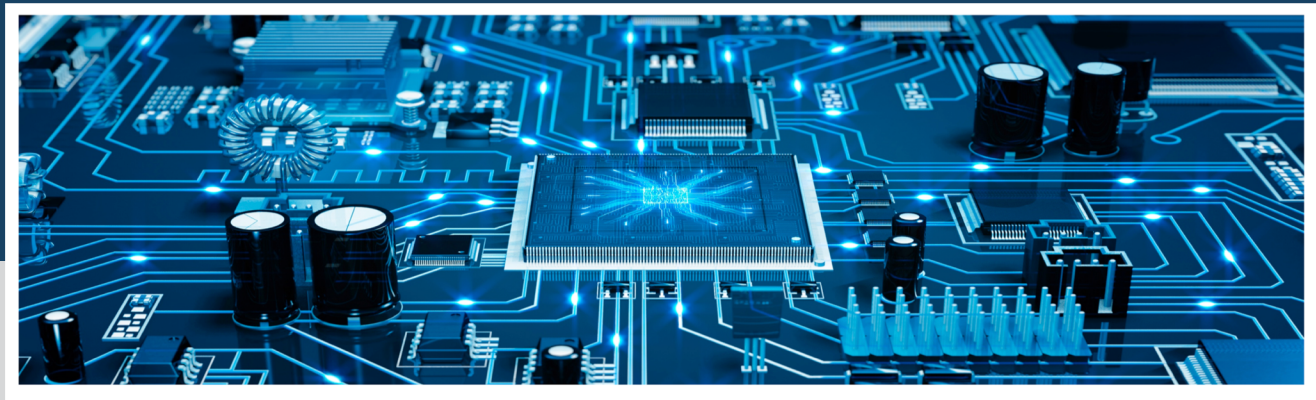
Study

“Emerging technologies in Electronic Components and Systems (ECS) Opportunities ahead (SMART 2018-0005)”



European Commission

Presented at EFECS – 20th November 2019

DECISION ETUDES & CONSEIL

AGENDA

- **PRESENTATION OF THE STUDY**
- RESULTS
- RECOMMENDATIONS

SCOPE OF THE STUDY

10 main applications fields

- Automotive
- Industrial & Robotics
- Aerospace - Defense - Security
- Health & Care
- Telecommunication infrastructures
- Mobile phones
- Professional data processing
- Consumer PC
- Audio & Video
- Home Appliances

Sub-applications

- Autonomous driving / ADAS
- Automotive infotainment
- Digital Identities
- E-readers
- ...

Crossed applications

- Smart home
- Smart cities
- Wearables
- Big data / Data analysis
- IoT & emerging sensors
- ...

Electronic materials, components, sub-systems and/or systems among the value chain

- Active components
- Passive components
- Electronic boards
- Sensors
- Software
- Materials
- Systems

ELECTRONIC PRODUCTS

COUNTRIES

MARKETS - APPLICATIONS

PLAYERS

3 types of players

- Industrial actors
- Research organisations
- Public support programs, clusters, pillars...

SCOPE OF THE STUDY

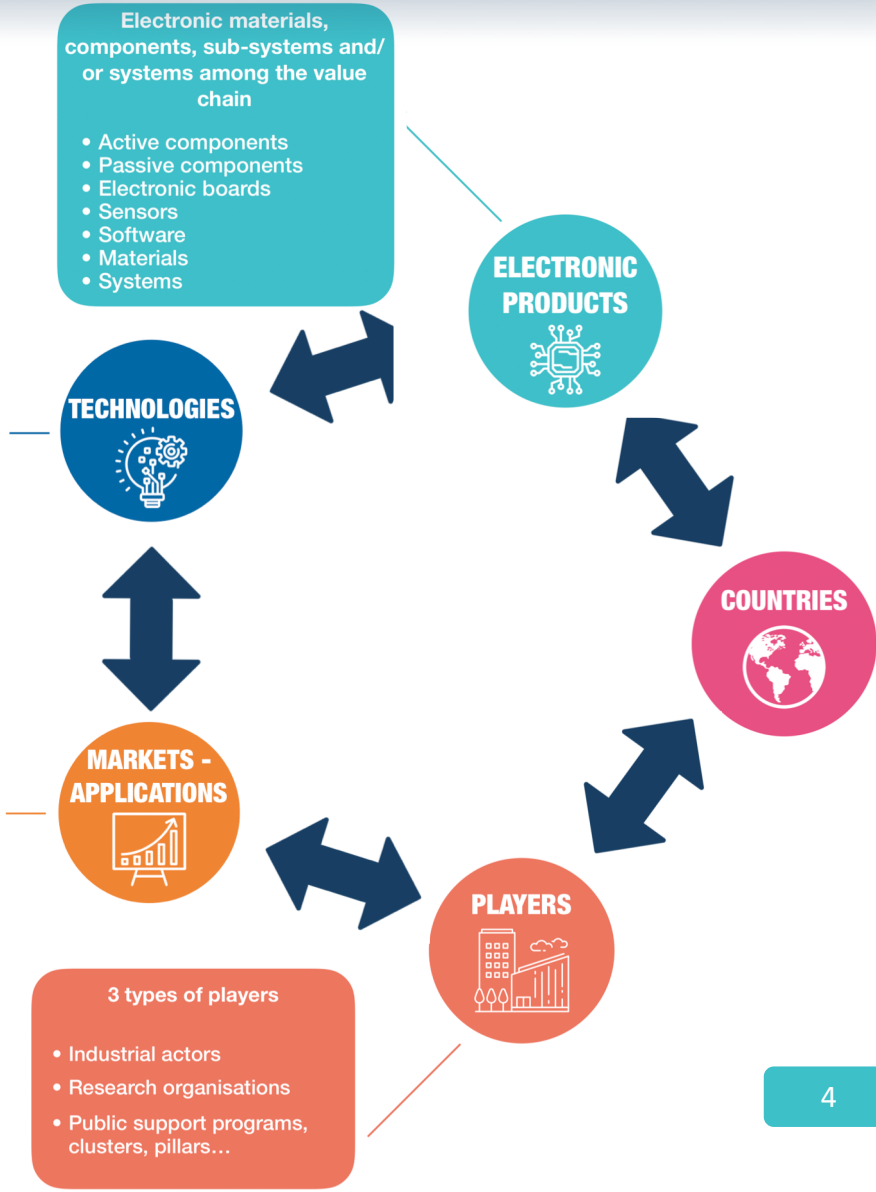
From components To Systems & computing apps

From technologies to markets

Emerging / Enabling technologies

- Components
- Components architectures
- Systems & algorithms
- Cybersecurity & Trust

10 main applications fields	Sub-applications	Crossed applications
• Automotive	• Autonomous driving / ADAS	• Smart home
• Industrial & Robotics	• Automotive infotainment	• Smart cities
• Aerospace - Defense - Security	• Digital Identities	• Wearables
• Health & Care	• E-readers	• Big data / Data analysis
• Telecommunication infrastructures	• …	• IoT & emerging sensors
• Mobile phones		• …
• Professional data processing		
• Consumer PC		
• Audio & Video		
• Home Appliances		



16 EMERGING / ENABLING TECHNOLOGIES STUDIED

Components

More Moore technologies
- Chips with nodes < 10 nm
- Advanced memories (multilayer 3D)

Beyond CMOS technologies
- In-memory computing
- Logic & information processing
- Cryogenic & security apps

Advanced packaging
- SiP, Fan-In/Fan-Out, 2.5/3D stacking, Etc.

Emerging Non-Volatile memories
- Phase-Change Memories (PCM)
- Magnetic Random Access Memory (MRAM)
- Etc.

Photonic interconnection networks
- Short-medium-long distance (chip-to-chip, DCIs, etc.)

Integrated photonics
- Photonic Integrated Circuits (PICs)
- Silicon photonics, etc.

Components Architecture

Neuromorphic computing
- Spiking Neural Networks, etc.

Quantum computing
- General computer
- Specific applications
- Quantum sensing & communications

Photonic computing
- Quantum optics, QKD
- Photonics reservoir computing
- Chaos-based photonics computing

Other approaches in rebooting computing
- PCMOS, Stochastic computing, probabilistic computing, etc.

Systems & Algorithms

Artificial Intelligence
- Machine leaning algorithms
- AI chips (Edge/Cloud)

High-Performance Computing

Smart sensors
- Smart dust, etc.

Cybersecurity & Trust

Secure elements

Cryptography
- Lightweight cryptography
- Homomorphic encryption
- Etc.

Blockchain

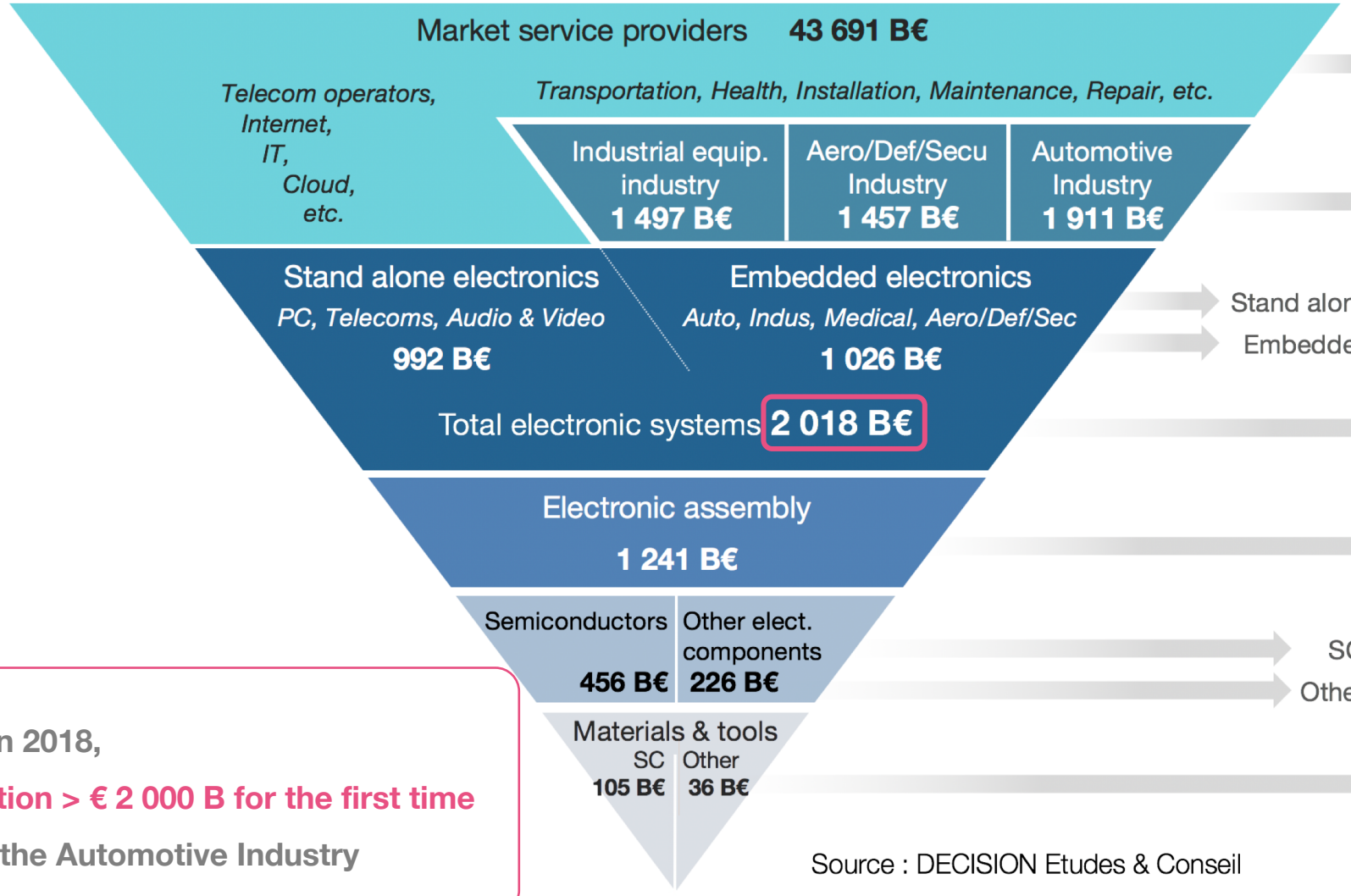
AGENDA

- PRESENTATION OF THE STUDY

- **RESULTS**

- RECOMMENDATIONS

NEW WORLD ELECTRONICS VALUE CHAIN - 2018



	Prod. in Europe (€ B)	% Europe / World
	11 054	25%
	980	20%
Stand alone	60	6%
Embedded	229	22%
	290	14%
	126	10%
SC	40	9 %
Other	15	7 %
	24	17 %

Source : DECISION Etudes & Conseil

In 2018,

Electronic system production > € 2 000 B for the first time

That is more than the Automotive Industry

NEW WORLD ELECTRONICS VALUE CHAIN - 2018

In 2018, for the first time:

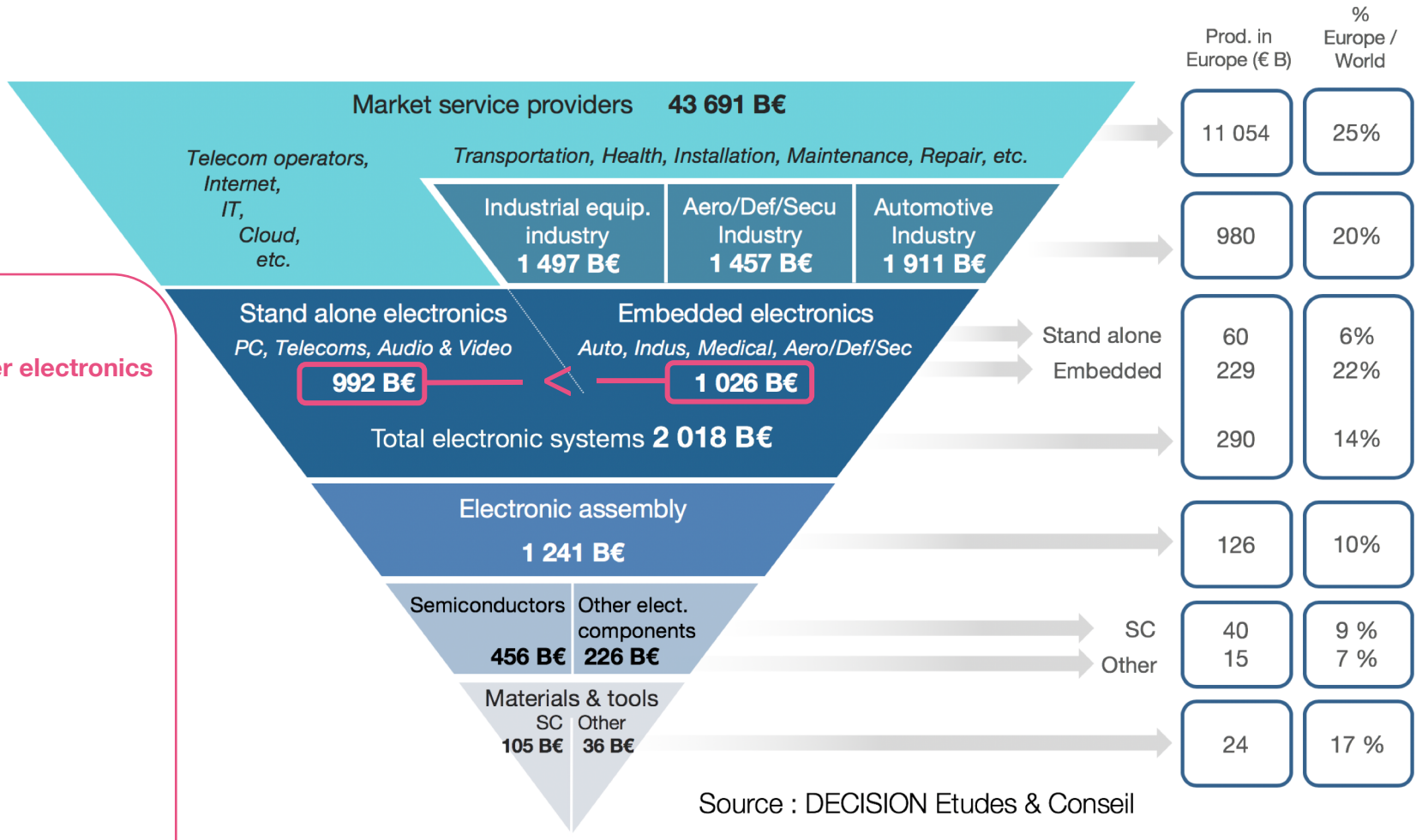
Embedded/Professional electronics > Stand-alone/Consumer electronics

Embedded / Professional electronics =

- Automotive electronics
- Industrial & Robotics
- Aerospace / Defense / Security
- Health & Care

Stand-alone / Consumer electronics =

- Telecommunications
- PCs
- Audio & Video
- Home application



NEW WORLD ELECTRONICS VALUE CHAIN - 2018

In 2018:

Embedded/Professional electronics = ~60% TOTAL electronics…

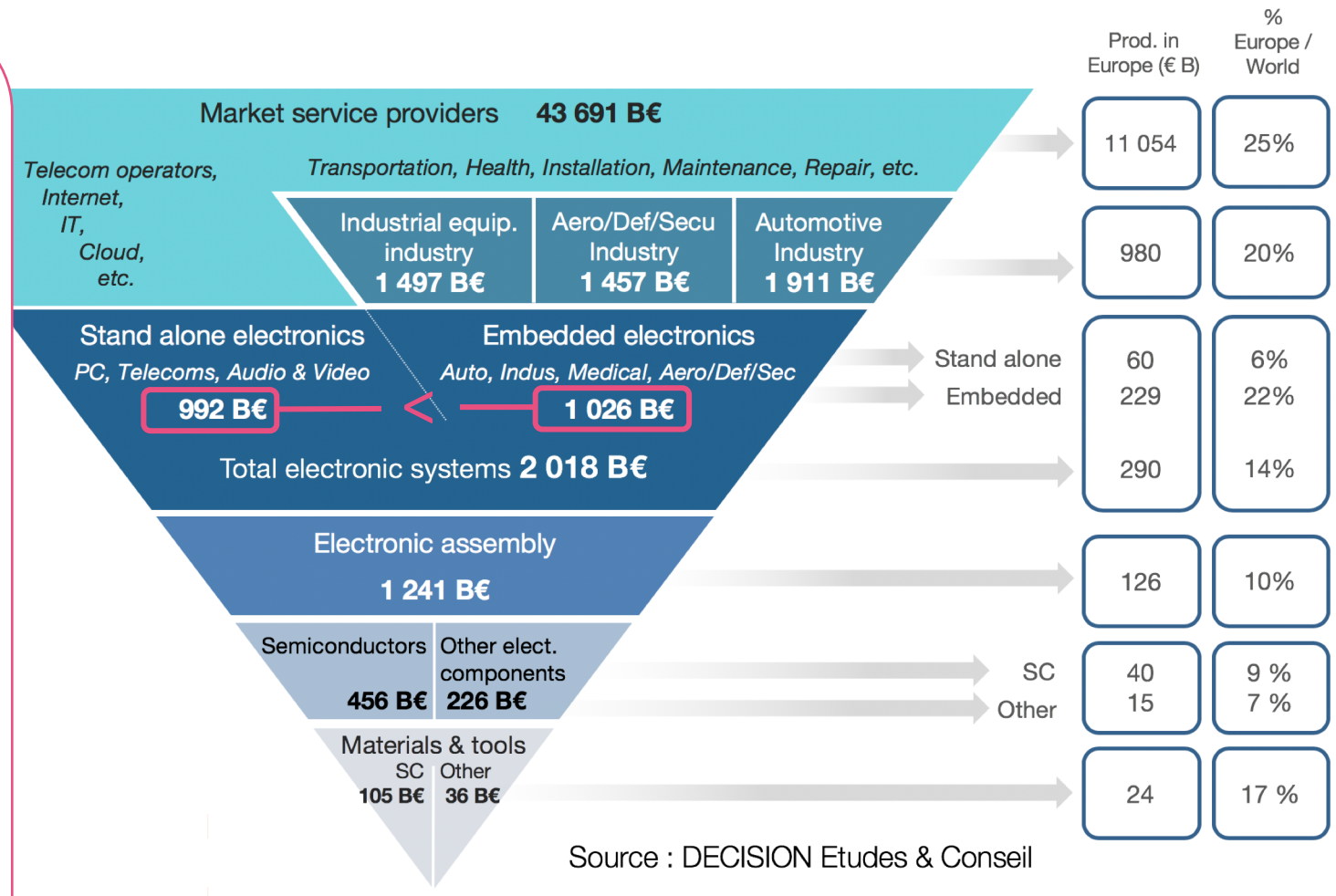
… if we include Telecoms infrastructures & Professional PCs in embedded/Professional electronics. That is with the following segmentation:

Embedded / Professional electronics =

- Automotive electronics
- Industrial & Robotics
- Aerospace / Defense / Security
- Health & Care
- Telecoms infrastructures
- Professional PCs

Stand-alone / Consumer electronics =

- Phones
- Consumer PCs
- Audio & Video
- Home application



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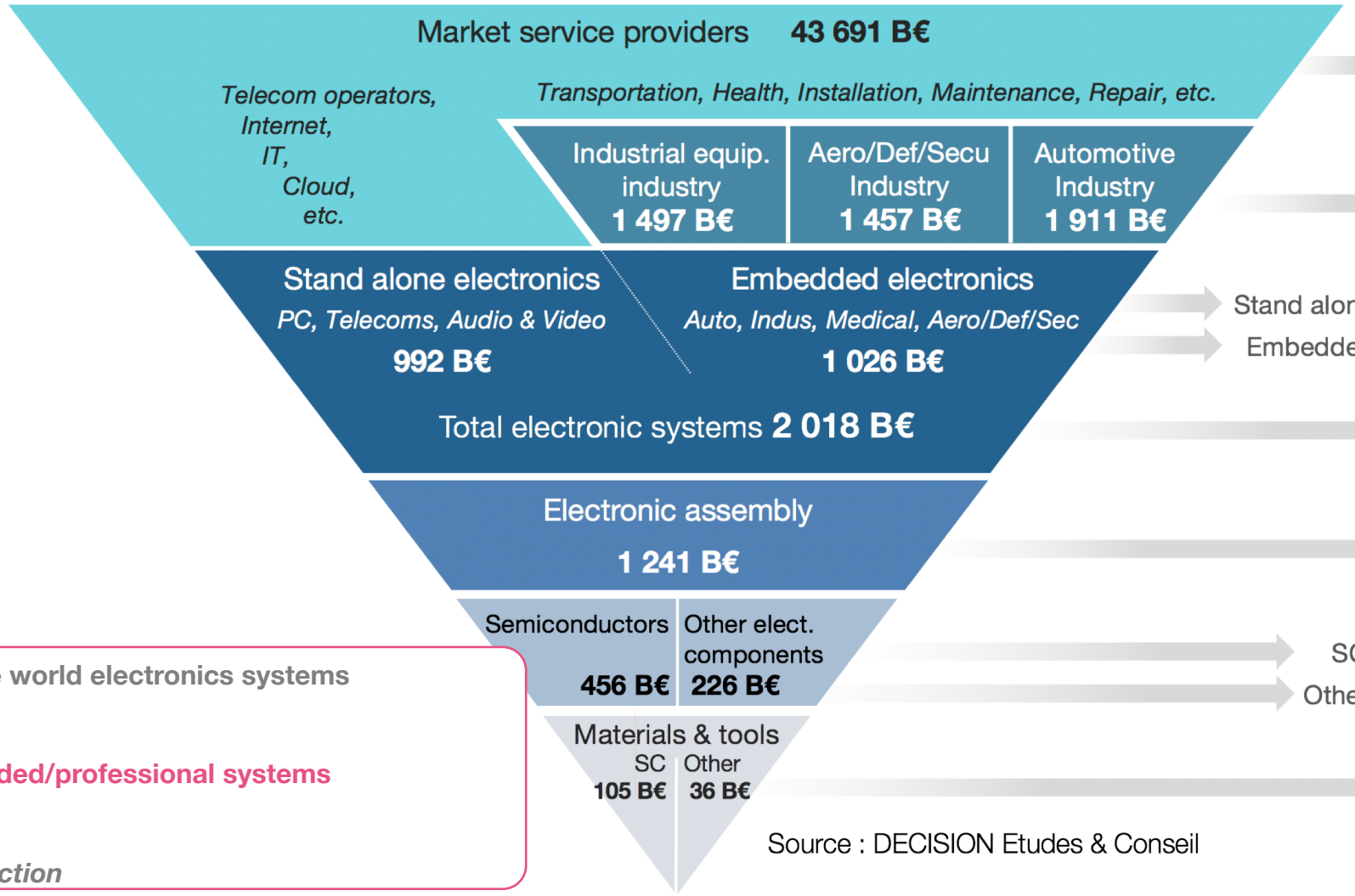

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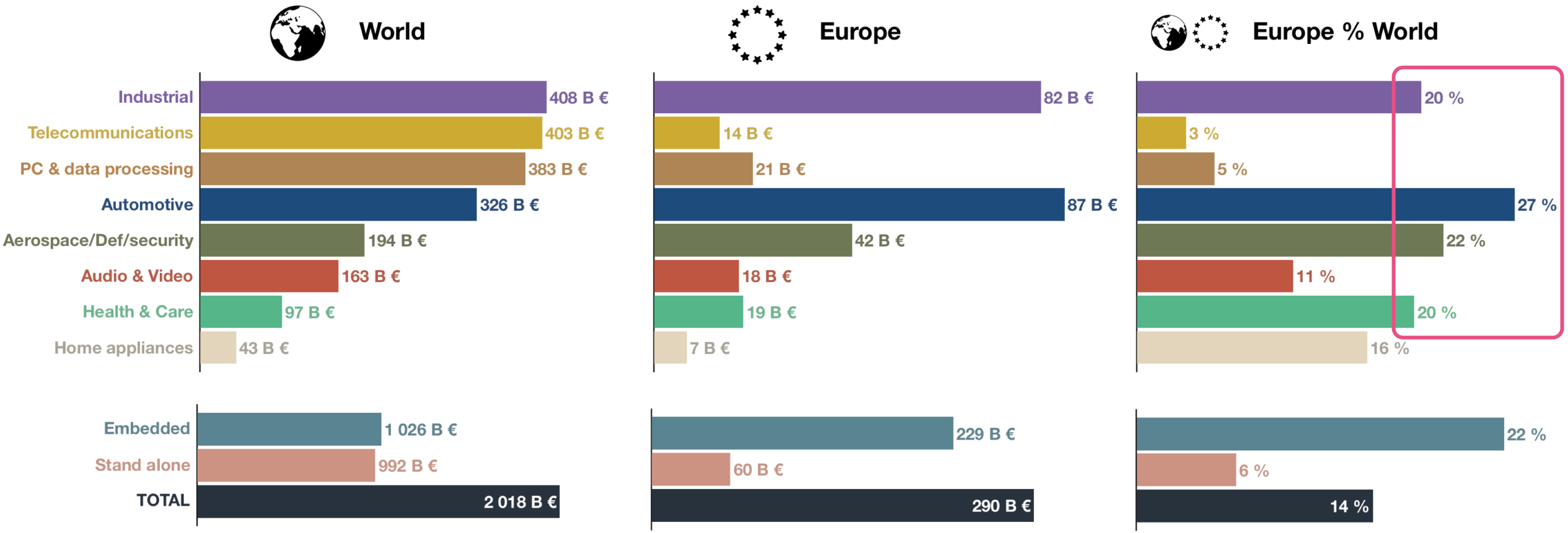
Source : DECISION Etudes & Conseil

- Europe accounts for 15% of the world electronics systems production*
- **Europe is specialized in Embedded/professional systems (22% of the world production*)**

** In terms of location of the production*

ELECTRONIC SYSTEMS - POSITION OF EUROPE - 2018



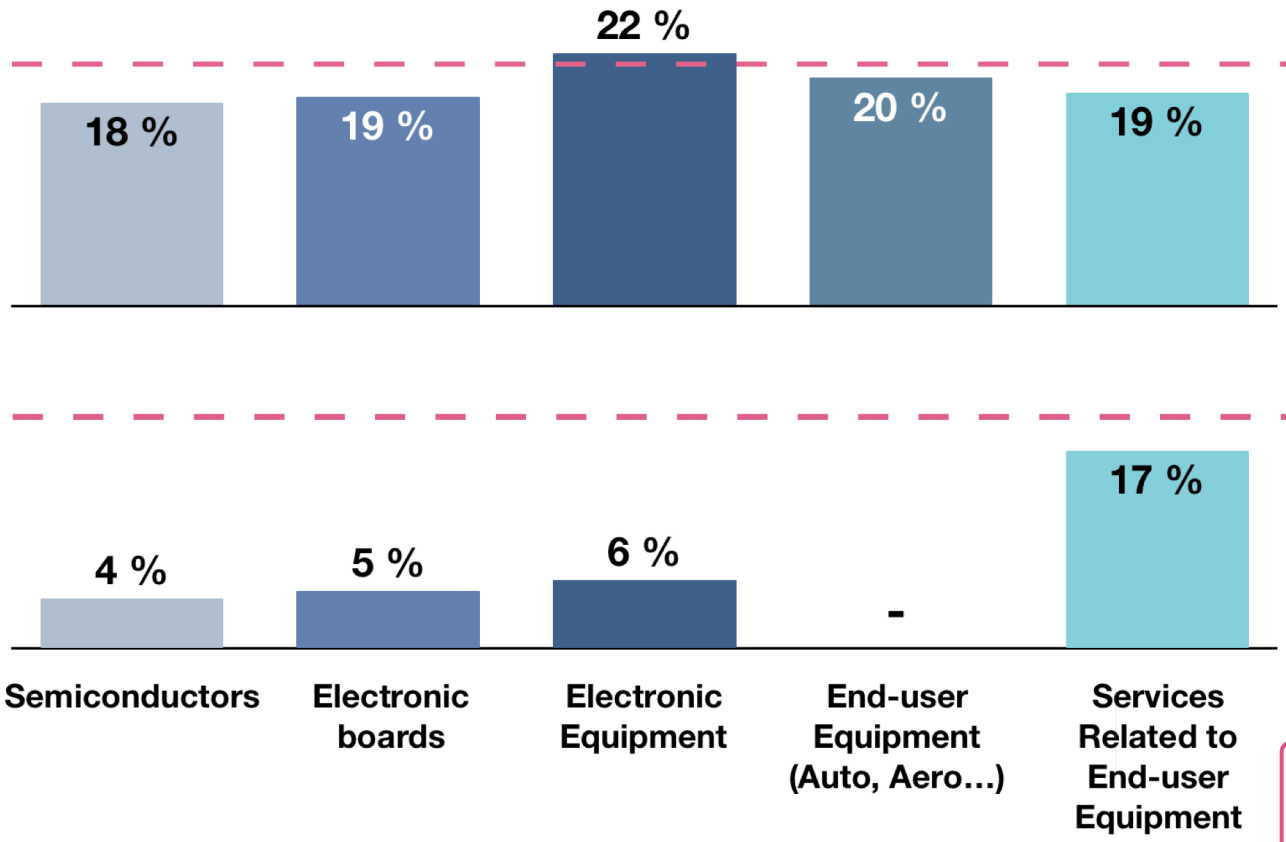
The EU is well positioned in professional / embedded electronics

ELECTRONICS VALUE CHAIN - POSITION OF EUROPE IN THE WORLD - 2018

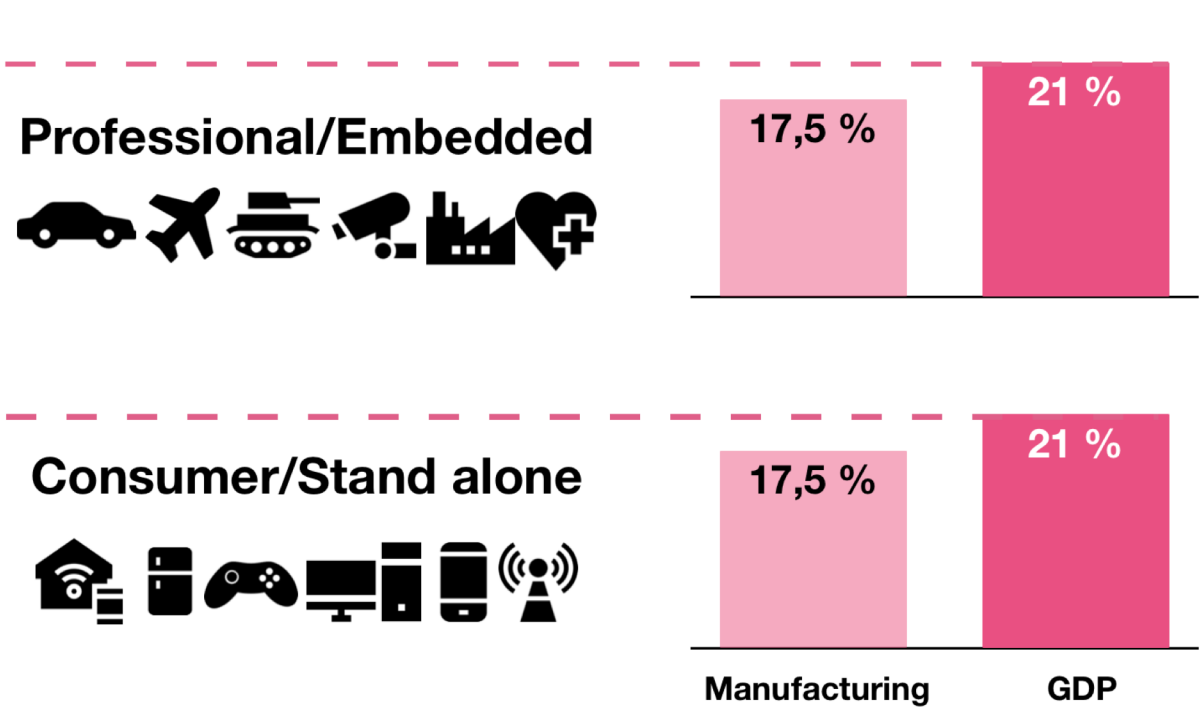
The percentages below correspond to the percentage of Europe in the World

Example: Europe accounts for 21% of the World GDP in 2018 and 17.5% of the World manufacturing production. In comparison, Europe accounts for 22% of the World production of professional/embedded electronic systems in terms of production location. Etc.

Electronic value chain



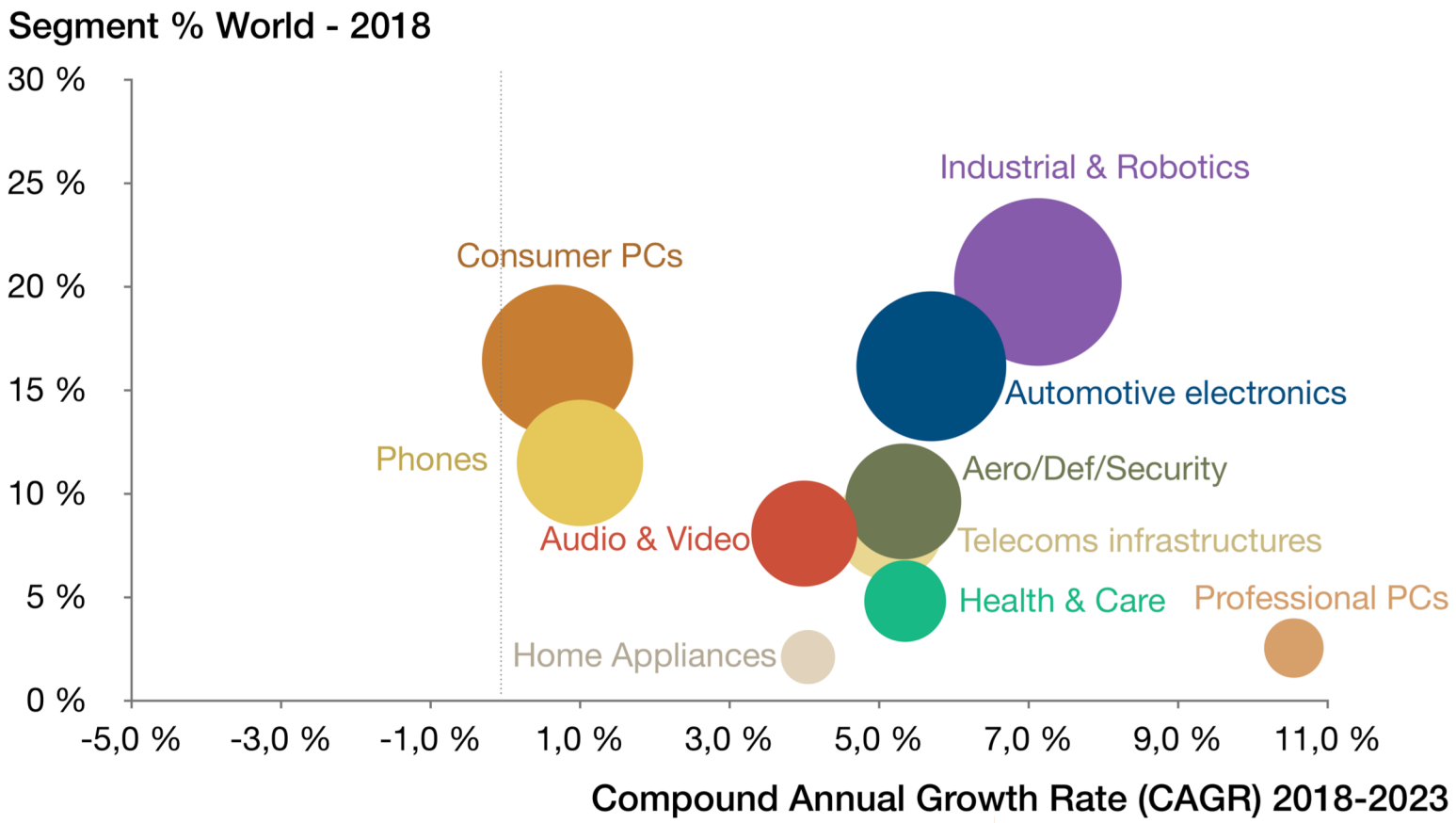
Macro figures



The EU is well positioned in professional / embedded electronics

MAIN GROWTH DRIVERS OVER THE COMING DECADE

Electronic systems in the World



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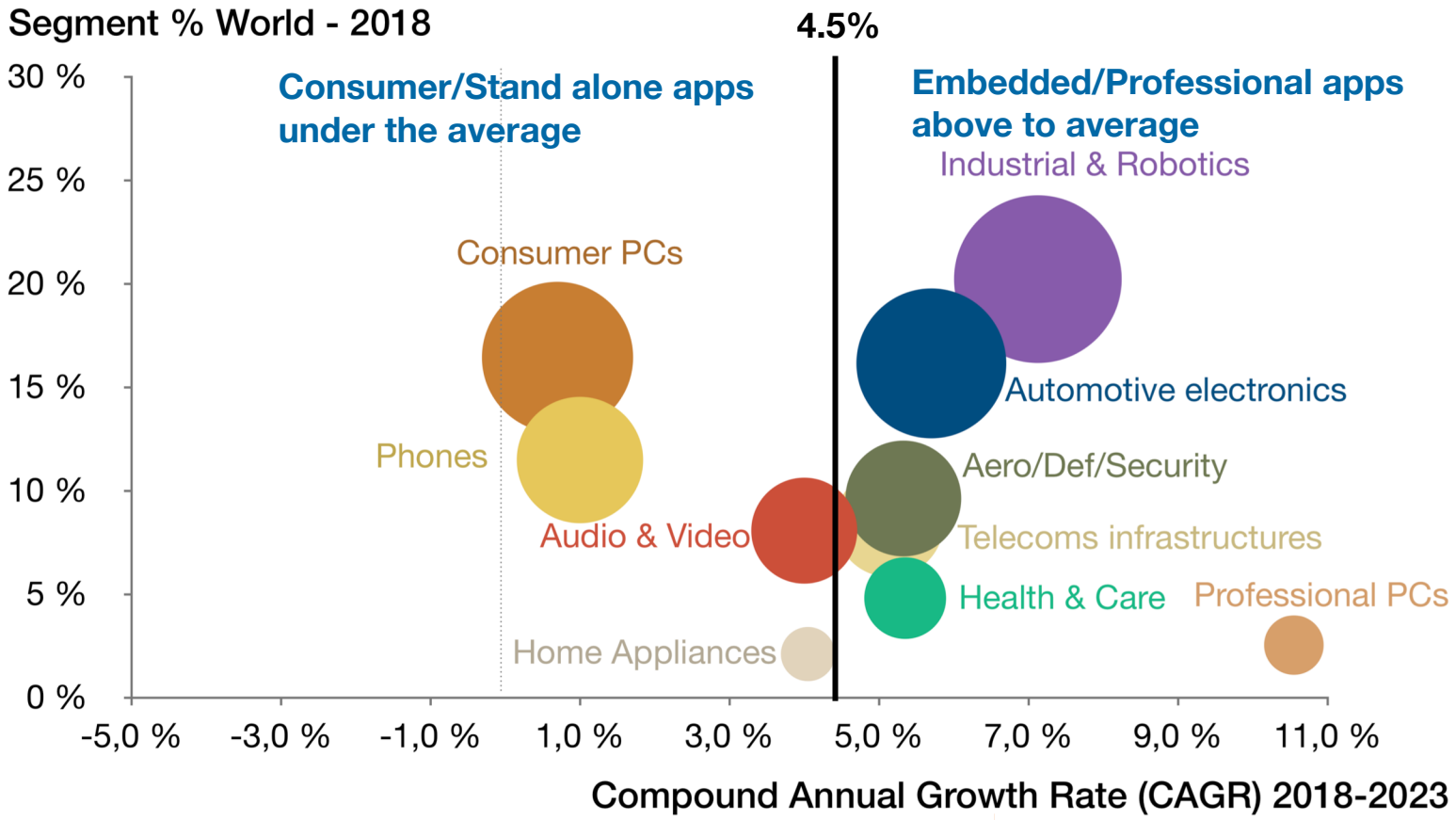

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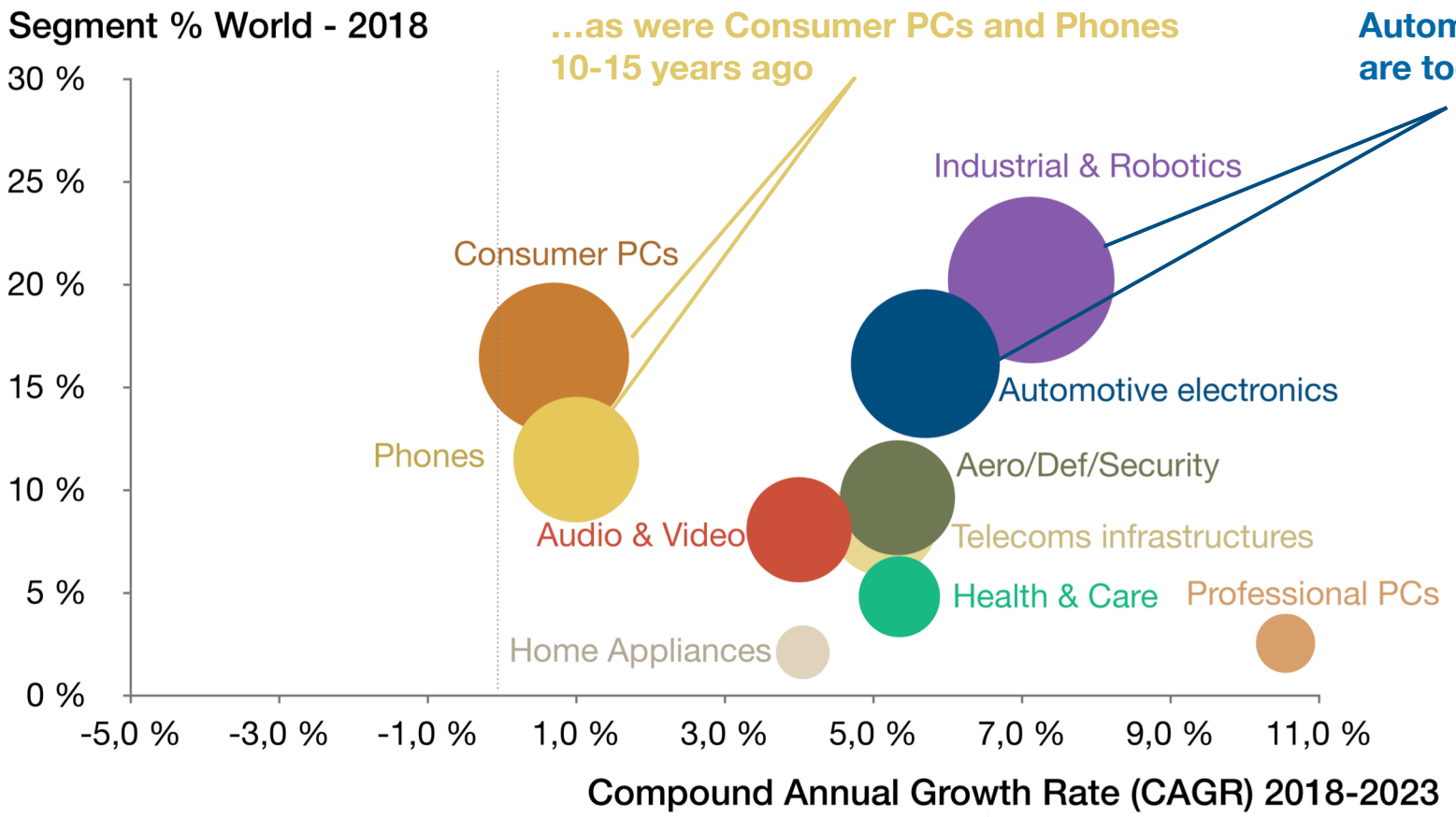

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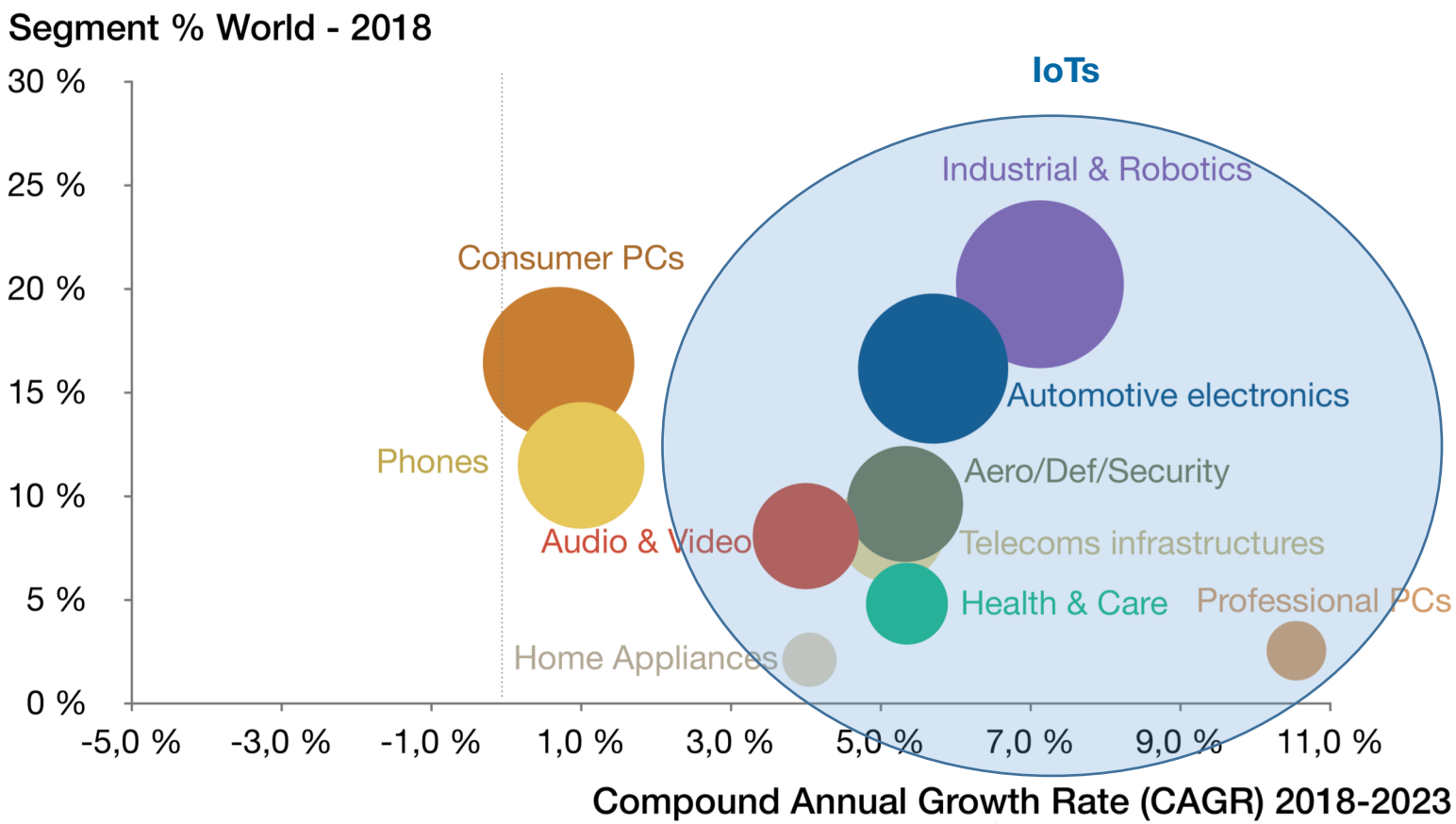
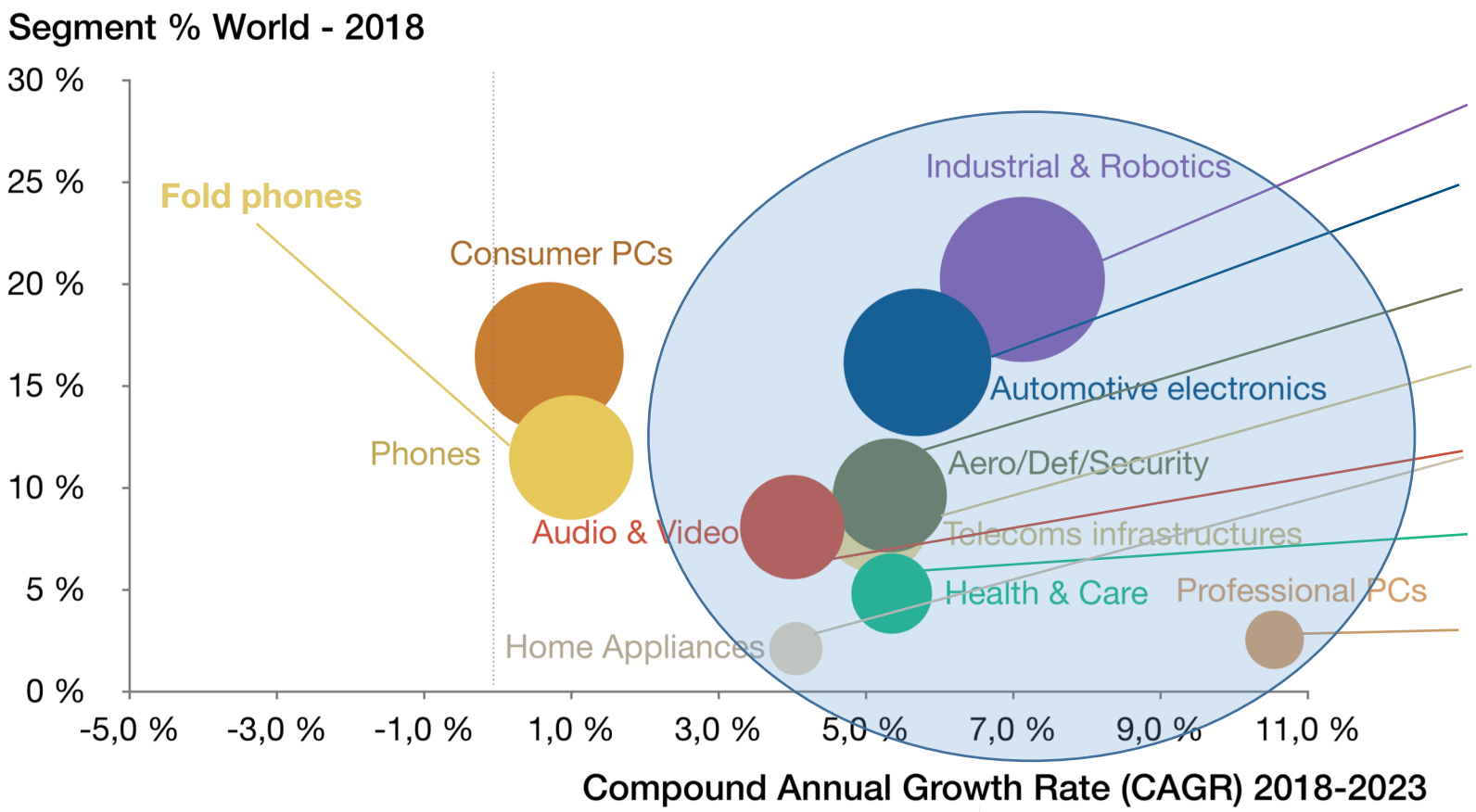


A growth led by IoTs…

MAIN GROWTH DRIVERS OVER THE COMING DECADE

Electronic systems in the World

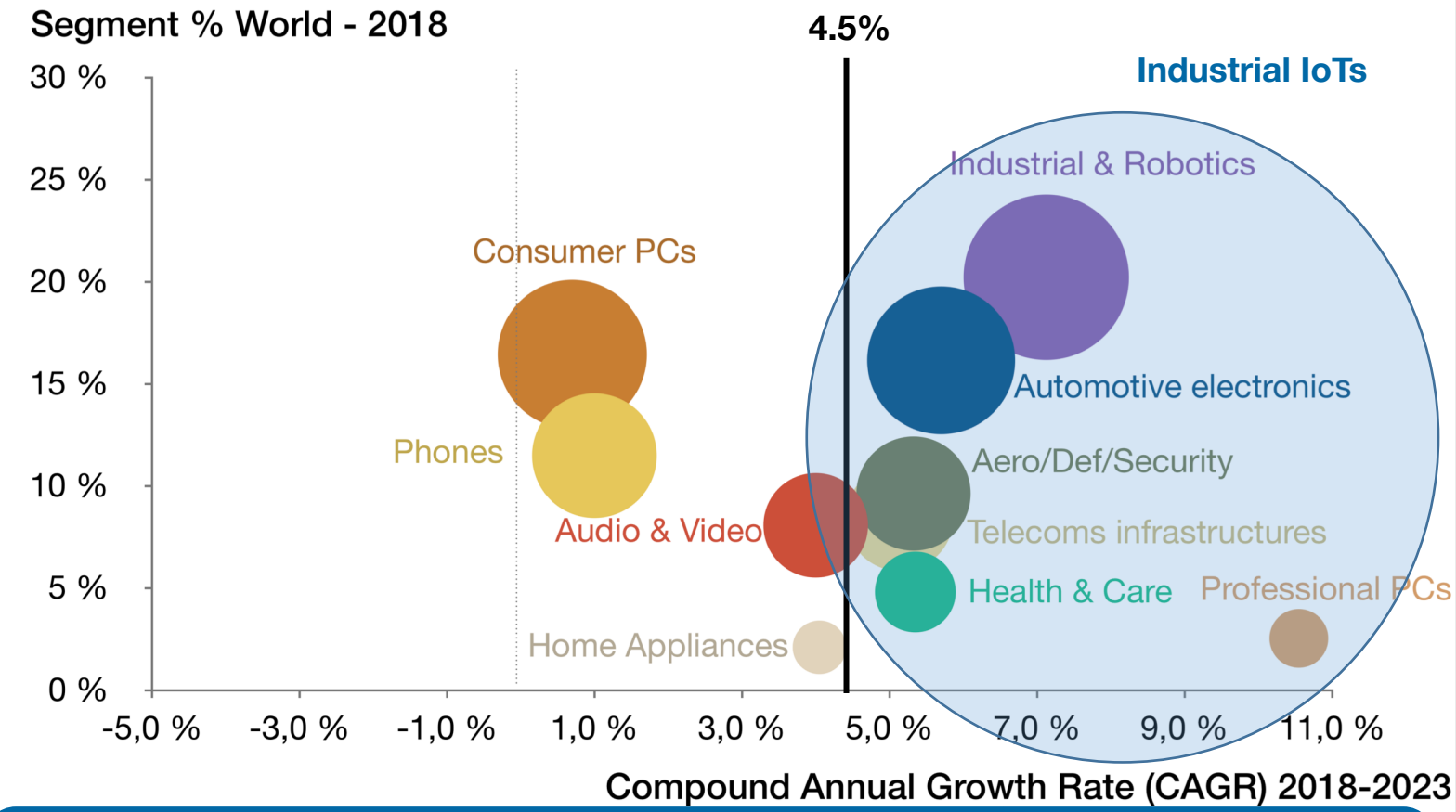


A growth led by IoTs…

- **Industry 4.0**
- **Infotainment / Autonomous / Connected vehicle**
- **Safe City / More Electric Aircraft / Border control**
- **5G / Lora / Sigfox / etc.**
- **Smart home / Personal assistants**
- **Wearables**
- **Big data applications** (through Cloud-based IoT apps)

MAIN GROWTH DRIVERS OVER THE COMING DECADE

Electronic systems in the World



CHALLENGE 2

- It is a technology-driven growth => New competitive factors & necessity for the players to integrate the associated emerging technologies in order to benefit from the growth.
- The slide below details the emerging technologies that will drive Industrial IoTs in the coming decade.

OPPORTUNITY for the EU

Over the coming decade, most of the electronic growth will be concentrated on the segments where the EU is well positioned*:

"Industrial IoTs" that is IoTs trends as defined above impacting embedded/professional segments

*(*except Professional PCs)*

Yet, this opportunity is associated to 2 great challenges

CHALLENGE 1

- The EU is not the only player to be well positioned in embedded/professional electronics: The USA and China are already better positioned in most of the sub-segments.
- For instance, in 2018:
  - Europe accounts for 20-22%
  - North America accounts for 24-25%
  - China accounts for 24-26%

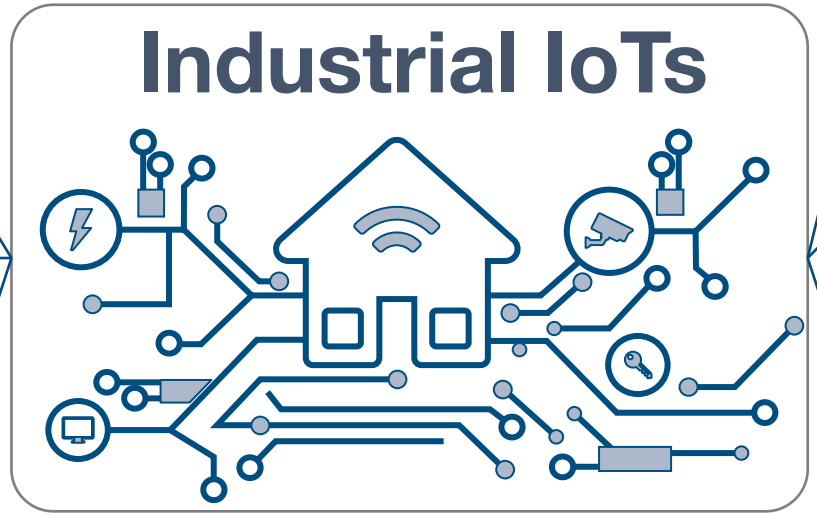
  …of the world embedded/professional electronics production in terms of location of production.
- The picture is slightly different but remains similar in terms of industrial leaders by value chain levels and end-user electronic systems.

INDUSTRIAL IOTs ARE BECOMING MULTIFUNCTIONAL

Towards **Security & Privacy**
- Cryptography
- Secure elements
- Blockchain

Towards **Sensing & connectivity**
- Smart sensors, smart dust
- MEMS
- IoT communication architectures (Lora, Sigfox, etc.)

More than Moore innovations
- Organic-printable electronics
- Photonics Interconnects, PICs
- Etc.



Towards **advanced packaging**
- SiP ⇧ value added of most embedded products

Towards **embedded software & data analysis**
- Machine learning algorithms
- Cloud AI chips / Edge AI chips

Rising **computing & energy-efficiency components**
- More Moore chips (< 20 nm)
- Advanced memories (especially Non-Volatile)
- Neuromorphic chips
- Beyond CMOS components

These are the technological trends that will drive the added value of Industrial IoTs (as defined in the previous slide), and their associated emerging technologies

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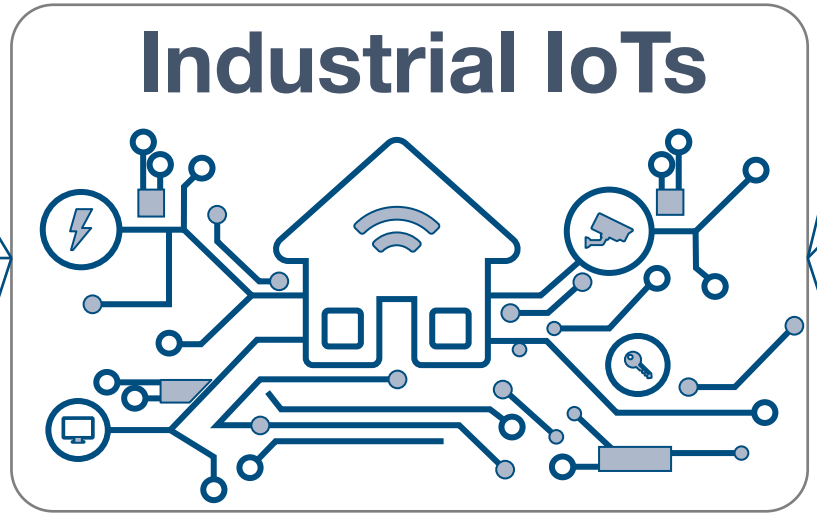

Towards **advanced packaging**
- SiP having ⇧ value added in most embedded products

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Strengths of the EU / **Weaknesses of the EU**

in terms of both R&D ecosystem and industrial ecosystem (ability to control the entire value chain associated to the technology), compared to the main competitors: the USA and China, but also South Korea and Japan in some fields.

INDUSTRIAL IOTs ARE BECOMING MULTIFUNCTIONAL

This global picture can be nuanced:

- Strengths: Yet, the EU industrial landscape is not that strong in Smart sensors, and even more in Blockchain and PICs compared to the US. The EU is also weak in the emerging field of smart dust (miniaturized smart sensors)
- Weaknesses: Yet, the EU has strong capacities in packaging for power apps (European IDMs) and opportunities in edge computing (edge AI, etc.). In terms of pure R&D, the EU is also excellent in Machine learning and good in Advanced memories, although without the associated great industrial players

Strengths of the EU

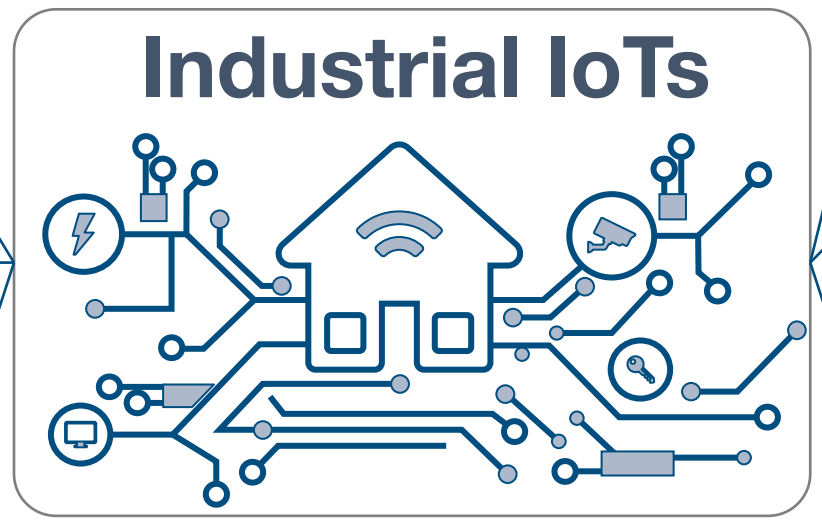
Towards Security & Privacy
- Cryptography
- Secure elements
- Blockchain

Towards Sensing & connectivity
- Smart sensors ← smart dust
- MEMS
- IoT communication architectures (Lora, Sigfox, etc.)

More than Moore innovations
- Organic-printable electronics
- Photonics Interconnects, PICs
- Etc.

: Weakness in terms of industrial players

: Strong R&D ecosystem



Weaknesses of the EU

Towards advanced packaging
- SiP ⇧ value added of most embedded products

Packaging power: IGBT, etc.

Towards embedded software & data analysis
- Machine learning algorithms
- Cloud AI chips
- Edge computing / Edge AI chips

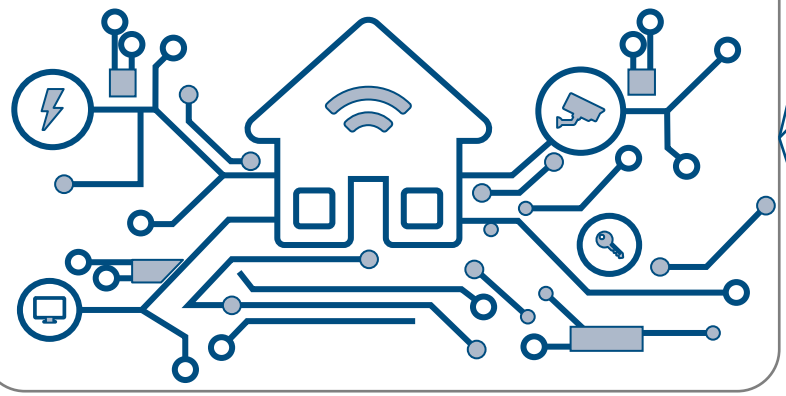
Rising computing & energy-efficiency components
- More Moore chips (< 20 nm)
- Advanced memories (especially Non-Volatile)
- Neuromorphic chips
- Beyond CMOS components

INDUSTRIAL IOTs ARE BECOMING MULTIFUNCTIONAL

: Weakness in terms of industrial players

: Strong R&D ecosystem

Industrial IoTs



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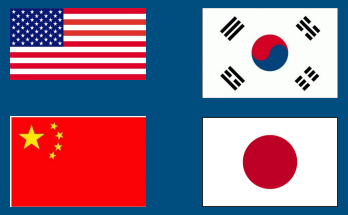

have the opportunity to gain market shares over the EU in embedded/professional applications through the following functions (and associated technologies) on Industrial IoTs:
- Advanced packaging
- Embedded software & data analysis
- Computing & energy-efficiency components

3 ADDITIONAL CHALLENGES – ON EMBEDDED SEGMENTS

These are 3 additional opportunities for US/Chinese players to gain market shares over EU players on embedded/professional electronics applications within the coming decade.

SEGMENT	TECHNOLOGIES	LEADING COUNTRY	INDUSTRIAL LEADERS	EU COMPETITORS
Professional PCs & Data analysis	HPC & Quantum ML algorithms	The USA => China	➢GAFAMI, HPE, Dell, Cray… ➢BATX, Lenovo…	➢Atos/Bull, Thales, OVH, etc. ➢Telecoms operators
Telecommunications infrastructures	5G Technology	China	Huawei	➢Nokia ➢Ericsson
Automotive batteries	Lithium-Ion	China	➢BYD, CATL, CBAK, AVIC… ➢80% rare earths production ➢50% cobalt production *(through secured provisioning from the DRC)*	➢European Battery Alliance ➢Saft Batteries ➢…

AGENDA

- PRESENTATION OF THE STUDY

- RESULTS

- **RECOMMENDATIONS**

1) SUPPORT INDUSTRIALISATION

The EU is globally well positioned in terms of **Scientific leadership (R&D)**

Compared to the USA and China

But suffers from weaknesses in terms of **control of the value chain**

- Micro & Nano Electronics
- Data analysis (Hard/Soft & services)
- Software

Compared to the USA and China

1. Bring **more flexibility in the EU competition rules**: enabling support to competitive steps
2. Include the criterium of **nationality of capital ownership** in the selection of the beneficiaries of public funding (ECSEL JU, etc.)
3. Develop an **industrial strategy** to **support industrialization** in Europe

2) WHICH TECHNOLOGY TO SUPPORT IN HORIZON EUROPE?

Innovation Field	Support in priority emerging/enabling technologies with	
	Strong value chain in the EU	**No Value chain clearly set up**
Security & Trust	➢**Cryptography:** Public Key, Quantum Key Distribution, Lightweight crypto, post-quantum crypto, homomorphic encryption, GAN crypto, etc. ➢**Secure elements:** embedded / integrated UICC, Trusted Execution Environment, etc.	➢Blockchain
Sensing & connectivity	➢Smart Sensors ➢5G	➢IoT communication architectures
Edge computing		➢Edge AI chips ➢Open hardware/software platforms for Edge & IoT computing ➢…
More than Moore technologies	➢Analog electronics ➢RF electronics ➢Power electronics	➢Organic-Printable electronics ➢Photonics innovations: Chip-to-chip interconnects, etc. ➢…

3) LEGAL ISSUE : AN EU SOVEREIGNCY ON DATA

Data will become a key issue in the next decade (and already are) :

- **Sovereignty** reasons (and Privacy/Security)
- But also for **economic issues as a key competitive factor** (main ML innovations through CNNs training using large datasets, etc.)

AN EU SOVEREIGNTY ON DATA

Use **regulatory leverage** to fight the GAFAMI / BATX
Example : China => Foreign companies are obliged to store data in China through joint ventures with Chinese players

Leave room for the **development of existing European players** (Atos / Bull, OVH, telecommunication operators, etc.)

Leave room for the **development of emerging European Players**

Support the development of European players on a large number of technologies and market

Data analysis & management, smart sensors, AI algorithms & chips, IoT communication architectures (Lora, Sigfox), but also software edition, ICT consulting, etc.

WHAT WOULD IT LOOK LIKE?

Could be articulated around the **development of Digital Identities**

World leaders in Europe
Thales/Gemalto, Atos/Bull, Idemia

Enables a **strong identity from a public trusted organization** associated to **derivative user-centric identities** (Blockchain?)

Associated with **user data** that should be mandatory **stored either by European companies or in Europe** with a possibility of exploitation by European players

Respecting **rules of security & privacy** (type GDPR)
=> Answer to the American Cloud Act

Thank you for your participation!

OUR TEAM IS AVAILABLE TO ANSWER ALL YOUR QUESTIONS

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European Commission

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