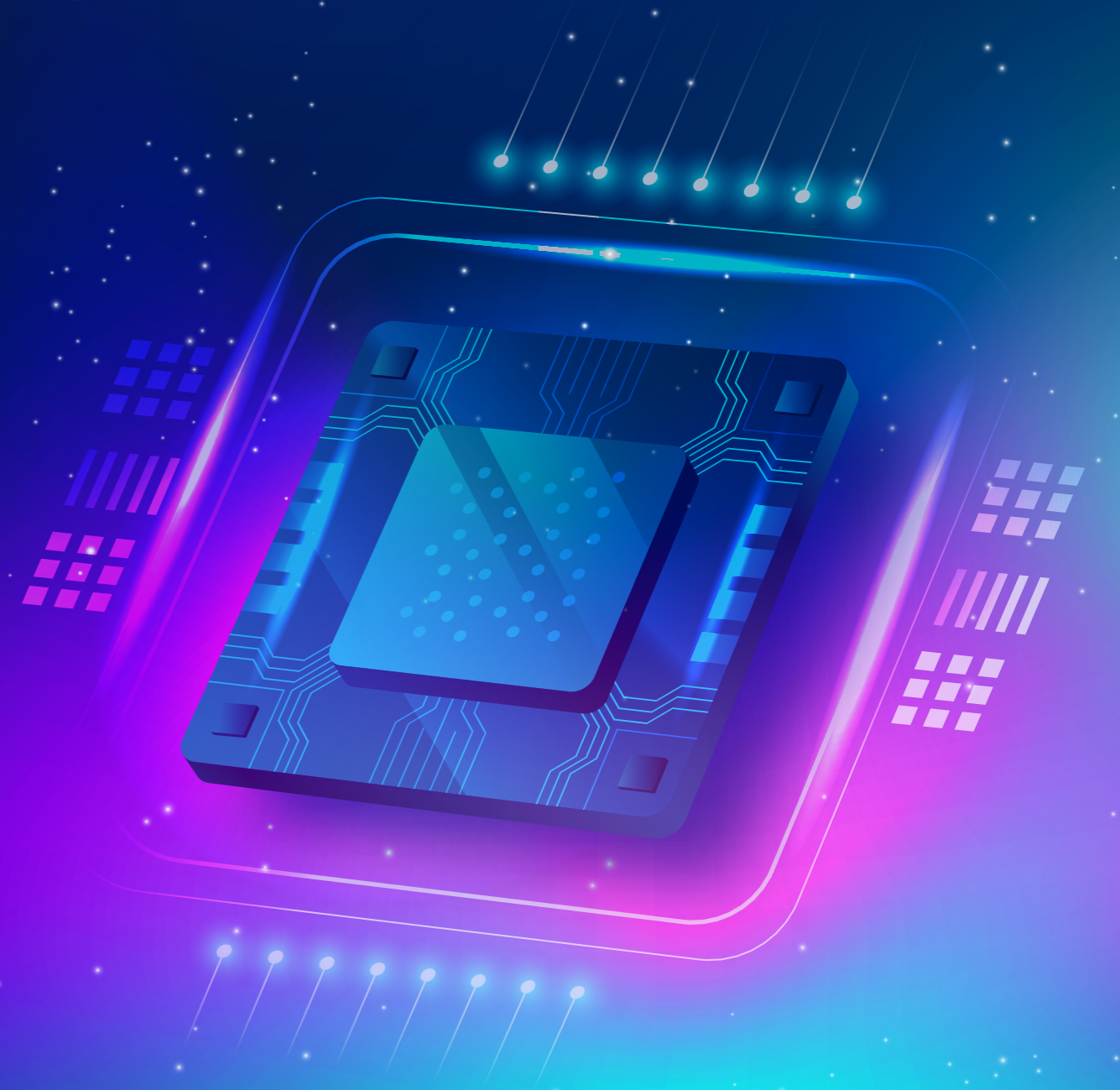


P3

# Semiconductor Management Microcontroller units (MCUs)

Current market development & implications for the automotive industry



# Management Summary

Prepared by

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MCU (microcontroller unit) is the semiconductors category with the highest lead time. In addition, MCUs enables critical functions for ADAS (advanced driver assistant systems).

MCU lead times are twice as high as the market average, caused by the current market phase within the supply chain cycle.

**Current bottleneck in the value chain is the front-end.**

The top 5 MCU designers control ~90% of the market. TSMC (Taiwan Semiconductor Manufacturing Company) controls the MCU foundry with ~70% market share.

To build resilient supply chains for MCUs, the automotive industry highly depends on managing the TSMC monopoly.

Strategic partnerships in the value chain, dual fab approaches, coopetition and investments in R&D (research & development) offer potential solutions for the automotive industry.



# Agenda



1 | MCU market, value and functions in the car



2 | Value stream breakdown focus front-end



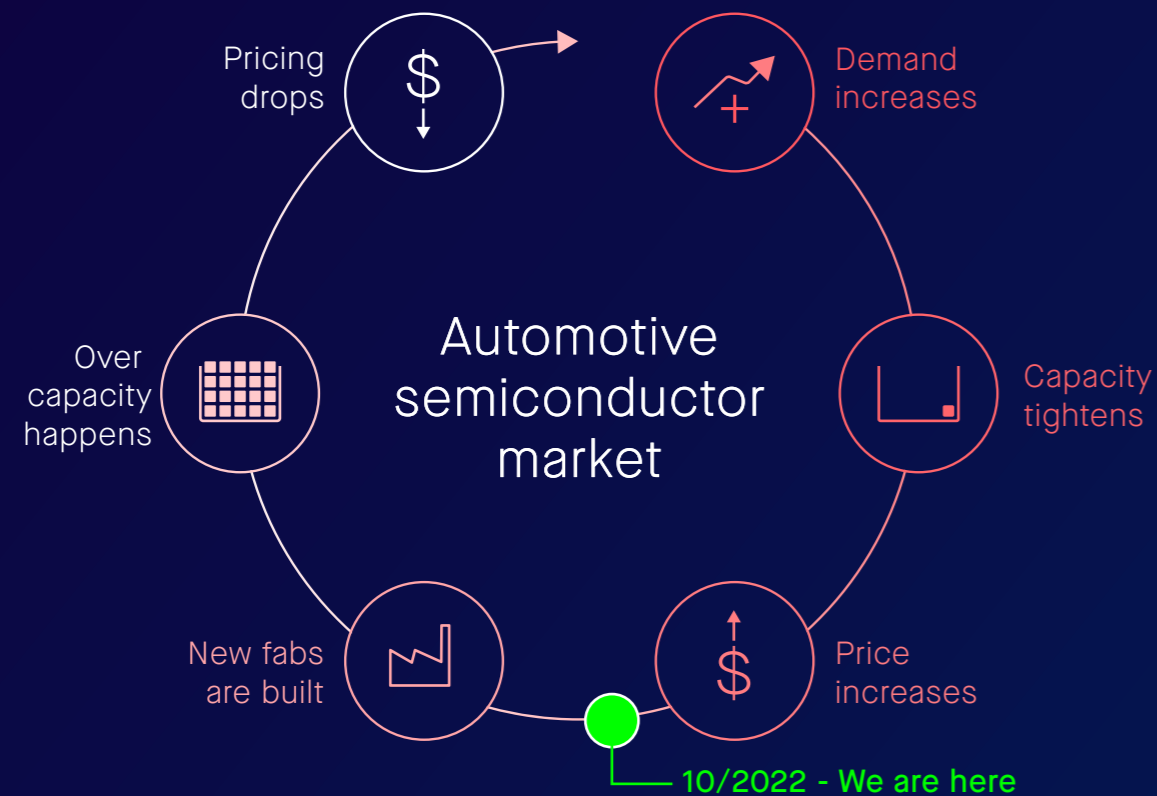
3 | How to manage TSMC's monopoly



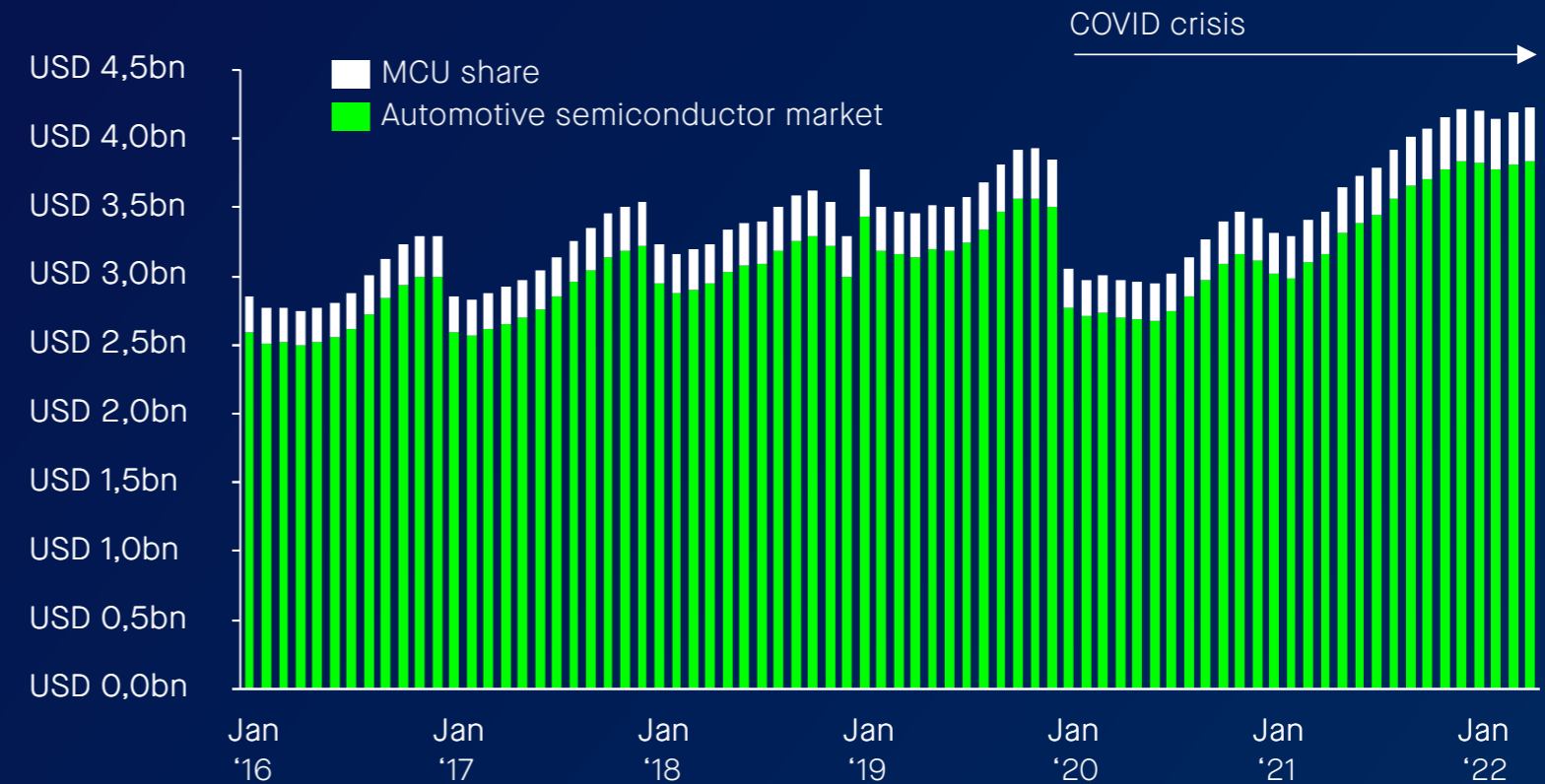
# Current automotive MCU market

Semiconductor market dynamics.

## Supply chain market cycle (schematic)



## Automotive semiconductor market [monthly]



→ Current market situation: Allocation since 2020 leads to price increases and will incentivize capacity increases.

→ Cyclical industry: 2022 ~4bn USD, CAGR (compound annual growth rate) within the next 7 years ~10% with upcoming capacity increases.

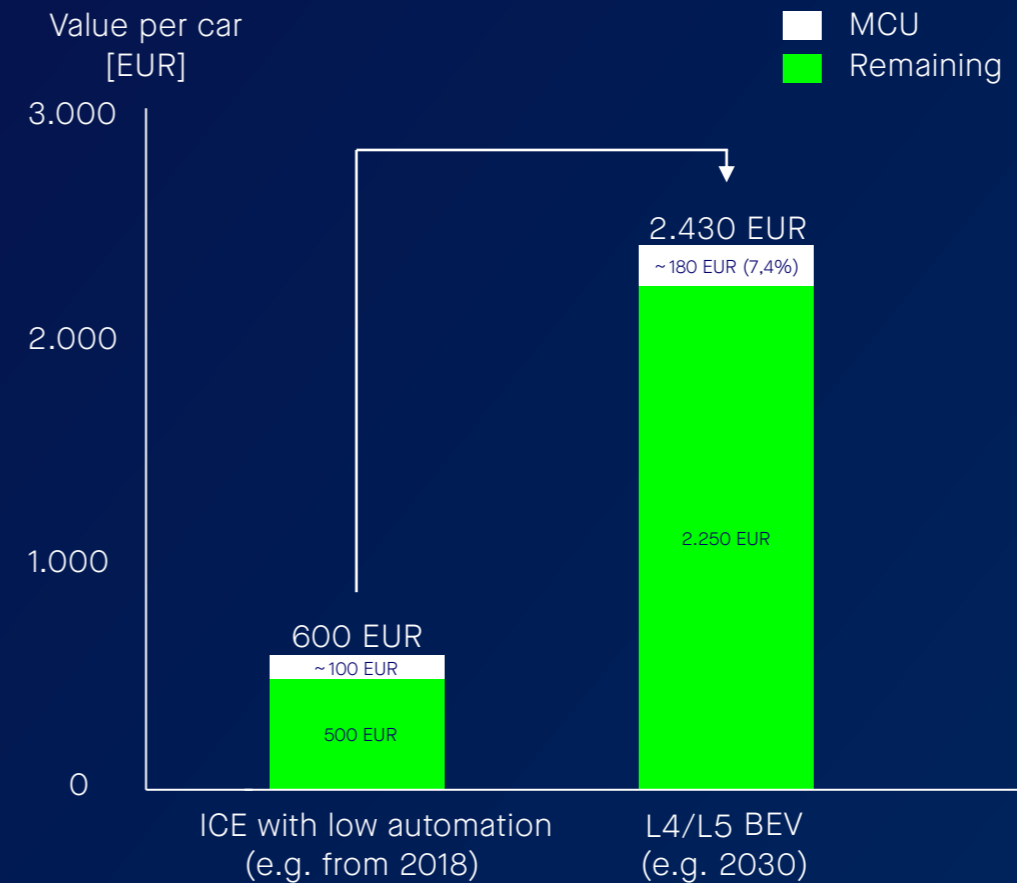
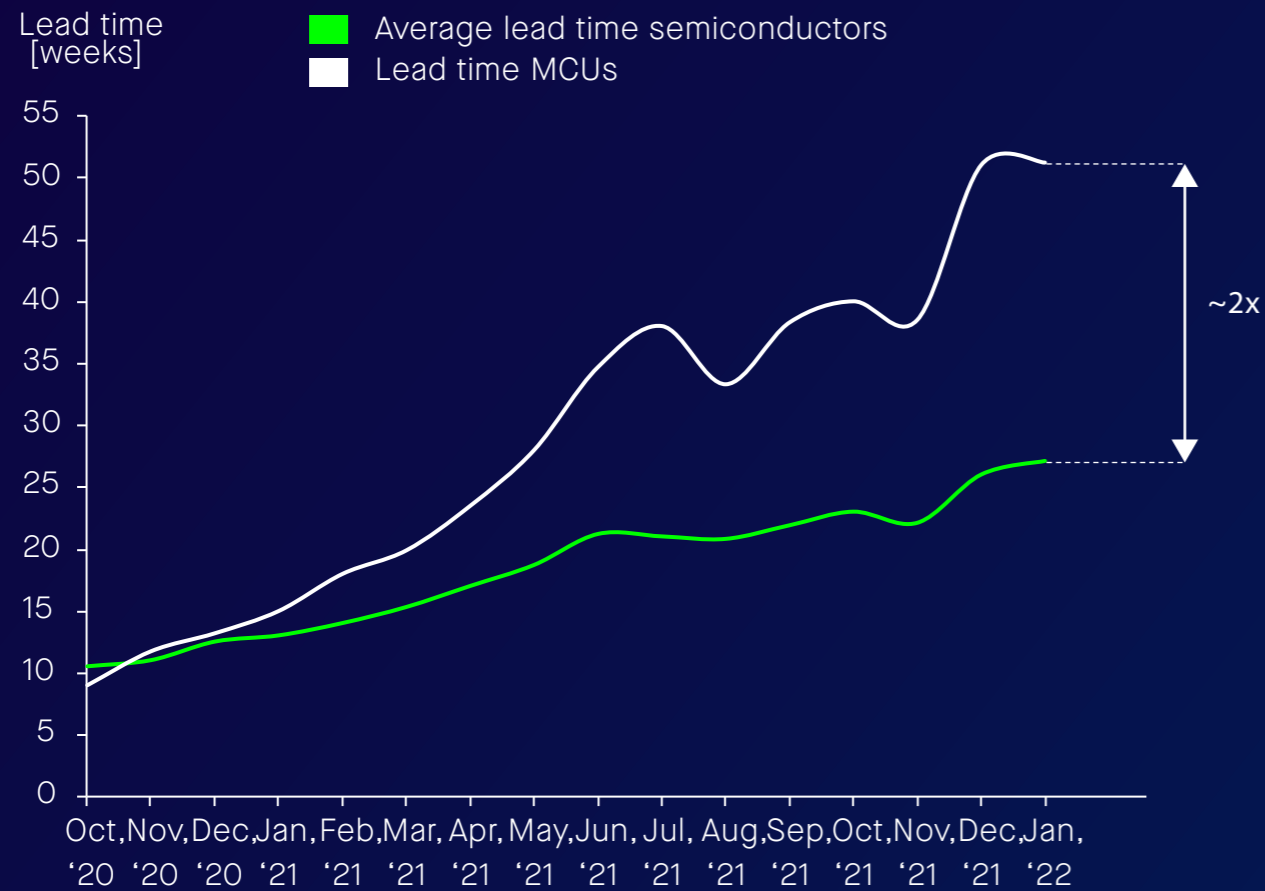


# MCU lead times and value per car

Increase in demand and lead times.

## Lead times for semiconductors

## Semiconductor value per vehicle



→ Lead times for MCUs are twice as high as for the overall semiconductor market.

→ Though the monetary effect of MCUs is only 7,4% per car, they highly contribute to current production interruptions.

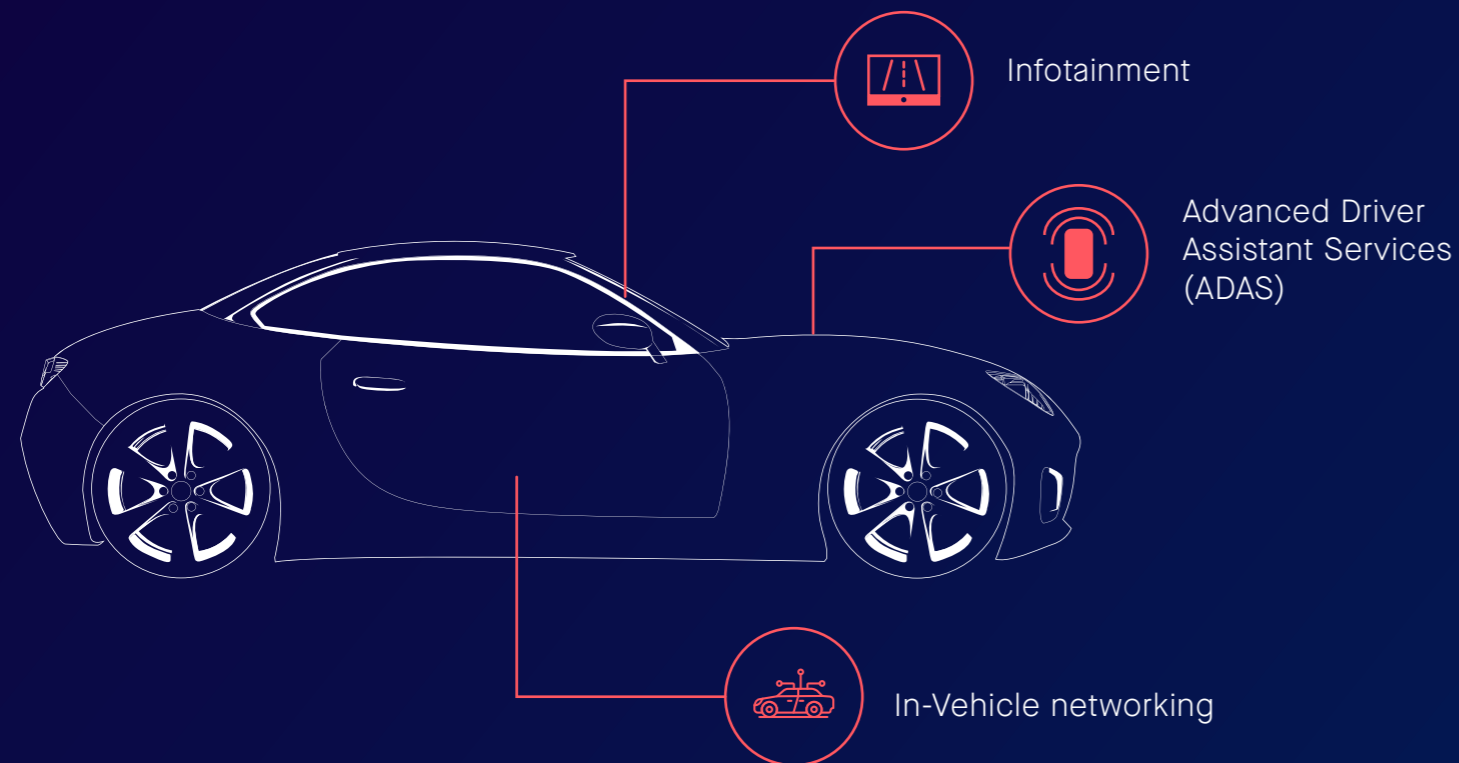


# MCU application in the car

The intelligence of any passenger car depends on MCUs.

→ In contrast to consumer electronics, larger node and wafer sizes are used.

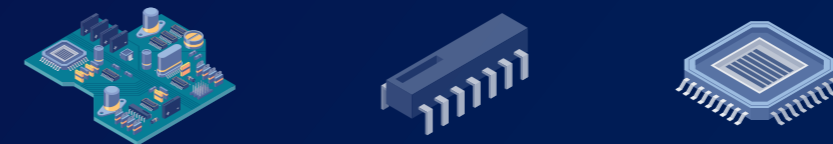
## Main MCU applications in an automobile



## MCU as one of the most important semiconductors

### General MCU information:

- Parts of a MCU, core, memory, and peripherals
- Application: information processing (e.g. ADAS, infotainment, ... )



### Automotive specific MCU characteristics:

- Common node size: 22-90nm node size
- Common wafer size: 300mm
- Common processing volume: 32-bit
  - Current cars in the market still contain 8 and 16-bits on 200mm wafers, caused by long product lifecycles
- Automotive share in the MCU market: ~20%



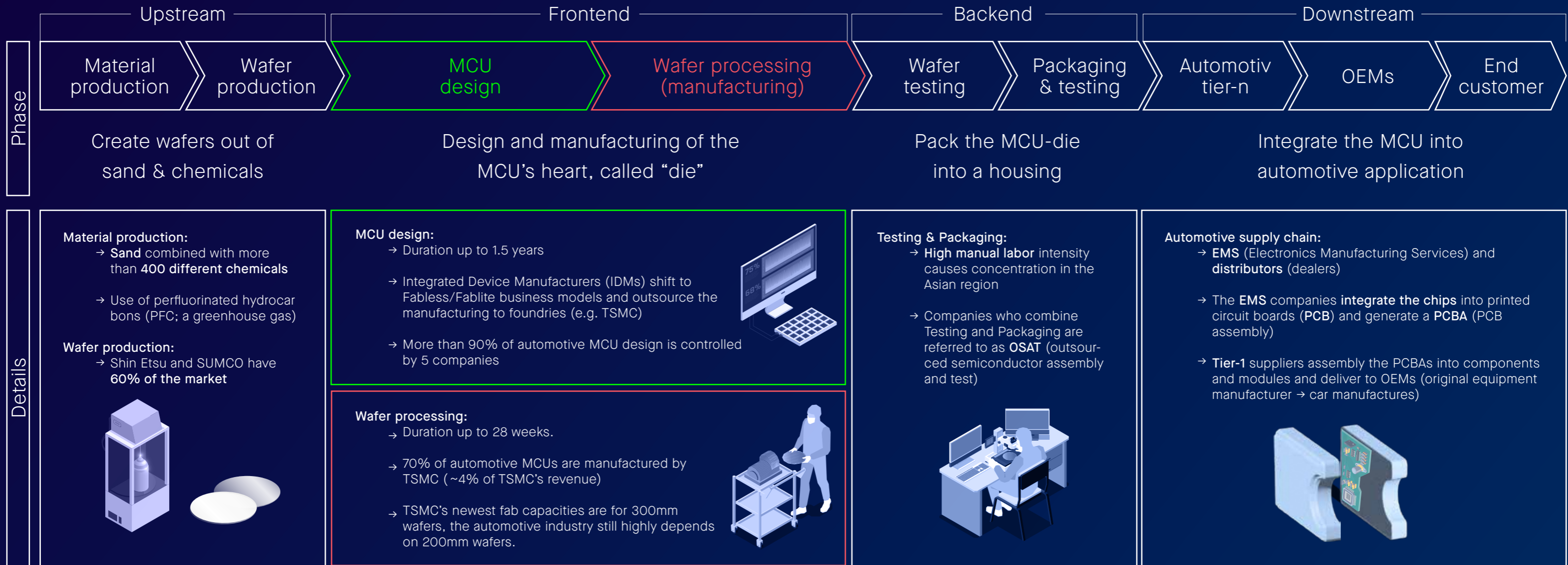
→ In contrast to consumer electronics, the automotive industry uses larger node sizes (22-90nm).

→ Currently, several 8 and 16-bit MCUs are replaced by one 32-bit MCU (e.g. door module).



# MCU value stream

Front-end production is the longest lasting step in the MCU supply chain for automotive application.



→ The longest lasting value-steps are the MCU-design (up to 1,5 years) and the wafer processing (up to 28 weeks).

→ Caused by the low market share, the automotive industry is not prio 1 for the front-end.

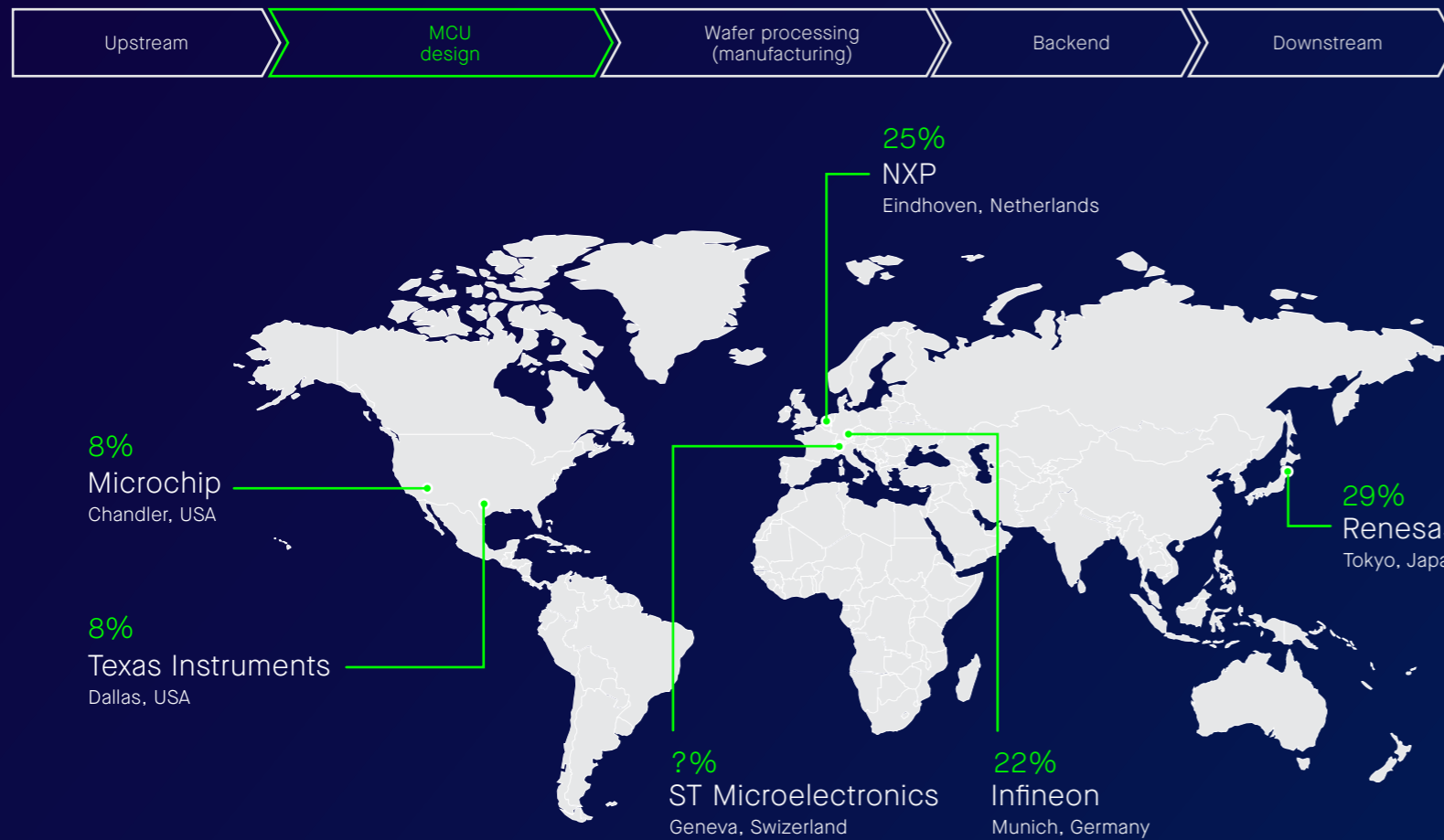




# Automotive MCU oligopoly for chip design

Biggest automotive players are IDMS, high investment costs drive specialization.

## Big players in automotive MCU design and their market share



## Interpretation

- More than 90% of the automotive MCU (32-bit) market is controlled by 5 players (Renesas, NXP, Infineon, Texas Instruments and Microchip).
- ST Microelectronics is currently intensifying its automotive business. Traditionally, its focus is more industrial.
- The preferred working model of semiconductor companies is an Integrated Device Manufacturer (IDM).
- For 32-bit MCUs, IDMs outsource the production (fabless / fab-lite), caused by low overall volumes.
- 70% of all automotive MCUs fabrication is outsourced to 1 semiconductor foundry company TSMC.
- The major foundry companies are Samsung, UMC, Global Foundries and SMIC.



- For 32-bit MCU the automotive supplier from being an IDM to fabless.
- With IDMs going fabless, TSMC is going to gain more prominence in the automotive MCU manufacturing.

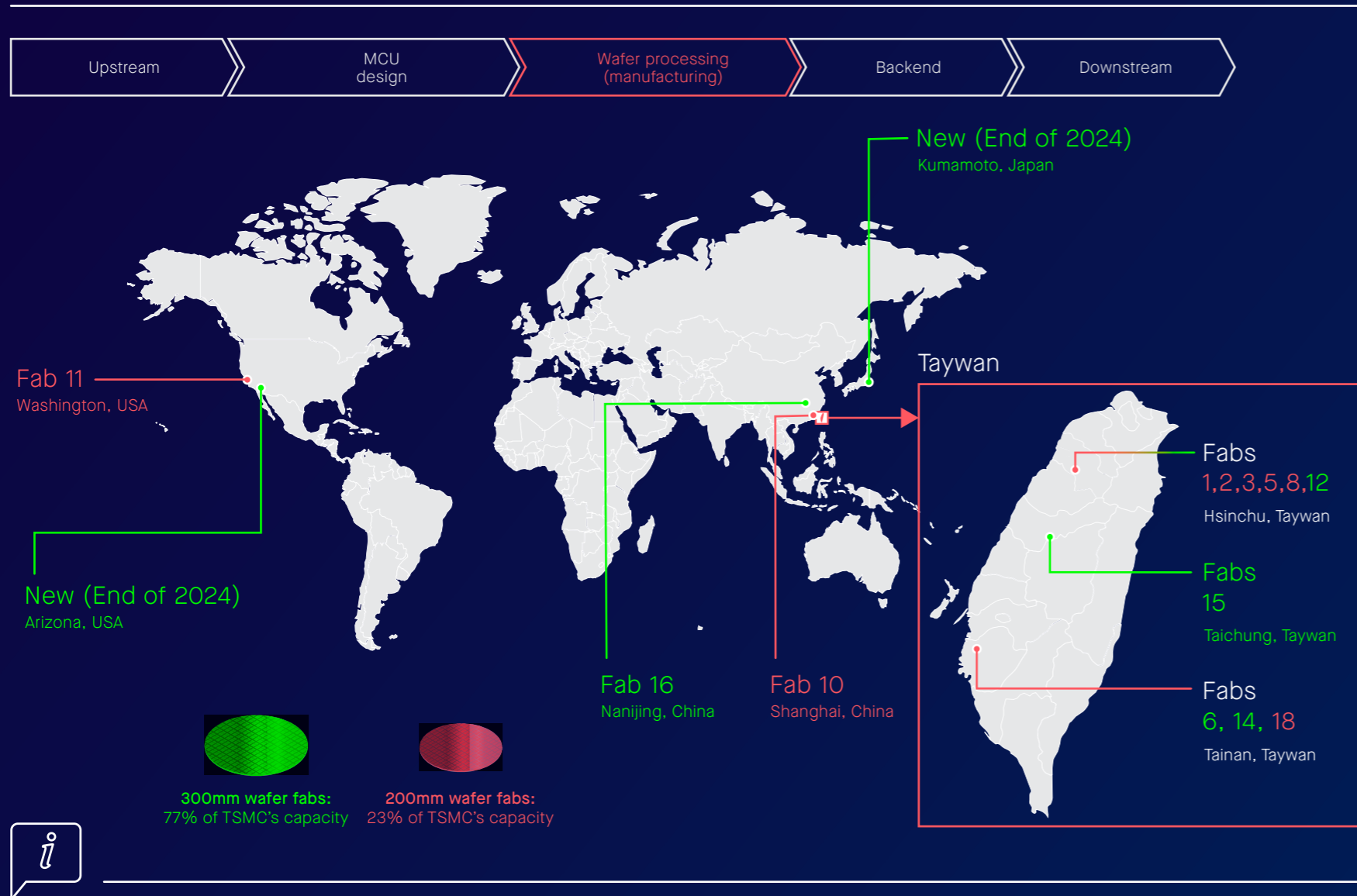




# TSMC's monopoly for outsourced manufacturing

High dependence on TSMC, high concentration on Asia, low dependence on the automotive industry.

## TSMC's fab locations

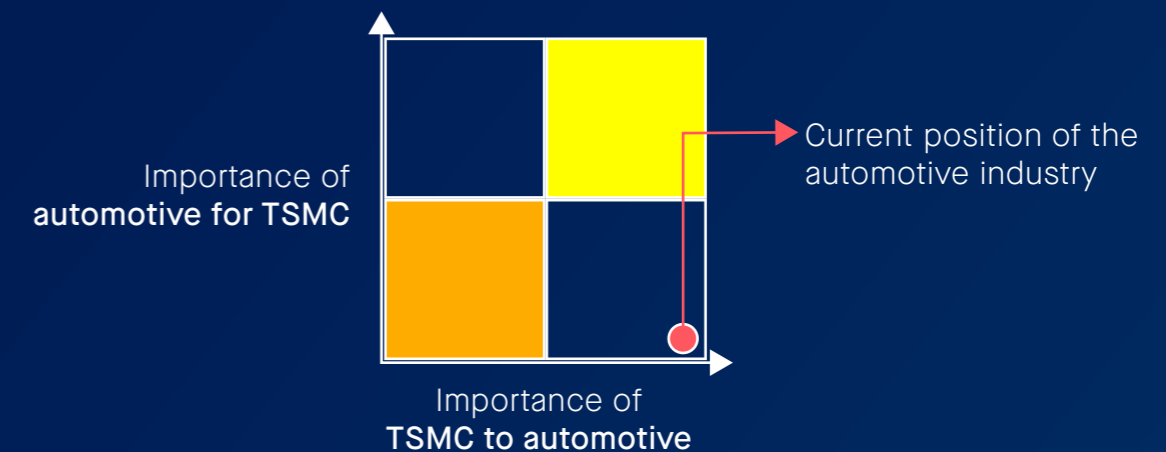


- Only 1 fab of TSMC is outside Asia, and 3 fabs outside Taiwan - 1 in USA and 2 in China.
- 70% of automotive MCUs are manufactured by TSMC, but it accounts for less than 4% of its revenue.

Source: TSMC Annual Report, 2021

## Interpretation

- Most of TSMC's fabs are in **Taiwan**, which is a country under **geopolitical pressure** and located in a region known to have **seismic activity** -> high risk of **supply chain disruptions**.
- Even though more than 70% of the automotive MCUs are made by TSMC, they contribute less than 4% to its total revenue. Following, **high dependence and low bargaining power** for the automotive OEMs.
- More than 80% of TSMC's revenue comes from chips/dies made from the **300mm wafer** and all the **newer fabs being built by TSMC** are based on the 300mm wafer technology. Newer automotive MCUs have moved to the 300mm wafer technology, but still **many automotive MCUs use the 200mm wafer technology**.



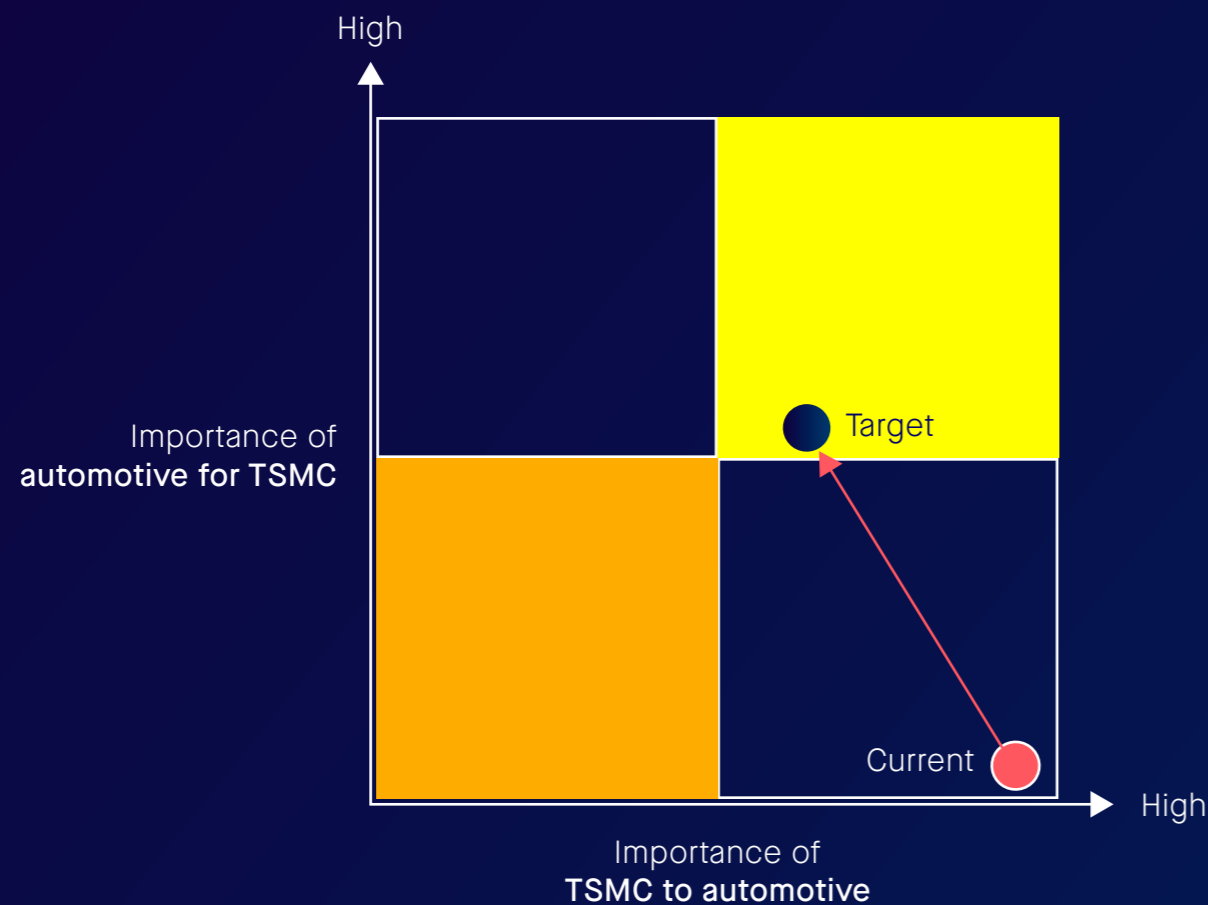


# How to manage TSMC's monopoly

How to increase the automotive importance for TSMC.

## Strategic evaluation of the market positions

## Measures to increase automotive's bargaining position



**Today's situation:** the automotive industry **highly depends on TSMC** for MCU manufacturing.

- **Build strategic partnerships with MCU-design companies:** sign LTSA (long term supply agreements) with e.g. Renesas, NXP, Infineon, Texas Instruments, and Microchip.
- **Build strategic partnerships with TSMC** e.g. purchase manufacturing capacities
- **Build dual fab approaches for wafer processing**
- **Push cooperation\* to incentive investments** into nearshore manufacturing capacities  
(\* Cooperation & Competition: strategic partnerships between competitors)
- **Invest in R&D**



→ Strategic partnerships within the value-chain are the necessary long-term measure to assure long term supply of MCUs for the automotive industry.

# P3 Team Get in touch

## About P3

P3 is an independent and international consulting company that offers consulting and engineering services, as well as software development for numerous customers.

Since its founding in 1996 in Aachen, Germany, P3 continues to grow with over 1.600 employees in 28 locations.

P3 has been working intensively on electromobility in all these facets and many more since 2008. This has given us a deep understanding of the technologies, production and players, which we continue to develop on a daily basis. This enables us to provide you with comprehensive strategic advice – and thanks to our proven practical relevance, we can also support you in the implementation.



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# Abbreviations

MCU	Microcontroller unit
ADAS	Advanced driver assistant systems
TSMC	Taiwan Semiconductor Manufacturing Company
R&D	Research & development
CAGR	Compound Annual Growth Rate
OSAT	Outsourced semiconductor assembly and test
EMS	Electronic manufacturing services
PCB	Printed circuit boards
PCBA	Printed circuit boards assembly
OEM	Original equipment manufacturer
LTSA	Long term supply agreements



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