

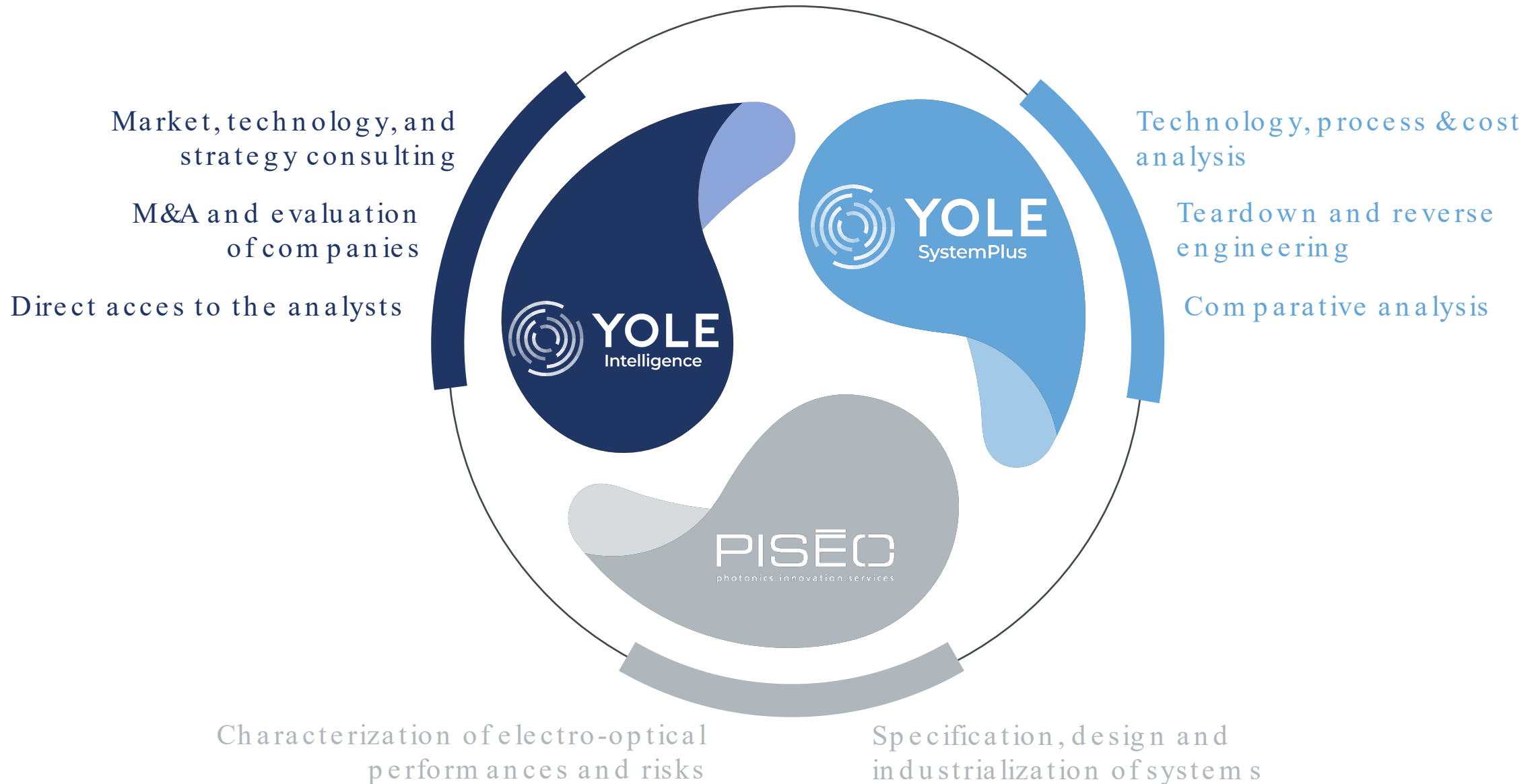
Overview of the
promising
applications in the
MEMS & Sensors
industry



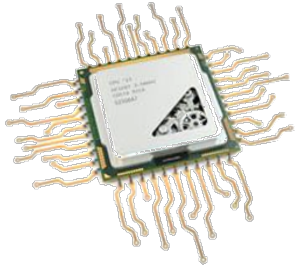
- Yole Group presentation
- Context, market overview and examples of promising applications for:
 - Wearables
 - Automotive
- MEMS & Sensors market shares
- Takeaway

YOLE GROUP PRESENTATION

YOLE GROUP'S MAJOR ACTIVITIES PER ENTITY

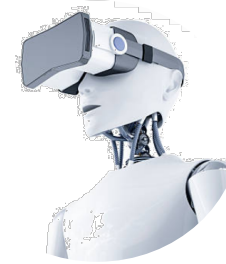


FIELDS OF EXPERTISE COVERING THE SEMICONDUCTOR INDUSTRY



- Semiconductor Packaging
- Semiconductor Manufacturing
- Memory
- Computing and Software

- Photonics & Lighting
- Imaging
- Sensing & Actuating
- Display



- Radio Frequency
- Compound Semiconductors
- Power Electronics
- Batteries



- Electronic Systems
- Emerging Technologies

WEARABLES

FUNCTIONALITIES AT THE HEART OF WEARABLES

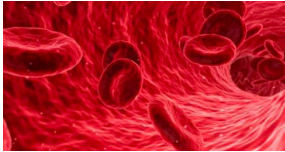


Biosensing

Heart rate



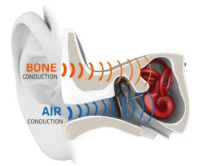
Oxygen SpO₂



Glucose level



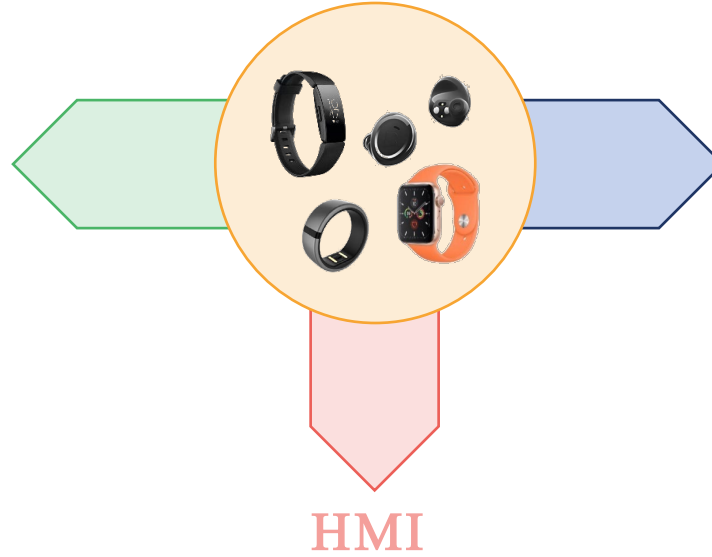
Temperature



Bone conduction for voice pick-up



Proximity sensing



HMI



Crown position



Touch



Force



Presence sensing

Environment

3D Sensing

Projection /display

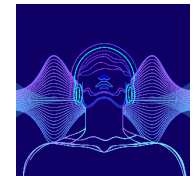


Photography

Sound



Head orientation



Light

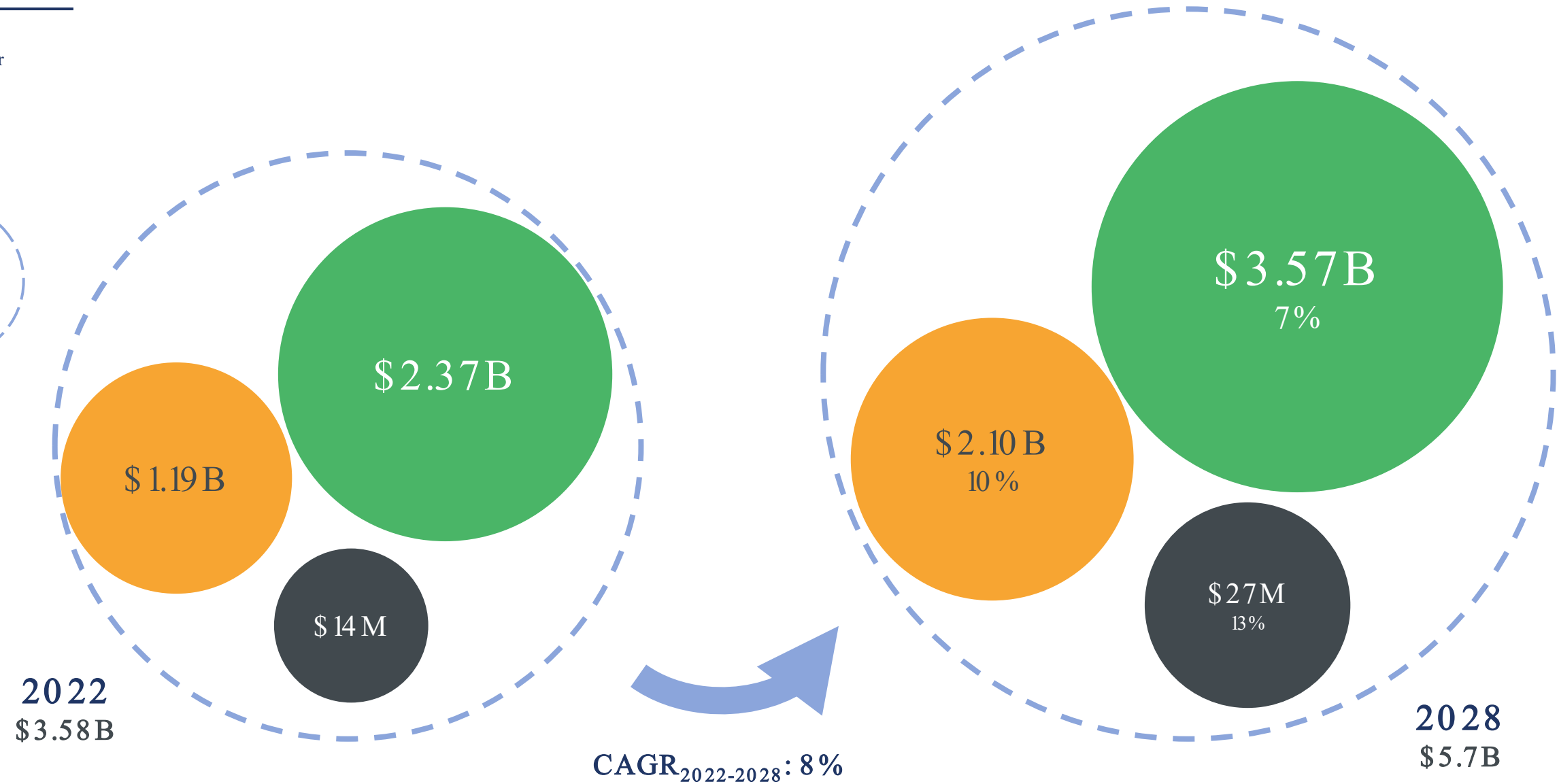


SENSORS & ACTUATORS WEARABLES MARKET FORECASTS



By end-market – Revenue (\$M)

- Consumer
- Medical
- Industrial



SENSORS & ACTUATORS FOR WEARABLES MARKET SHARES

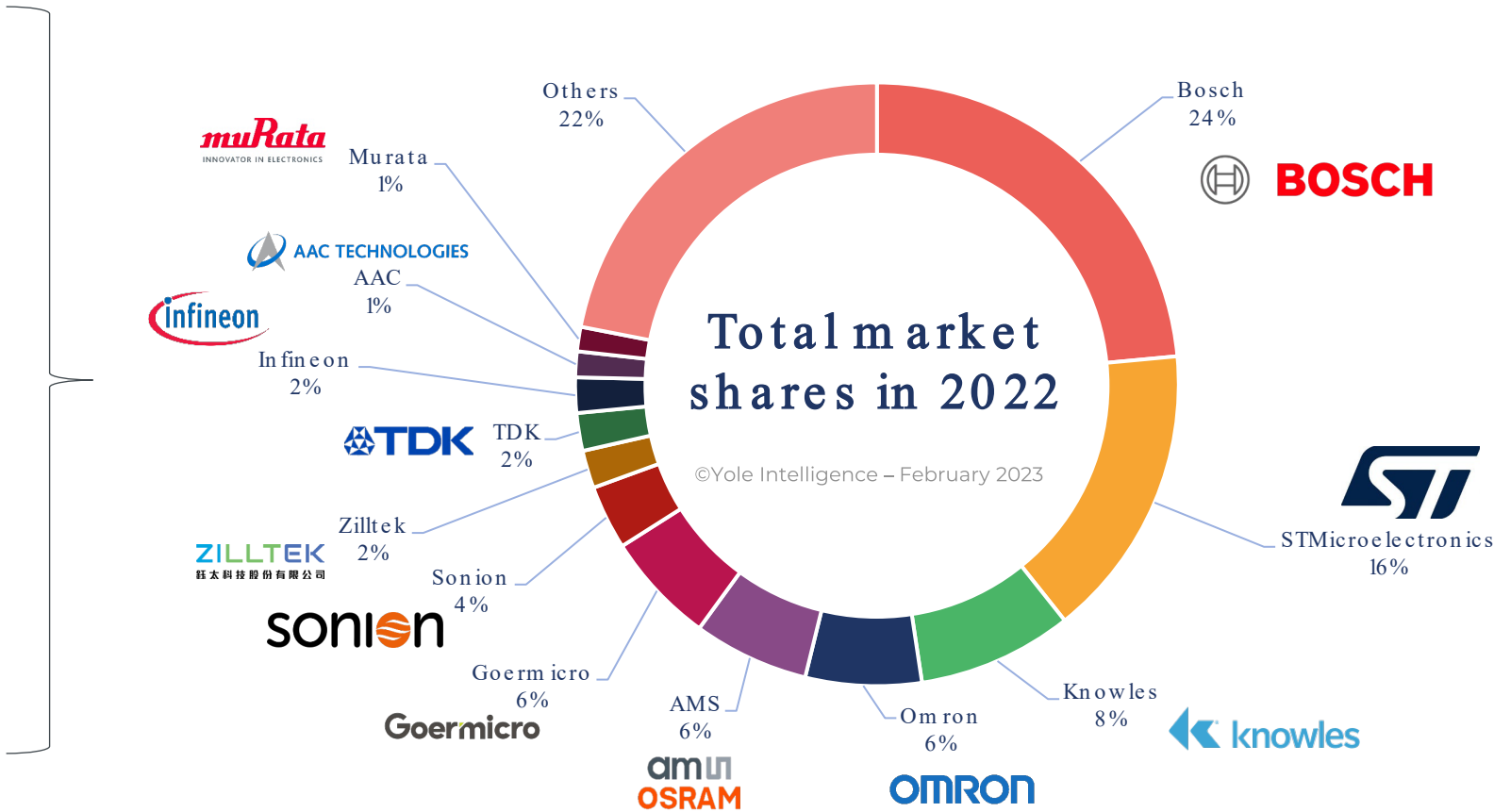


Consumer



Medical

Sensors & Actuators for Wearables 2022 market shares



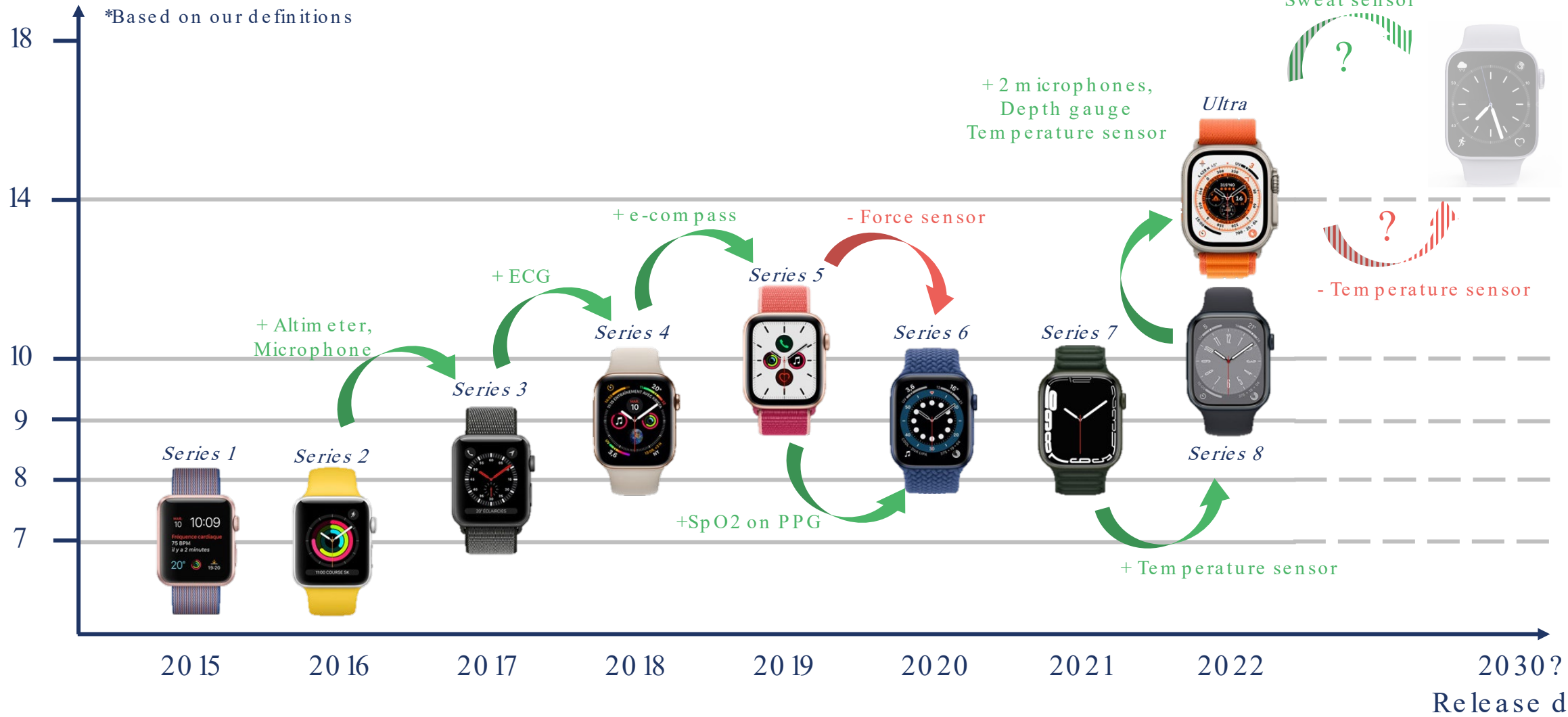


EXAMPLE OF SMART WEARABLE

Apple Watch and the evolution of the sensing requirements

Number of sensors

*Based on our definitions



Candidates:

- + 4th PPG generation: temperature and glucose monitoring
- UV sensor
- Sweat sensor



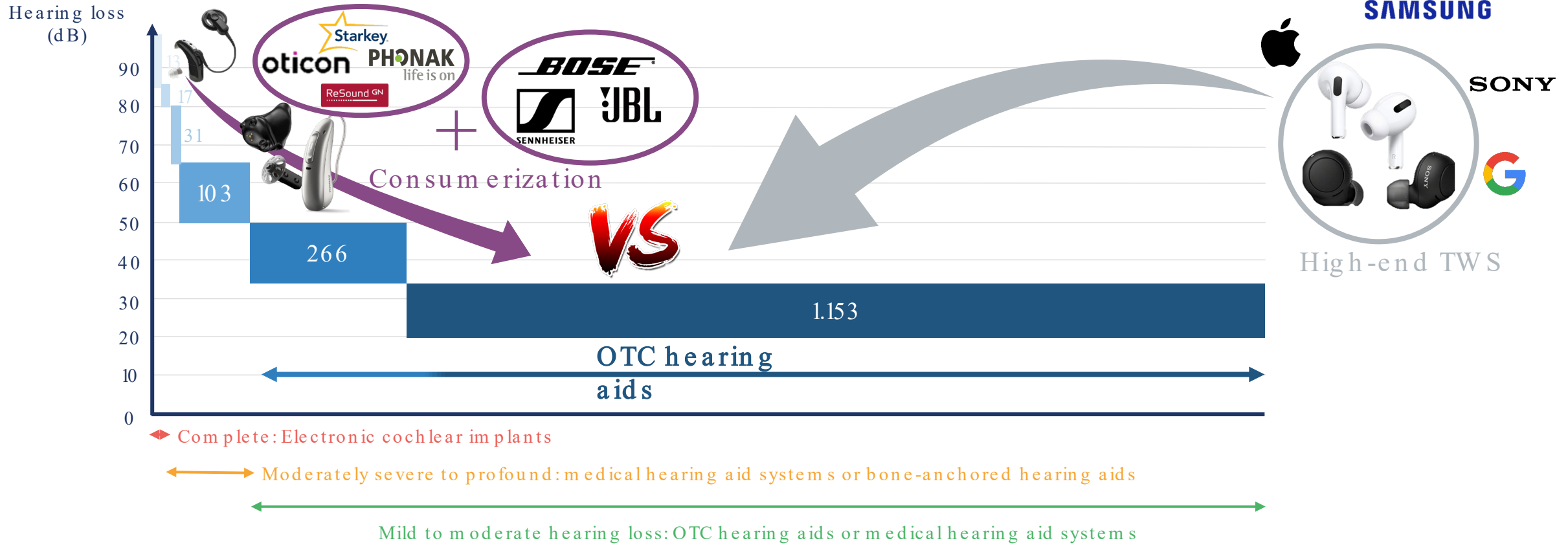
- Temperature sensor



EXAMPLE OF SMART WEARABLE

Hearing aids and the advent of OTC

People with varying degrees of hearing loss (in millions)



CONSUMER AND MEDICAL END-MARKETS ARE COMING CLOSER AND CLOSER



Consumer Healthcare



Fitness and well-being applications
 No approval
 From 10k to a million units
 Retail stores

Consumer healthcare (OTC)
 Approval, or function approved by a health organization
 From thousands to millions of units
 Over the counter

Medical device
 Approval from health organization
 From thousands to 100k units
 Prescription mandatory

AUTOMOTIVE

CONTEXT IN THE AUTOMOTIVE INDUSTRY

C.A.S.E. – the acronym taking over the auto industry



Autonomous

Sensor suite and computing developments for safer roads.



Sharing

Owning, sharing, or renting, the mobility of the future offers greater flexibility.

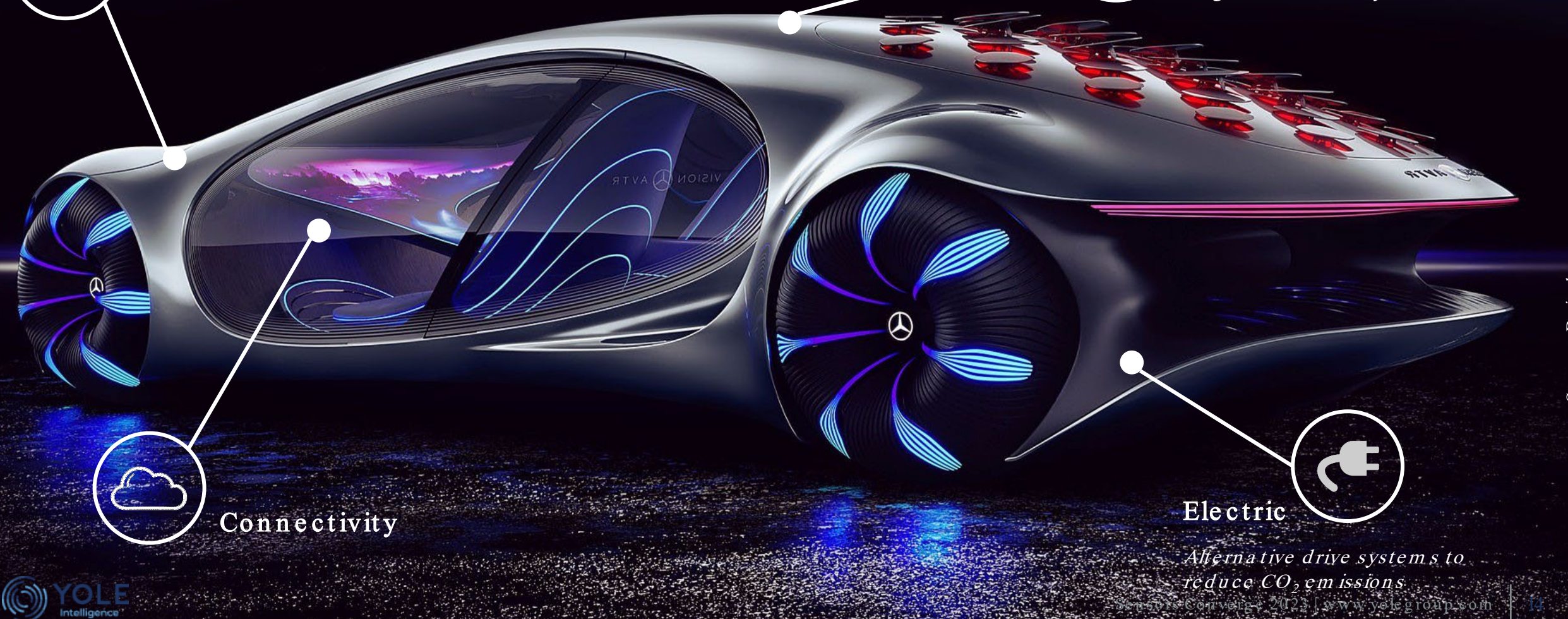


Connectivity



Electric

Alternative drive systems to reduce CO₂ emissions

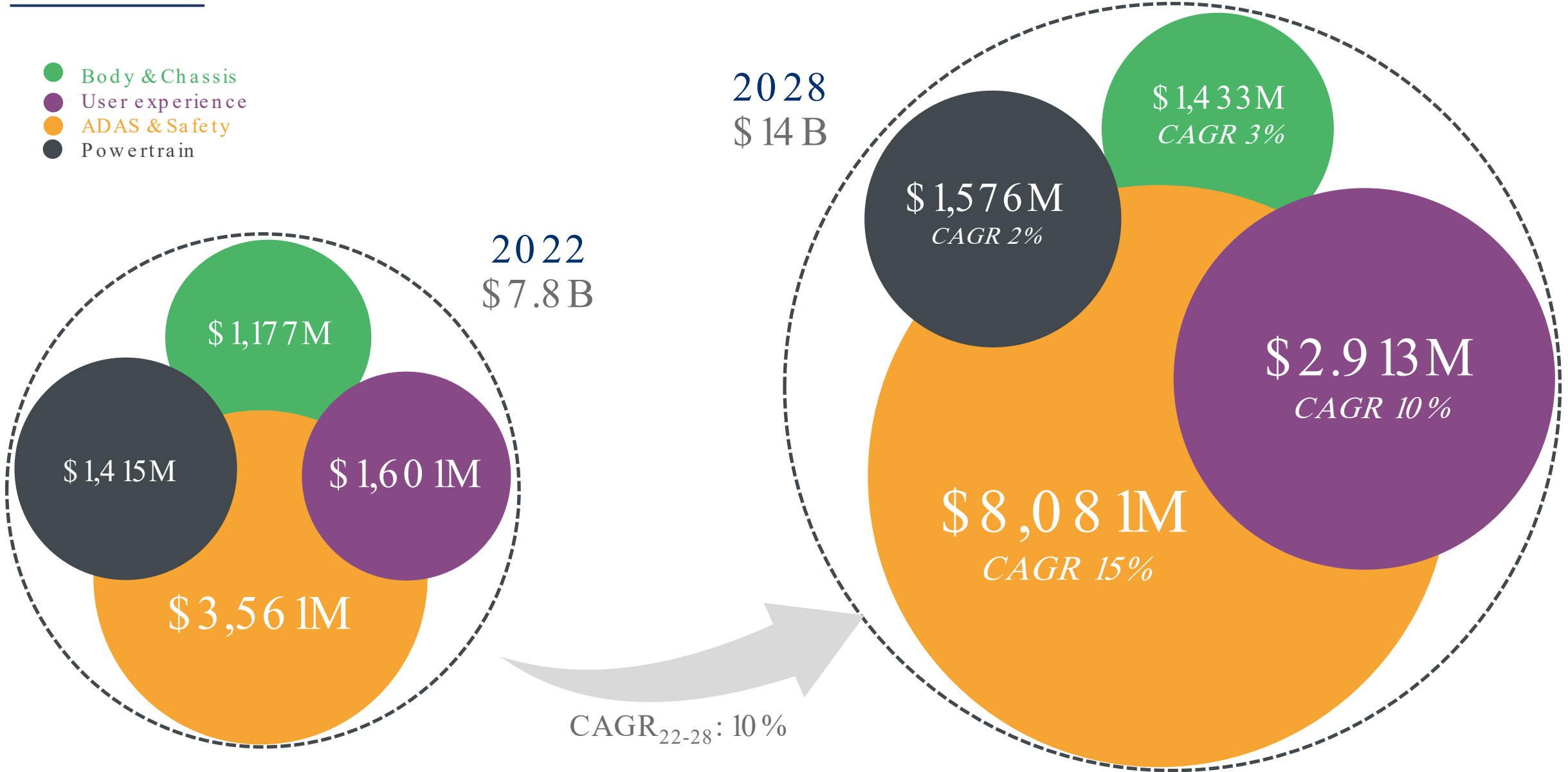


Source: Daimler

2022-28 SENSOR MARKET* FOR AUTOMOTIVE APPLICATIONS BY DOMAIN



- Body & Chassis
- User experience
- ADAS & Safety
- Powertrain

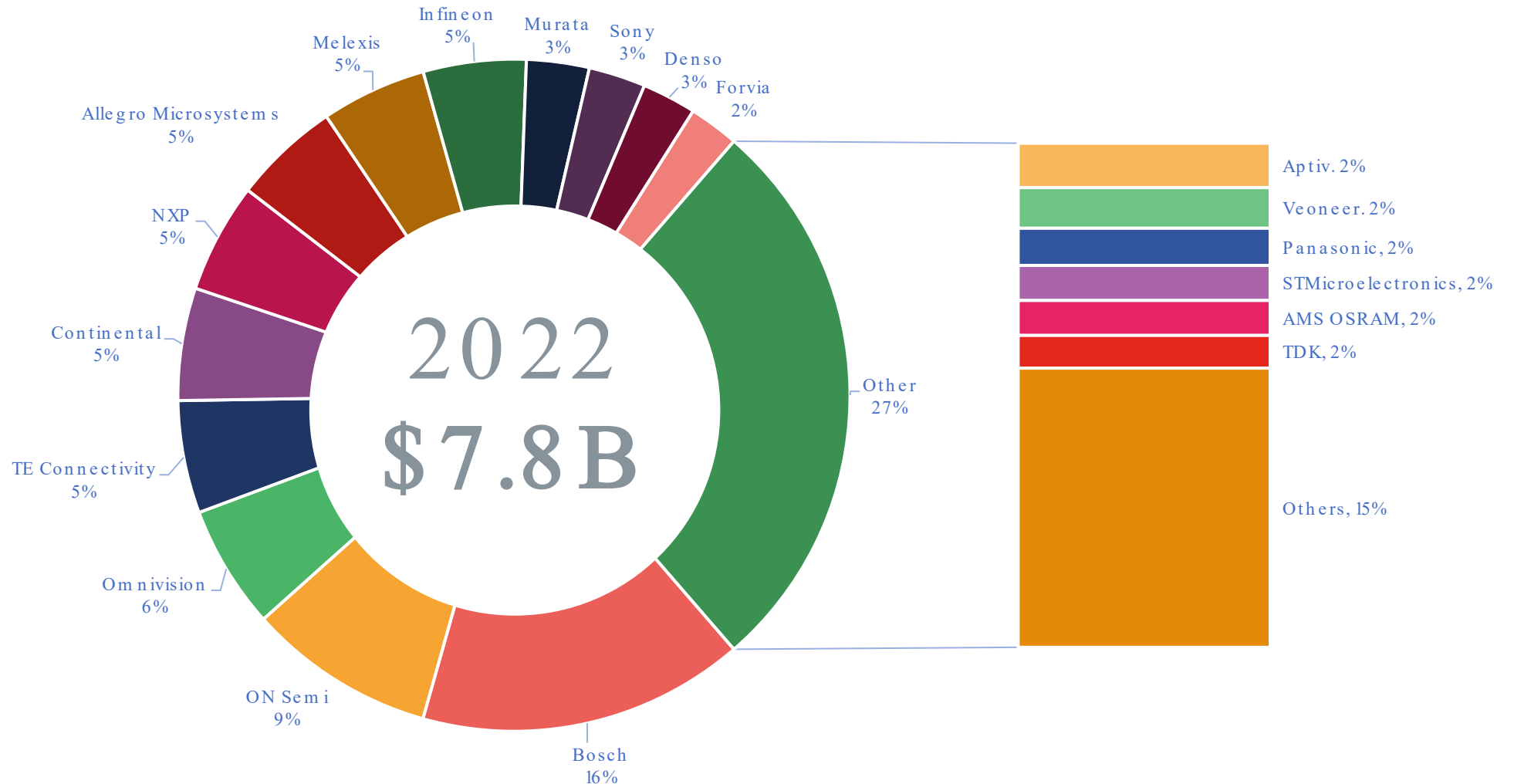




SENSORS FOR AUTOMOTIVE SUPPLY CHAIN

Global semiconductor sensor market shares

Semiconductor sensors - 2022 Global market shares



Bosch is the player having the highest market share, with 16% of the market that represent \$1.2B in revenue.

FROM PRESSURE MONITORING TO SMART TPMS

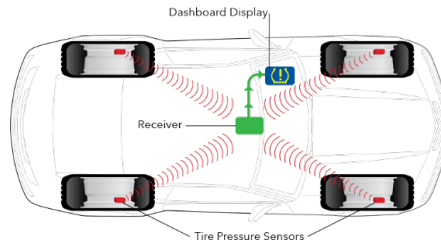


By collecting the pressure sensors' data and compensating for the temperature drift. Thanks to the accelerometer, the pressure is only measured when the car is moving.



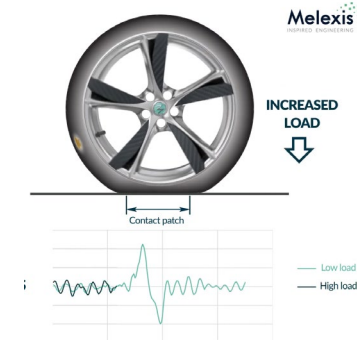
One-time pressure measurement

Identifying which TPMS module is mounted on which wheel (no need to have a pairing process) based on the acceleration pattern of sensors



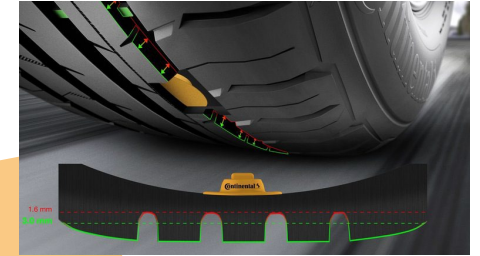
TPMS module identification

By analyzing the accelerometers data during each cycle



Load detection

By analyzing the evolution of the rolling characteristics of the tire

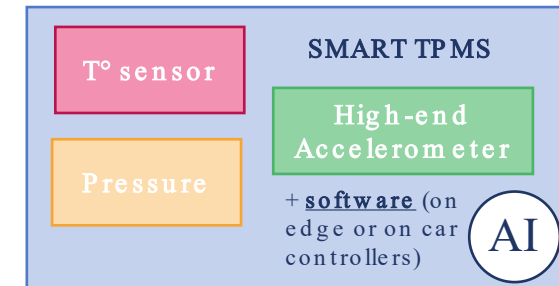
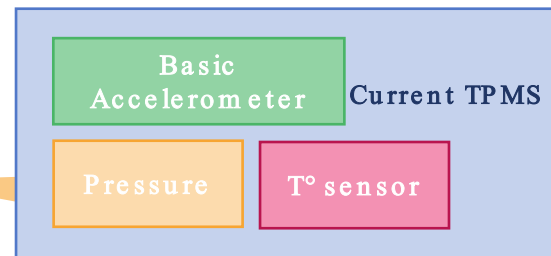


Tread depth

2030?

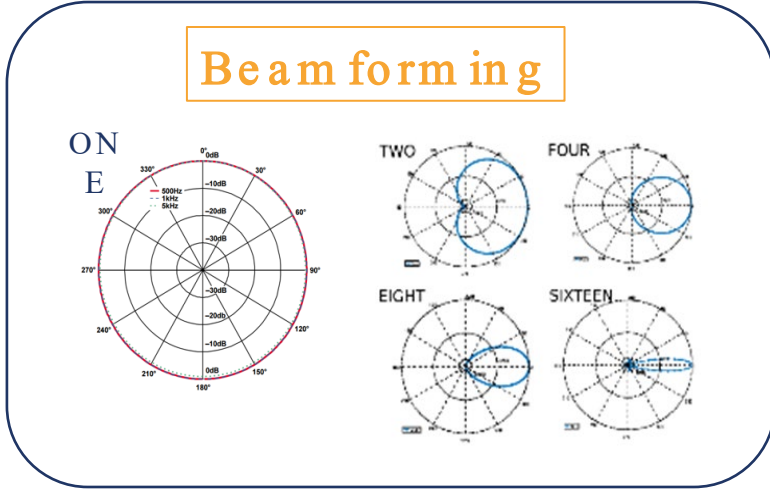
Currently

2010+

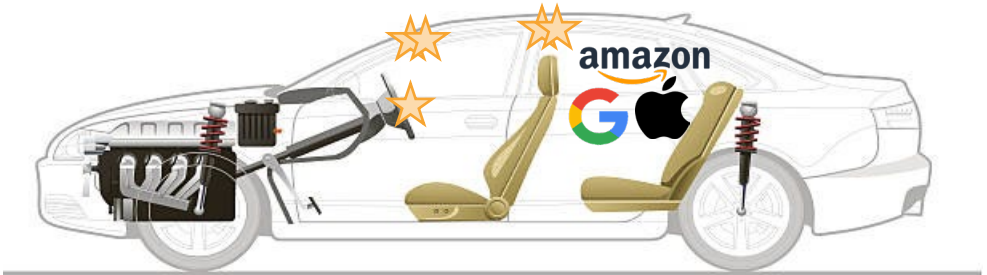




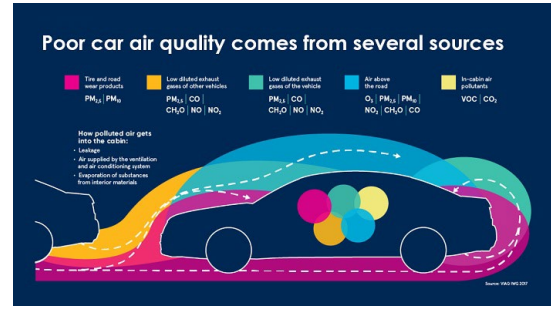
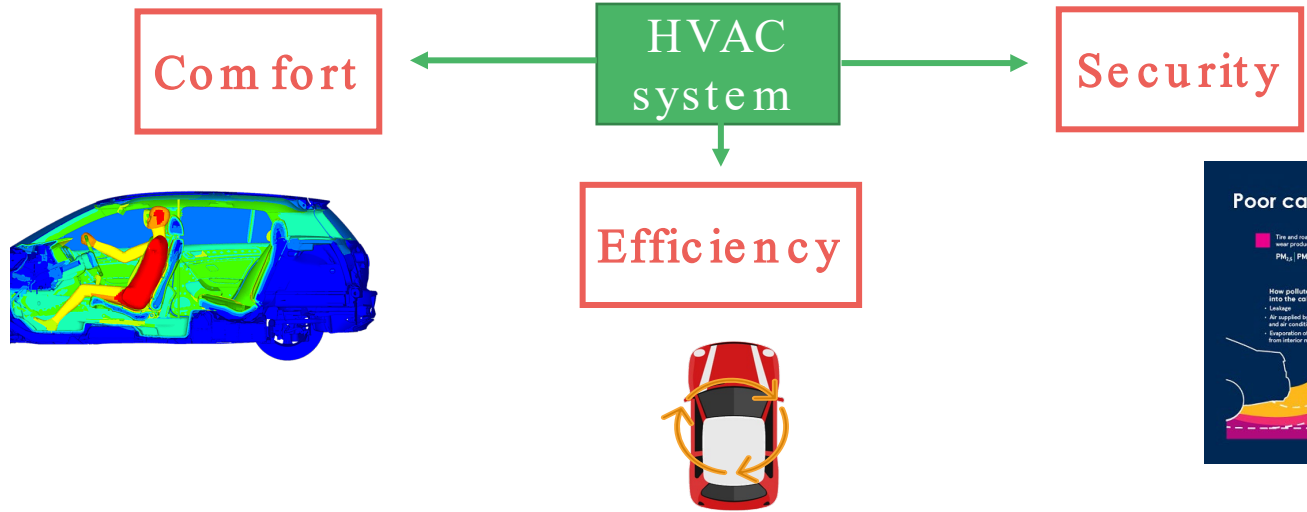
MEMS MICROPHONES



★ MEMS microphones' potential locations



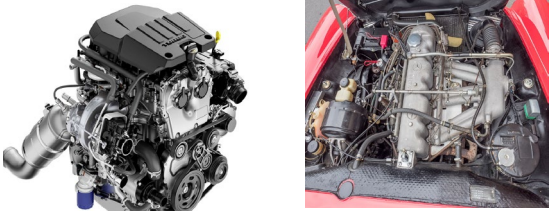
ENVIRONMENTAL SENSORS






Internal Combustion Vehicles

- ICE is loud → covers the road noises



- Road noises are canceled using noise-isolating materials → **passive technology**

HEAVY MATERIALS




electrification



Electric cars


- Electrical engine is quiet → does not cover the road noises



- **More weight**

↓

- **More power consumed**



And battery/power management is a key feature for electric vehicles

- **MEMS Accelerometers**: detects the vibrations of the road
- **Microspeakers** (probably **not** MEMS as you need a high sound pressure levels) to offset the road-induced vibrations
- **MEMS microphones**: providing feedback data to the controller to adjust the signal

TAKEAWAY



Pushed by mega-trends like the:

- Increasing interest in biosensing functionalities
- Sensorization of end-systems for more enjoyable experiences

- Electrification of cars
- Autonomous driving
- Improved HMI & in-cabin comfort

} Wearables

} Automotive

we expect MEMS & Sensors to remain mandatory in the coming years.

Key new applications are on their way to nurture this multi \$B industry!

THANK YOU FOR LISTENING



Sensors & Actuators for Wearables 2023



Semiconductor Sensors for Automotive 2023



Status of the MEMS Industry 2022
(2023 edition planned for July)

Thanks for listening, and if you have any question on the presentation or on related topics, don't hesitate to contact me:

pierre.delbos@yolegroup.com



Magnetic Sensor 2022



Gas & Particle Sensors 2021
(2023 edition planned for October)