Microcontrollers & Digital ICs Group

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President, Microcontrollers & Digital ICs Group
Revenue overview - MDG

MDG Group Revenue $B

$3.77B

MDG Sub-Group Revenue $B

Microcontrollers and Memory Sub-Group: $3.26B

RF Communications Sub-Group: $0.51B

30% of ST FY21 Revenues

FY19 FY20 FY21

FY19 FY20 FY21
Era of the cloud-connected intelligent edge

From: Internet of Things
To: Cloud-connected, Autonomous Things

Our Goal:
Making these Things more **Secure**, more **Connected**, and more **Intelligent**

**STM32 | STM32Cube**
The edge computing platform of Autonomous Things

**GHz Wireless Infrastructure and Edge RF Front-Ends**
To efficiently connect Autonomous Things to and from the Cloud
32-bit GP MCU: Accelerating the world’s digitalization

Digitalization + Cloud-Connection = Increasingly faster growth of 32-bit GP MCU market versus GDP

Growing pervasion of 32-bit GP MCU
- Robot mower: from 4 in 2013 to 12 in 2019
- Industrial circuit breaker: from 0 in 2012 to 2 in 2022
- Power tools: 1 in 2015 to 3 in 2022
- Drones: from 1 in 2014 to 7 in 2018

Sources: World Bank, IMF, Omdia
STM32: the leading 32-bit MCU for Industrial

**ST market share: 23% - #1**
of 2021 General Purpose MCU* TAM

<table>
<thead>
<tr>
<th>Year</th>
<th>Competitor A</th>
<th>Competitor B</th>
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<tbody>
<tr>
<td>2017</td>
<td>B</td>
<td>#3</td>
</tr>
<tr>
<td>2018-2020</td>
<td>#2</td>
<td>A</td>
</tr>
<tr>
<td>2021</td>
<td>#1</td>
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**Organic growth driving ST market share gains**

**2021-2026 Industrial market growth drivers**
- Home appliances - Energy efficiency & cloudification
- Factory automation - AI based predictive maintenance
- Power tools - Wireless connectivity
- Automotive electrification - Infrastructure development
- Building - Smarter, safer and more energy efficient

**2021 32-bit GP MCU* TAM($M)**

- Major Home Appliances: +26%
- Manufacturing & Automation: +9%
- Building & Home Control: +9%
- Computer: 16%
- Communication: 12%
- Consumer: 21%
- Medical Security & Video: -9%
- Other Industrial: -9%

Industrial growing from 52% of TAM in 2021 to 65% in 2026

Sources: Omdia, WSTS
* Excluding Automotive and Smartcard MCU

CAGR 2021-2026
Developer-first strategy: STM32Cube

Applicative Reference Implementations

Extension Libraries and AI toolkit

HDK
Embedded SDK
Development tool kit
Development resources

2M* Unique Developers
2M* HDK shipped
8M* SDK & tool kits Downloads
10k/y X-Cube.AI Downloads

> 120 HDK references
> 150 Cube Expansions
> 150 MOOC hours
> 100 Partners

Developers CAGR = +27%

Cumulative over 5 years

* Developers
* Downloads


Developers
Downloads

> 2M unique developers
> 2M HDK shipped
> 8M SDK & tool kit downloads
> 10k X-Cube.AI downloads

> 120 HDK references
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Next growth drivers for the STM32

1. Increase existing GP MCU socket value with Security, Wireless Connectivity, AI, and ST adjacencies (Analog, MEMS, Power)

2. Capture new higher value MPU sockets

Capitalize on our 100,000+ STM32 customer base
Democratizing Edge to Cloud Security

Building turn-key secure solutions for IoT nodes

Scalable Security

- Highest security certifications
- MCU only or MCU+Secure Element
- Certified by major Cloud vendors

STM32U5 / STSAFE-A110

Ready for IoT

Discovery kit for IoT nodes with STM32U5

STM32

STSecure

Level 3

Level 5+

SESIP

psacertified

COMMON CRITERIA

From portable device

Milwaukee Tools

Battery

SpaceX-StarLink

Router & antenna

To Highly Secure

Milwaukee

SpaceX

STARLINK

Router & antenna

From portable device

To Highly Secure
The Cloudification of the STM32 customer base

Wireless Connectivity growth drivers

- Network Effect
- Cloud connectivity for new use cases
- Diversity of wireless technologies

Source: ABI

Connecting 100 000+ STM32 customers

- Brodest wireless protocol offering
- Seamless Software migration
- Built-in Security
- Cloud Native

Source: ABI

Wireless Connectivity growth drivers

CAGR +24%

B$ 0 2 4 6 8

2021 2026

Wireless
STM32 SAM

LoRa
NB-IoT
LTE-M
WiFi
m2m

STM32
Trust

STM32 Cube Expansion
Accelerating momentum in wireless connectivity

Seamless Software Migration
STM32Cube is the Foundation

Broad range of Industrial Wins

Building customer trust
>$100M*, 42% Industrial

**Building customer trust**

$100M* forecast

Industrial applications estimate as % of revenues

*ST 2022 forecast

1st time >$100M of BLE/802.15.4 revenue

Industrial applications estimate as % of revenues

They made the switch!

STM32

STM32WB

STM32WL

STM32 Cube

Non-ST BLE Radio

Non-ST LPWAN radio

GEBERIT

APATOR

STM32

STM32 Cube

STM32WB

STM32WL

BLE/802.15.4 Customer base

3k+

2019

2022

World 1st true open dual-core BLE/802.15.4/Matter MCU
Making AI at the edge a reality

Introducing ST’s game-changing Neural MCU

- **STM32N6**
  - First MCU with **ST Neural-ART NPU Accelerator**
  - State of the art Inference/W and Inference/$

**Performance**
- **Inference/s**
  - MPU
  - ST
  - x12 ST

**Energy Efficiency**
- **Inference/W**
  - Value for money
  - Inference/$
  - x11 ST

**Comparison with competitor quad-core microprocessor with AI hardware acceleration**

- **Value for money**
  - Inference/$
  - x11 ST

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1. Comparison with competitor quad-core microprocessor with AI hardware acceleration

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**Introducing ST’s game-changing Neural MCU**

- **First MCU with ST Neural-ART NPU Accelerator**
- State of the art Inference/W and Inference/$

**Accelerating Development of Edge AI Solutions**

**CARTESIAMS Edge AI Productivity Lab**
- No AI experts required
- Up to 95% shorter development cycle
- Fit small footprints, MCU & ISPU
- Accretive royalty model

**Anomaly detection sensor**
- **STM32F4**
  - 12 months from concept to market
  - Multi sensor capability
  - Extreme flexibility
  - Broad deployment planned

**Predictive maintenance**
- **STM32F4**
  - 30% increase in cutting tool life
  - Preventing operational failure
  - Extending to all drilling & cutting tools

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*The new STM32N6 Neural MCU is dramatically lowering the AI technology implementation price point. This breakthrough supports our roadmap of new generation intelligent sensors allowing rapidly growing adoption in Smart Cities*  

**Vincent SABOT**, Executive Managing Director, LACROIX - City activity
Maximizing ST attach rate in industrial applications

**Typical industrial application**

- AC-DC
- DC-DC
- Control Unit: STM32
- Gate Driver: MOSFET/IGBT
- Signal conditioning
- Sensors
- Connectivity

**Driving ST Growth**

ST analog, power, sensors, ...

**Photovoltaics**
- STM32: $17.1
- Attach: $131
- x8

**Factory automation**
- STM32: $8.8
- Attach: $16.9
- x2

**Metering**
- STM32: $1.8
- Attach: $6.2
- x3

**HVAC 2 kW**
- STM32: $2.4
- Attach: $12.4
- x5

Actual implementation based on selected customer products
STM32 MPU: Building on STM32 industrial success

Differentiate in Open Source Software

Expanding our 100K+ MCU customer base in embedded processing

Leverage STM32Cube

The natural evolution of STM32 MCU portfolio

Source: WSTS, IC Insights, ST
STM32MP: General purpose MPUs for the Industrial Market

24 STM32MP1 product lines

STM32MP15x
- Single and dual A7 core
- Real Time domain with Cortex M4
- Industrial interfaces (Ethernet, CAN,...)
- GPU + display interfaces

STM32MP13x
- Single A7 core
- Dual Ethernet
- Sub $3
- PCI security
- Ramping soon at OEMs

“We are adopting ST’s new STM32MP135 because it offers the perfect cost/performance balance while meeting the strong security requirements of our next generation product family”

150+ Customers
10M+ units*
3x YoY growth since 2020

Smart home & building
Point-of-Sales
SOM** makers
Factory Automation
Digital power & energy management

*cumulative since launch
**System on Module

World leader in payment services

New customer: VIESSMANN
Growing STM32 revenue faster than the SAM

**SAM expansion** from $15B to $23B

1. **GP MCU** revenue to grow in line with SAM in units and more than SAM in $, leveraging added value

2. **Wireless MCU** revenue to grow faster than SAM thanks to portfolio expansion, customer base & ease of SW migration

3. Double digit **MPU revenue** growth - growing faster than SAM thanks to enriched and accelerated product line introductions

*GP MCU + Wireless MCU + Embedded-MPU

Source: WSTS, ABI, ST
GHz Wireless
Addressing GHz wireless growth opportunities with RF

**Infrastructure**
- GEO & LEO Satellite constellations
- SATCOM User Terminals
- 5G Sub 6 GHz & mmWave

**Edge**
- Wi-Fi 6 & Cellular-IoT

**Diverse business models**

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<tr>
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<th>ASSP</th>
<th>CSSP</th>
<th>ASIC</th>
<th>COT</th>
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<td>System &amp; Product specification</td>
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<tr>
<td>Wafer manufacturing</td>
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<td>STI</td>
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<tr>
<td>Packaging, test &amp; supply-chain</td>
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<td>STI</td>
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*excluding Smartphone
Fast growing GHz wireless market

GHz Wireless growth drivers

- **LEO satellite communication** gaining traction as an alternative for broadband internet access
- **5G mMIMO** deployment globally
- **Wi-Fi 6 & Cellular-IoT** growing fast

GHz wireless SAM*

<table>
<thead>
<tr>
<th>Year</th>
<th>Infrastructure</th>
<th>Edge</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>2021</td>
<td>$1.4B</td>
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<td>2026</td>
<td>$5.7B</td>
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CAGR +32%

*Source: ST

*SAM:
- Infrastructure: RF Front-End & Beamformer for 5G BTS mMIMO, mmWave & Small Cells, LEO Satellites
- Edge: RF Front-End & Beamformer for LEO Satellite User Terminals, C-IoT, Wi-Fi 6 (excl. Smartphones)
Key technology drivers of the GHz wireless market

### Multiplication of RF chains
- Driven by **Massive MIMO & Phase Array Antenna**
- **Number of RF chains dramatically increases** from traditional Base Station

### Adapting key RF FE KPIs
- **Fundamental importance of Noise Figure** for receiver sensitivity
- **New transmitted peak power paradigm allows highest power efficiency**

### Wide frequency span
- **Higher throughput** calls for more bandwidth,
- **Available bands** are many & broadly scattered
- From **SubGHz** to **mmWave**

This requires **new core technologies** optimized for these new targets and **consumer-like volume**
Building GHz wireless products on ST technology leadership

BiCMOS
200mm wafers for high-volume 130nm SiGe (B9MW)
300mm wafers for leading-edge 55nm SiGe (B55X)

• LNA20GHz NF -0.2dB (B55X vs best available foundry)
• LNA20GHz Gain +6dB (B55X vs best available foundry)
• Fmax*Ft x1.9 (B55X vs best available foundry)

Best Noise Figure (NF) on the market for beamformers

Major B55X product tape out in H2’22

ST’s BiCMOS technology benefits in term of Noise Figure performance proved fundamental for SpaceX system performance.”
Mark Juncosa, SpaceX VP of Engineering

GaN-on-Si
Cost-effective GaN for RF volume markets
150mm – 200mm CMOS-like manufacturing

• Power Density x5 vs LDMOS* (on par with best available GaN)
• Drain Efficiency >75% (on par with best available GaN)
• PA Efficiency +10% vs LDMOS

Qualification in progress

Optimal solution for 5G mMIMO PA

“GaN-on-Silicon is a highly competitive technology versus LDMOS and GaN-on-SiC in key markets and its near-term availability makes it an attractive choice.”
Steve Daly, Macom CEO

* Lateral Drain Extended Metal Oxide Semiconductor
ST products for GHz wireless market

**Sampling now**

- **FE Ku Band CSSP**
  - 12-15GHz

**2023**

- Increase frequency to Ka band
- Porting to B55X for even better NF
- Cost-down through 300mm volume

**5G Tx line-up**

- **STFETxx LPPD**
  - 1.8-5GHz
- **GAN PAM**
  - 3.4-3.8GHz

**Portfolio extension to new bands / power**
- Complete integration in a SIP
- Cost-down with 200mm GaN-on-Si volume

**Perfect technologies to cover the full Tx line-up**
- Right cost & Power
- Added Efficiency (PAE)
Growing revenue faster than the GHz wireless market

Leverage ST technology leadership in core technologies:
- BiCMOS & GaN-On-Si, Beamformers, Front-End modules
- Volume-ready packaging & test

Capitalize on leadership for LEO Satellite Communication
- 500M ICs delivered to date

Expand in 5G mMIMO and mmW with breakthrough GaN-on-Si PA technology
- Sampling lead customer in H2 2022

Expand engagements on Cellular-IOT and Wi-Fi 6 FEMs & RF switches
- Multiple engagements currently ongoing

Source: ST
Supporting ST $20B+ revenue ambition

Two strong pillars of growth
STM32 and GHz Wireless RF Front-End & Beamformer

STM32: Leveraging our established customer base and STM32Cube ecosystem to expand the SAM of the franchise

GHz Wireless: Leveraging ST technology innovation and leadership to build new product lines in fast growing markets

Strong potential for **incremental revenue** over next 5 years, accretive to company operating margin targets
Our technology starts with You

Find out more at www.st.com