# Chips

What is a chip?

Where are they used

How are they made

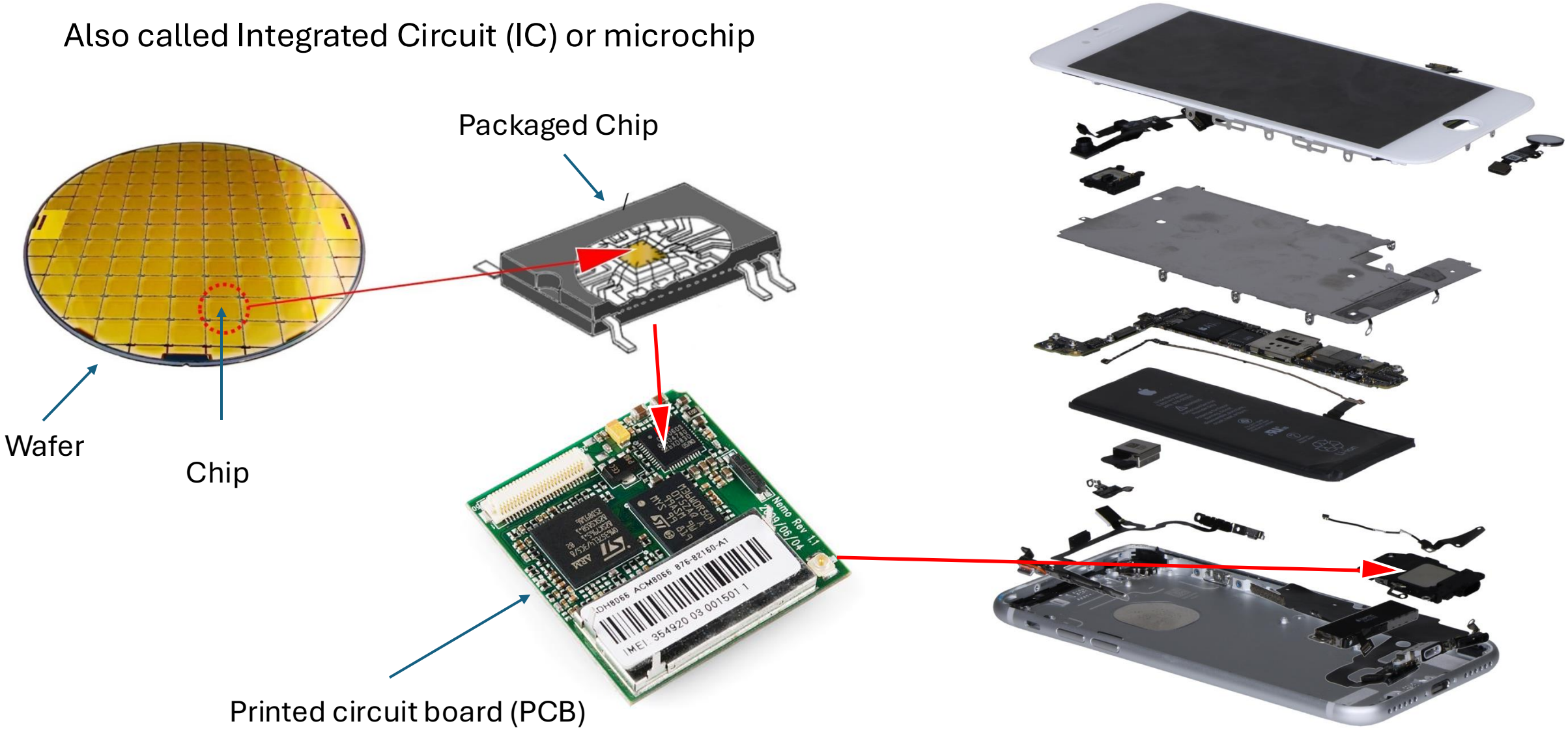
The semiconductor value chain

Australia’s place – where do we participate, can we do more?

Macquarie University - Silicon Platforms Lab

# What is a chip?

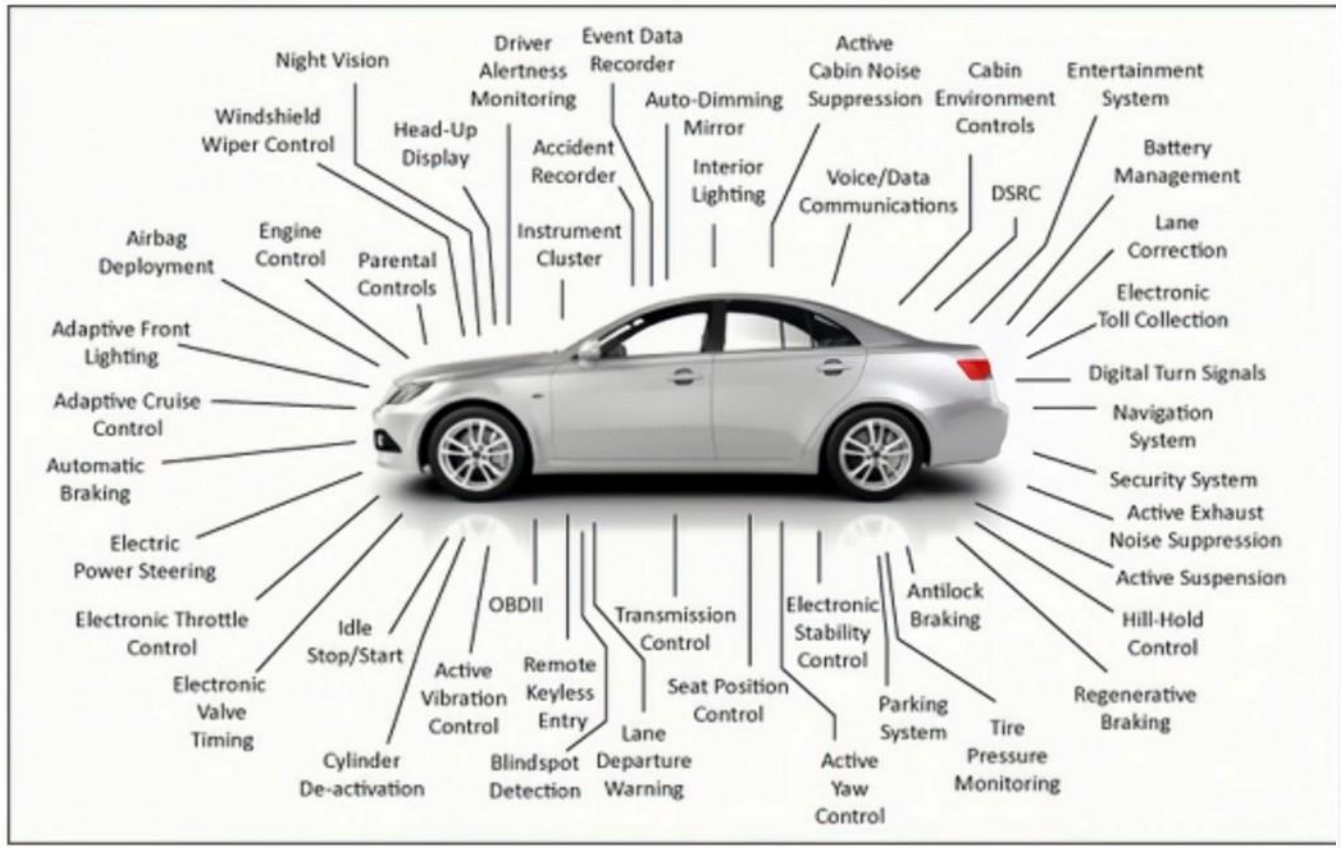
Also called Integrated Circuit (IC) or microchip




https://www.nanowerk.com/transistors-explained.php

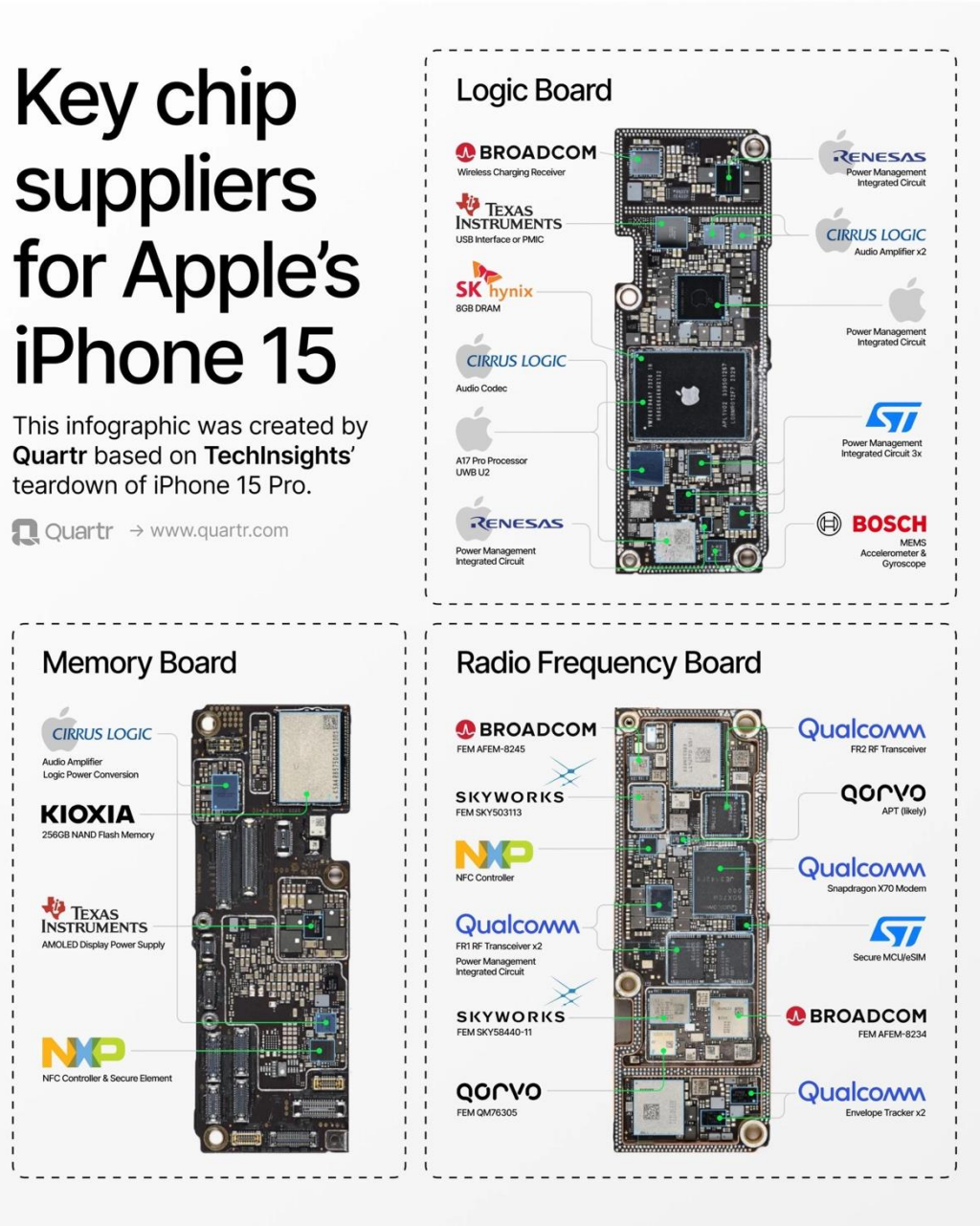
# Where are they used?

## >1000 in a modern car




Computers in modern cars monitor many different systems

## >50 in a modern smartphone




https://www.sciencedirect.com/science/article/abs/pii/B9780128150320000111

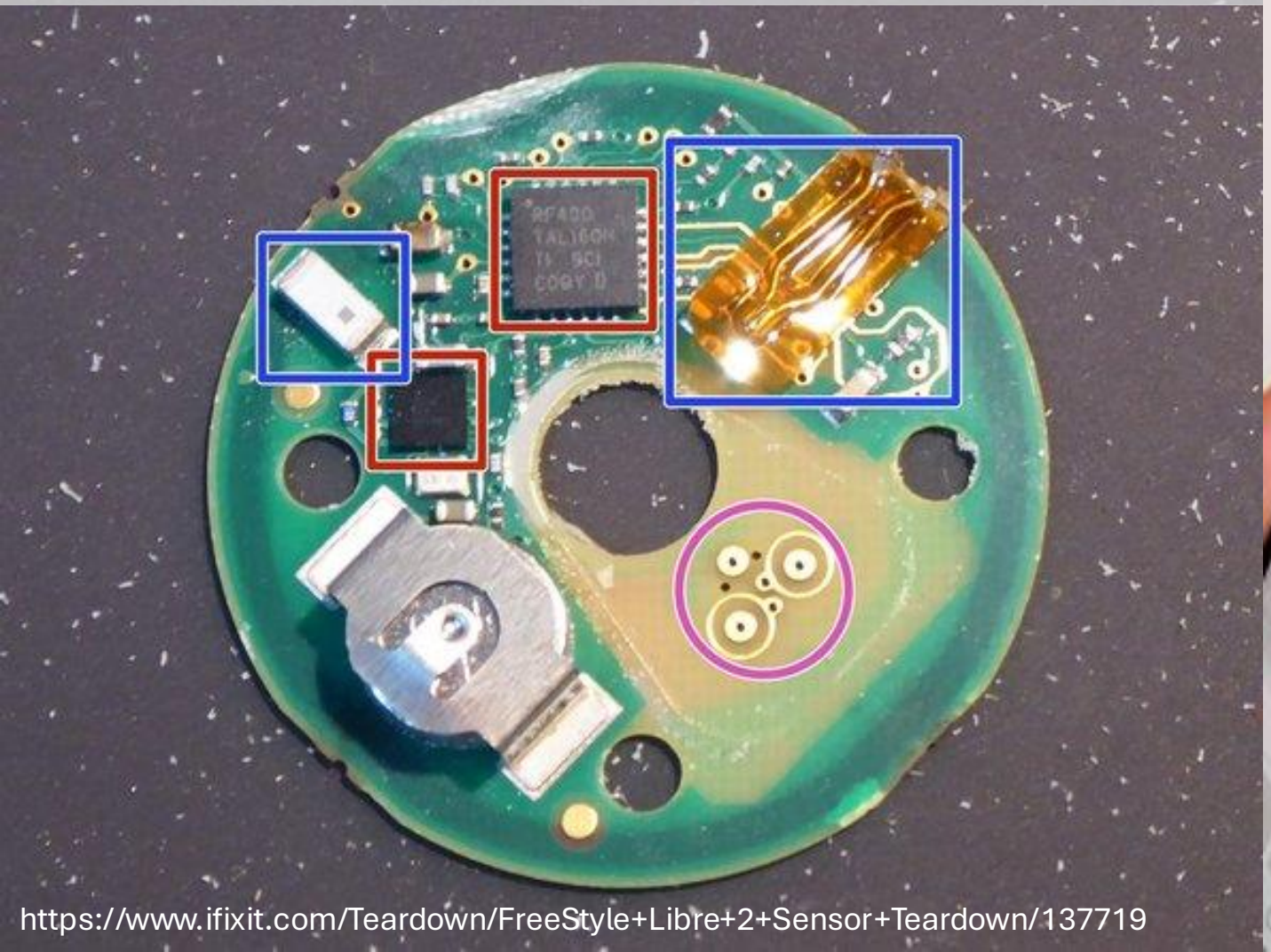
# Communications

Starlink satellite terminal >400


https://www.esat.kuleuven.be/cosic/blog/dumping-and-extracting-the-spacex-starlink-user-terminal-firmware/

# Medical Devices

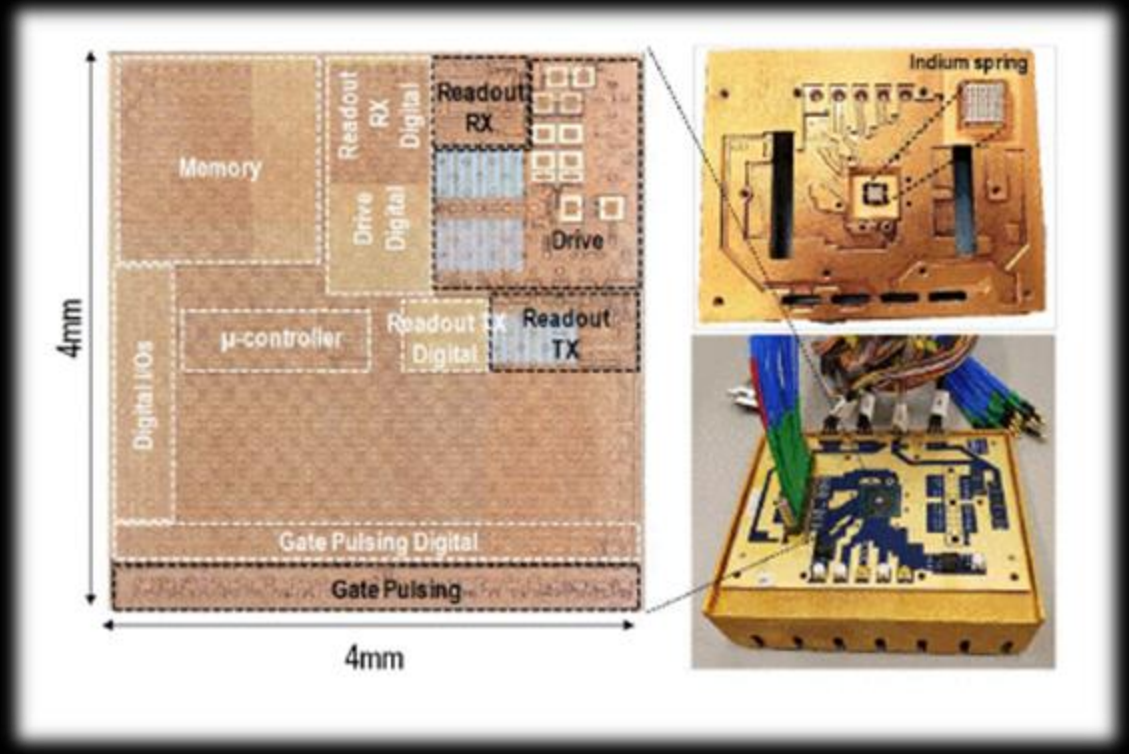
Continuous glucose monitor 2-3

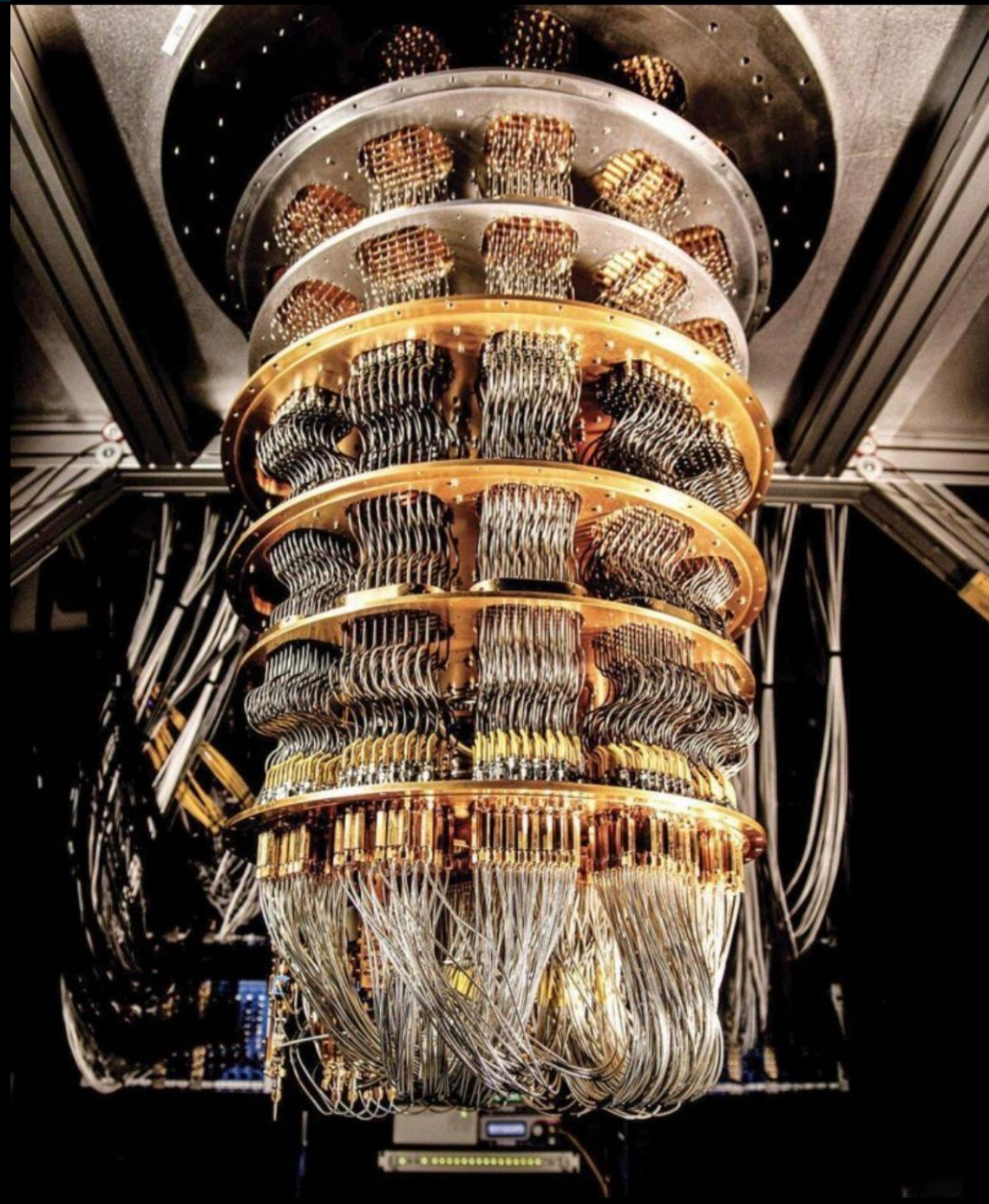


https://www.ifixit.com/Teardown/FreeStyle+Libre+2+Sensor+Teardown/137719

# Quantum

## Qubit control and readout

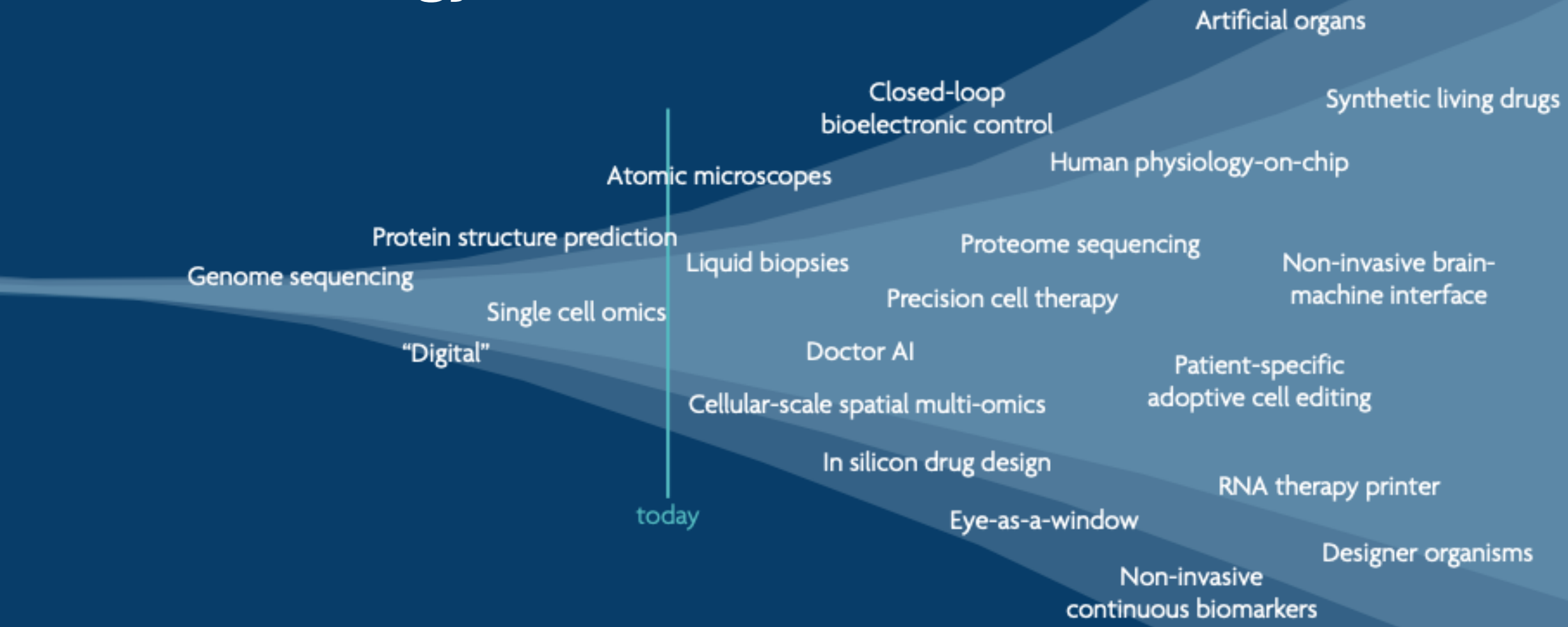


https://quantumai.google/quantumcomputer
https://www.nature.com/articles/d41586-024-03288-3

# The explosion in bioconvergence has just started

## Biotechnology



# Critical technologies

The critical technology priority fields are:

- advanced manufacturing and materials technologies
- artificial intelligence (AI) technologies
- advanced information and communication technologies
- quantum technologies
- autonomous systems, robotics, positioning, timing and sensing
- biotechnologies
- clean energy generation and storage technologies.

**Critical technologies are built on integrated circuits!**

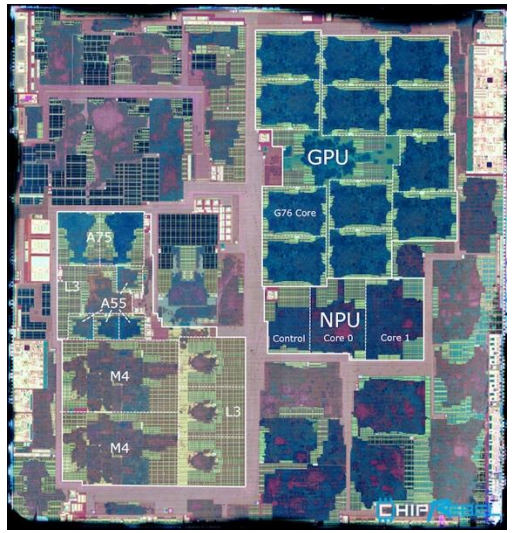
# Integrated Circuit Types

By technology

## **Silicon** (single element)

~100K-1B transistors / chip
90% of the global market

- CMOS
- BiPolar




90% of the market

## Compound

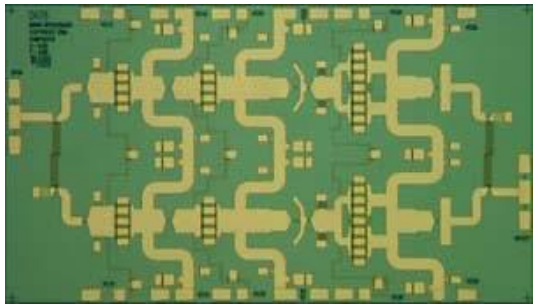
~10-20 transistors / chip
10% of the global market

### III-V

- GaAs
- GaN
- InP

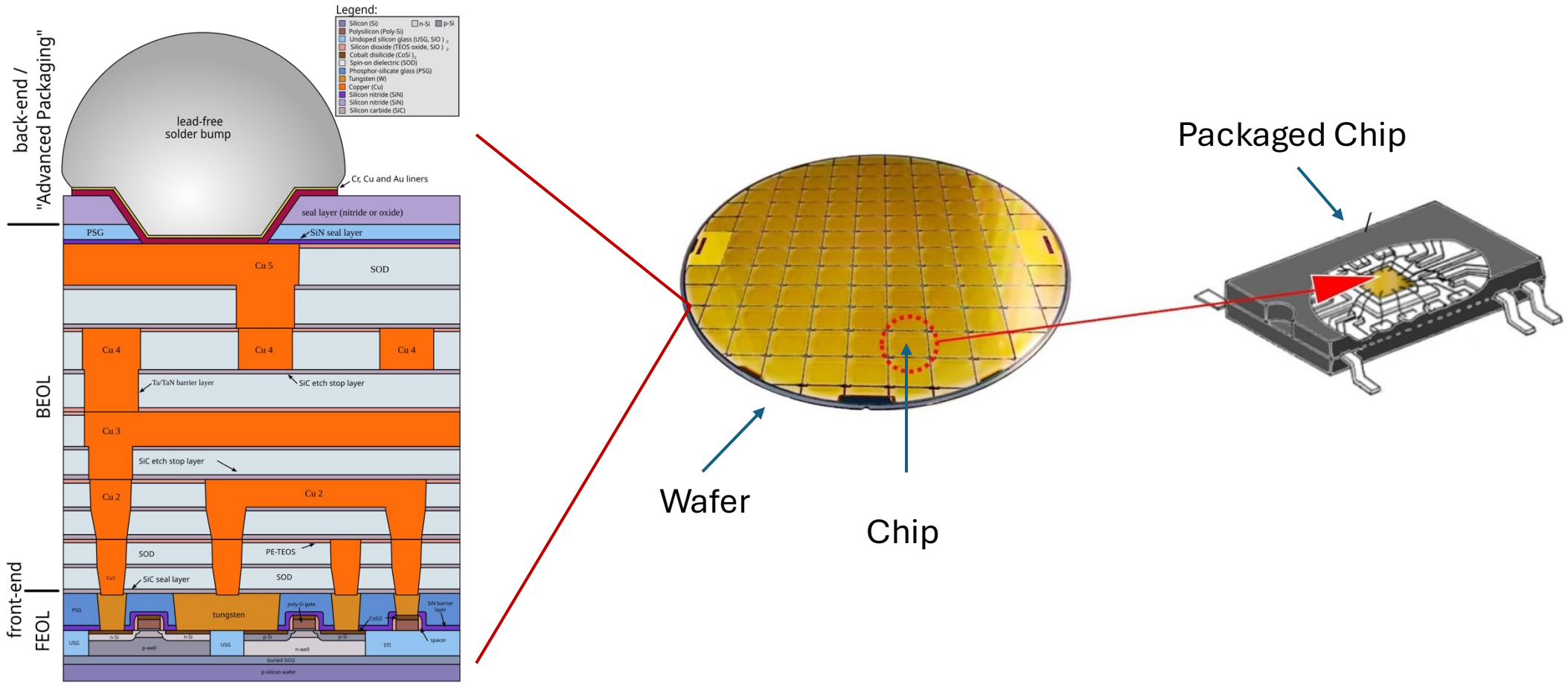
### IV-IV

- SiC
- SiGe

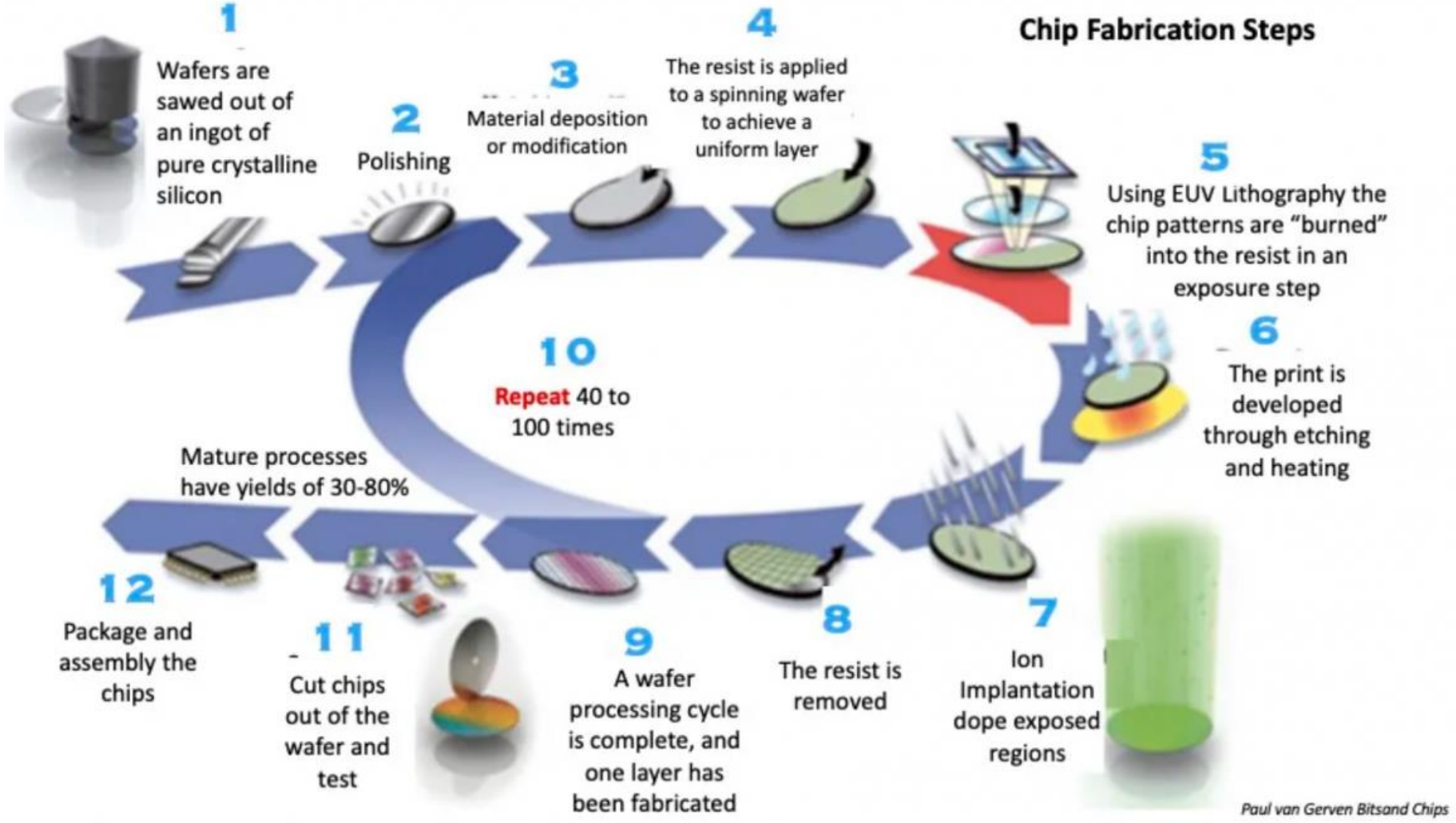


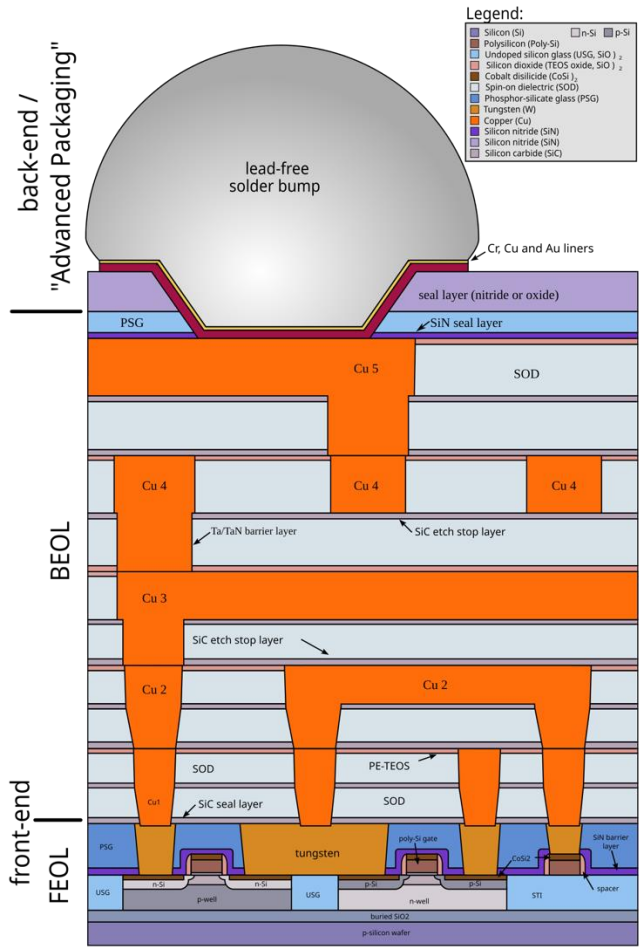
10% of the market

# How are they made? (CMOS)



# How are they made? (CMOS)




https://www.the-waves.org/2022/03/17/semiconductor-value-chain-globally-distributed-ecosystem/


https://www.youtube.com/watch?v=h_zgURwr6nA

# Semiconductor Value Chain

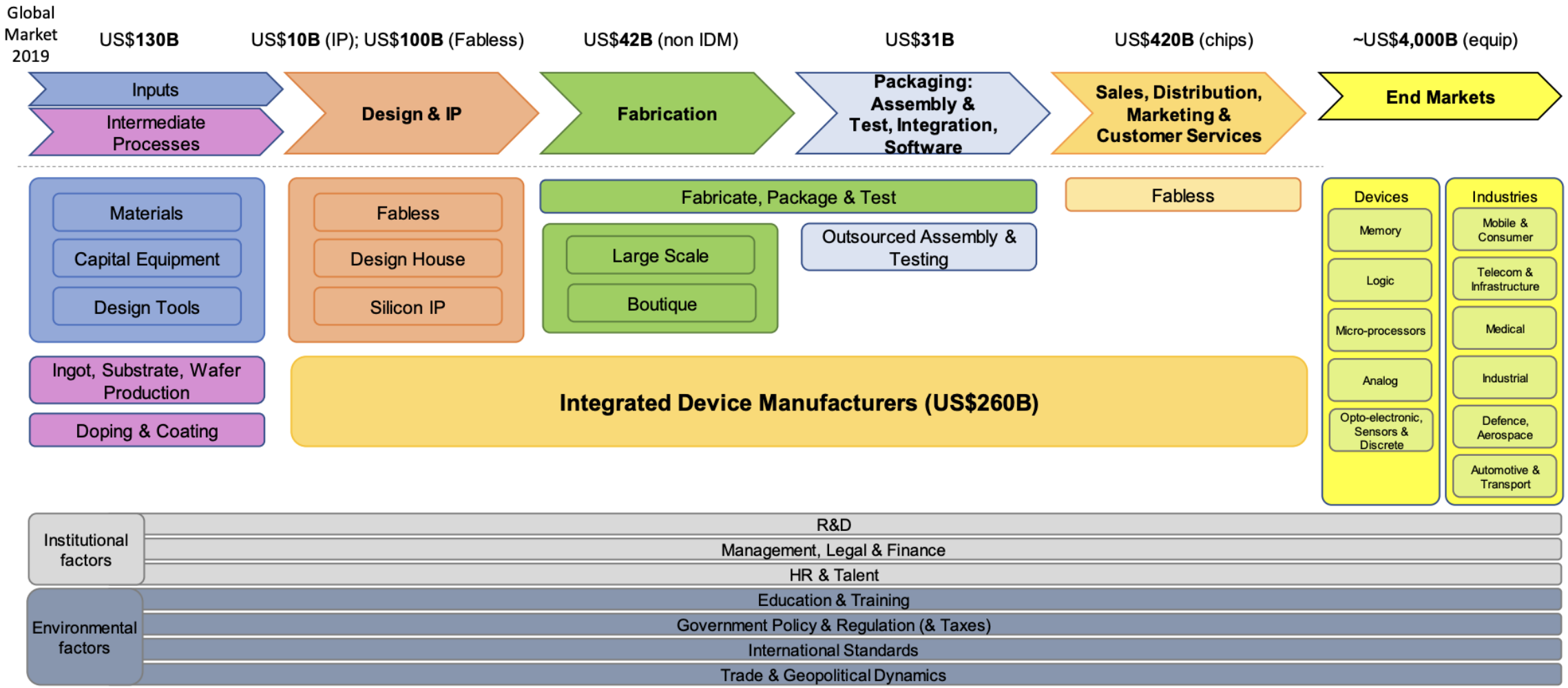
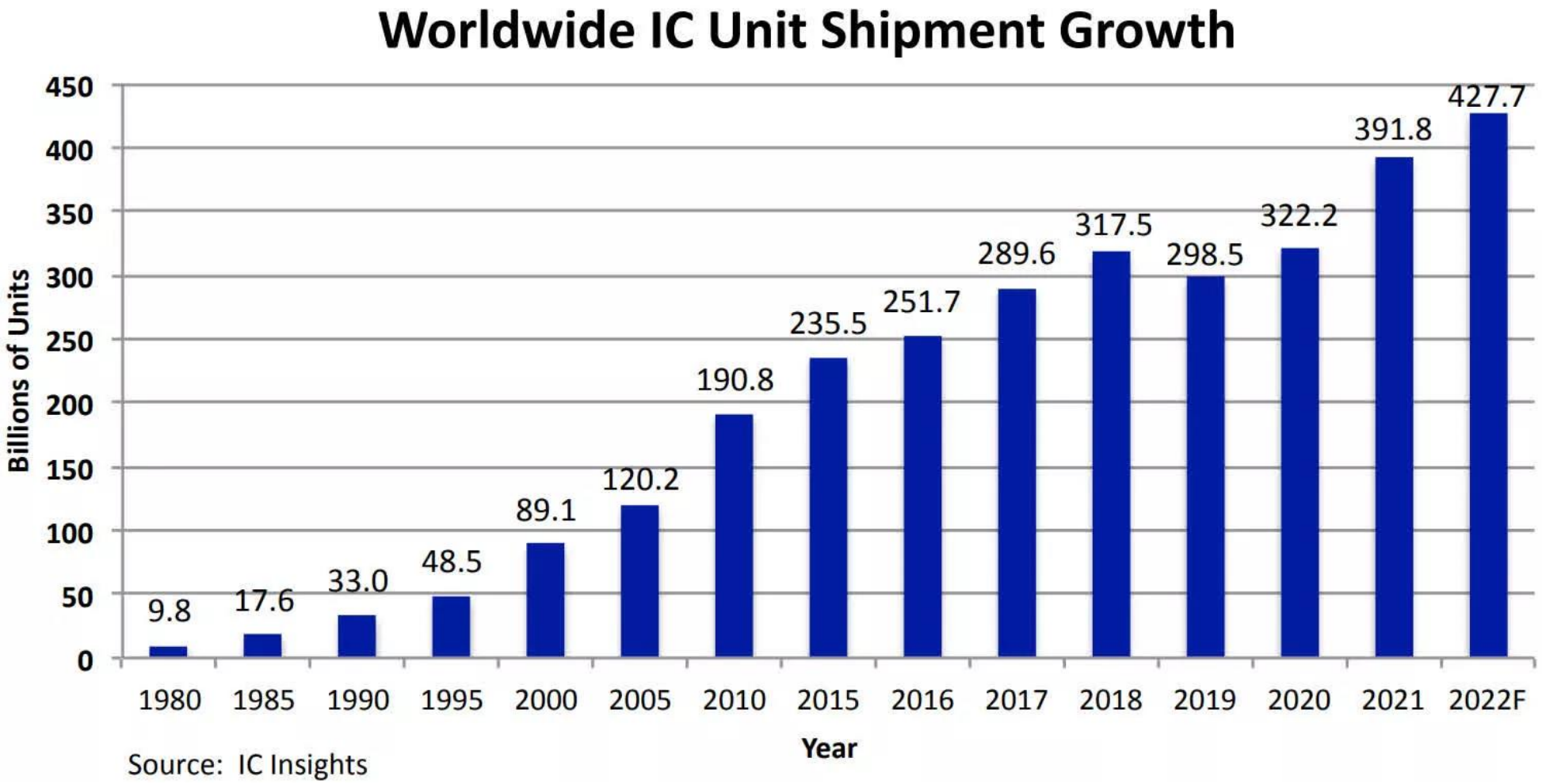



**Figure 1: Semiconductor value chain**

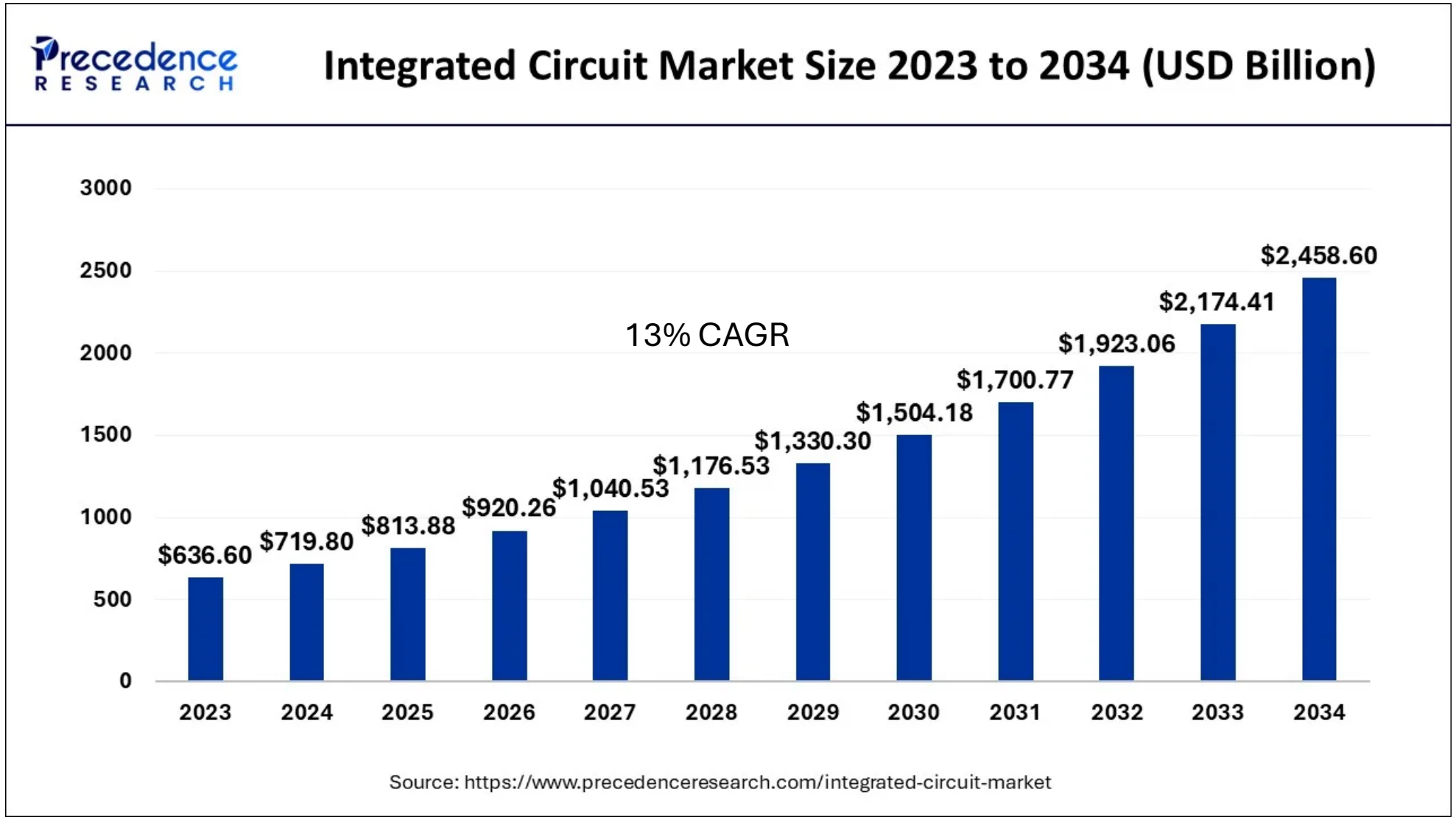
Note: Global market size estimates in US$ billion. Refer to Appendix 2 for references supporting estimates of market size in 2019.

https://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0005/339647/Australian-Semiconductor-Sector-Study.pdf

# Market Size - Annual Shipments

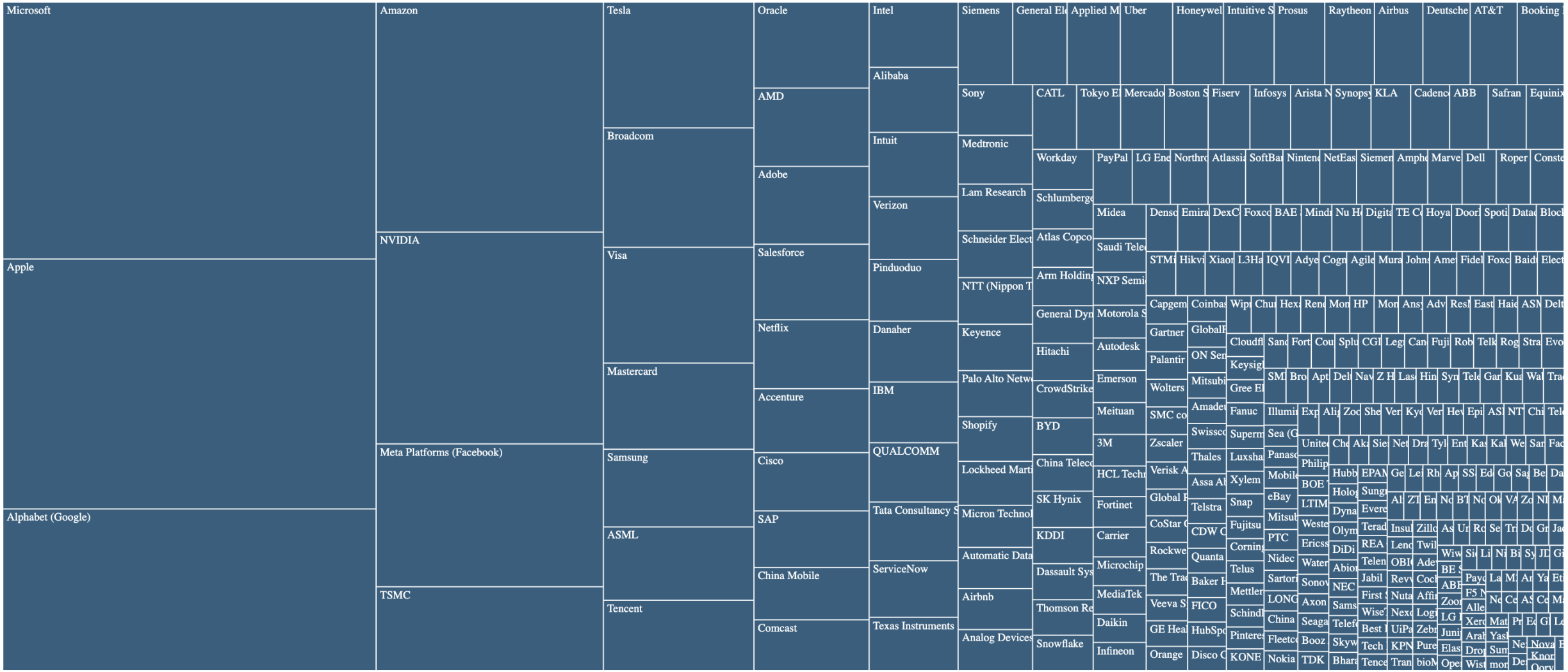


# Market Size – Sales to 2034



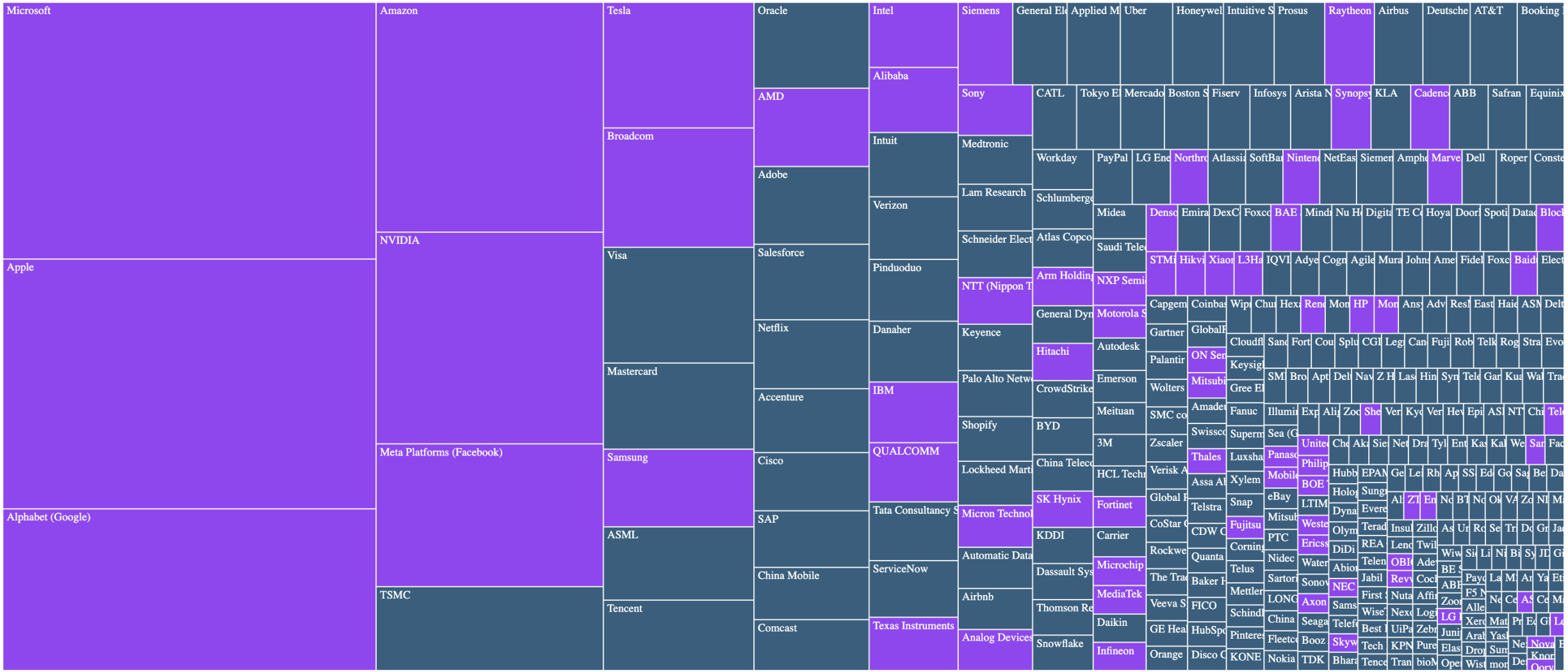
# Tech Companies

>$10B USD market cap, total is $33T



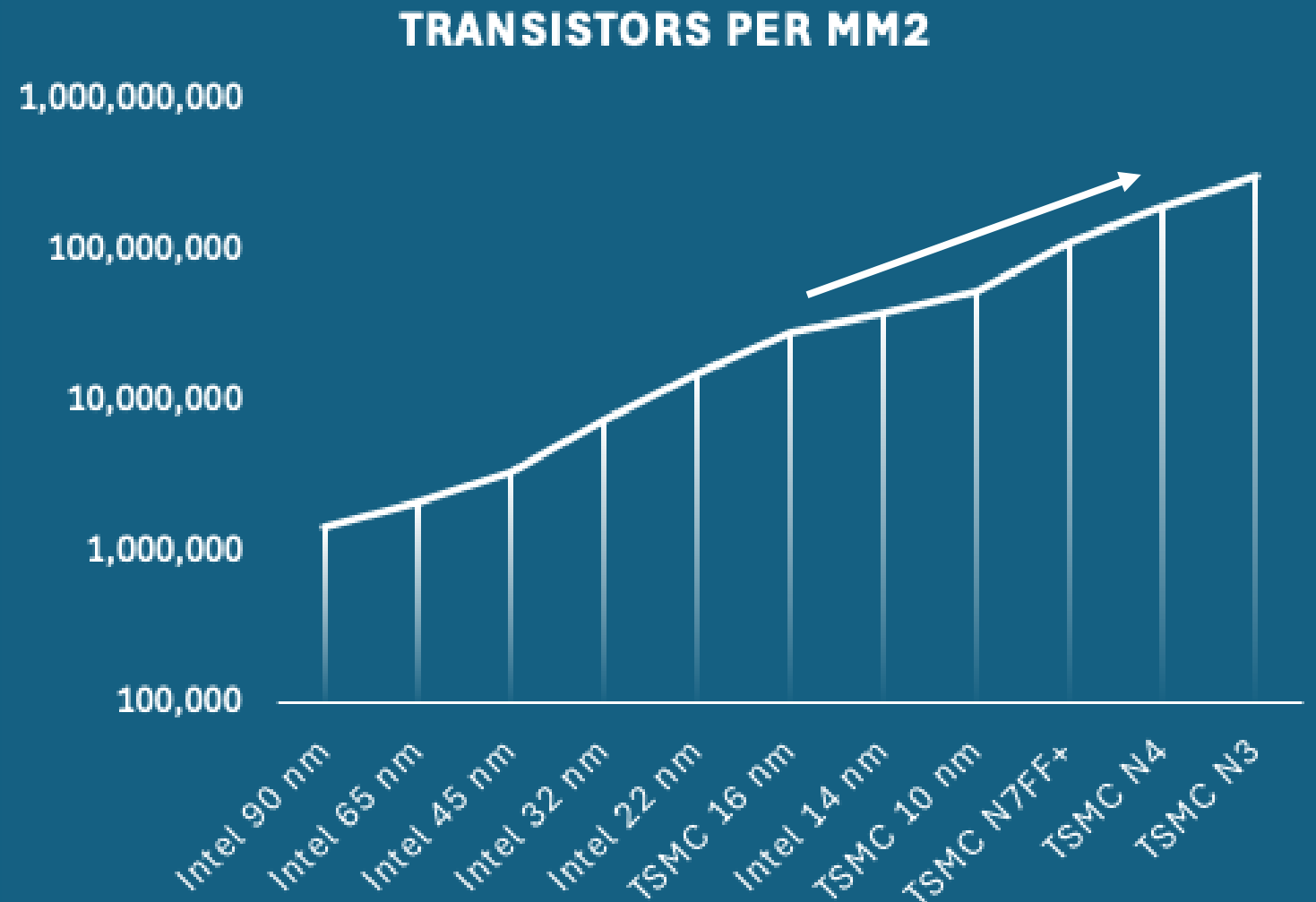
# Tech Companies – That Design Chips

>$10B USD market cap, total is $33T



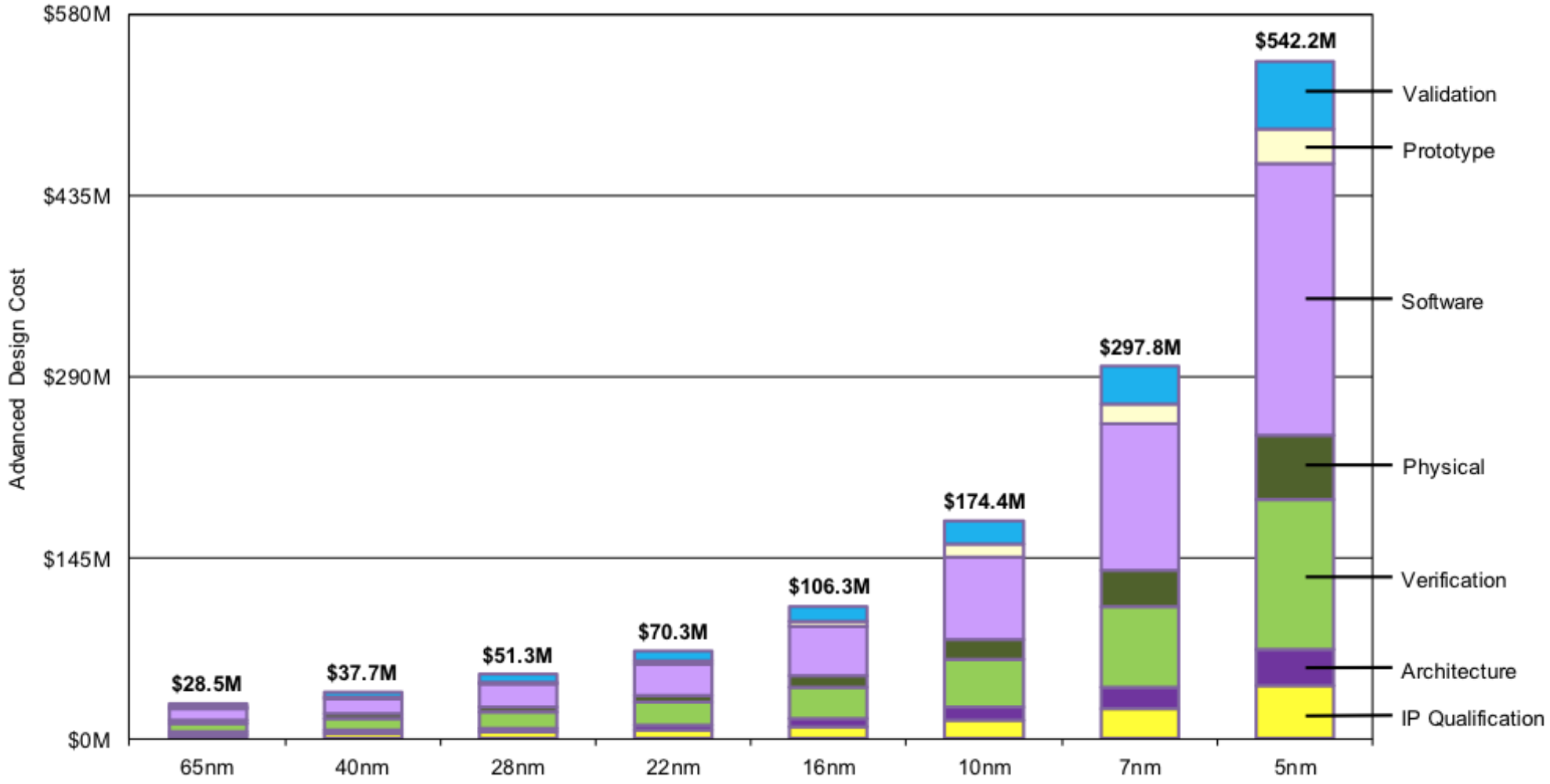
# Trends

# Trends – Transistor Density




Based on selected data from https://en.wikipedia.org/wiki/Transistor_count

# Trends – Increasing costs




https://semianalysis.com/2022/07/24/the-dark-side-of-the-semiconductor/

# Trends - Advanced Packaging


https://www.electronicdesign.com/markets/automation/video/21244190/electronic-design-chiplets-technology-helps-integrate-advanced-computing-platforms

## TRANSISTOR DENSITY => MORE DIGITAL

Complex RF -> ADC

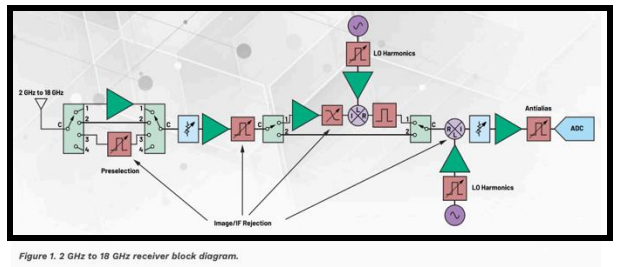
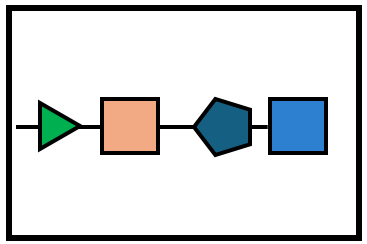
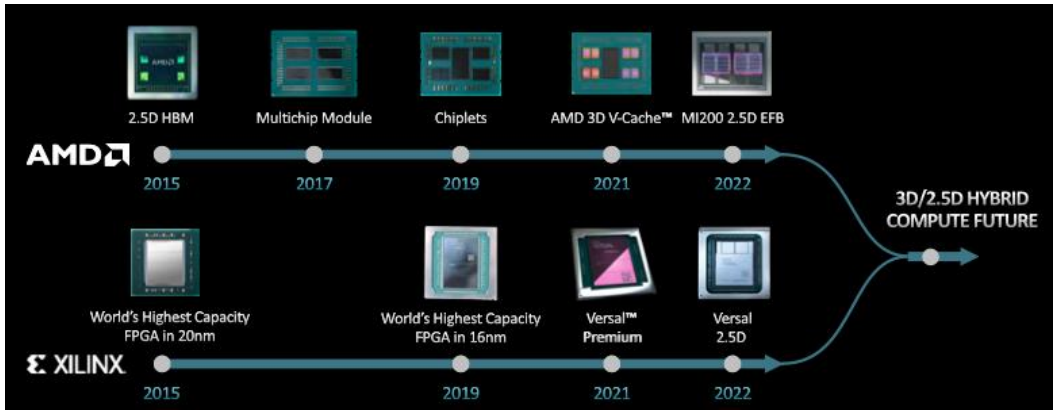



Figure 1. 2 GHz to 18 GHz receiver block diagram.

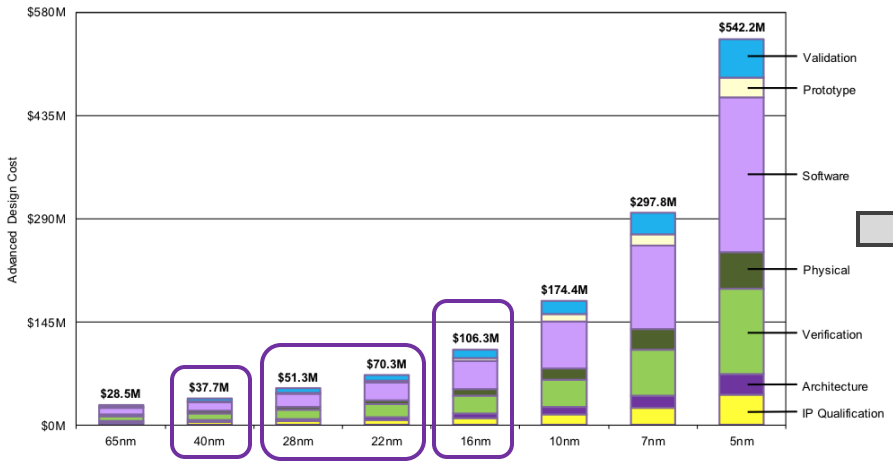
LNA -> ADC + Digital

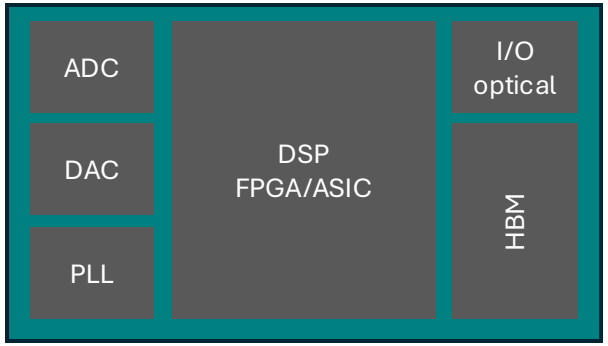


## CHIPLETS + ADVANCED PACKAGING

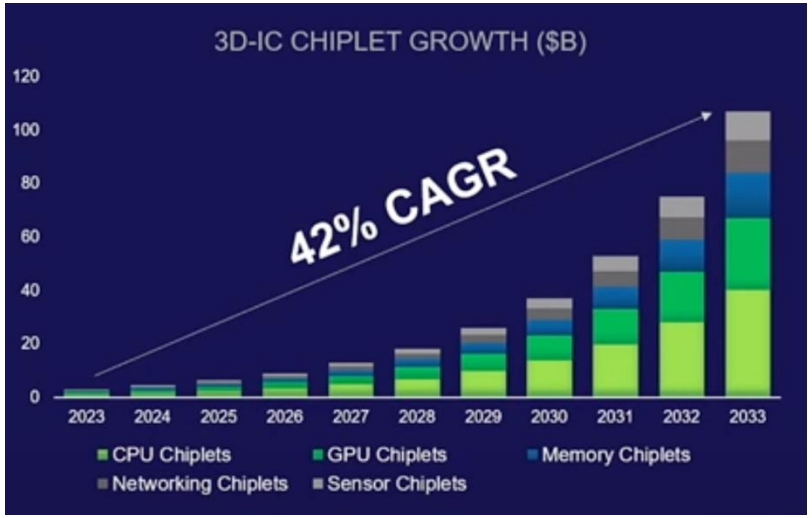



## INCREASING COSTS => SIMPLIFY




## MARKET GROWTH




## SW (AI/ML) DRIVEN DESIGN AND VERIFICATION => REDUCE DEV COSTS

# Chips In Oz

# Chip Design in Australia

## Headquartered in Australia

Morse Micro

Perceptia™ IP and Design Services

astc

ATTO DEVICES

MILLIBEAM

RADLogic
Research. Analysis. Design.

semitech semiconductor

FUSION SEMICONDUCTOR

BRisbane Silicon

memjet

## Design Centre in Australia

AMD

movandi

BROADCOM

ALTUM RF

ANALOG DEVICES

Silanna Group

## Also make chips

diraq

## Listed in Australia

brainchip

# Increasing Participation

## Inputs

Critical minerals, mining and processing

Rare earth minerals, mining and processing

New design tools/ techniques/methodologies

## Fabless Design and IP

Design centres and startups

Quantum

Biotechnology

Photonics

Communications and sensing

Defence and critical technologies

## Manufacturing

Advanced packaging

*Mature CMOS fab (12-28nm)?*

*Compound (GaAs/GaN/Other..)?*

MACQUARIE
University

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**SILICON PLATFORMS LAB**

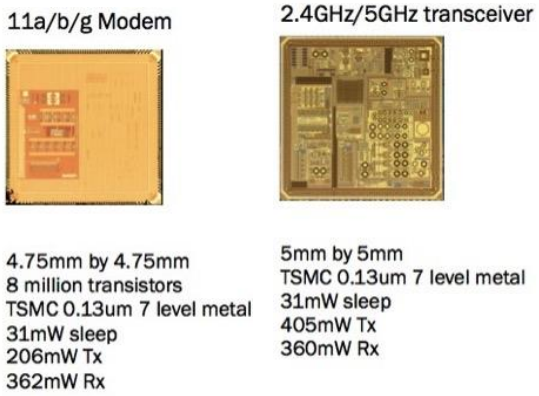
# Macquarie University

MACQUARIE University

SILICON PLATFORMS LAB

1990-2000

WiFi (Radiata)
(CMOS)




Neil Weste
David Skellern

2006-2010

60GHz GLIMMR
(SiGe)

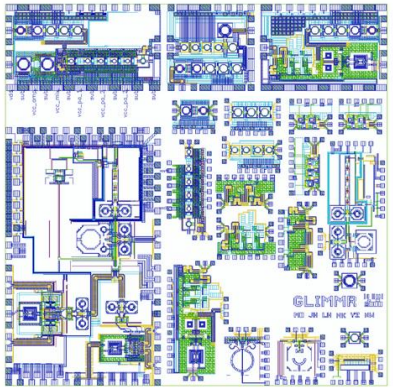
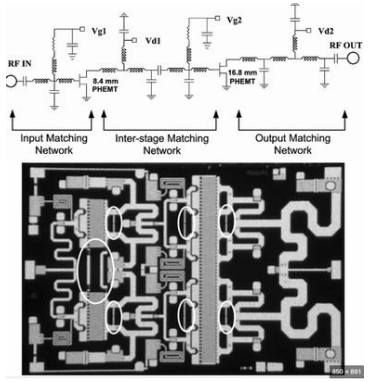


**Figure C.3:** *GLIMMR test-chip 3 (GTC3).*

Neil Weste

2020-

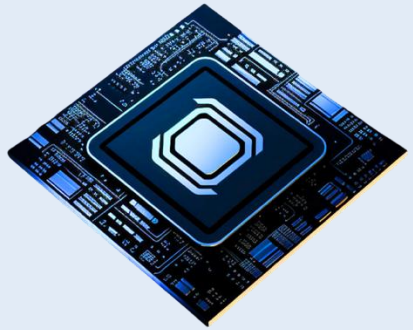
MADLab
(GaAs, GaN)




ANALOG DEVICES

2024-

SiP Lab
(CMOS, SOI
advanced packaging)



# Silicon Platforms Lab

PEOPLE

MACQUARIE University

SILICON PLATFORMS LAB

## Industry Professor Mike Boers

RF / mmWave
WiFi
Cellular
Satellite

## Senior Lecturer Jafar Shojaii

ASIC
CMOS
Rad Hard

## Admin Officer Shannah Gray Williams

# Silicon Platforms Lab

PEOPLE

MACQUARIE University

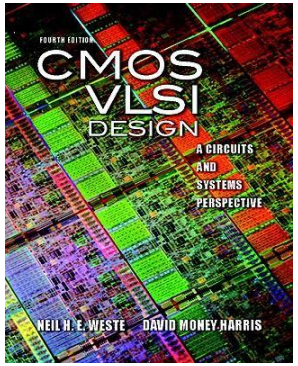
SILICON PLATFORMS LAB

## Adjunct Professor
## Neil Weste

AT&T Bell Laboratories

CISCO

Morse Micro




ASIC
CMOS
Digital Design
RF / mmWave

## Adjunct Professor
## David Skellern (AO)

NICTA

ASIC
CMOS
GaN/GaAs
Satellite

# Silicon Platforms Lab

PEOPLE

MACQUARIE University

SILICON PLATFORMS LAB

**Senior Principal Engineer**
**Lead Systems Architect**
**Ric d berg**

RF / mmWave
Cellular
DSP, DPD

**Lead Digital Engineer Hiring**

**Lead HW Engineer Hiring**

**Lead ASIC/AMS Engineer Hiring**

# We are hiring

PEOPLE

MACQUARIE University

SILICON PLATFORMS LAB



**You!**

## 7 Open Positions + HDR Roles

- Digital Backend Engineer
- Layout Engineer
- Lead Analogue/Mixed Signal Engineer
- Lead Digital Engineer
- Lead Hardware Engineer
- Research Fellow in High Performance Mixed Signal CMOS Design
- Senior Software Engineer
- Masters + PhD scholarships

## Learn More

https://www.mq.edu.au/faculty-of-science-and-engineering/our-research/silicon-platforms-lab

# Focus areas

- Communications and sensing systems using chiplets and advanced packaging – with a focus on SW driven efficient design
- Training the next generation of integrated circuit design engineers
- Supporting research teams and startups that require integrated circuits
  - Biotechnology
  - Quantum sensing and compute
  - Photonics

# Why now?

- Integrated circuits power all advanced technology
- Critical technologies and Defence rely on them
- New era of scaling using heterogenous integration provides a good entry point
- Opportunity for new highly efficient SW driven design flows
- Huge market opportunity

# How to work with us

- Research collaboration
- Support for early-stage start-ups and University spin-outs
- Research and design services for industry
- Custom ASIC design
- Student internships

# Thank You!

Contact
Mike Boers
m.boers@mq.edu.au

MACQUARIE University
SYDNEY·AUSTRALIA