

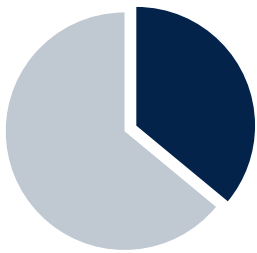


**Capital  
Markets  
Day 2022**

# Analog, MEMS & Sensors Group

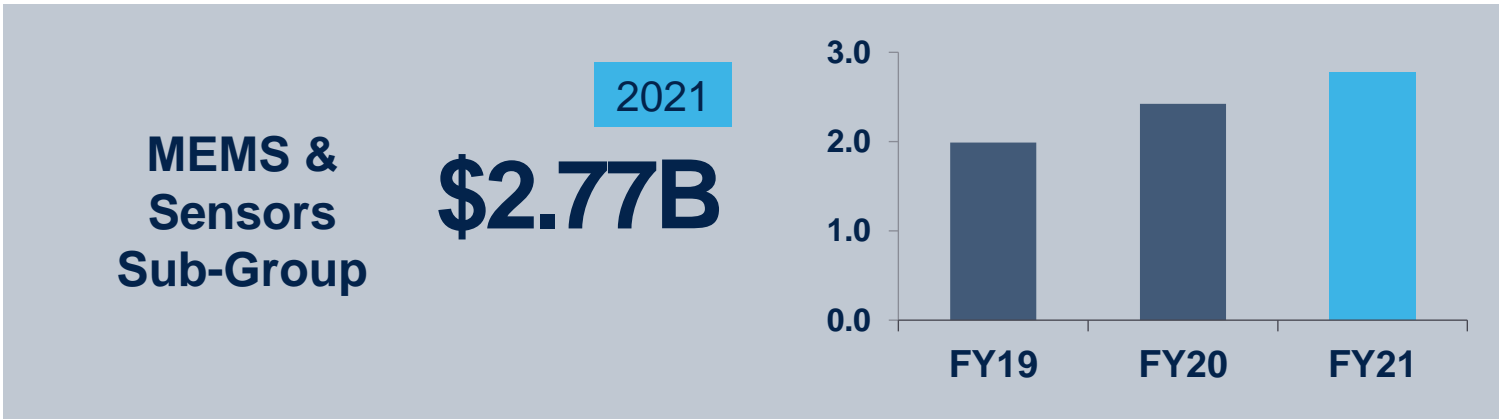
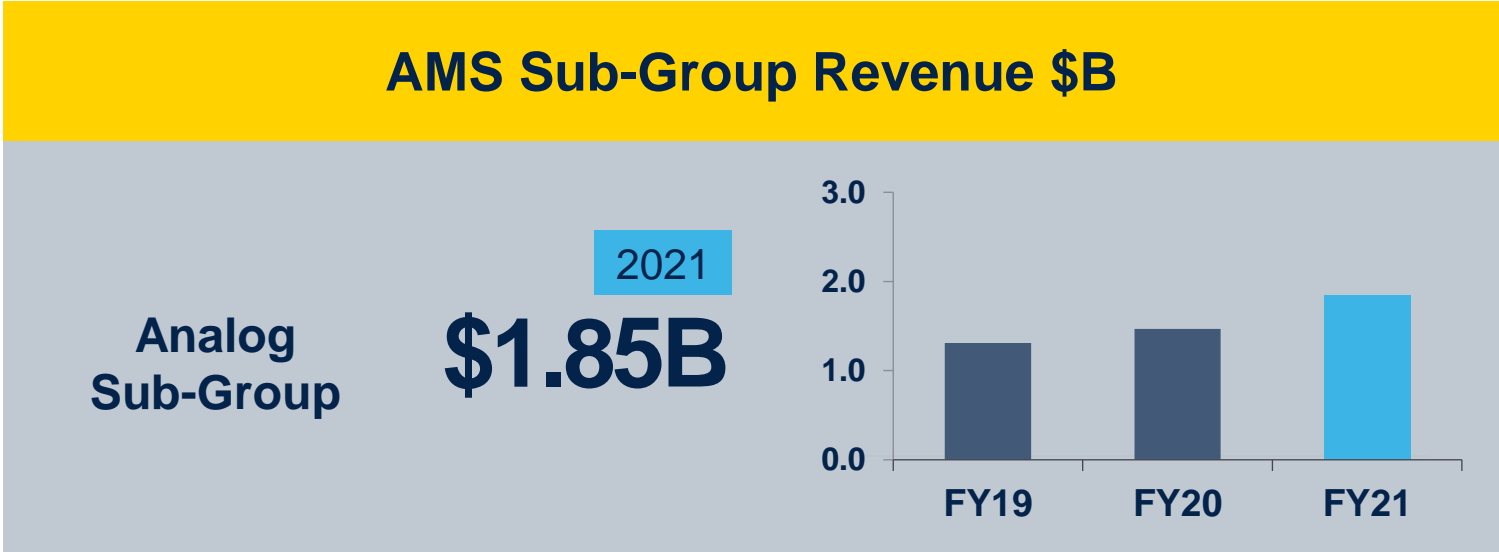
**Marco Cassis**

President, Analog, MEMS and Sensors Group, Head of STMicroelectronics' Strategy, System Research and Applications, Innovation Office



36% of ST FY21  
Revenues

# Revenue overview - AMS



# AMS strategy addressing underlying trends

## Trends

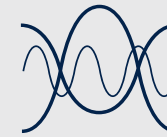


**Sensorization &  
digitalization**



**Smarter & more efficient  
energy use**

## Products



### **Analog**

Application specific  
General purpose

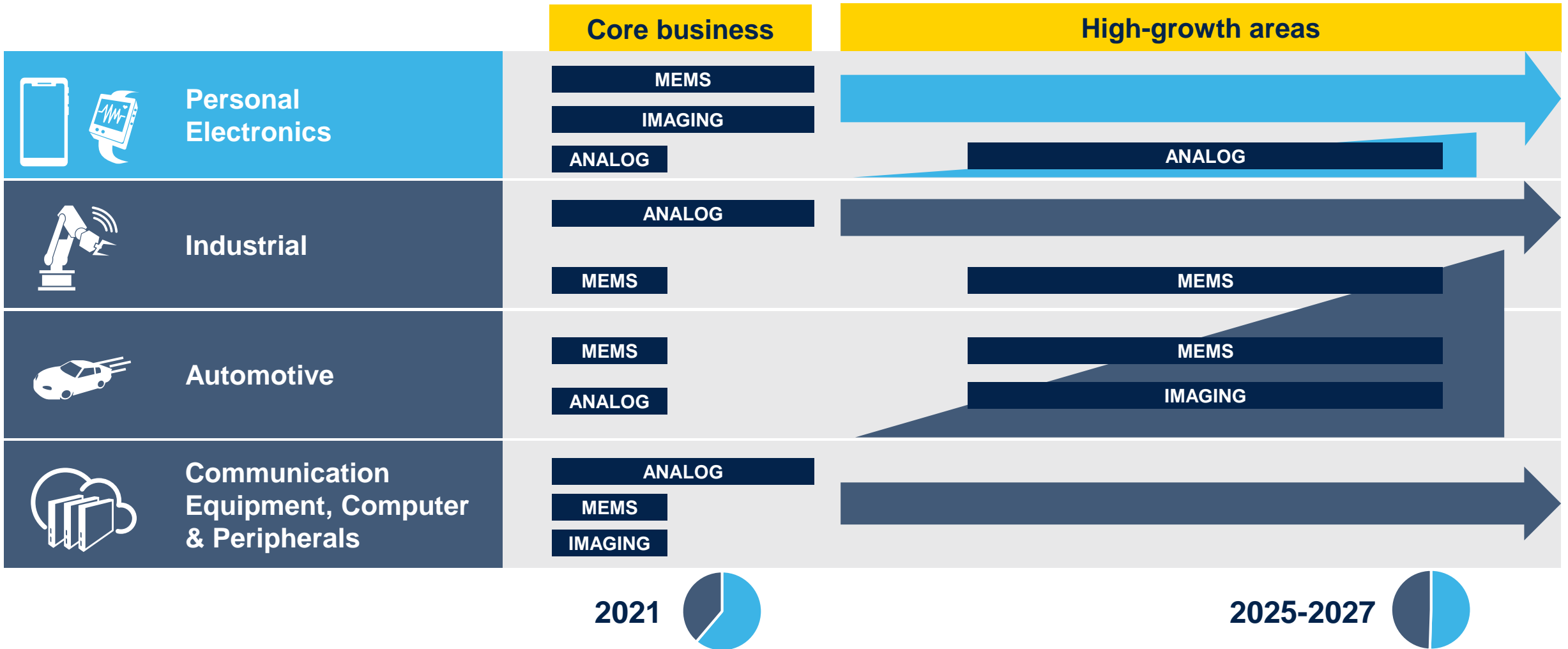


### **MEMS & Sensors**

MEMS sensors & actuators  
Optical sensing solutions



# Growing and balancing revenue streams across ST end markets





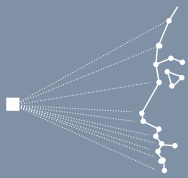
# Optical sensing solutions





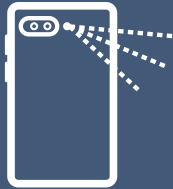
# Optical sensing solutions

## Core business



### Smartphone front facing

Face authentication  
Biometrics  
Ambient Light Sensing



### Smartphone world facing

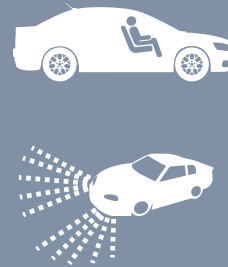
Camera assist (bokeh, laser autofocus..)  
Ambient Light Sensing



### PC / Laptops

Low power presence detection  
Face authentication  
Security

## High growth areas



### Automotive

Driver monitoring  
Occupancy monitoring  
LiDAR



### Industrial

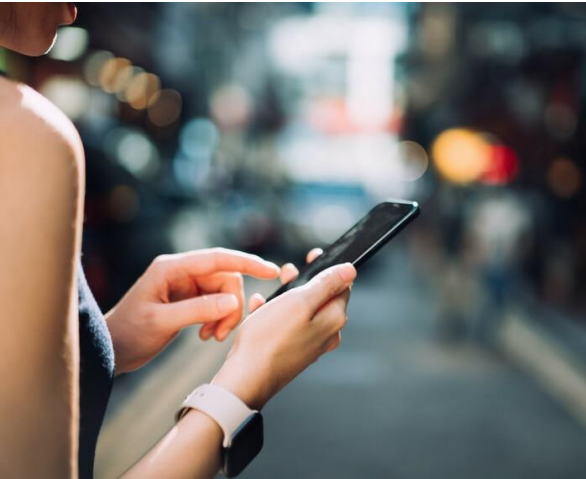
Robotics  
People counting  
Touchless operation  
Smart home  
Depth sensing



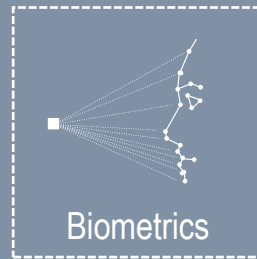
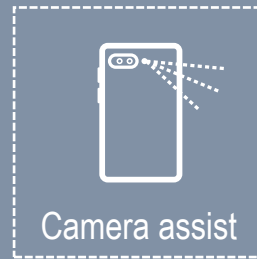
### Emerging applications

AR / VR / MR  
Consumer LiDAR  
Gesture control  
AI computer vision

# ST leadership positions in 3D & depth sensing



## Personal electronics



**> 200 smartphones** adopting ST depth sensing solutions

**Leadership** in ToF with > 1.7 Billion units shipped



## Computer & Peripherals



**Leadership** in global shutter sensors

**> 90 computers / laptops / tablet / monitor models** including ST optical sensing solutions



# ST addresses a variety of optical sensing solutions thanks to differentiated proprietary technologies

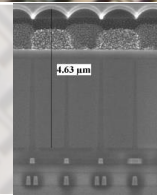
**Direct Time-of-Flight**  
40 nm SPAD, 3D-SPAD



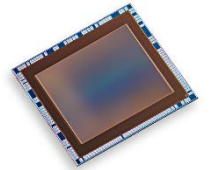
**Indirect Time-of-Flight**  
4.6  $\mu\text{m}$  fast photodiode, 3D-BSI



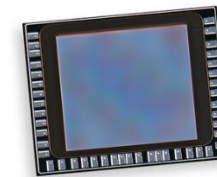
**Global Shutter pixels**  
Smallest pixel pitch, FSI & 3D-BSI



**All-in-one  
ToF modules**



**3D ToF  
sensors**



**Global Shutter  
sensors**



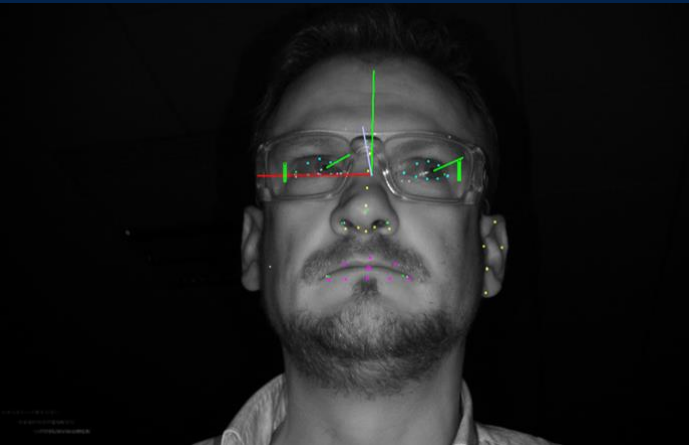
**ALS & Proximity  
combo**



# Safer driving with ST optical sensors

## Fast-growing market driven by regulatory push

Cars equipped - 10M in 2022 - 50M in 2027



### Driver monitoring systems

Drowsiness detection  
Distraction monitoring  
Driver authentication  
Driver identification

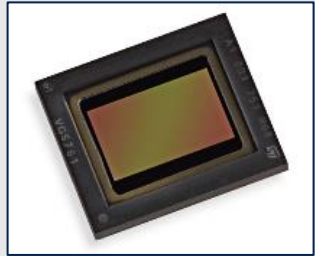


### Occupancy monitoring

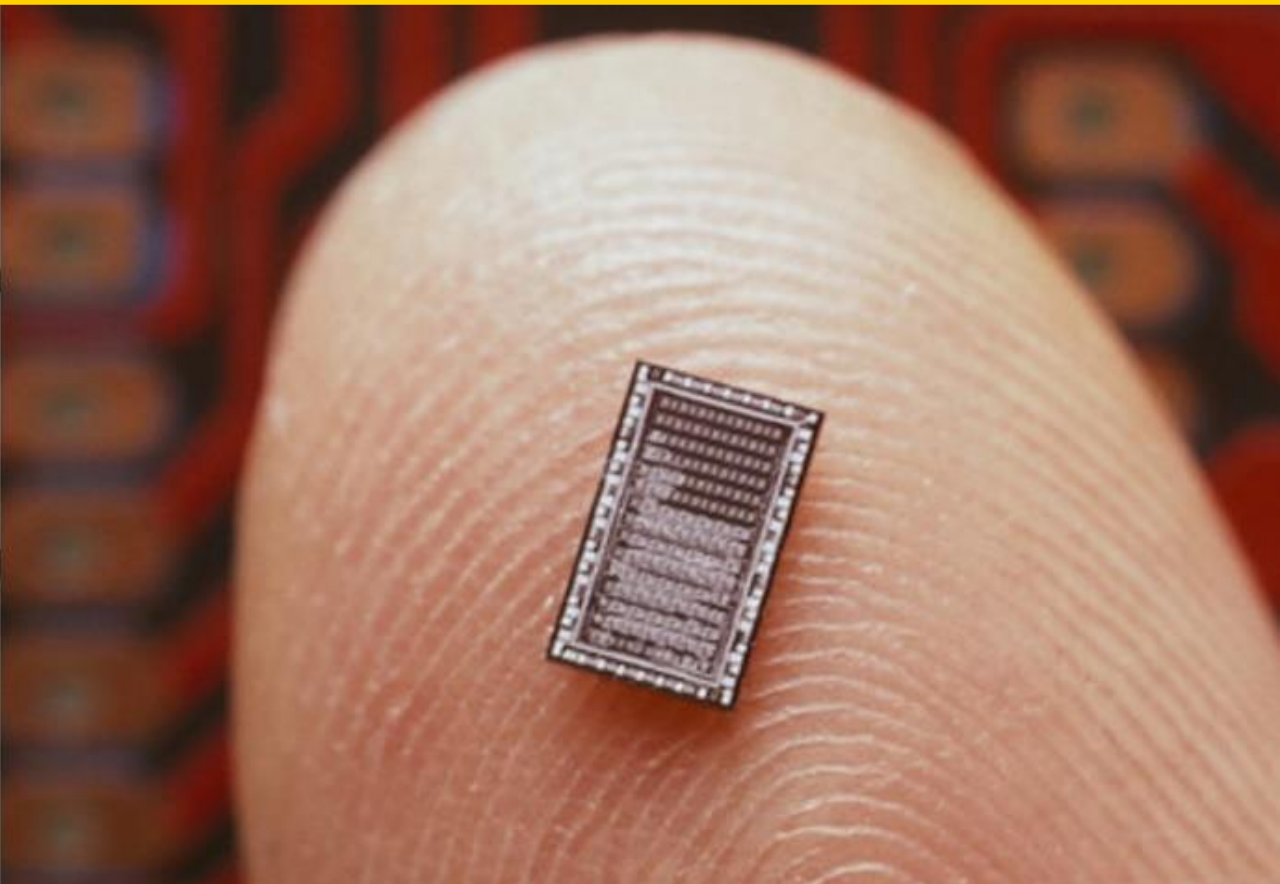
Passenger detection  
Child surveillance  
Intrusion detection  
Accident recording

## Positioning & strengths

- Leading global shutter technology & products
- Target all Tier1s, all OEMs, all regions leveraging ST automotive ecosystem
- Mass production since 2021 with early adopter
- Additional design-wins with Chinese, European & US OEMs, mass production in 2022
- Key customer program design-ins driving 2024 volumes
- Diversification enabling long-term revenue stream



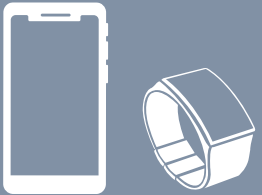
# MEMS





# MEMS sensors and actuators

## Core business



### Smartphones and wearables

User Interface  
Gaming  
Optical stabilization  
Smart watches &  
Fitness bands



### CECP

Printheads  
Memory array  
temperature sensing



### Automotive safety and infotainment

Electronic stability control  
Navigation  
Telematic box

## High-growth areas



### Emerging applications

TWS  
AR / VR / MR  
Health data sensing



### Industrial

Industry 5.0  
Predictive maintenance  
Building structure monitoring  
Presence detection



### Automotive

ADAS  
Electrification  
Powertrain management  
LiDAR

# Leadership positions in MEMS



## Personal electronics



**1.1 Billion units  
in 2021**

**#1 in inertial and pressure  
sensors**



## Computer & Peripherals



**1.2 M wafers  
in 2021**

**#1 in MEMS actuators printheads**



## Automotive



**100 M units  
in 2021**

**Fastest growing player in sensors  
for telematics and safety in 2021**



# Continuing to build competitive advantage in MEMS through our technologies and IP

Leveraging ST MEMS proprietary technologies and accuracy + ecosystem + AI in the edge

**Thelma**  
MEMS sensor transducer technology

**P&TRA**  
MEMS actuator technology

**TMOS**  
Thermal transistors MOS technology

**Sensors** - Calibration friendly

**ST factory** calibrated

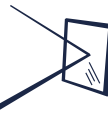
**High and stable** performance



**Actuators** - System-integration friendly

**Small form factor** and **light weight**

**Low-voltage** driven



# Creating highly efficient intelligent sensors with embedded AI engine

Maximizing efficiency and minimizing energy consumption to make large-scale sensor proliferation sustainable

Sensors with DSP  
(Intelligent Sensor  
Processing Unit “ISPU”)  
for real-time processing  
and AI

**1000x** power  
consumption reduction  
vs. traditional solutions



## Optimization

### Power consumption vs. performance

Ultra-low power consumption ( $\mu$ W envelope)

## Efficiency

### Optimized algorithms

Built-in operations capabilities to create optimized functions

## Interoperability

### Machine Learning & Deep Learning

Easy programming, interoperable with main AI frameworks



# Targeting leadership from industry 4.0 to industry 5.0 through MEMS

## Industry 4.0

Motion, vibration,  
angle measurement



Motion sensors, inclinometers

Temperature monitoring  
& calibration



Temperature sensors

Pressure monitoring



Pressure sensors

Humidity monitoring



Humidity sensors

Acoustic monitoring



MEMS microphones

## Industry 5.0

Advanced interface



Artificial Intelligence  
in the edge



Automation



Visual aid  
Laser Beam Scanning



Infrared TMOS



**Human centric**

Helping workers be more  
efficient

**Resilient**

Based on versatile  
technology

**Sustainable**

Conceived to optimize  
processes

# Targeting MEMS leadership in high-growth automotive applications

## MEMS sensors

## MEMS sensors

## MEMS actuators

## AI in the Edge



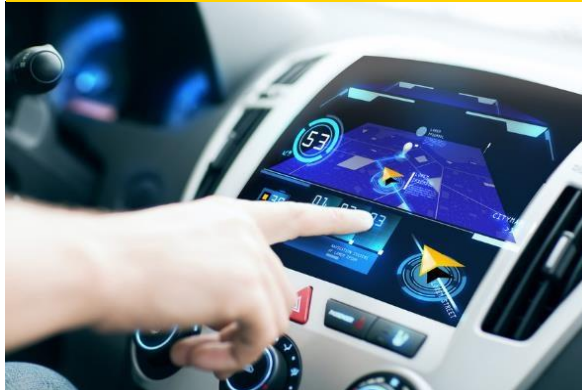
## Electrification



- Road noise cancelling
- Condition monitoring



## Connectivity



- Navigation / V2X
- Telematics boxes
- Personal key entry



## ADAS



- Driver assistance systems

## Self driving



- Accurate positioning
- LiDAR
- Head-up display



# Analog



## Core business

### Motion control

Industrial motor drive SoC and SiP  
IGBT and MOS Driving  
Real-time connectivity

### Smart grid & industrial IoT

Power Line Communication  
Smart metering SoC  
Wired connectivity and IO-Link

### Power conversion

AC/DC and DC/DC converters  
LED Driving  
Power management ICs

### PMIC for CECP

High-efficiency server power management  
Printer driver  
PMIC for storage

## High-growth areas

### Factory automation & industrial infrastructure

Smart meters  
Digital power conversion  
Digital motion control  
Embedded galvanic isolation  
Advanced industrial connectivity NB-IoT

### Consumer industrial

Power conversion  
Galvanic isolated SiC & GaN Drivers  
Smart power GaN  
Battery operated tools  
Home appliances

### Application specific analog for personal electronics

Wireless charging  
Battery management  
Display PMICs  
PMIC for portable & wearable electronics

# Analog leadership positions

Broad & diversified  
portfolio of more than

**7,000**  
products

Serving more than

**75,000**  
customers



## Motion control

**1 Billion low-voltage motors driven by ST**  
**> 1 Billion I/O channels in factories**  
**9% market share**



## Smart grid & Industrial IoT

**#1 in powerline communication**  
**20% market share, 150 Million smart meters installed**  
**Leadership in industrial analog ASICs**



## Power conversion

**#2 in high-voltage converters**  
**> 5% market share**  
**3 Billion high-voltage converters delivered**



## PMIC for CECP

**#1 in PMIC for HDD**  
**> 90% market share**  
**> 3 Billion PMICs delivered**



# ST offers advanced analog & digital technology and IP combined with deep system knowhow

**Smart power  
BCD**

**Smart power  
GaN**

**Analog & RF  
CMOS**

## **Digitalization**

Advanced connectivity, AI in the edge, digital power management

**eNVM CMOS**

**Vertical  
Intelligent  
Power**

**Galvanic  
isolation**

## **Efficiency**

Improve power density for greater energy efficiency & portability

## **Packaging technologies**

Leadframe – Laminate – Advanced SiP – Wafer level

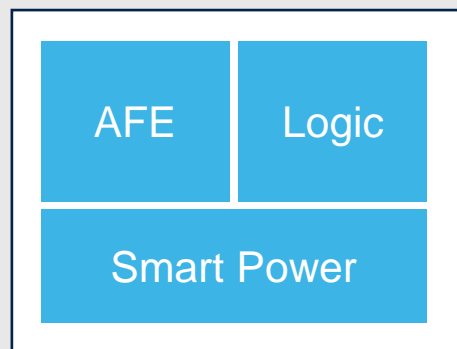
## **Safety**

High-voltage applications, safer, more robust with improved noise immunity

# ST leading the digitalization trend in application-specific analog

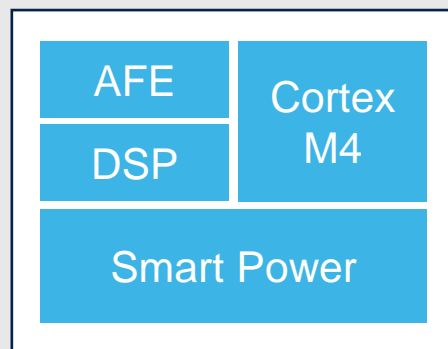
**System-level integration + Flexibility + Connectivity**

## Motor control ICs



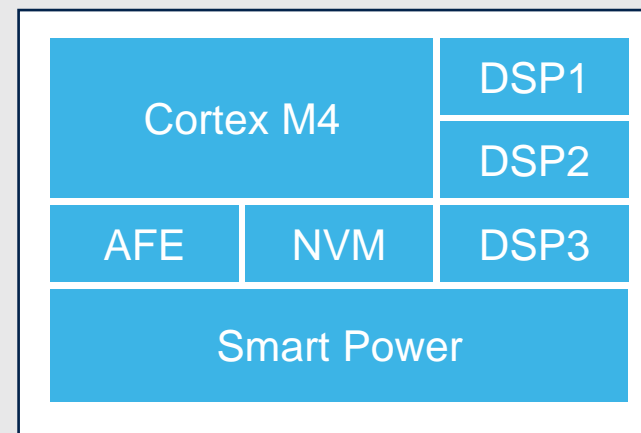
**BCD8 160 nm**  
**100k gates/mm<sup>2</sup>**

## Wireless charging ICs



**C90D 90 nm**  
**> 300k gates/mm<sup>2</sup> – ePCM**

## ASIC for smart industry



**BCD40 40 nm**  
**> 2M gates/mm<sup>2</sup> – eNVM**

**Digitally-managed power provides configuration, monitoring  
and supervisory functions to meet advanced system needs**

# ST capturing increasing value of analog content in smart meters

Functionality increase in smart meters is directly linked to the semiconductor content





# Adoption of wide bandgap materials for power conversion drives semiconductor content value

Gallium Nitride drives a step function in power conversion efficiency and density enabling smaller, less power-hungry adapters



**Legacy: \$\$**

**Analog**

Analog control

Power MOS

**Low power density**  
< 10 W / inch<sup>3</sup>

**Today: \$\$ x2\***

**+ Efficiency**

MasterGaN

HV Driver

Power GaN

Analog control

**Medium power density**  
> 20 W / inch<sup>3</sup>

**Tomorrow: \$\$ x4\***

**+ Digitalization & safety**

MasterGaN II

Power GaN

HV Driver

ST-ONE

USB-PD

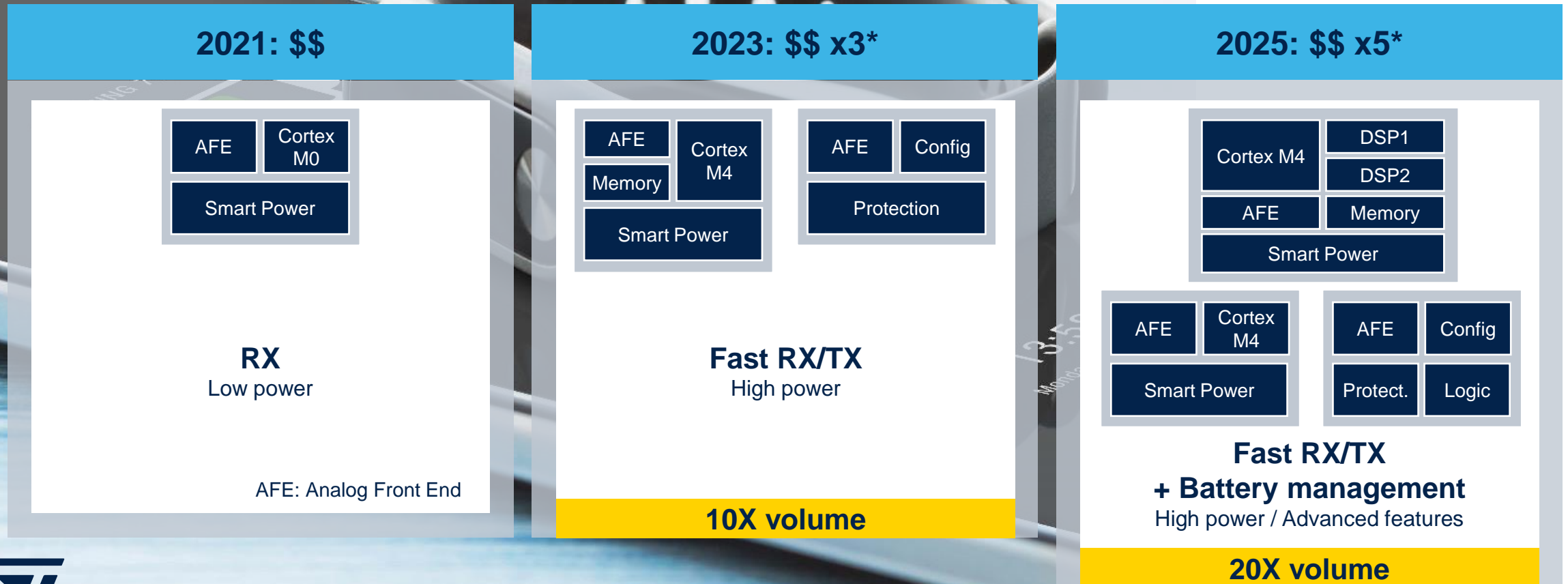
Digital Power

Galvanic isolation

**High power density**  
>> 30 W / inch<sup>3</sup>

# ST capturing increasing value and volumes of wireless charging market

Leveraging core technologies and proven volume manufacturing capabilities to capture significant market share in wireless charging



# AMS has a large, diversified customer base

A small selection of the over 75,000 AMS customers





# Maximizing ST content in industrial applications

## Typical industrial application

AC-DC

DC-DC

Control Unit  
STM32

Gate Driver

MOSFET/  
IGBT

Signal  
conditioning

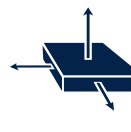
Sensors

Connectivity



+

ST analog, power, sensors, ...



Driving ST Growth



STM32

\$6

AMS

\$60



STM32

\$8.8

AMS

\$30



STM32

\$17.1

AMS

\$16



STM32

\$1.8

AMS

\$6

Actual implementation based on selected customer products



# Supporting ST \$20B+ revenue ambition

**Continuous investments in technology & product innovation for balanced and profitable long-term growth**

## **Two strong pillars of growth in AMS**

Double digit growth in industrial & automotive  
Continuous leadership in Personal Electronics and CECIP

## **Solid, growing analog market position**

Targeting double digit market share in application specific products  
Wireless charging, battery management, smart grid, power conversion

## **Broadest portfolio of MEMS sensors and actuators**

Diversification to industrial and automotive

## **Continued leadership in optical sensing solutions**

Expanding through diversification in all markets served by ST

# Our technology starts with You



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