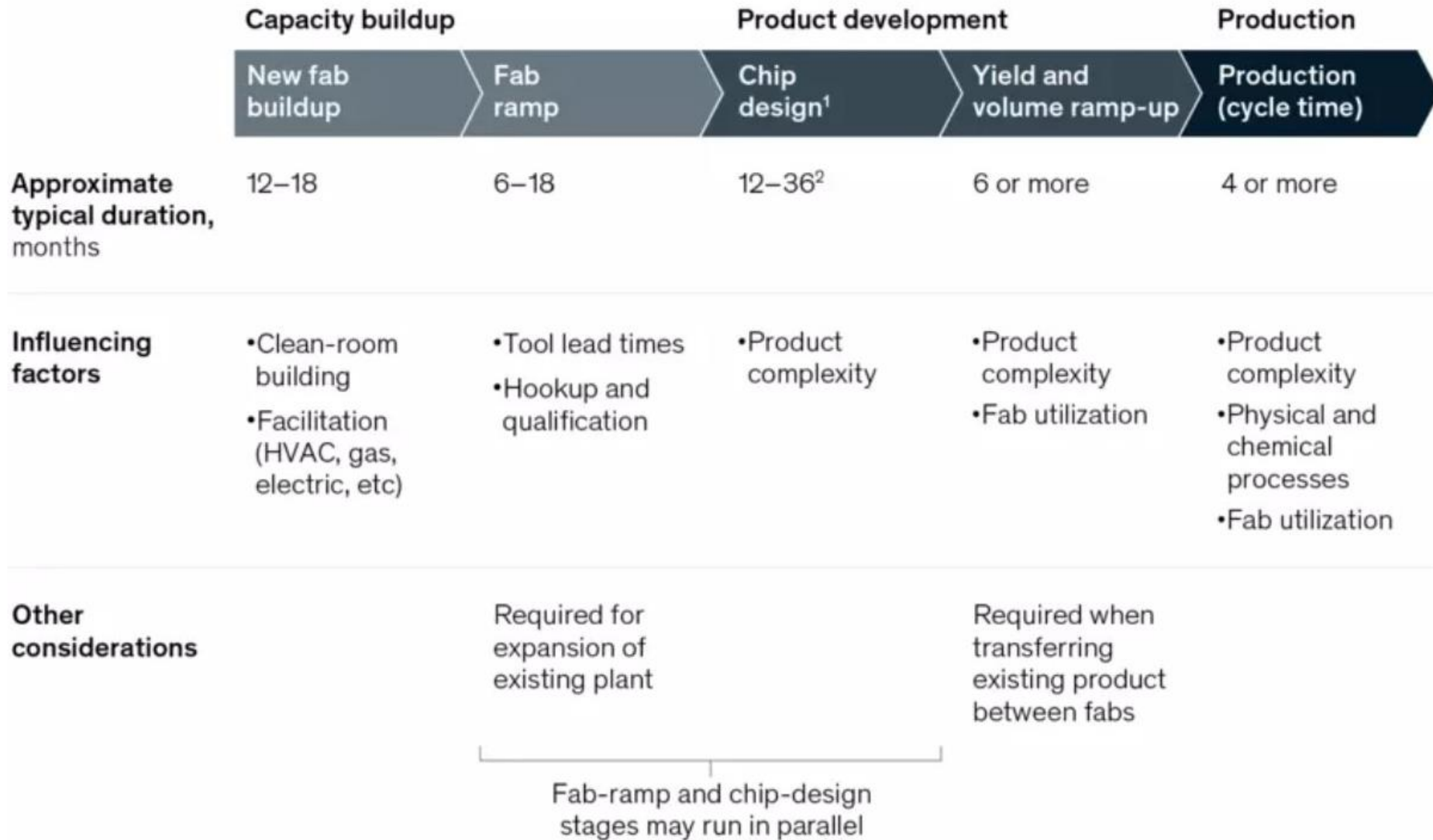
Ref: <https://cset.georgetown.edu/wp-content/uploads/The-Semiconductor-Supply-Chain-Issue-Brief.pdf>



Ref: <https://www.semiconductors.org/strengthening-the-global-semiconductor-supply-chain-in-an-uncertain-era/>

How long it takes to manufacture a chip?

Semiconductor development and production timelines



Ref: <https://www.weforum.org/agenda/2022/02/semiconductor-chip-shortage-supply-chain/>

Factors responsible for the chip shortage



- COVID-19 introduced unprecedented challenges in the existing constrained fab situation
- Sudden increase in the demand for WFH technology like PC, tablet, other computer accessories along with Gaming and Home Entertainment products
- Chip demand for both devices and data centers shot up in 2020 and 2021. The pandemic caused PC sales to rise by more than 50% Y/Y in early 2021, while cloud computing data center chip purchases went up by 30%
- Auto demand recovered faster than expected in 2H20; fabs had already shifted resources to other applications
- Events like a fire at Japanese chipmaker Renesas Electronics and winter weather in Texas that knocked more than 70 power plants offline and cut power to Samsung Austin chip plant adding to the ongoing shortage

Sectors affected by chip shortage: Auto



- Today's cars are considered as computers on wheels which have chips to control almost everything.
- Cars are becoming increasingly digital-
 - The average car in 2010 contained US\$300 worth of microchips whereas in 2022 it accounts to US\$500
 - EV can contain up to \$1000 worth semiconductor components
- Demand vs Supply –
 - During the initial phase of pandemic, the demand for cars plummeted
 - On the other hand, chip demand hit the roof for PC and data centers
 - Automakers use processors that don't require cutting-edge chipmaking technology
- 'Just in time' model –
 - Automotive companies rely on JIT to cut inventory cost whereas chip making is a slow process and can take several weeks to get the chip out of the door
- The situation has cut their revenue by an estimated \$210 billion in 2021, and auto manufacturing could suffer through 2023
- The shortage forced auto makers to halt production, some carmakers have shipped vehicles without accessories, leaving customers without touchscreens in their new cars
- Getting repairs done on the existing cars is also challenging due shortage on replacement part

Sectors affected by chip shortage: Mobile



- Auto vs Mobile:
 - Mobile manufacturer use latest processor, cutting edge technology. Mobile volumes are far higher than vehicle volumes
 - Smartphone companies did not reduce their demand and inventory in 2020. In fact, they were benefited by extra capacity left behind by automakers
- Wireless:
 - Accounts for 40% of semiconductor business; the largest semiconductor segment
 - 5G smartphones and the associated infrastructure are the big drivers for many chips
 - Currently TSMC and Samsung are the only fab vendors capable of manufacturing 7 nm and 5 nm chips
- Apple & Samsung:
 - Apple suffered a \$6 billion shortfall in sales due to a shortfall in chips at 'Legacy nodes'
 - Samsung, the world's second largest buyer of chips after Apple, has to postpone the launch of high-end smartphones due to shortage despite being second largest producer of chips
- PMICs:
 - Used to control the flow and direction of electrical power
 - Manufactured using processes ranging from 180nm to 40nm
 - Shortages of PMICs are expected to continue through the end of 2022

- Scale & Margin:
 - The Hyperscalers get the benefit of scale and hence are getting bulk of supply.
 - Server CPU has more profit margins than other semiconductor products. So, chip manufacturer prioritized them and hence Data Center and Enterprise did not have to go through a similar pain like Auto industry
- Its about the tiny things:
 - Other small components needed in CPU assembly like Resisters, Capacitors, Transistor, Power Module etc. are in tight supply. Some having lead times as high as 52 weeks
 - Transistor: Major component for EV. 40% increase in SiC transistor expected by 2026
 - PMIC: Supply and hence price is seen to be improving. Over all 5% avg increase in prices for 2022

- High level of capital spending by chip manufacturers is expected in 2022. As per Gartner, total capital spending will increase by 22.2% in 2022
- **Intel** plans \$23 billion in spending this year in the US (AZ Fab 52, 62), followed by plans for additional fabs in coming years - totaling \$200 billion
- **Samsung** expects to spend \$145 billion through 2030. In November, Samsung announced \$17 Billion investment in Logic foundry fab in Tyler TX
- **TSMC** expects to spend \$100 billion over three years, including a new fab in Arizona, and recently announced a new fab partnership in Japan with Sony
- **GlobalFoundries** is investing \$1 billion to increase its current fab capacity in New York and add another fab there. It's also building a fab in Singapore and expanding one in Germany
- The shortage also gave new energy to chipmakers still building chips with earlier-generation "legacy node" manufacturing technology. This includes ST Microelectronics, Onsemi, Microchip, NXP and Infineon
- The fabs are expensive, but chip customers are sharing investment costs. To secure capacity for future products, "fabless" companies like Nvidia, AMD and Qualcomm pay billions of dollars to chip manufacturers

What are Governments doing to alleviate the situation?



- USA:
 - In 1990, 37% of the world's semiconductors were made in the US. Last year, U.S. market share was down to 12%
 - The government is hoping to change that with the CHIPS for America Act, which includes a proposed \$52 billion investment towards semiconductor research, design and manufacturing
- China:
 - Made in China 2025 plan - 70% self-sufficiency in semiconductors by 2025
 - China is struggling to master EUV technology needed for most advanced chip. MIC estimates - 19.4% by 2025
- Japan:
 - Once a world leader in semiconductor manufacturing, Japan has fallen far behind Taiwan and the U.S. Tokyo sees that as a national-security concern as well as a business problem for local auto makers, which rely in part on imported chips
 - Taiwan Semiconductor Manufacturing Co. and Sony Group Corp. said they would build a \$7 billion chip plant in Japan in a bid to ease the strained global supply chain for semiconductors. It will make an older type of chip that has been in particularly short supply this year and fill a gap in an industry that puts most of its investment dollars into the most advanced chips
- EU:
 - The European Commission announced the goal to have 20% of chips to be manufactured within EU by 2030 (right now at 9%).
 - EU concerns being caught up in the tech war between two superpower
 - US prevents ASML – a Dutch company to ship their EUV tools to China

Is there a light at the end of the tunnel?



- Semiconductor demand and Supply gap seems to be narrowing, easing global chip shortage in 2H22 – 2023
- Softening in demand for PCs and increased inventory may result in better outlook
- Regional lockdowns, Russia’s invasion of Ukraine continue to affect global supply commerce
- “...*We believe the overall semiconductor shortage will now drift into 2024, from our earlier estimates in 2023, just because the shortages have now hit equipment and some of those factory ramps will be more challenged*” - Pat Gelsinger, Intel CEO
- Consensus over the end of chip shortage seems to be around 2H22- 2023 with significant improvement in LT; followed by a period of oversupply and falling prices.

- Auto: Tesla vs others
 - Despite chip shortage's widespread impact to the auto makers, Tesla shipped 80% more vehicles in 2021(vs 2020)
 - Tesla has demonstrated its ability to mitigate disruptions due to in-house design and control over many of its parts, supplier relations and collaboration
- JIT vs Demand driven
 - Due to global supply chain risks, shortage in materials and human resources, businesses must work towards agile 'demand-driven' supply chain operation model
- Governments worldwide:
 - This global semiconductor supply chain crisis has put at risk many technologies and innovation
 - The strategic significance of semiconductors and their increasing importance for economic competitiveness have been well understood by all major government and are investing billions of dollars

Questions?
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