

The Global Semiconductor Industry Financial Opportunities Forum

Raunak Onkar - June 2021

INDUSTRY HEADACHE

Can't Meet Demand

Reduced Production

SEMICONDUCTOR SHORTAGE

Factory Shutdown

Work Stoppage

Supply Chain Nightmare

BOTTLENECK

**How to understand this
sector?**

Understanding Semiconductors

- History & The Benefit of Hindsight
- Types of Semiconductor Businesses
 - Ecosystem of Vendors
- Chip Shortage
- Geo-politics of Chip Manufacturing
- Outlook for India

**BEWARE
OF**

**WELL...
JUST
BEWARE**

Beware

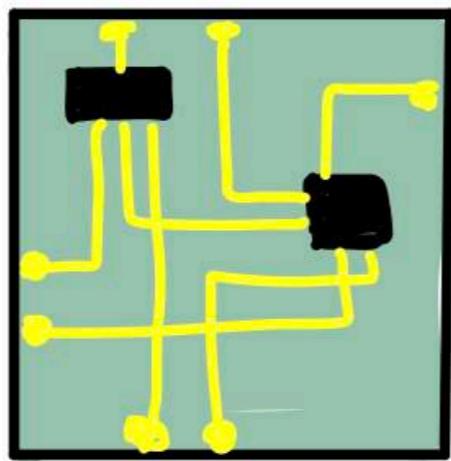
- “Slight” Oversimplification
- Limited coverage of Semiconductor Industry
- Extremely Technical Design & Manufacturing
- Simple Business Models
- Difficult to Map Future Winners / Losers
- Difficult to Map Capital Cycle

History & The Benefit of Hindsight

SILICON
TRANSISTOR



INTEGRATED
CIRCUITS

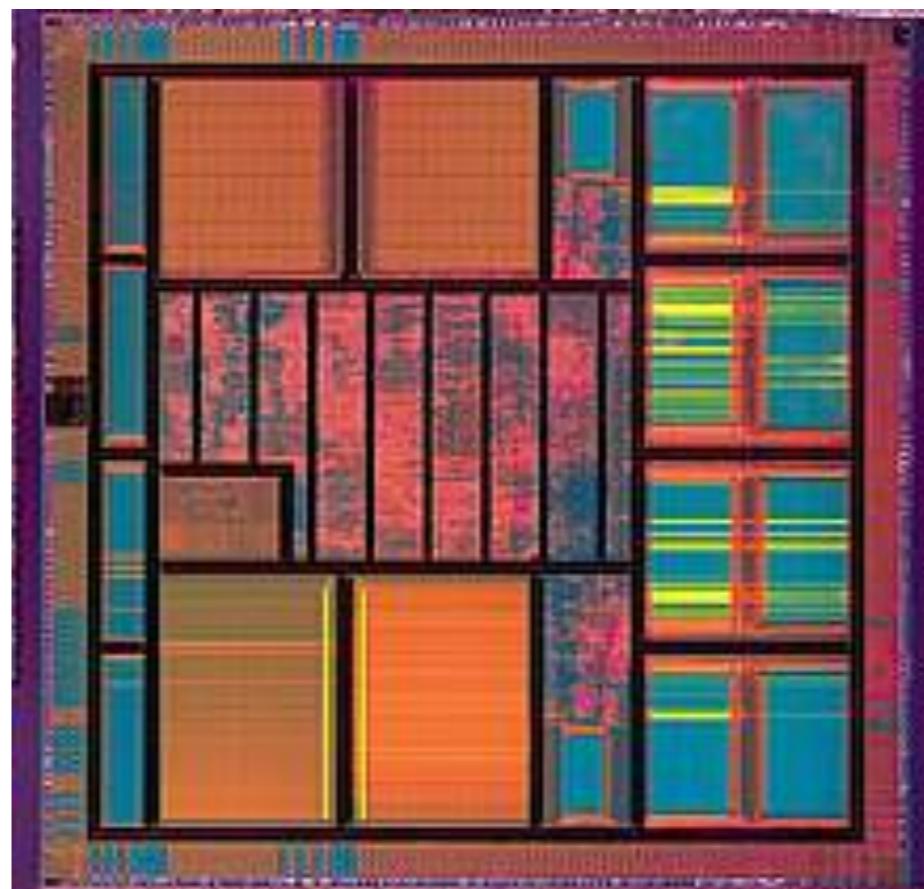


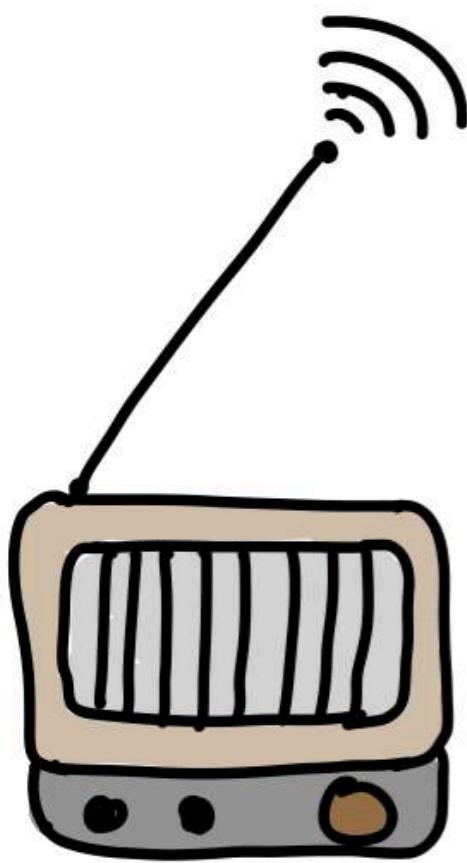
1947

1958

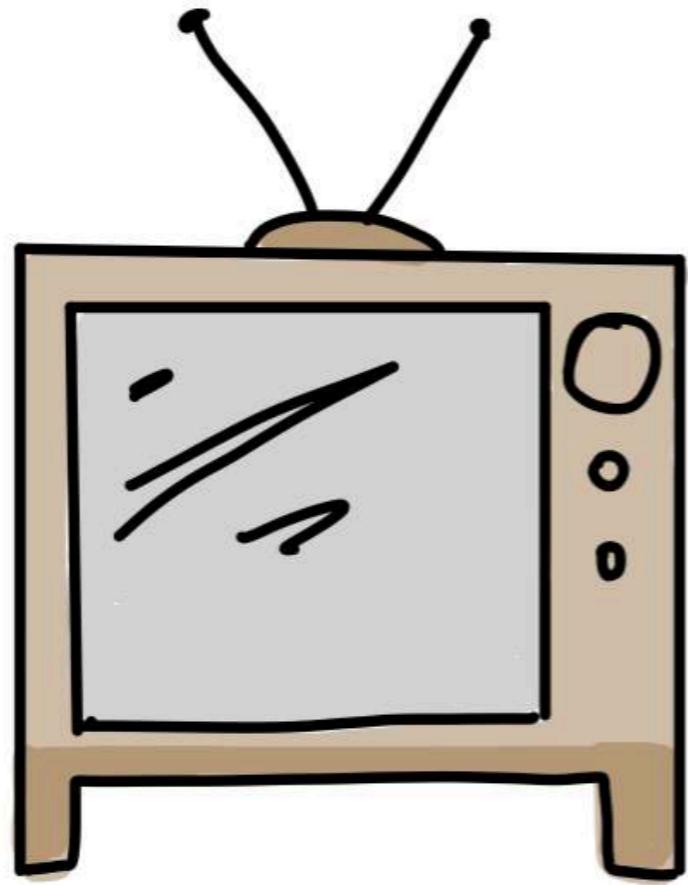
1970's - - - 2010's →

SCALED
INTEGRATION

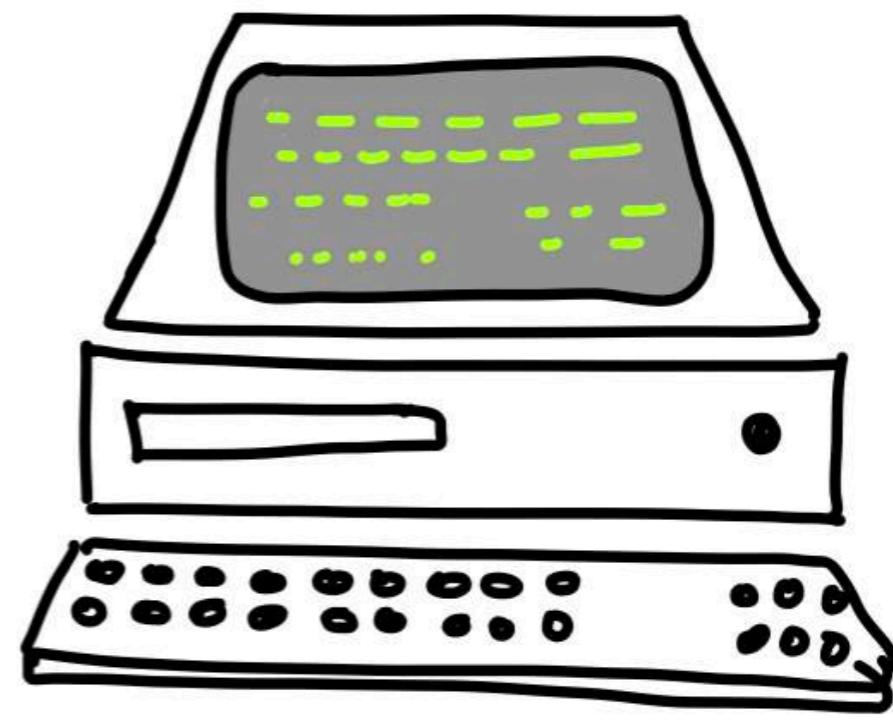




1950's

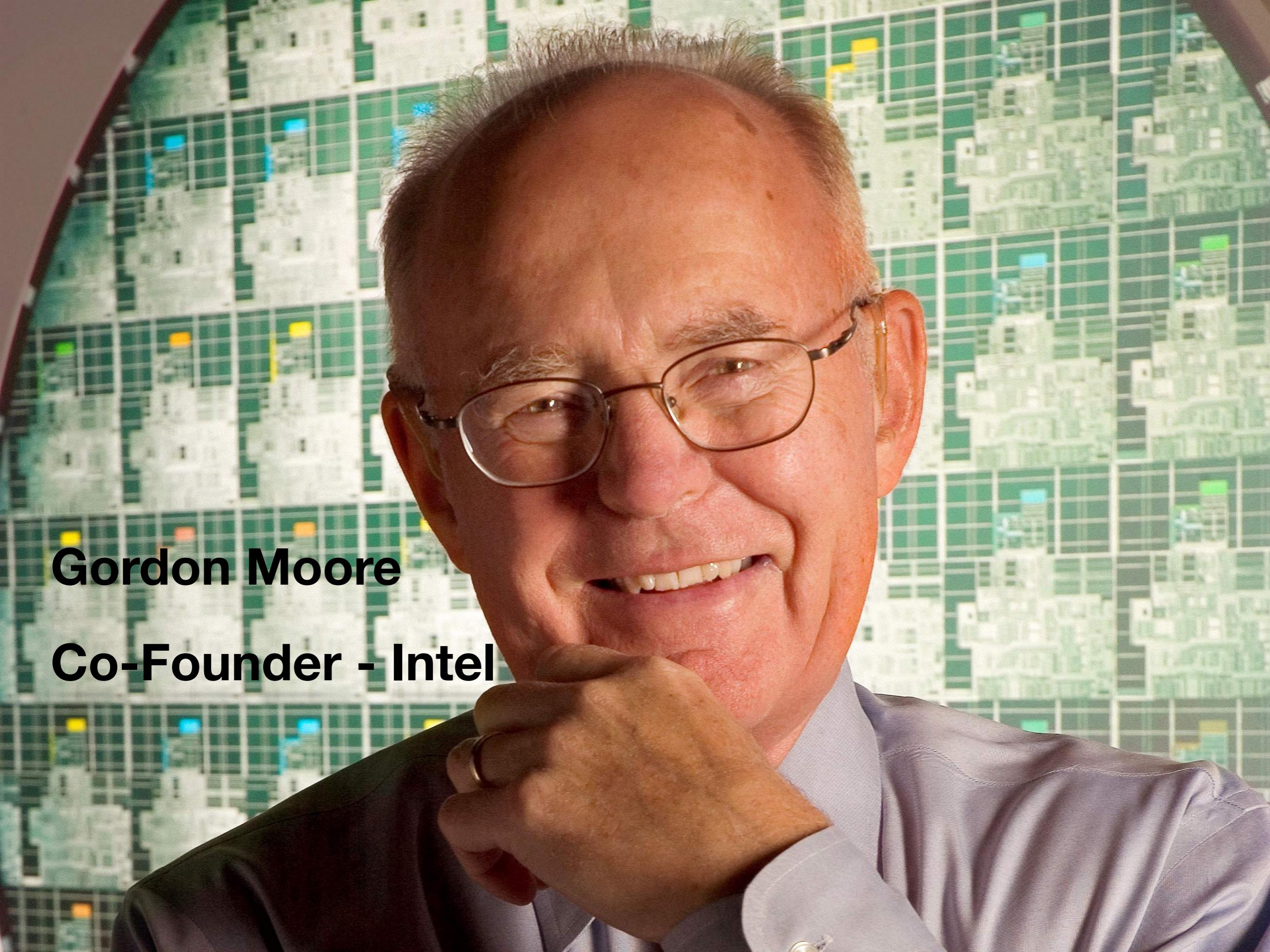


1960's



1970's - - - -

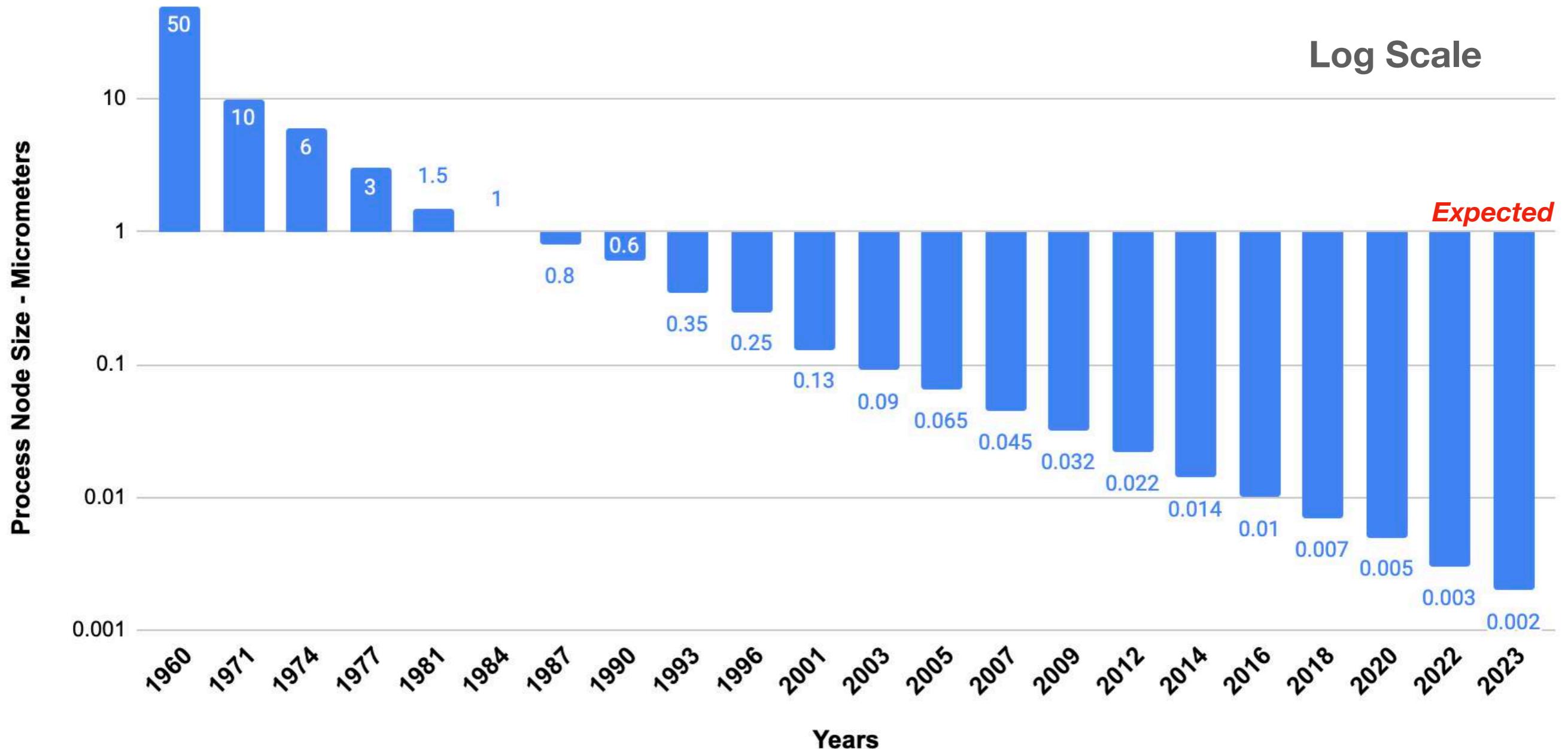


A close-up portrait of Gordon Moore, co-founder of Intel. He is wearing glasses and a light-colored shirt, smiling slightly. The background is a dense, green and white grid pattern, likely representing a microchip or circuit board.

Gordon Moore
Co-Founder - Intel

More Transistors Compressed on a single chip over time

1 CM = 1000 Micrometers

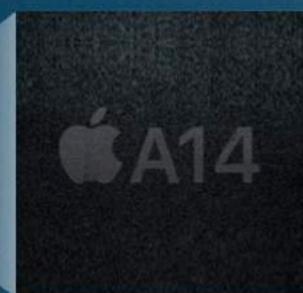


Source: wikichip.org

Zooming in on Smartphone Chip Transistors

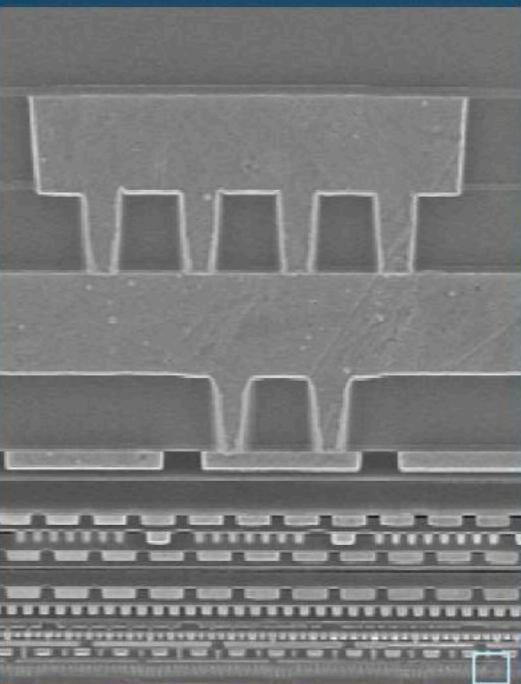


Source: Apple



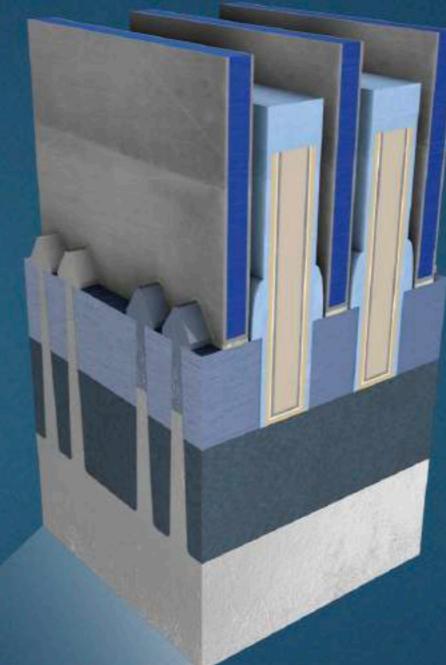
Source: Apple

Processor chip: 88mm² size
8.57 mm x 10.23 mm



Source: TechInsights

Microscope cross section view of chip



3D model of a transistor and contacts

5nm
technology node

>11.8 billion
transistors

>24 billion
contacts

7 threshold voltages
HPC and mobile compute

• V_T Threshold voltage

Applied Materials External Use

APPLIED
MATERIALS®

Source: Applied Materials

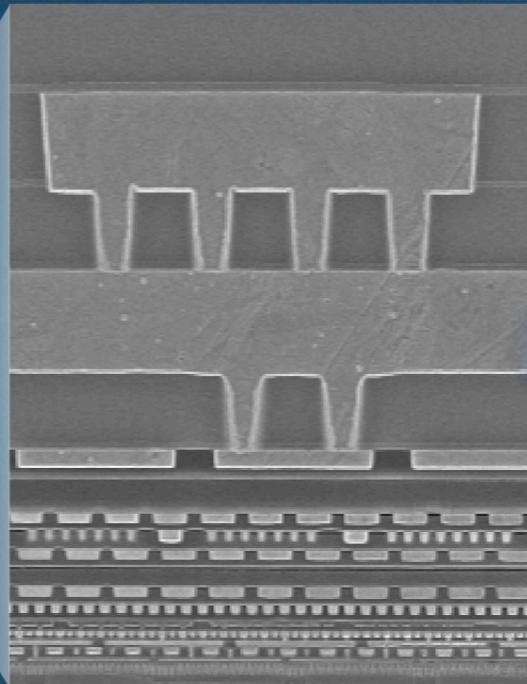
Zooming in on Smartphone Chip Interconnects



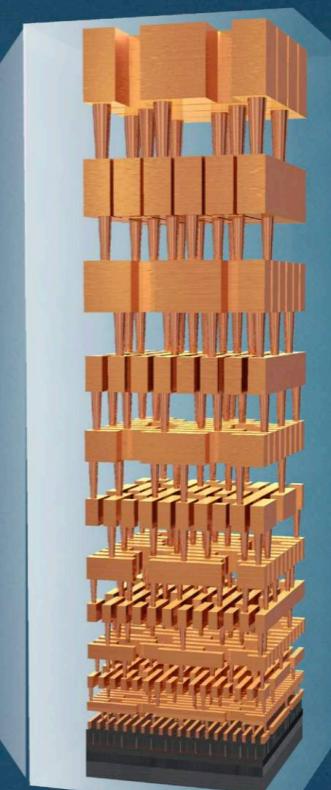
Source: Apple



Source: Apple
Processor chip: 88mm² size
8.57 mm x 10.23 mm



Source: TechInsights
Microscope cross section view of chip



3D model of a chip

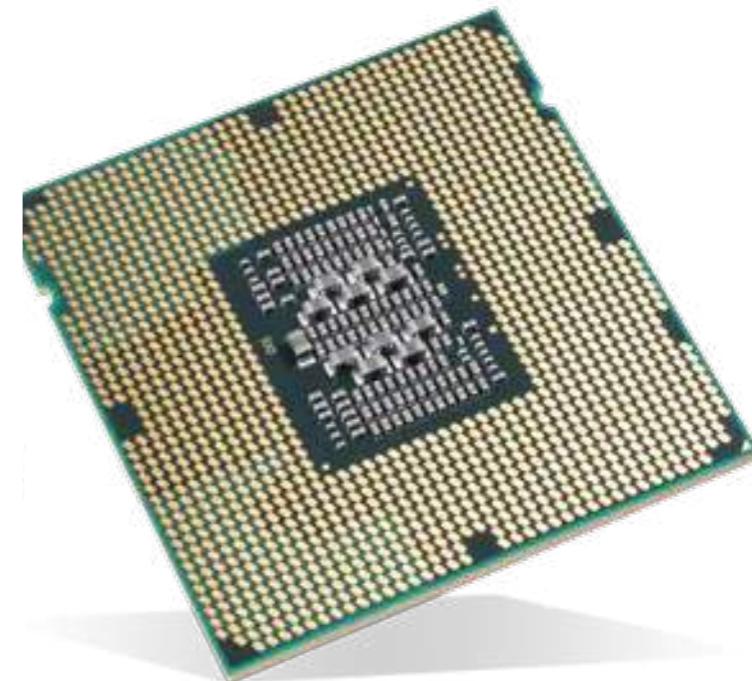
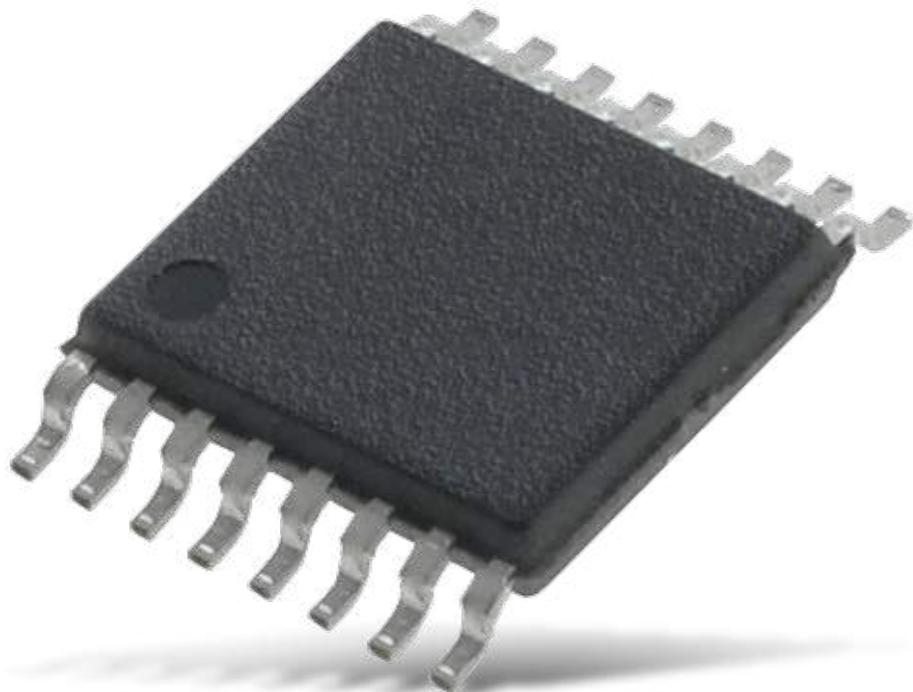
>15 layers
stacked copper interconnects

>24 billion
contact trench and via connections

>11.8 billion
transistors

\$

\$\$\$\$



 **TEXAS
INSTRUMENTS**



**ANALOG
DEVICES**



ANALOG

MIXED

DIGITAL

Data Generation By Category (ZB)



SEMI GROWTH NO LONGER LIMITED BY HUMAN CONSUMPTION

Source: Applied Materials

Applied Materials External Use



Source: *Applied Materials*

| Semi content per unit | 2015 | 2020 | 2025F | |
|---|---------|---------|---------|------|
|  HIGH END SMARTPHONE | \$100 | \$170 | \$275 | +62% |
|  AUTO (GLOBAL AVERAGE) | \$310 | \$460 | \$690 | +50% |
|  DATACENTER SERVER (CPU + ACCELERATOR) | \$1,620 | \$2,810 | \$5,600 | +99% |
|  SMARTHOMA (GLOBAL AVERAGE) | \$2 | \$4 | \$9 | |

SILICON CONTENT GROWING AS EVERYTHING GETS SMARTER

Source: Applied Materials

Applied Materials External Use



Source: *Applied Materials*

Technologies Involved In Chip Making...

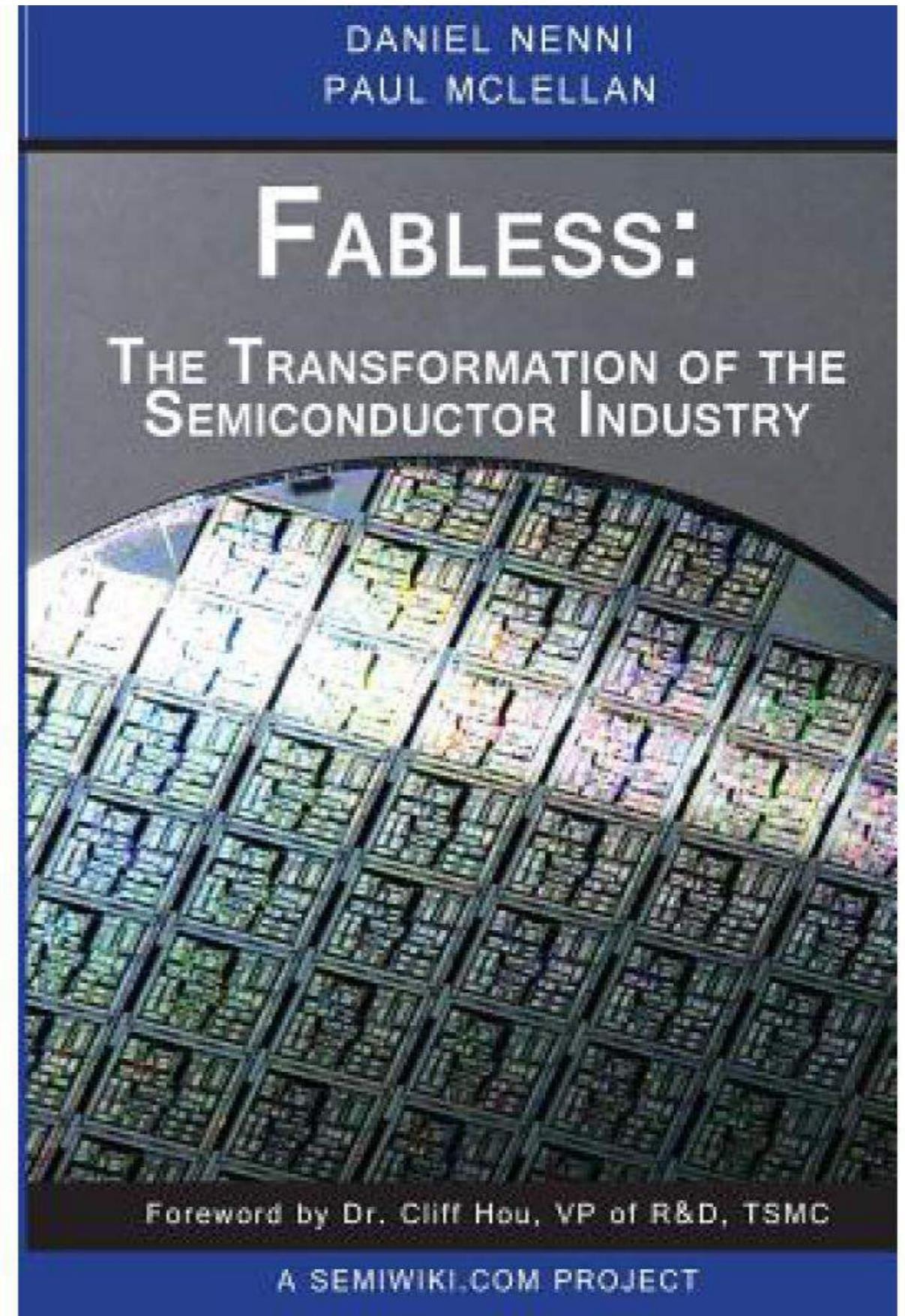
- Material Science
- Optics
- Microelectronics
- Computer Aided Design & Manufacturing
- Extreme Air Filtration HVAC
- Seismic Technology
- Advanced Packaging & Testing

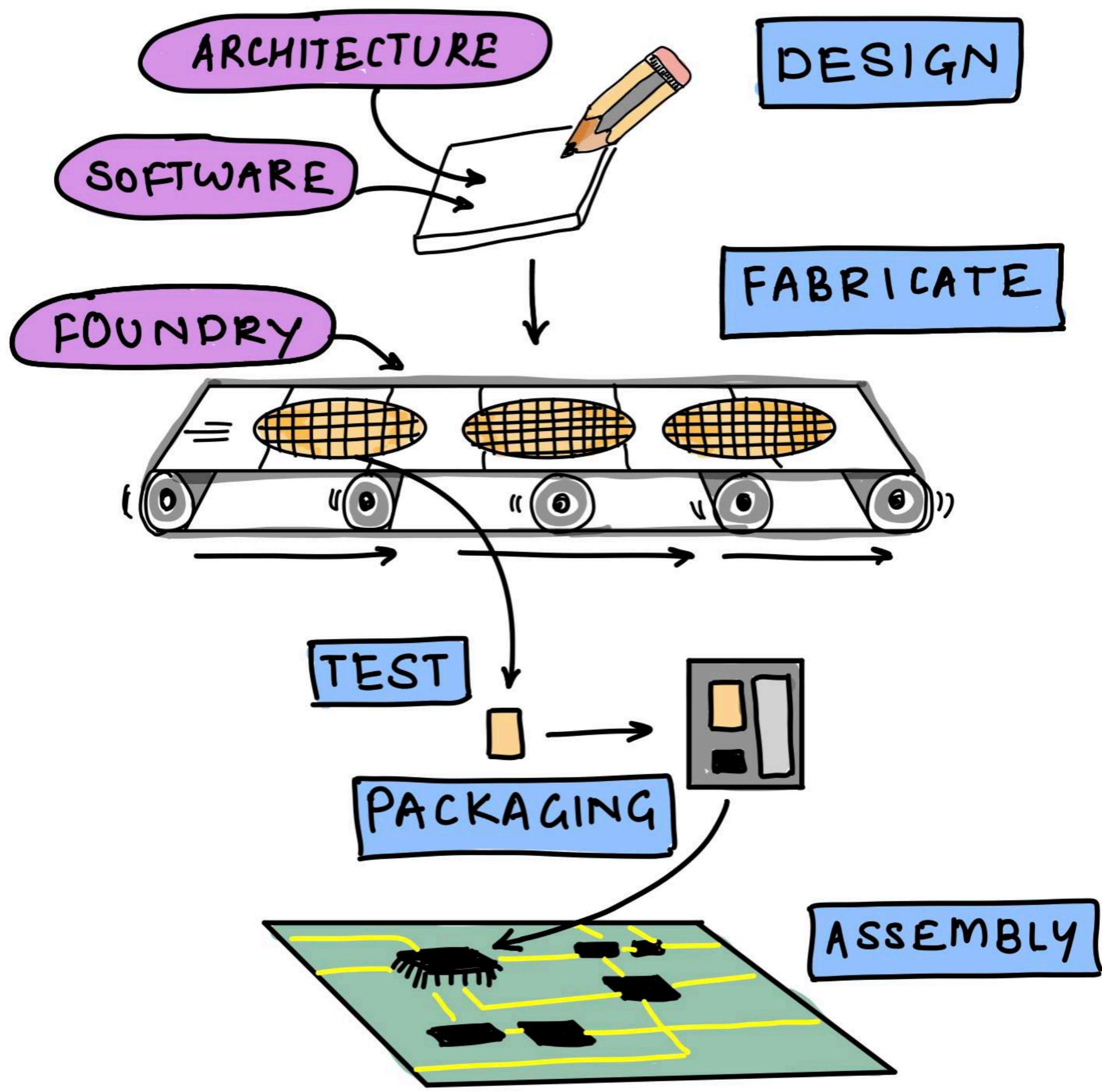
The Semiconductor Ecosystem

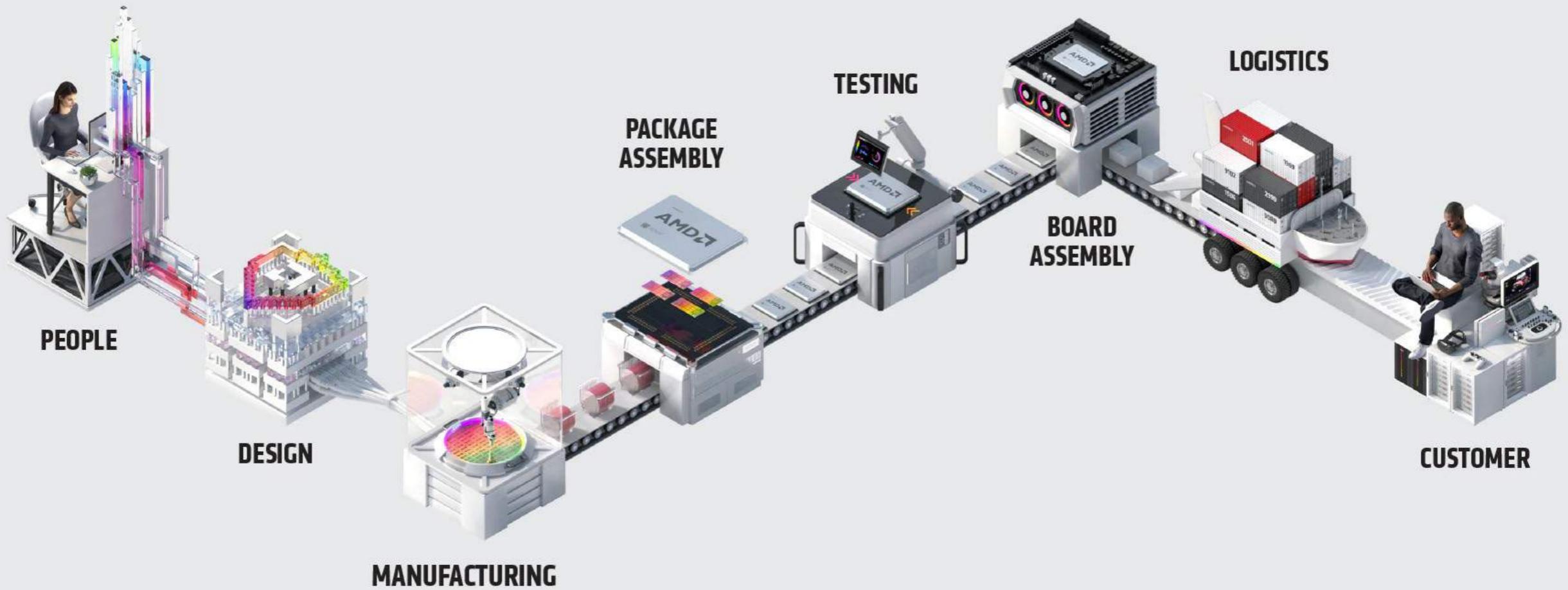
Fabless

The Transformation of the Semiconductor Industry

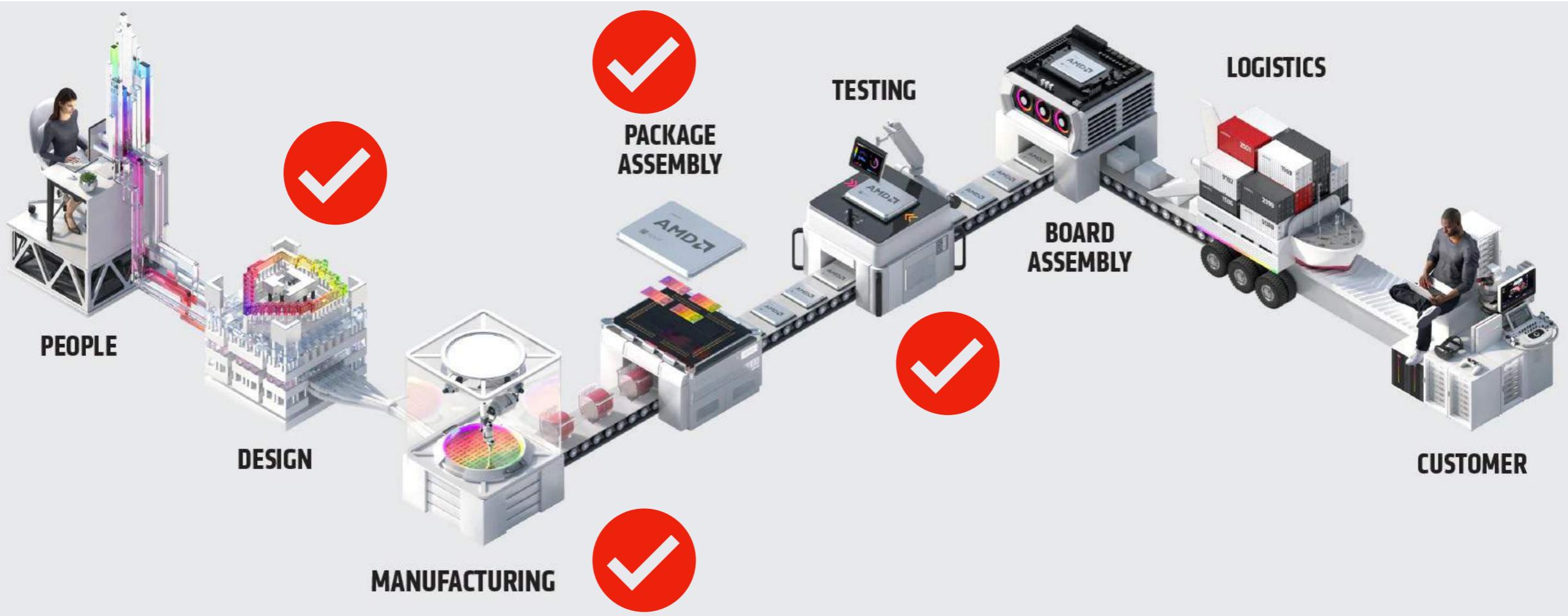
- Daniel Nenni
- Paul Mclellan
- <https://semiwiki.com/>







Source: AMD



Source: AMD

Integrated Device Manufacturer

Design



Source: AMD

Who are the Chip Designers?

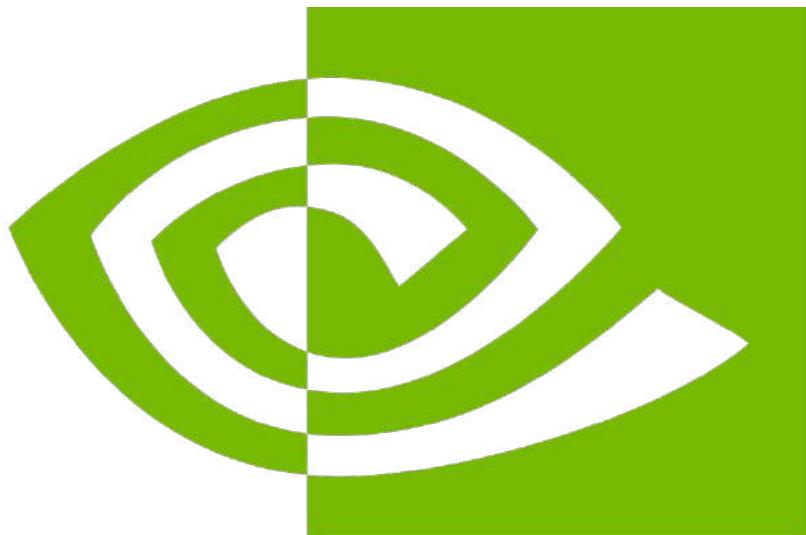
intel[®]

Qualcomm

AMD

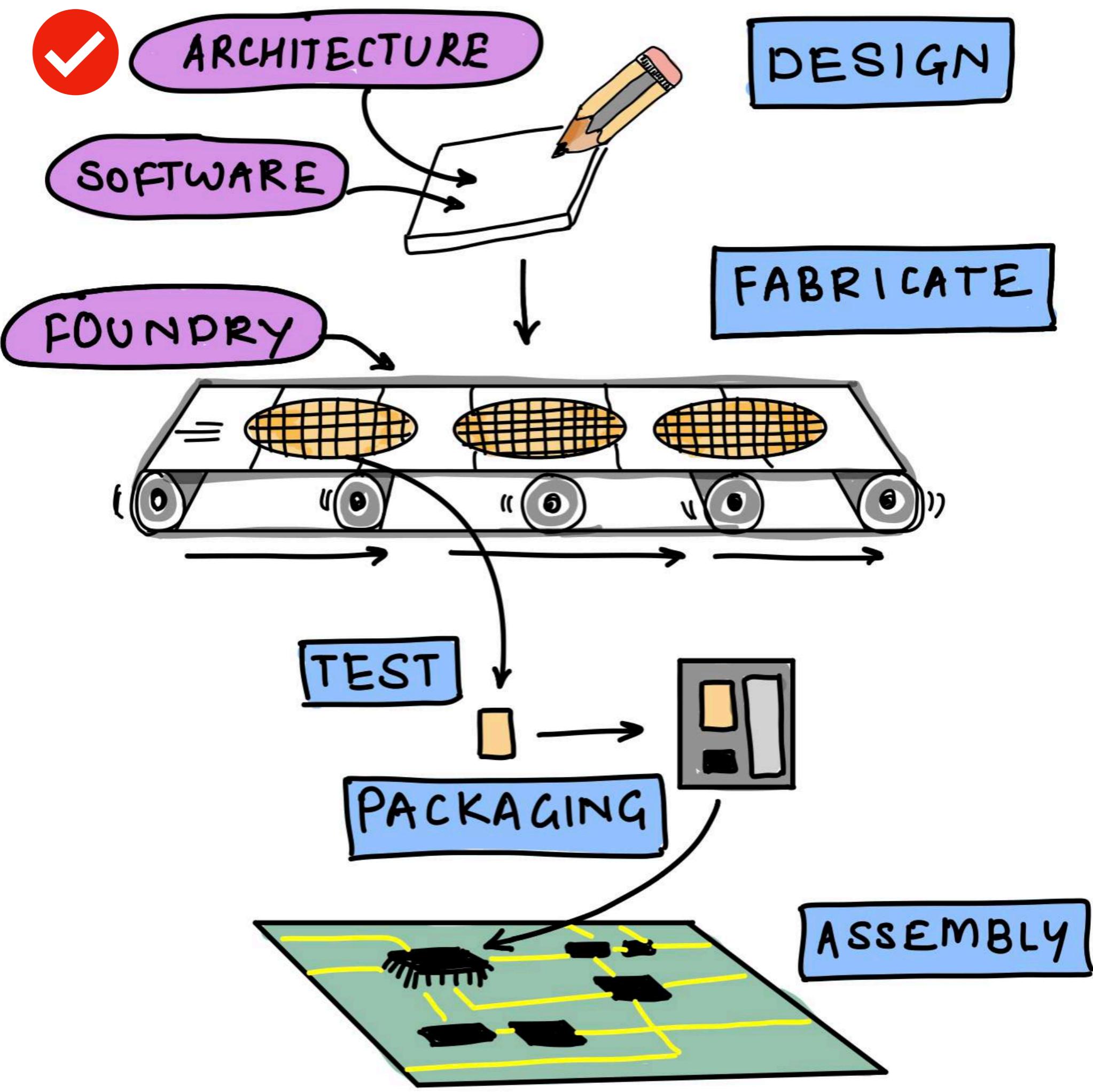
MEDIATEK

 **BROADCOM[®]**



nVIDIA[®]





How do they Design?

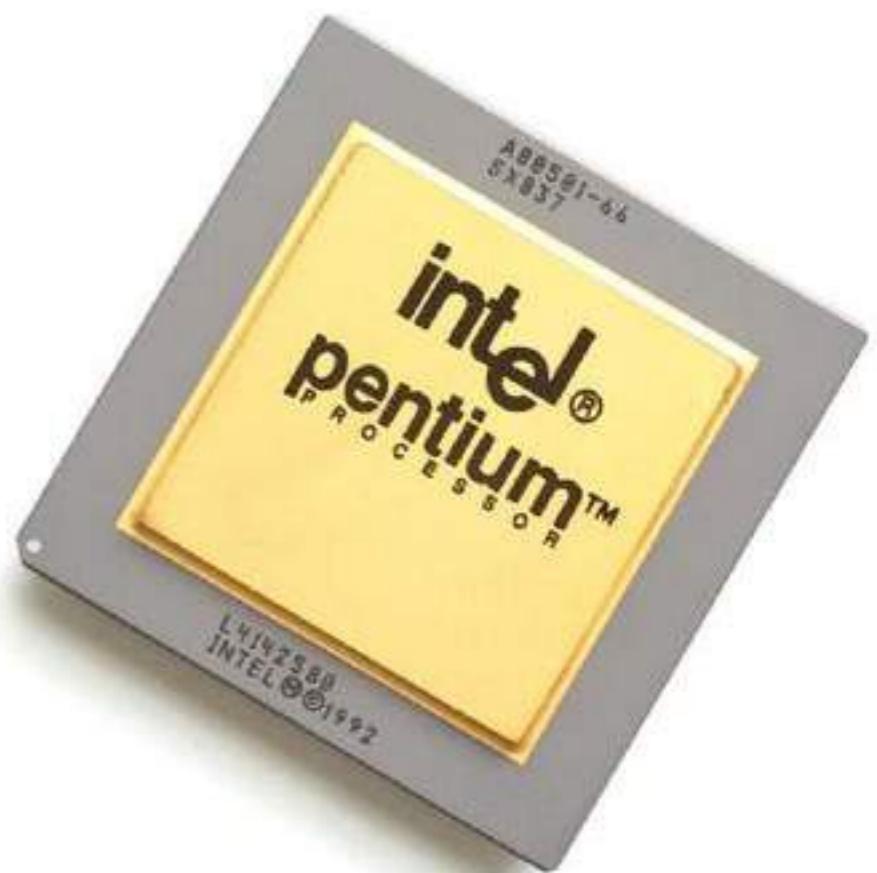
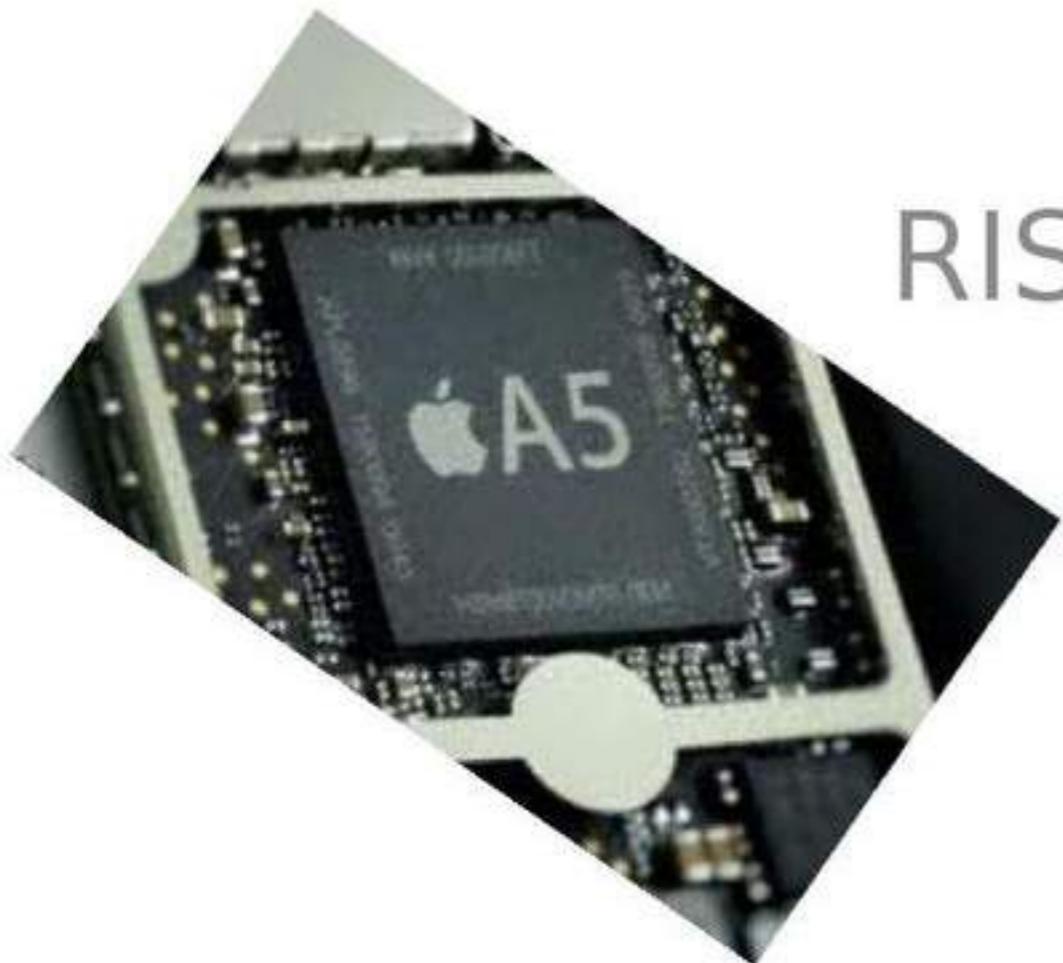


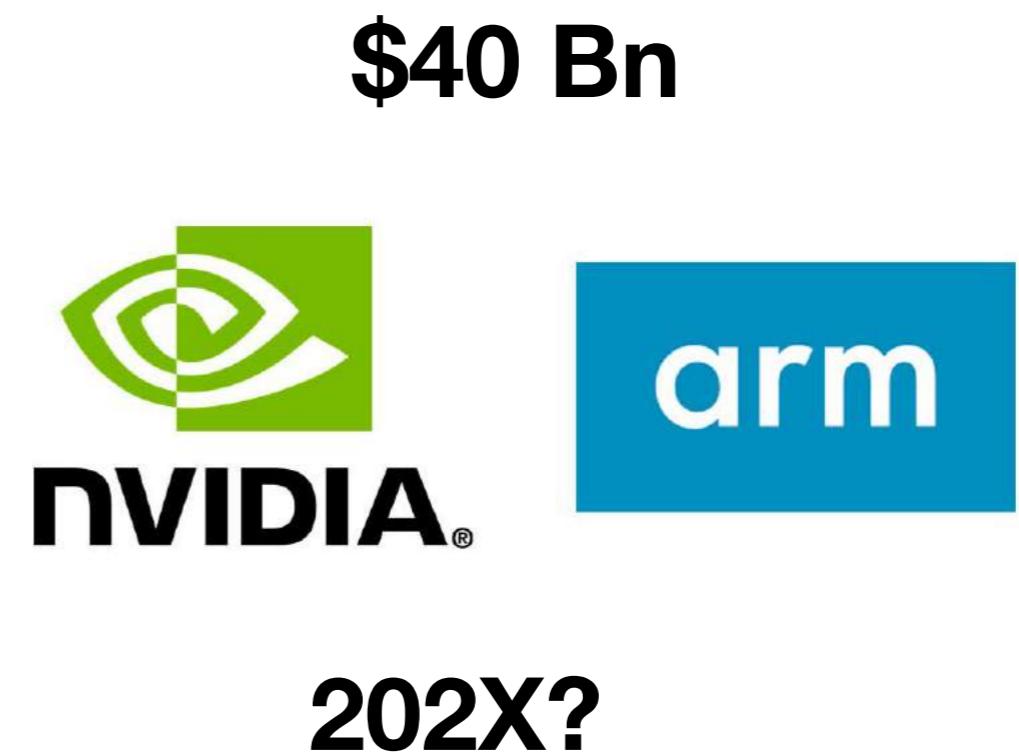
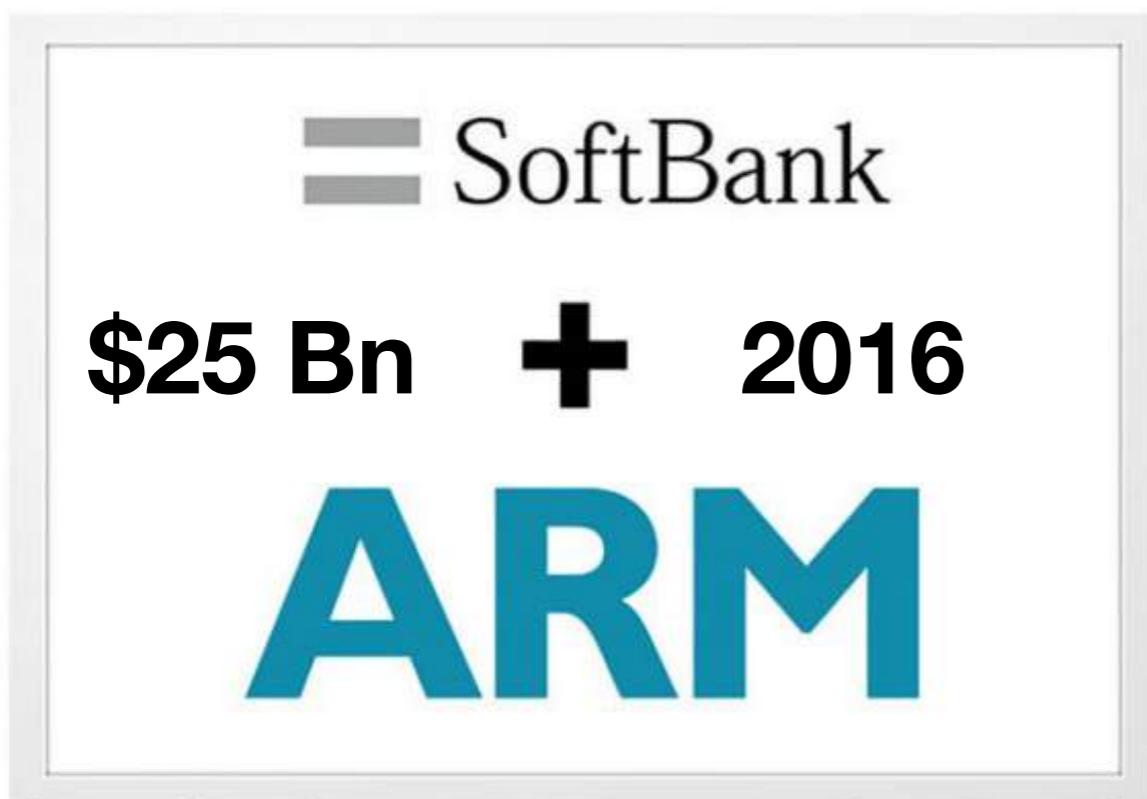
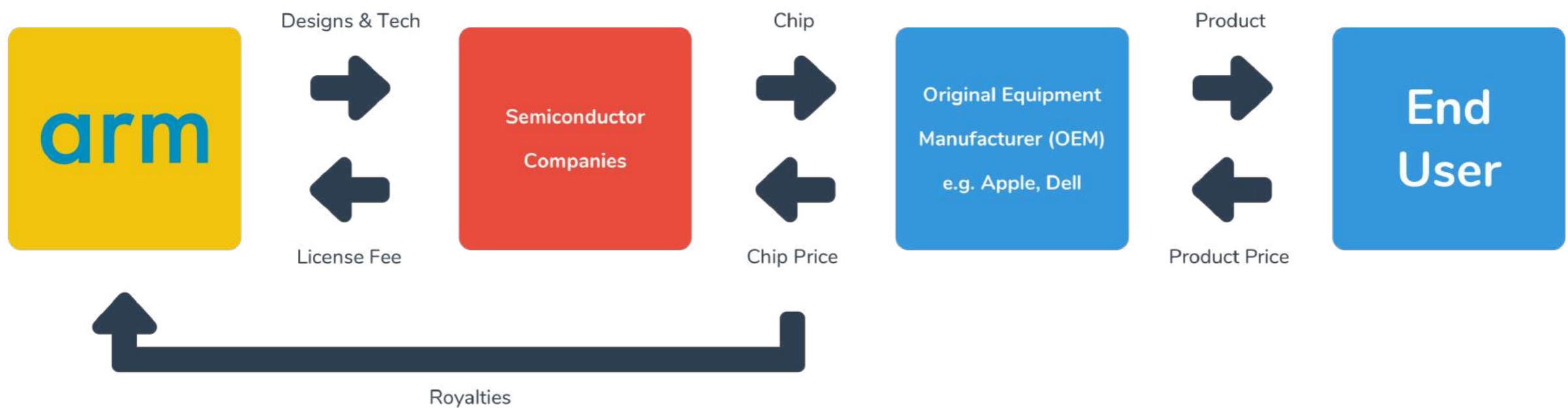
Source: AMD

1 - Architecture

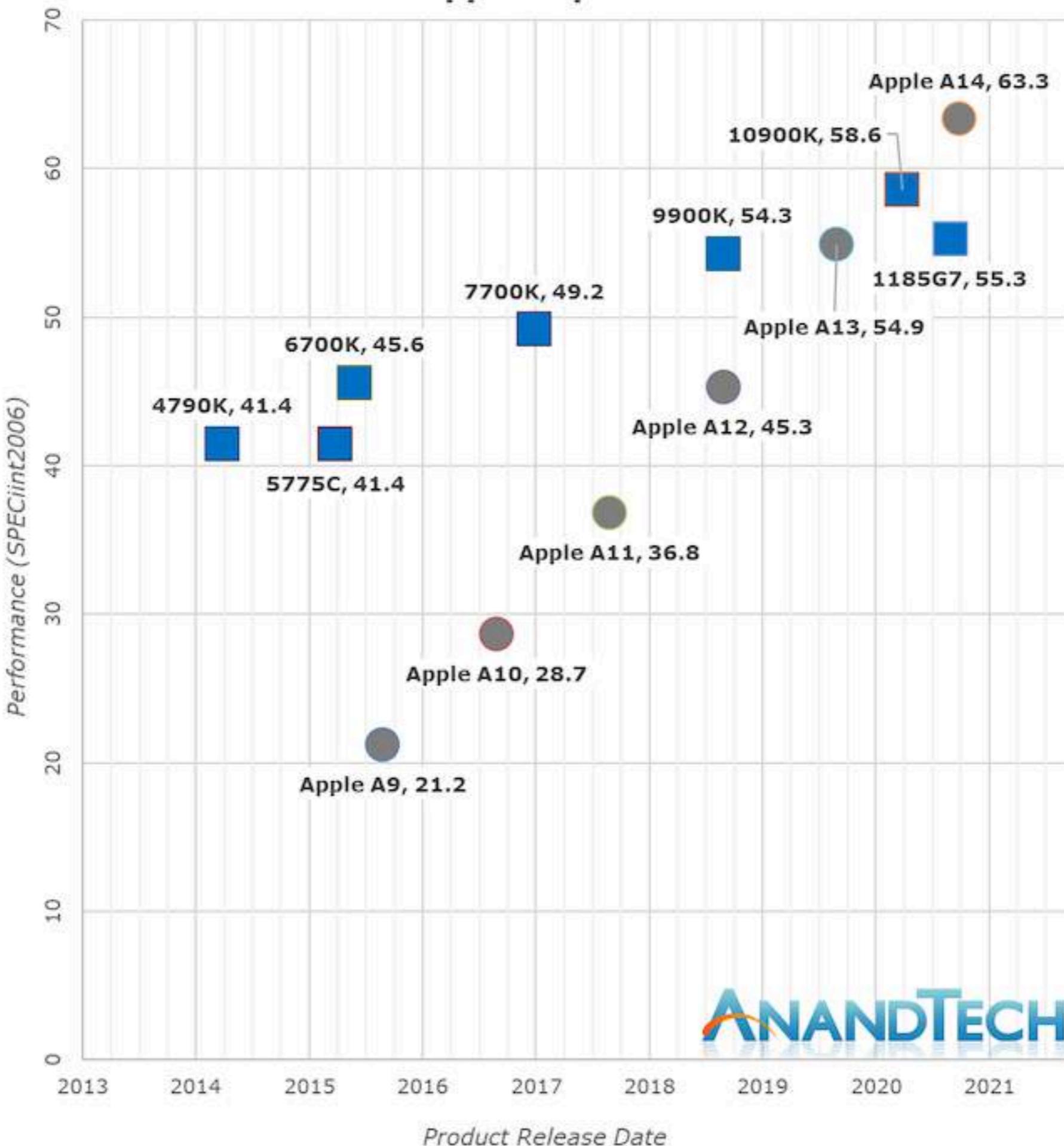
Types of CPU

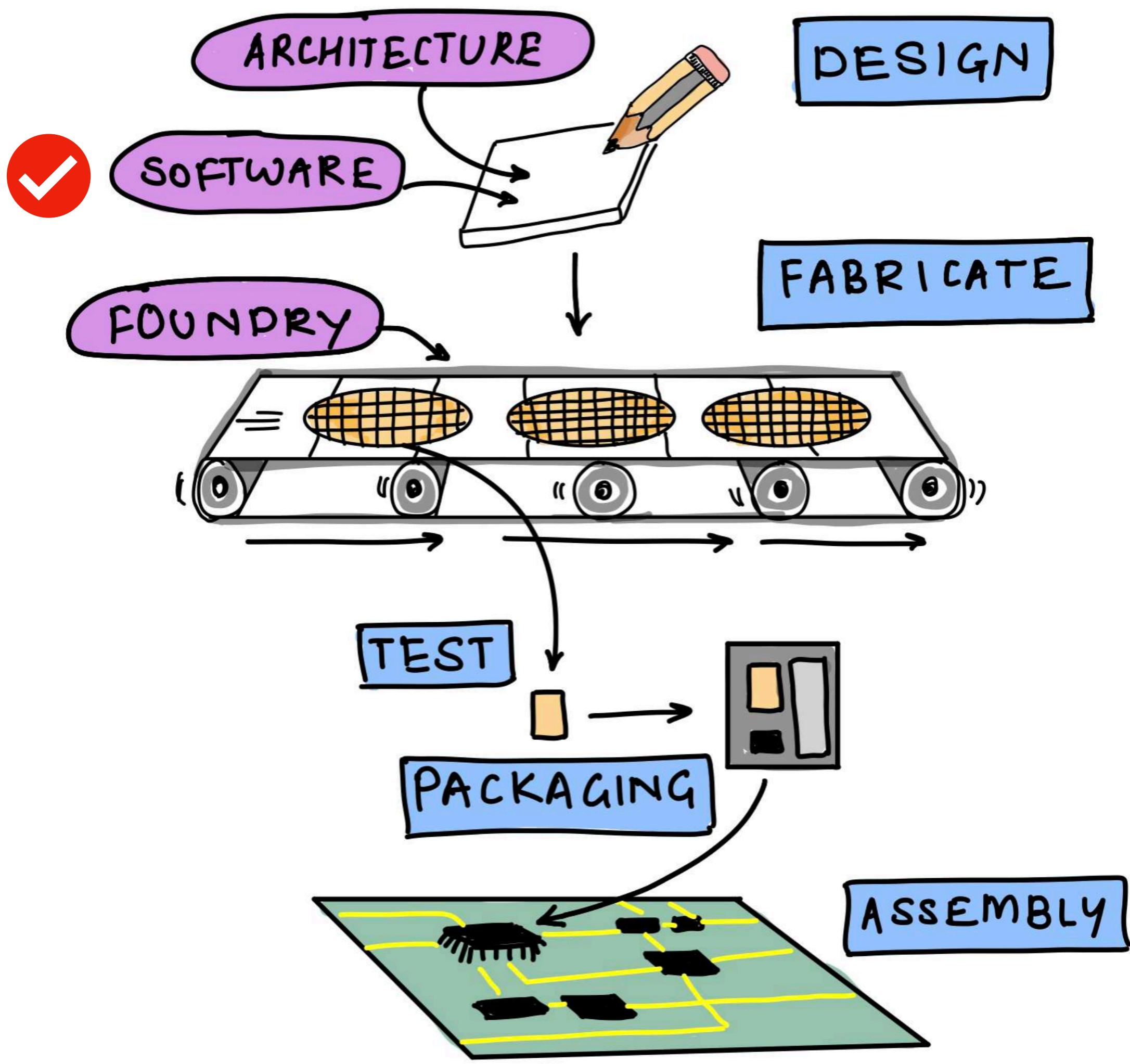
RISC vs CISC





Intel vs Apple Top Performance





How do they Design?

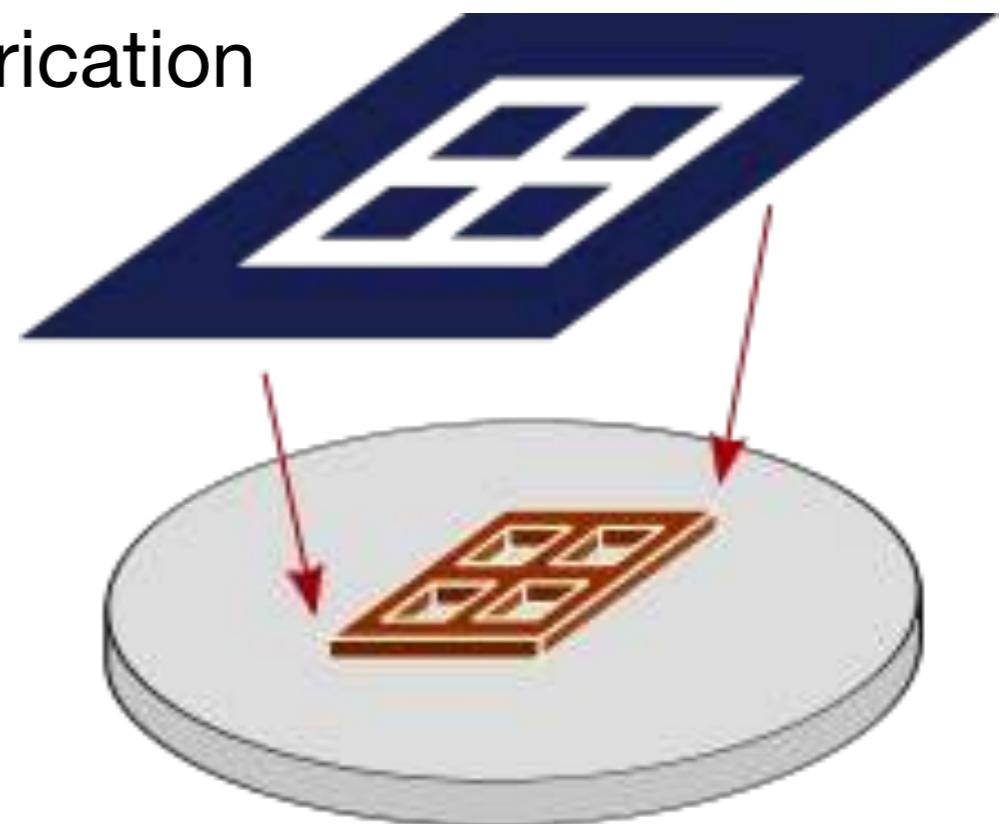


Source: AMD

2 - Electronic Design Automation (EDA)

What do Design Companies do?

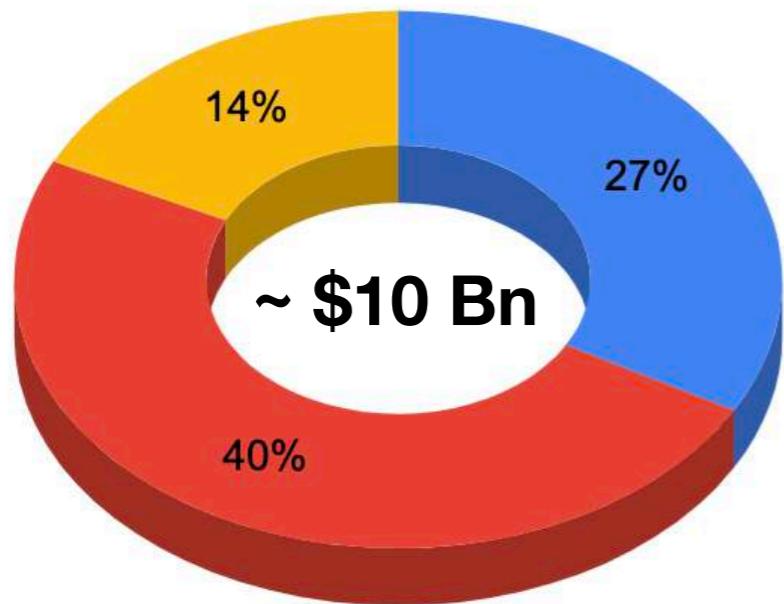
- Softwares help in Designing the chip
- Simulate the behaviour & performance of the chip
- Analyse & Verify if chip performance is optimal
- Prepare a ***photomask*** to send for fabrication



cadence

SYNOPSYS®

Siemens EDA, Cadence & Synopsys Market Share

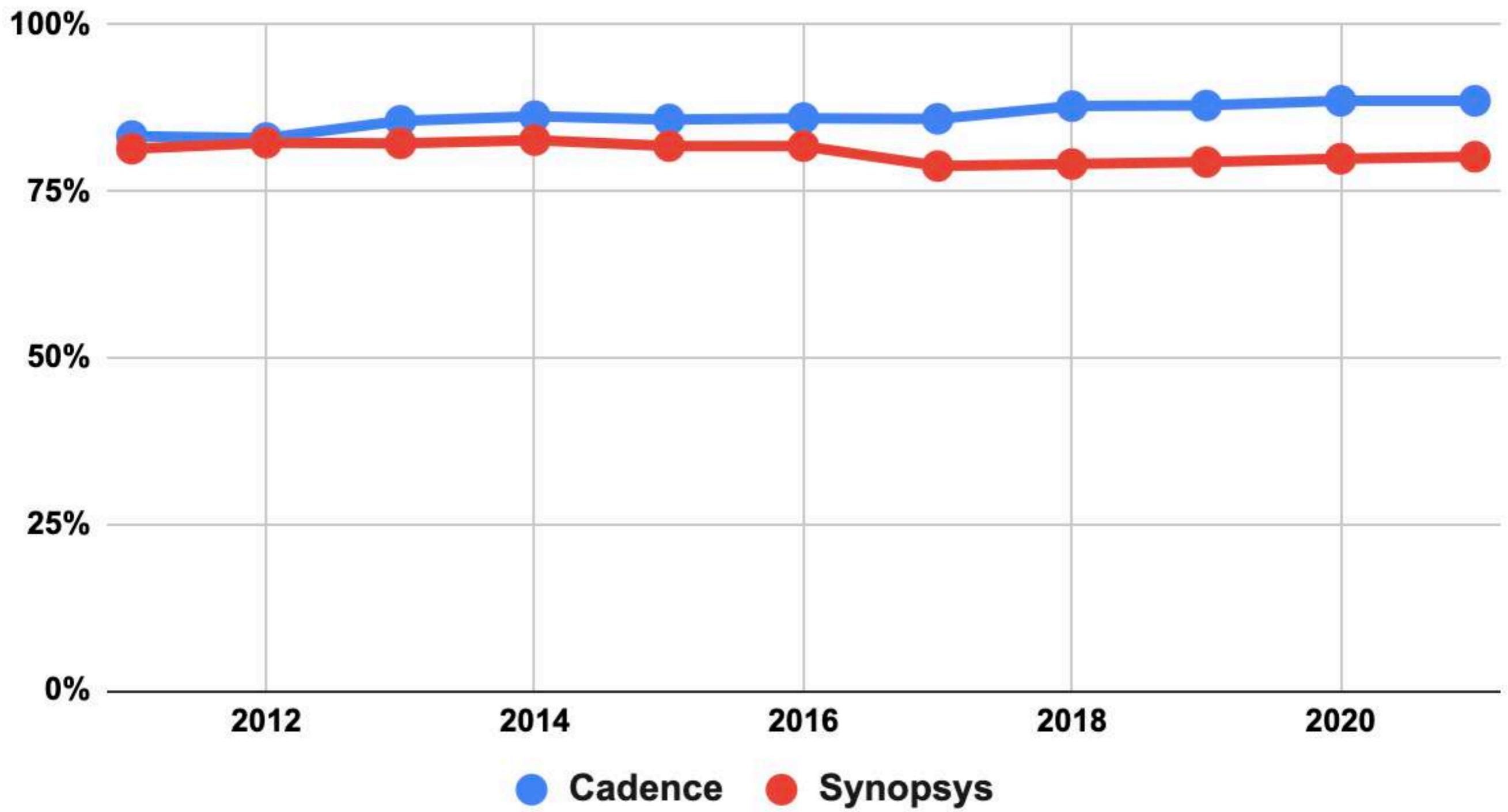


Mentor
Graphics®

SIEMENS

Source: Company Financials & Siemens EDA (estimates)

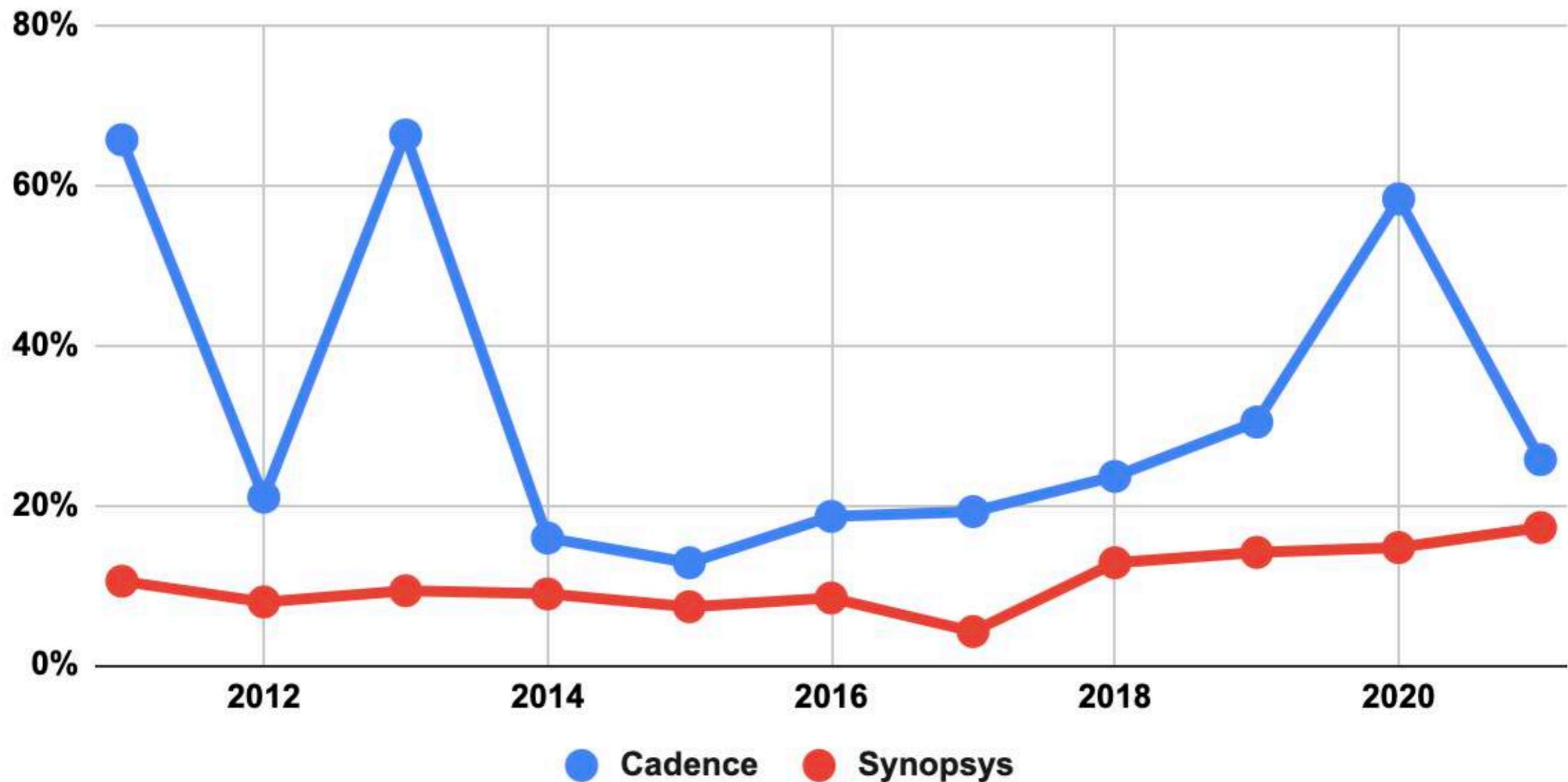
EDA Gross Margins (%)



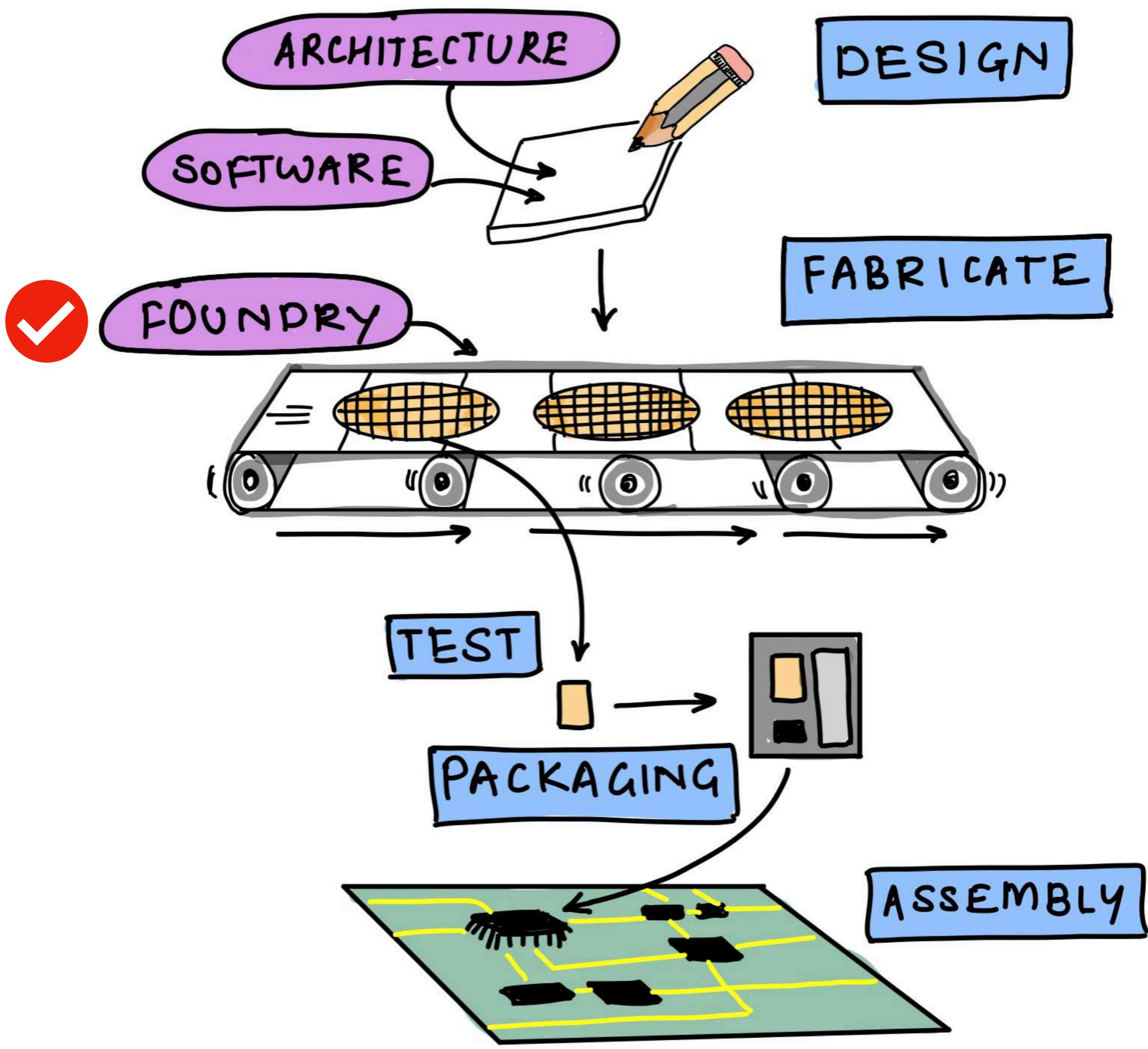
Source: Company Filings

EDA RoE (%)

Low Debt, Hi Margins, Hi Asset Turns



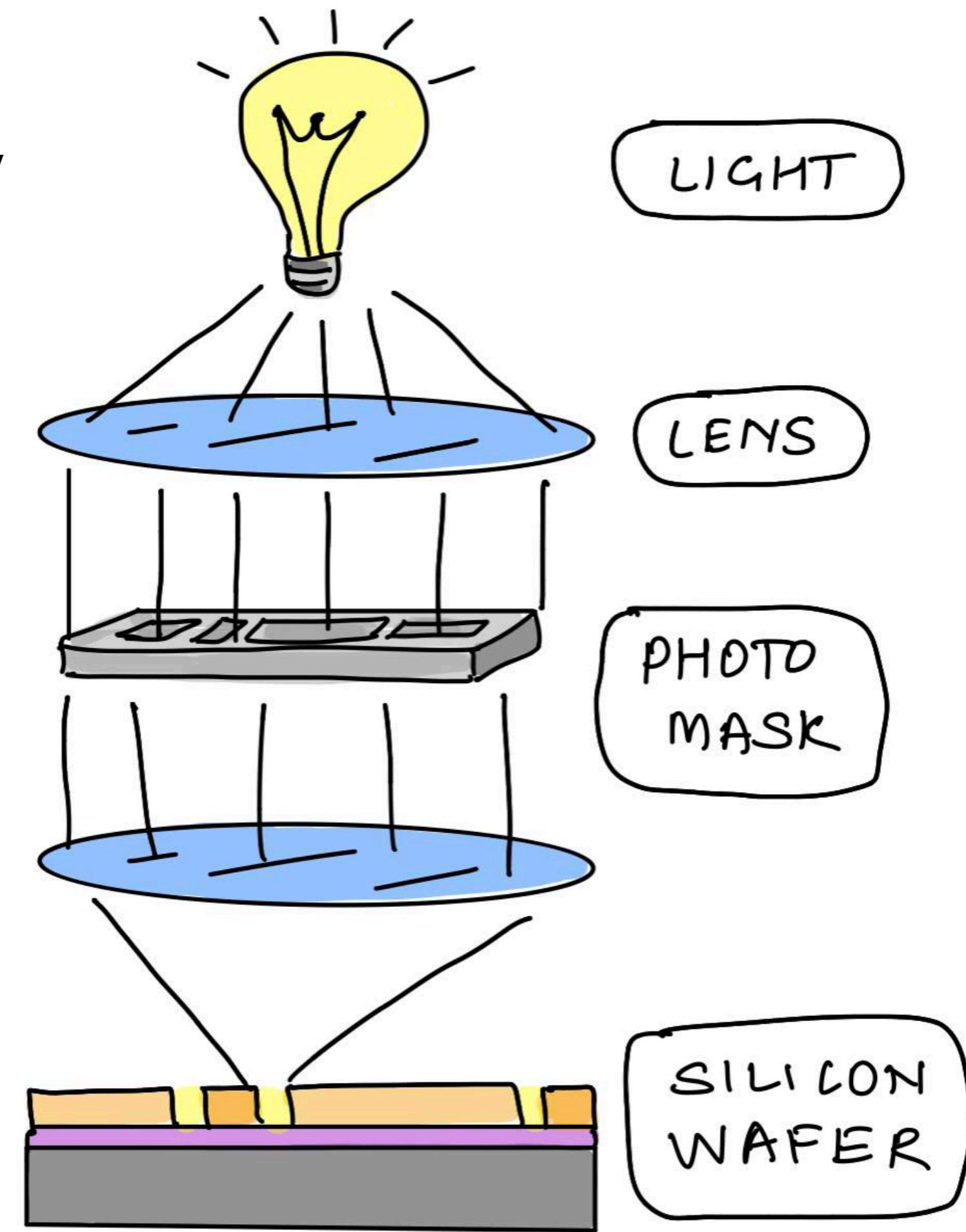
Source: Company Filings



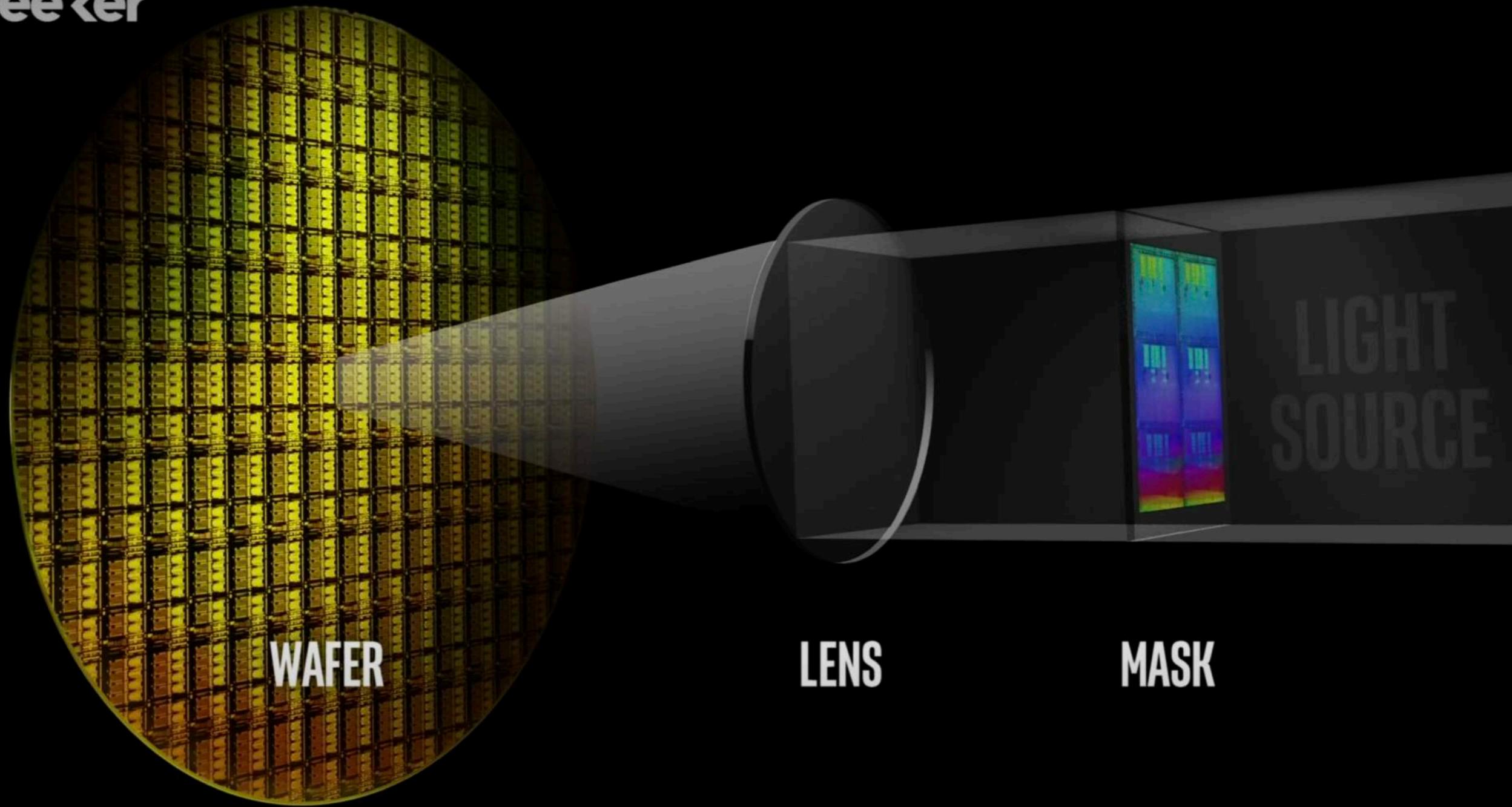




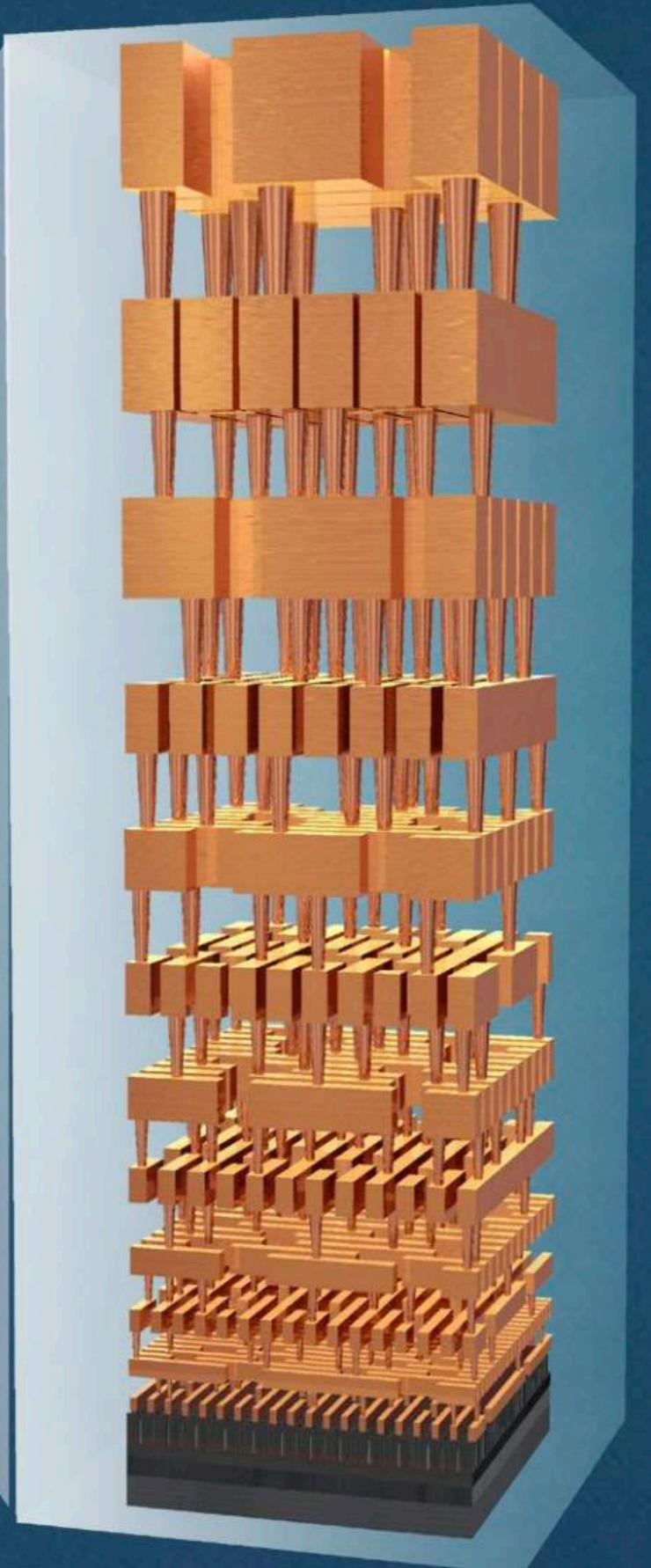
Photolithography



Seeker



Photolithography



3D model of a chip

> 15 layers
stacked copper interconnects

> 24 billion
contact trench and via connections

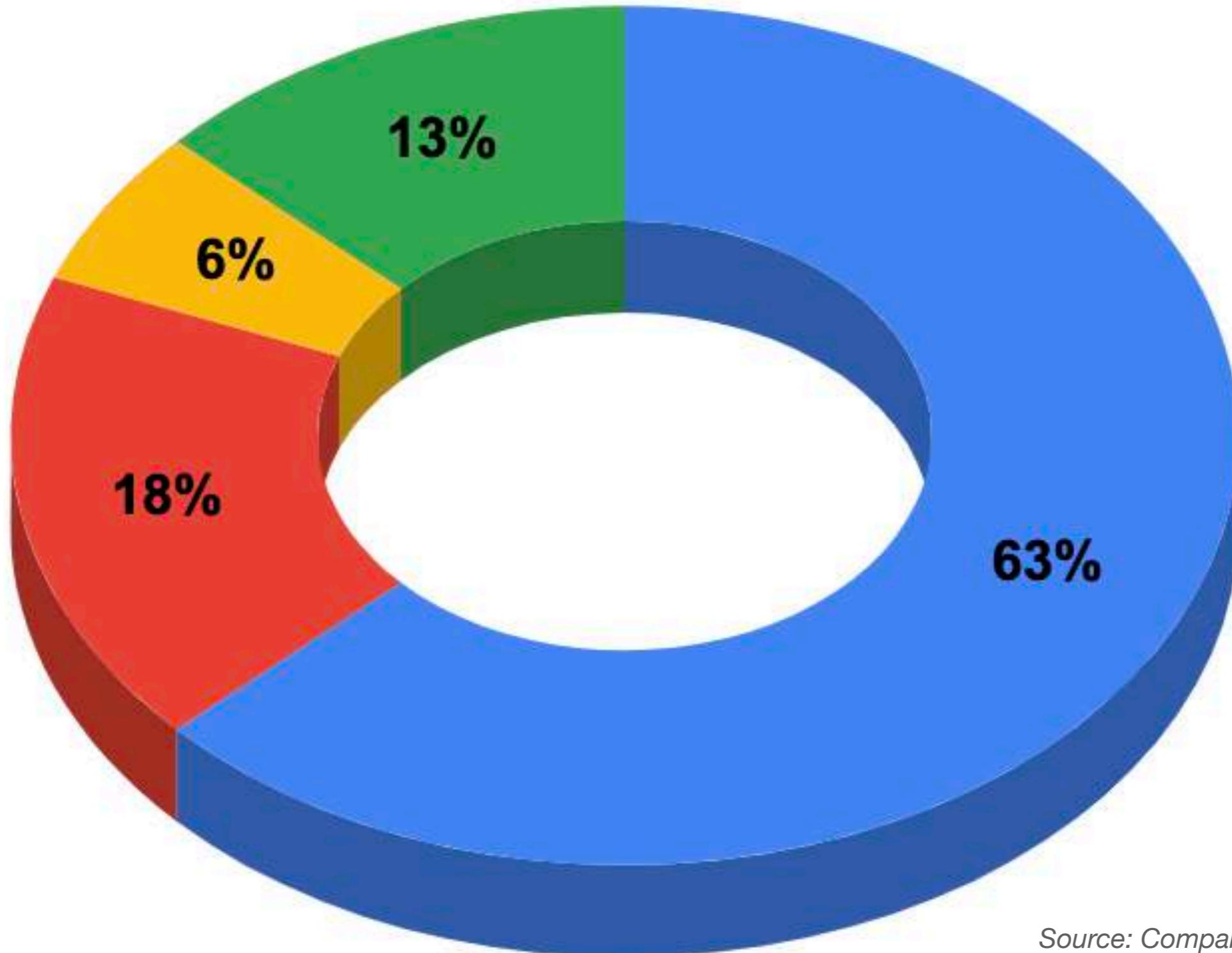
> 11.8 billion
transistors



Foundry Economics

Not for the faint hearted

- Heavy Capital Expenditure
 - Machines & other ancillary equipment
- Land
- Good quality power supply
- Large quantity of fresh water supply
- Skilled Labour
- Intense competition
- Pace of Technology Change
- Wild Capital Cycles in Commodity Semiconductors

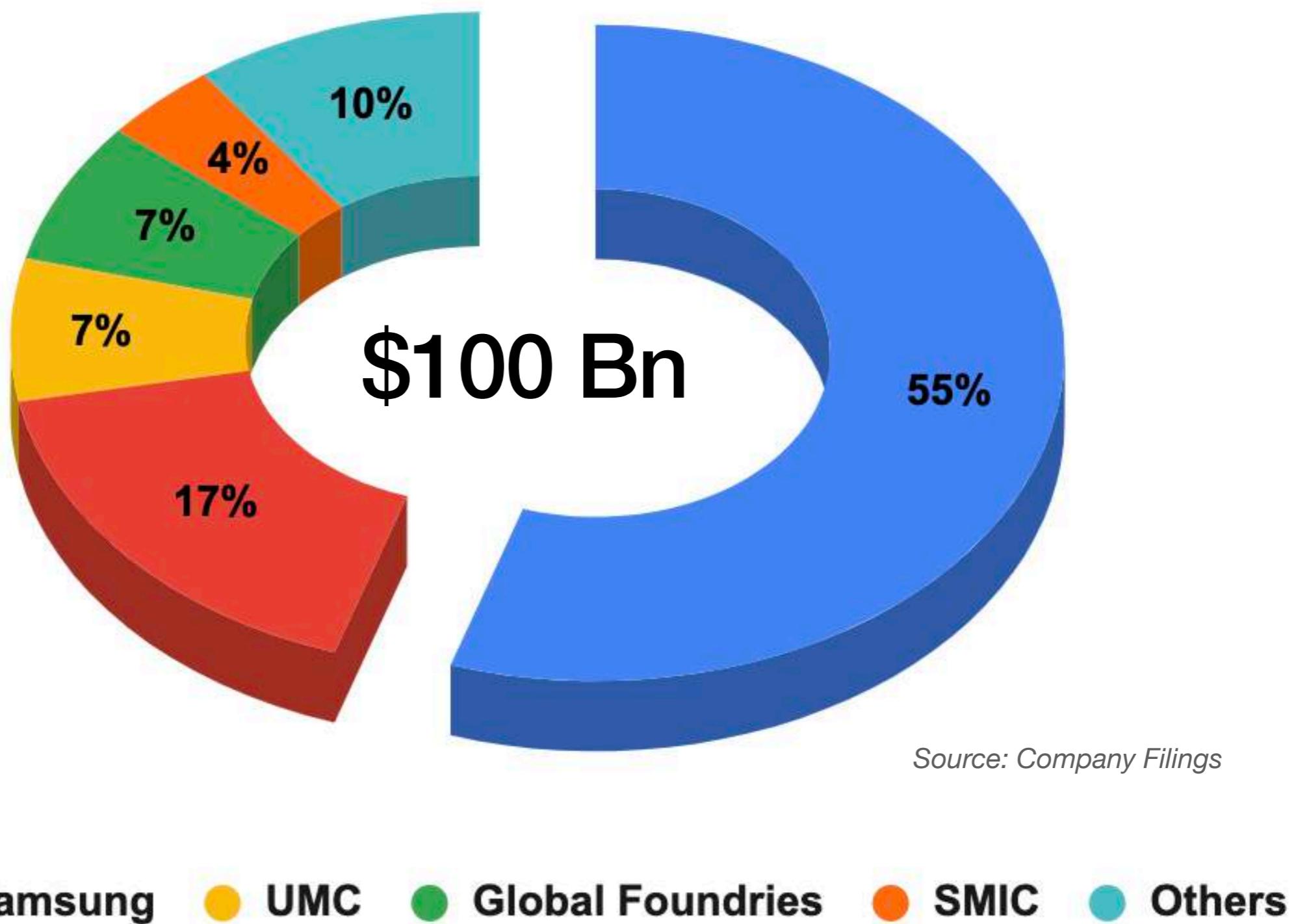


Source: Company Filings

Foundry by Country

- Taiwan
- South Korea
- China
- Others

Foundry Company Market Share





ASML/Bart v

A black and white portrait of Arthur C. Clarke. He is an elderly man with a receding hairline, wearing thick-rimmed glasses and a dark suit jacket over a white shirt. He is smiling slightly and looking towards the camera. In the background, there is a large, complex metal structure, possibly a bridge or a space station, with many beams and cables.

Any sufficiently advanced
technology is indistinguishable from
magic.

— Arthur C. Clarke —

AZ QUOTES

Must Watch



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FOCAL POINT S1 • E2

The Extreme Physics Pushing Moore's Law to the Next Level

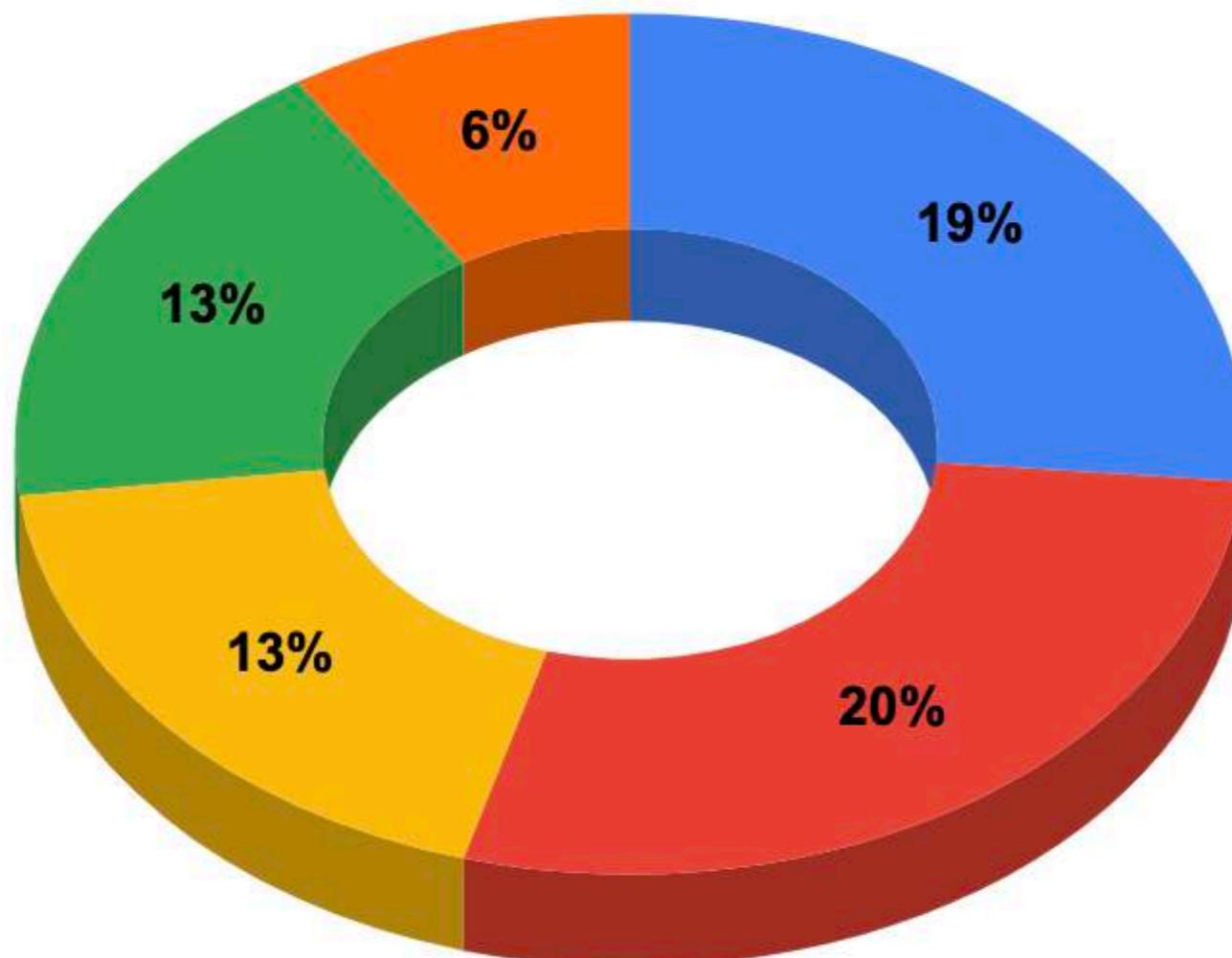
Seeker ✓ 4M views • 1 year ago

A look inside a new precision machine that wants to reinvent the chip making industry.

Seeker! <http://bit.ly/subscribesteker> »Watch more Focal Point |<https://bit.ly/31Ms6mj..>

Subtitles

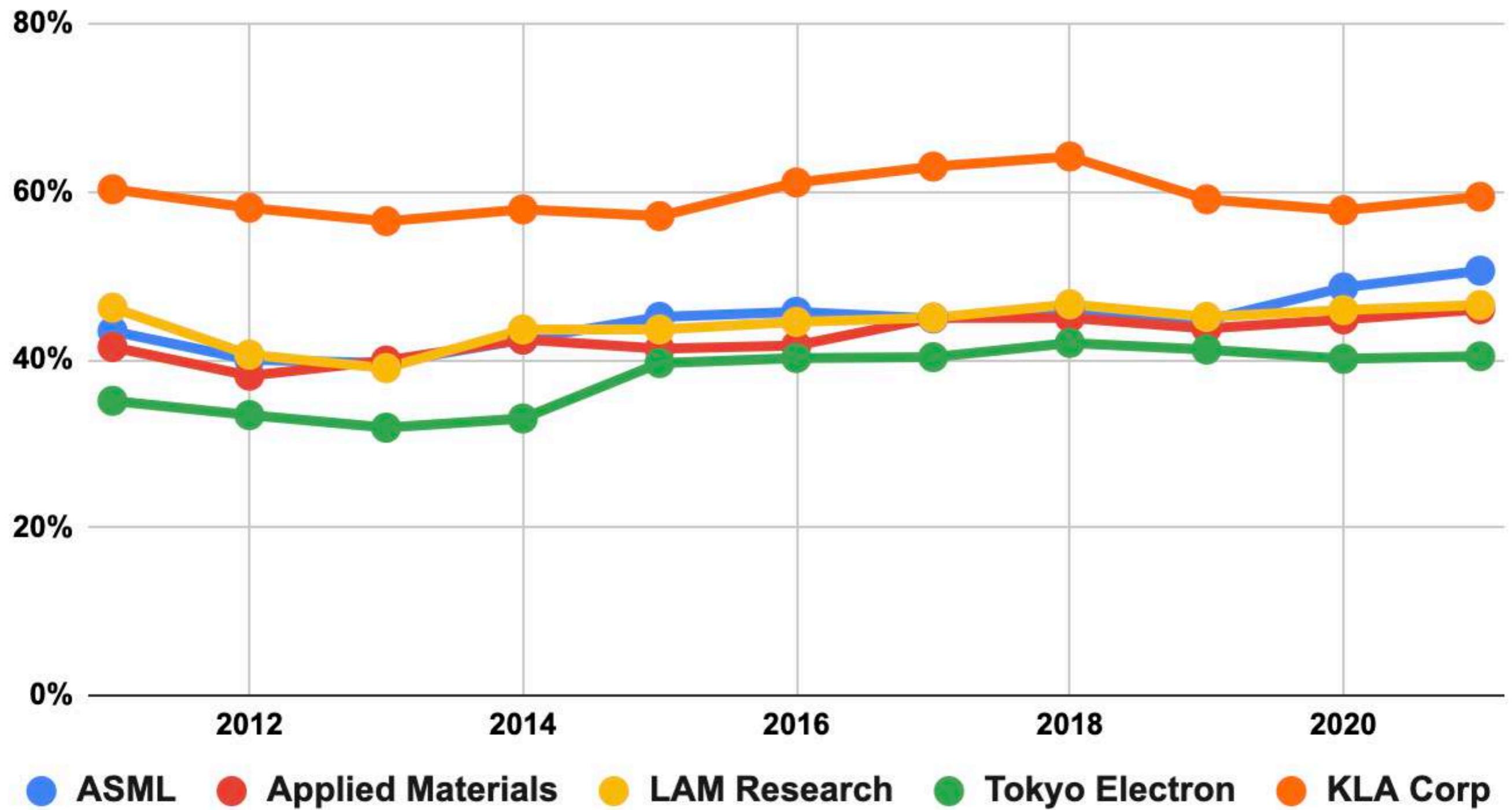
Equipment Makers - Market Share



Source: Company Filings

- ASML
- Applied Material
- LAM Research
- Tokyo Electron
- KLA Corporation

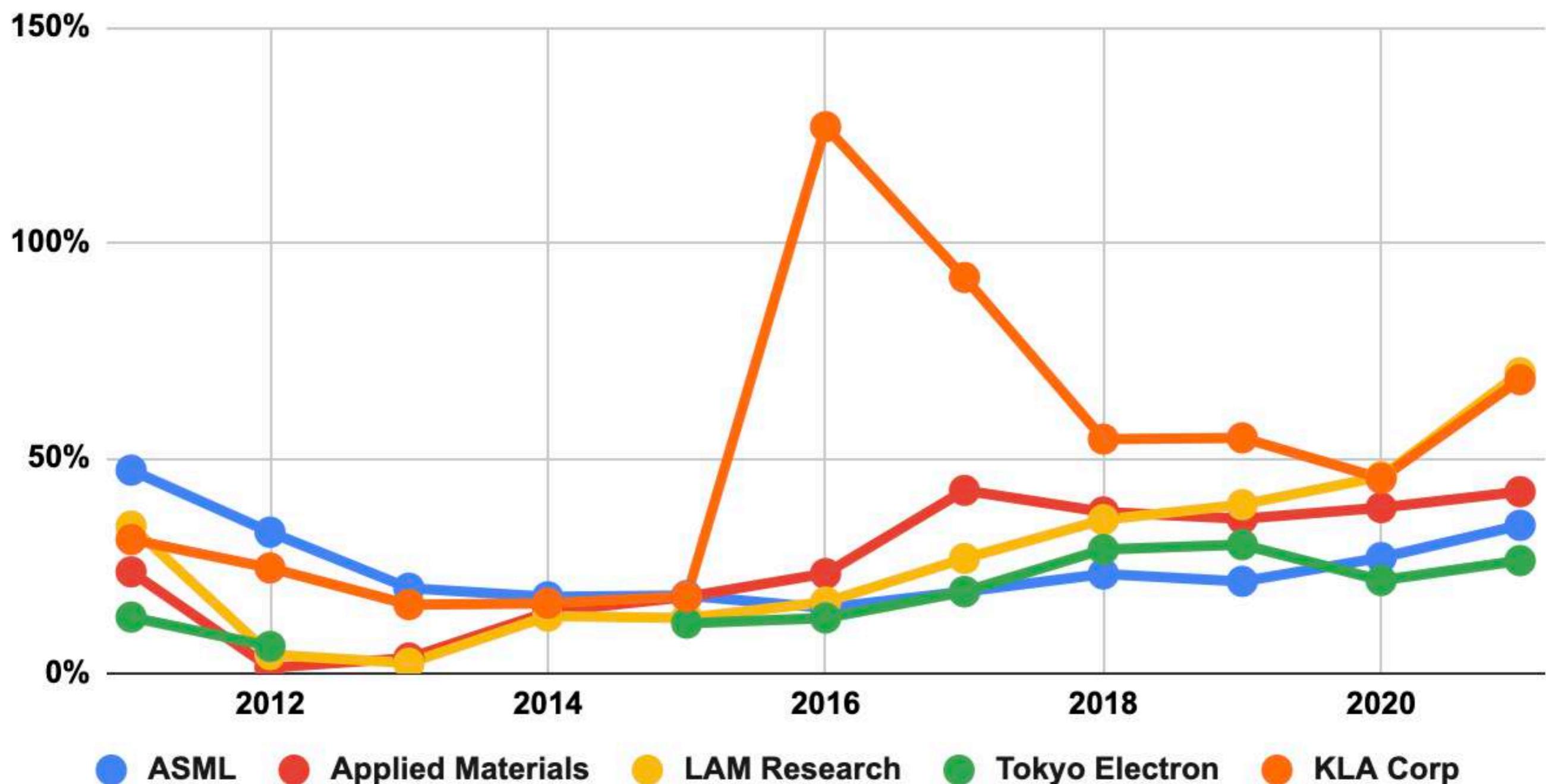
Equipment Makers Gross Margins (%)



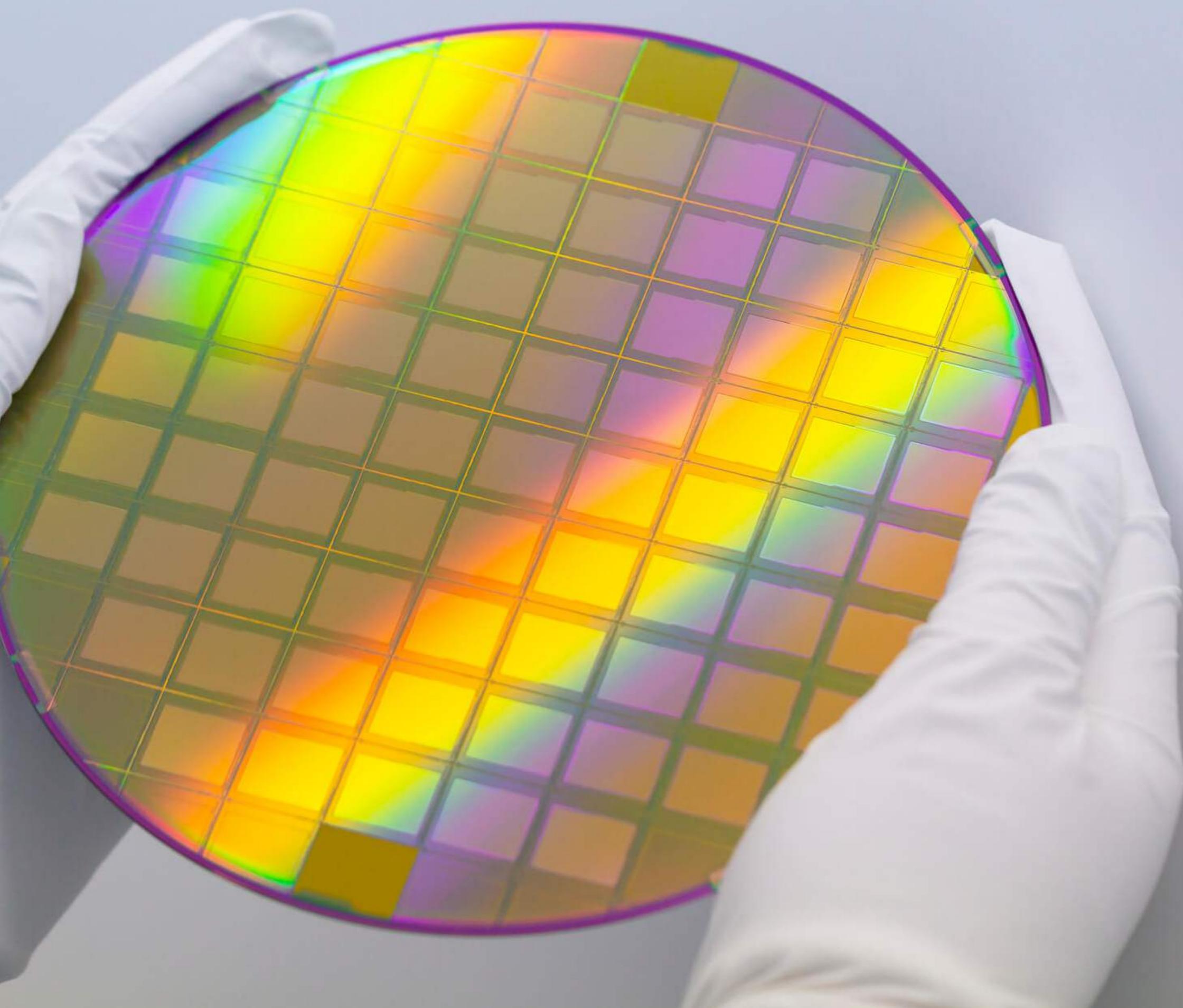
Source: Company Filings

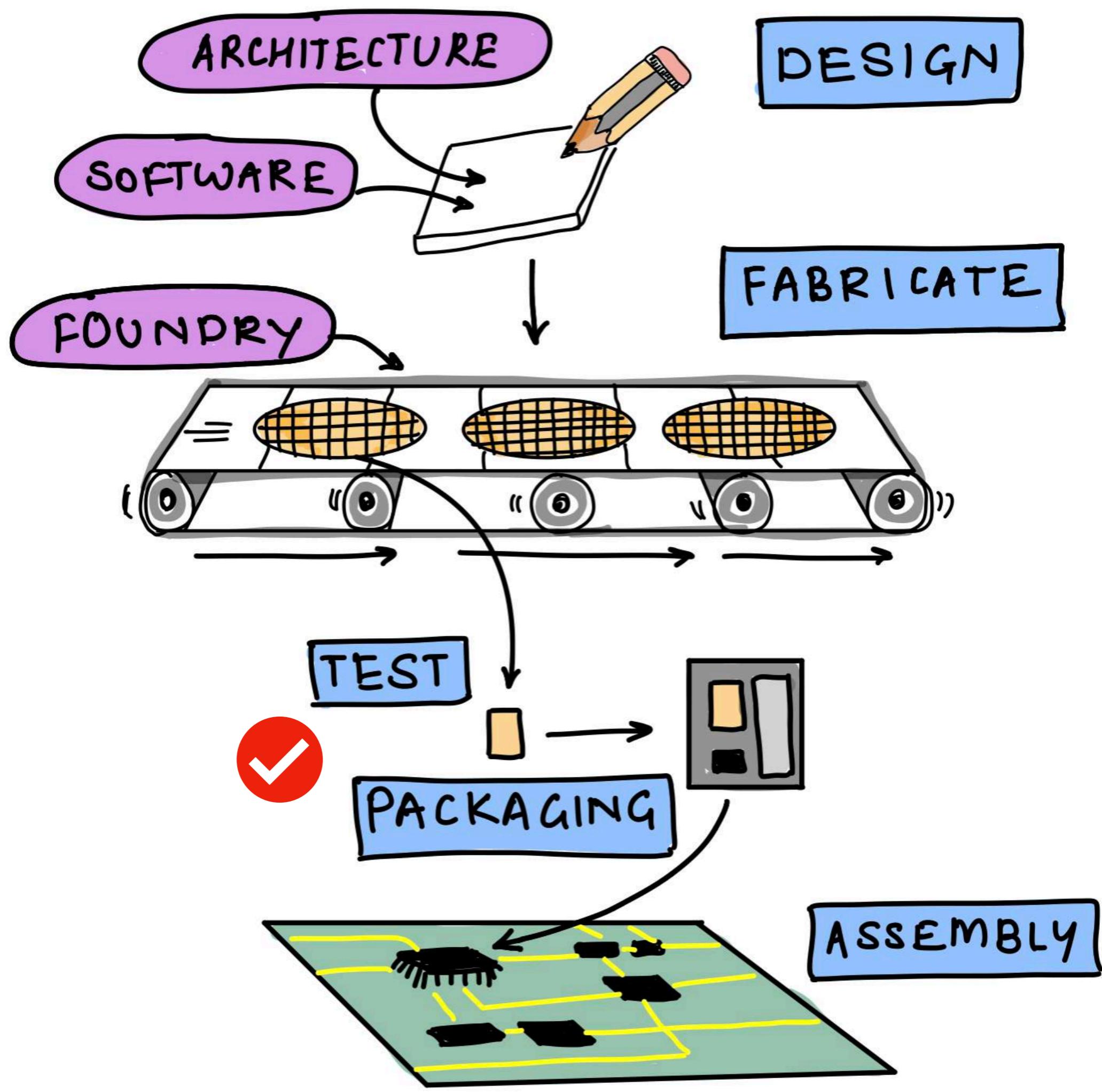
Equipment Makers RoE (%)

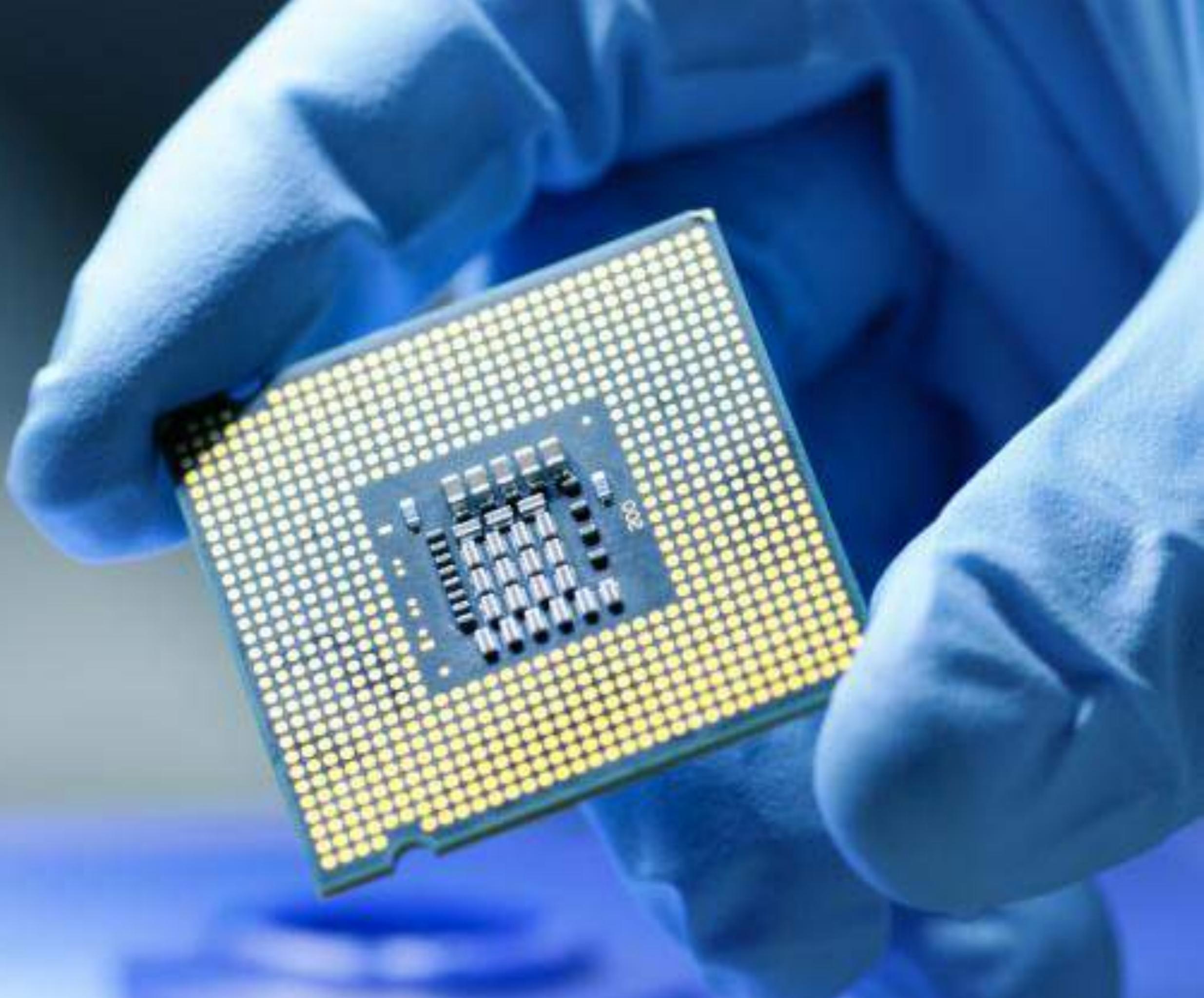
Hi Margin, Hi Asset Turns, Lo Debt

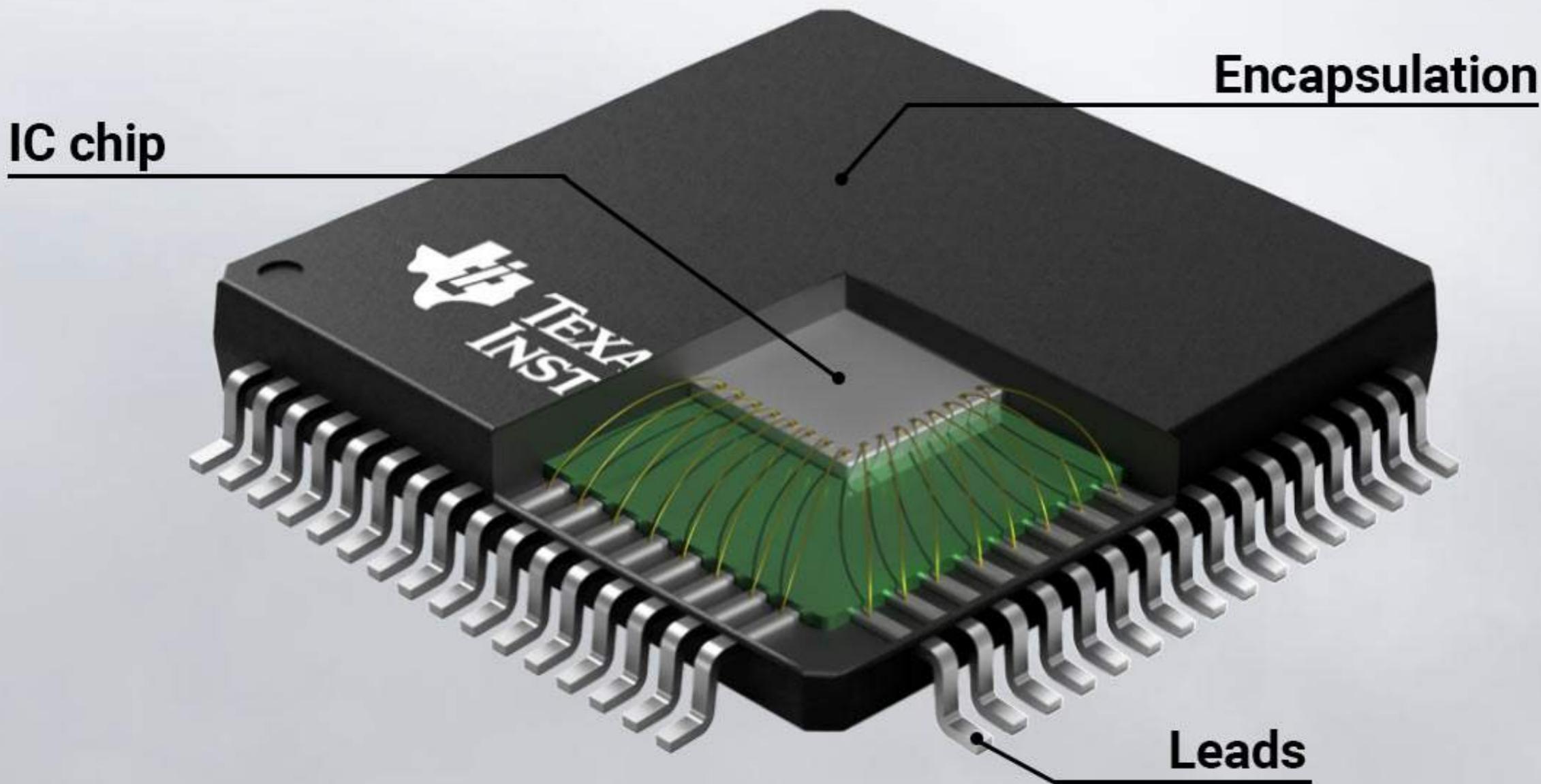


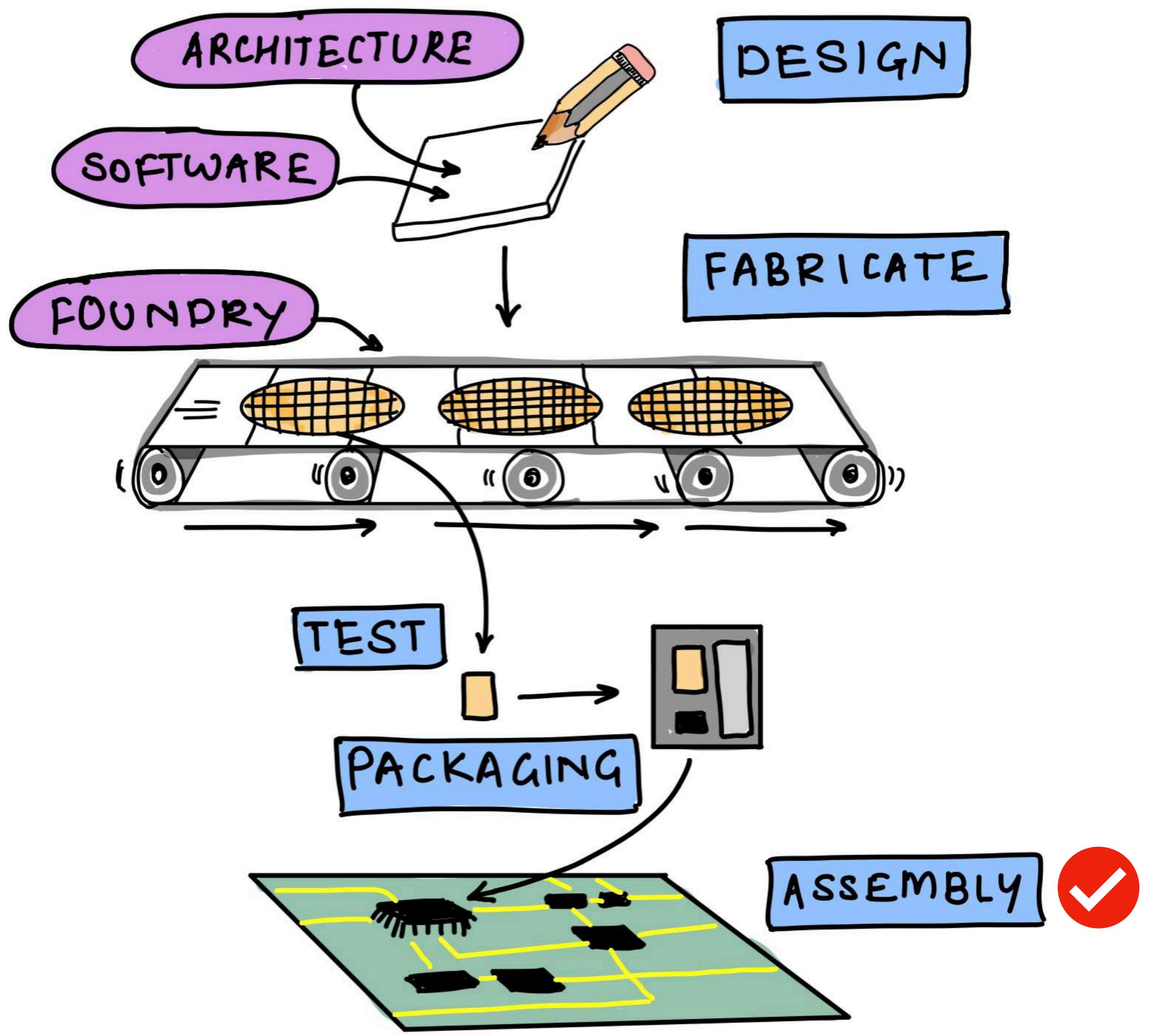
Source: Company Filings

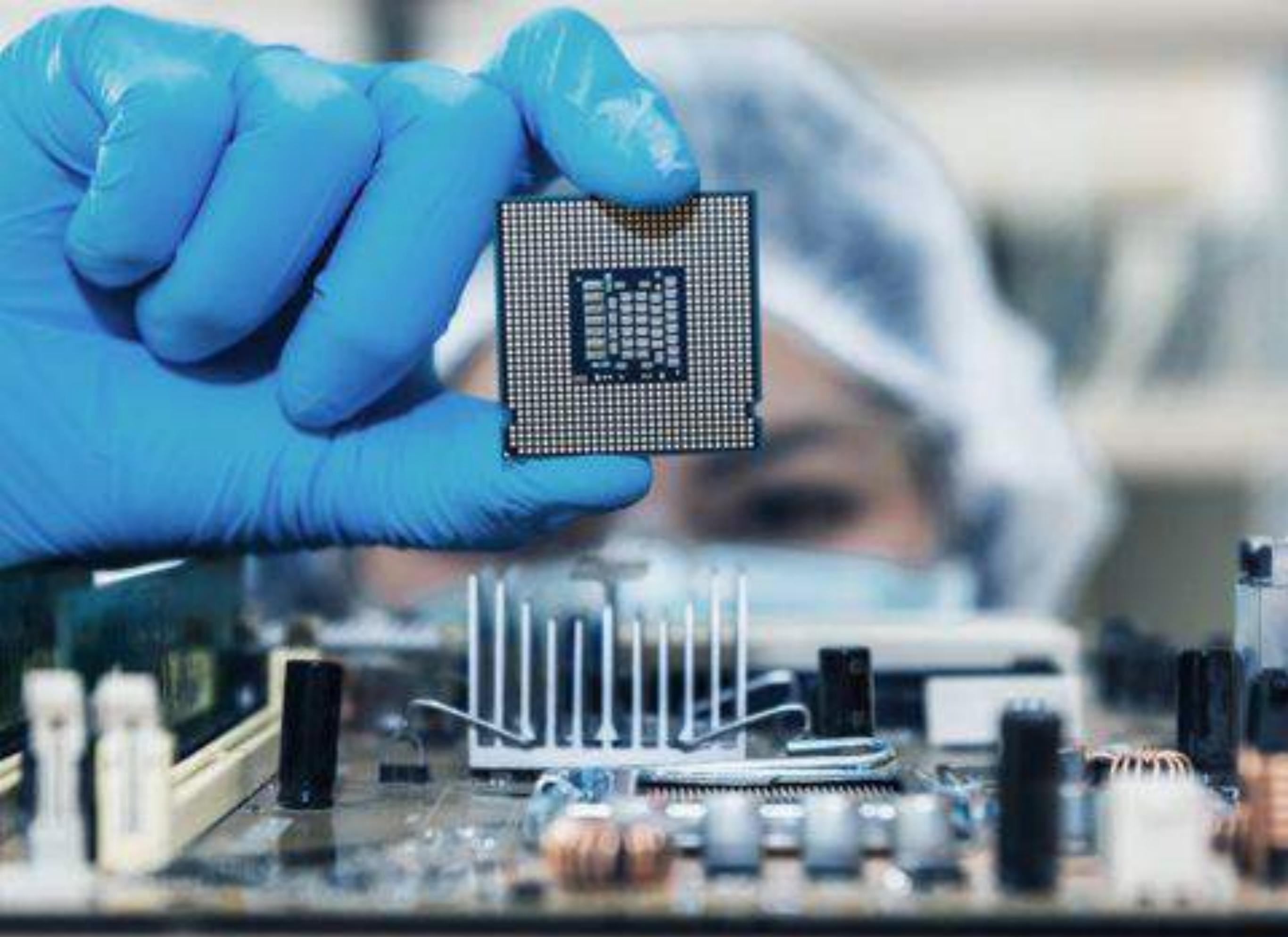












Why Chip Shortage?

On Infrastructure

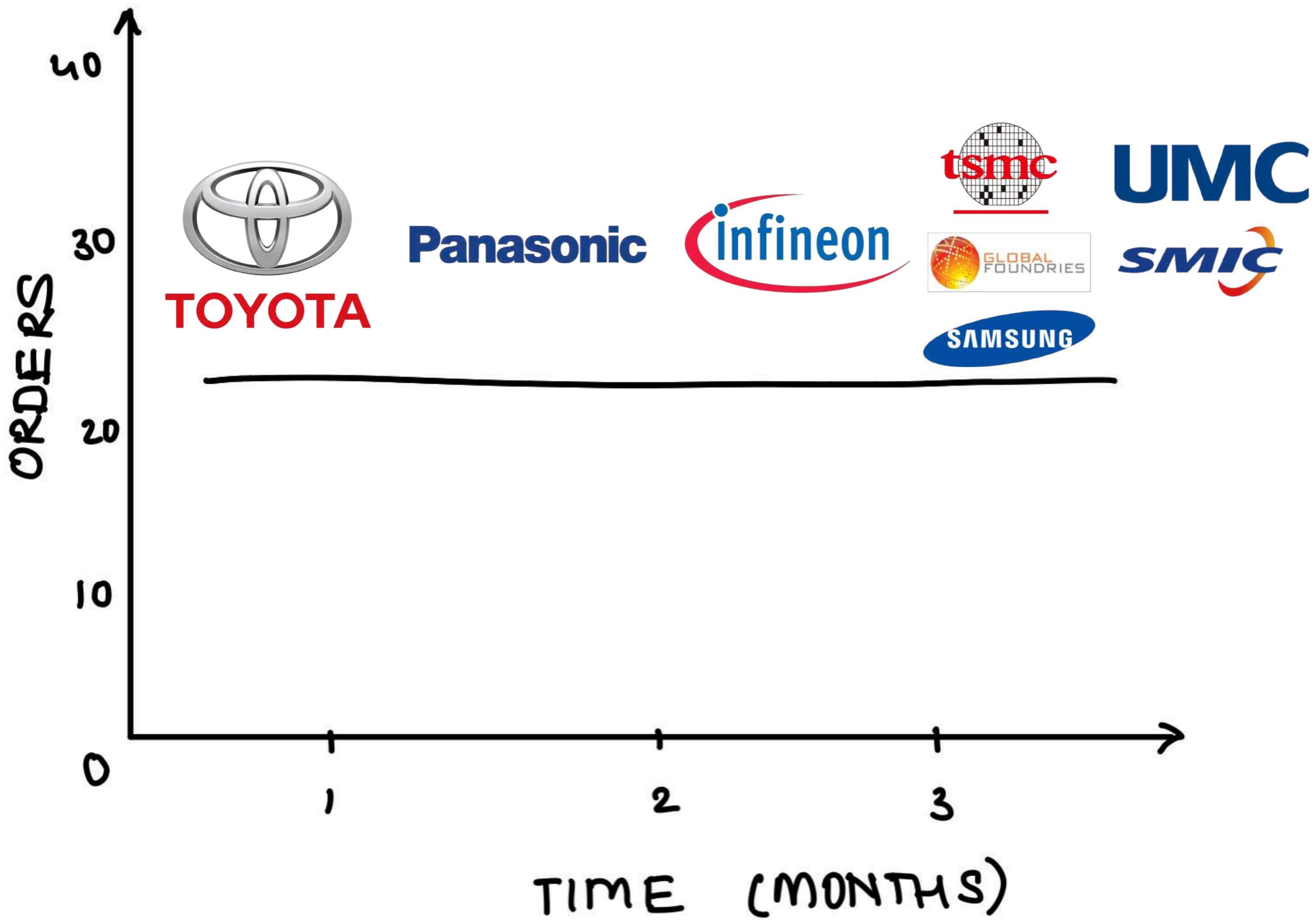
*“Becomes visible
upon Breakdown”*

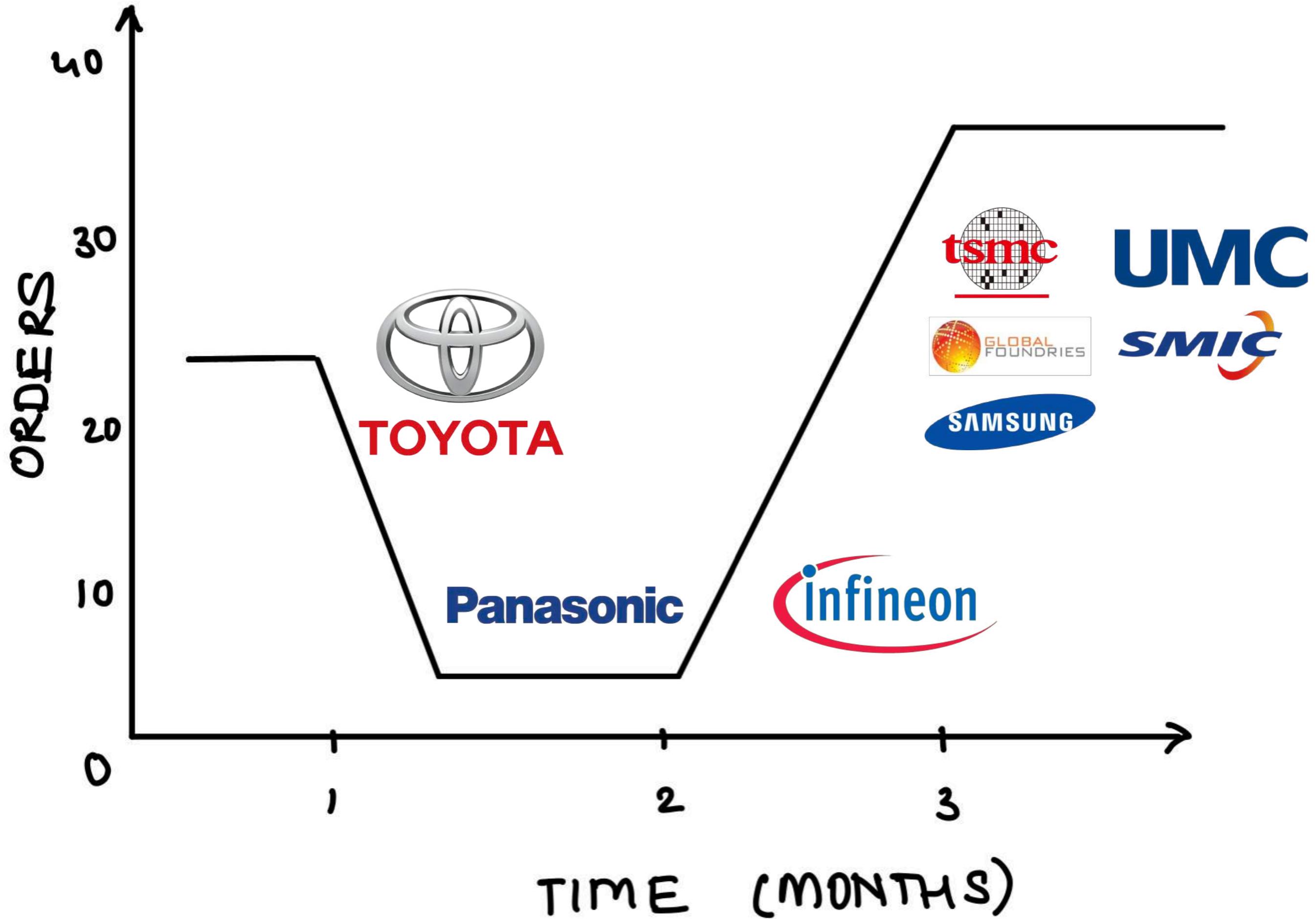


SORTING THINGS OUT

CLASSIFICATION AND ITS CONSEQUENCES

GEOFFREY C. BOWKER AND SUSAN LEIGH STAR





| Semi content per unit | 2015 | 2020 | 2025F | |
|---|---------|---------|---------|------|
|  HIGH END SMARTPHONE | \$100 | \$170 | \$275 | +62% |
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SILICON CONTENT GROWING AS EVERYTHING GETS SMARTER

Source: Applied Materials

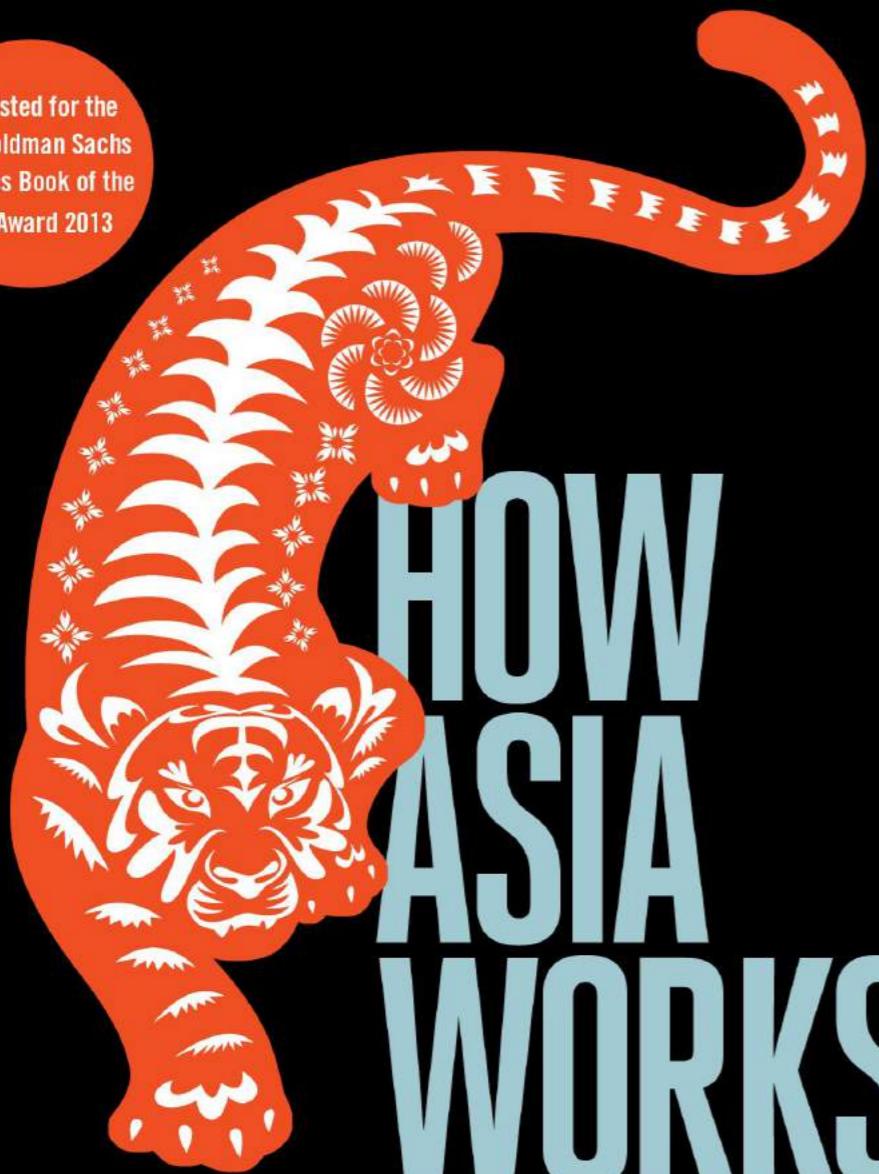
Applied Materials External Use



Source: *Applied Materials*

Geopolitics

Longlisted for the
FT & Goldman Sachs
Business Book of the
Year Award 2013



HOW ASIA WORKS

Success and Failure
in the World's Most
Dynamic Region
JOE STUDWELL

'Pithy, well-written and intellectually vigorous'

FINANCIAL TIMES

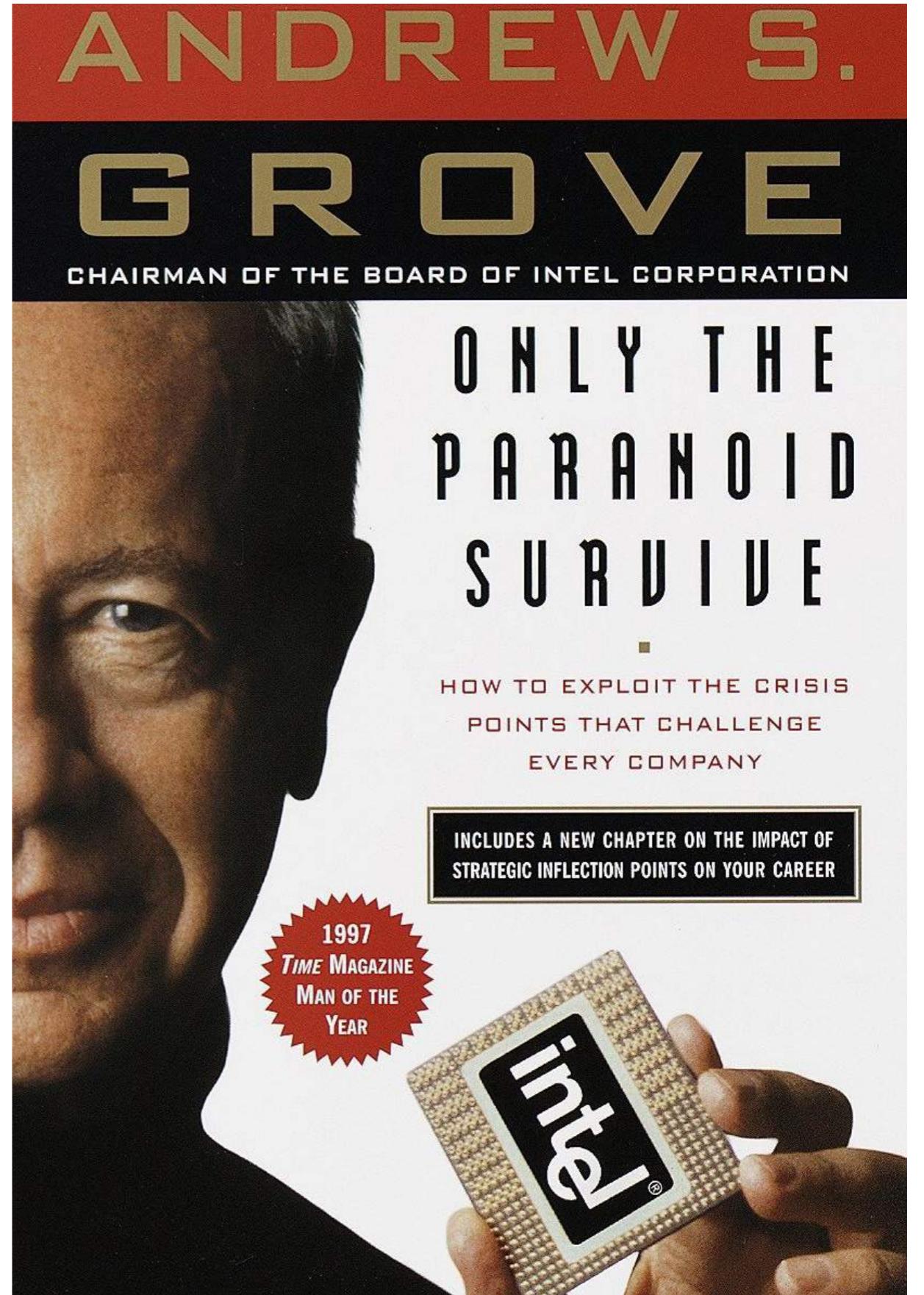
**How Asia
Works**
Joe Studwell

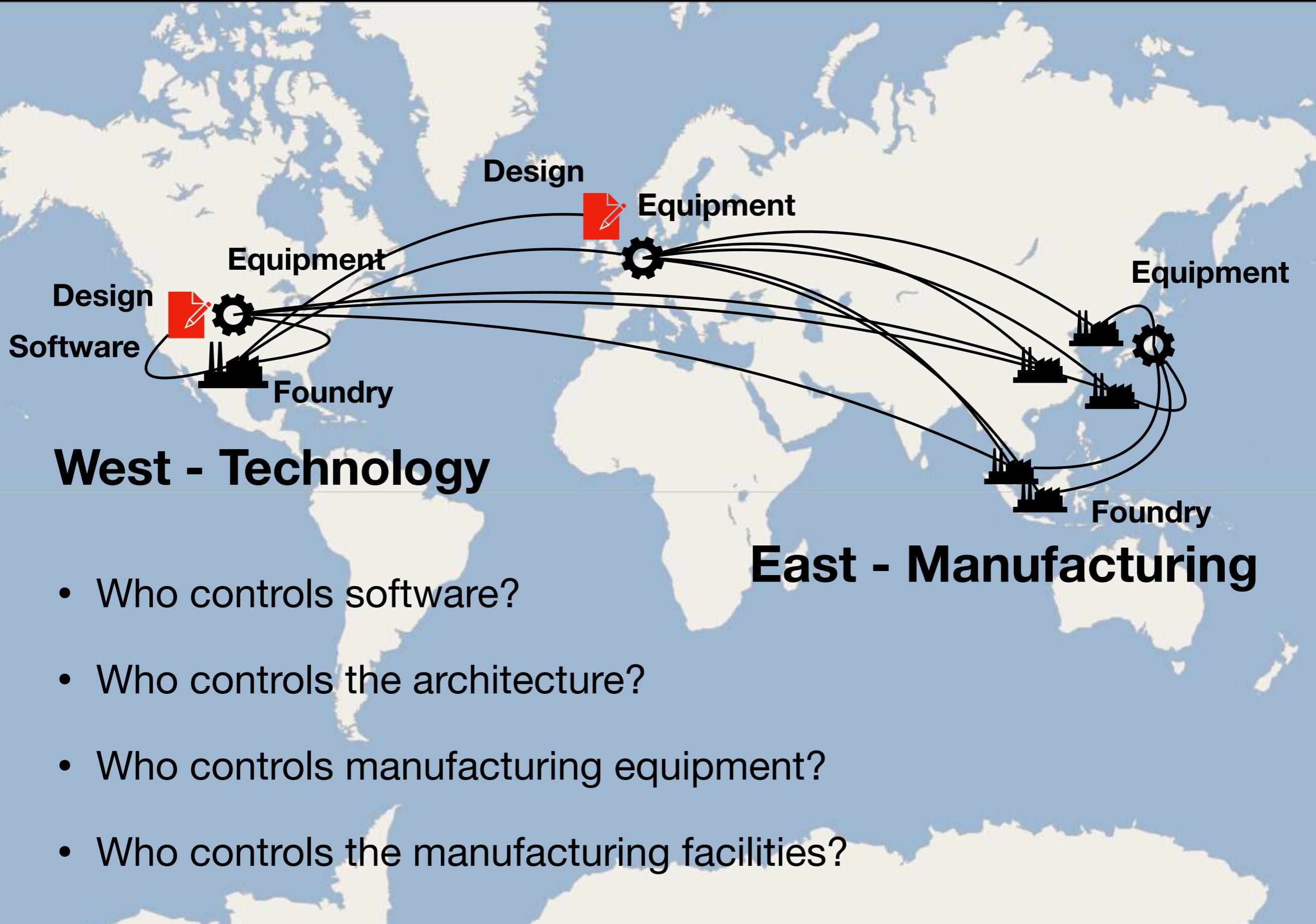
**Historical context of
Asian Economies
(ex-India)**

Andy Grove

Former CEO - Intel

- Intel's survival
- Intel's revival



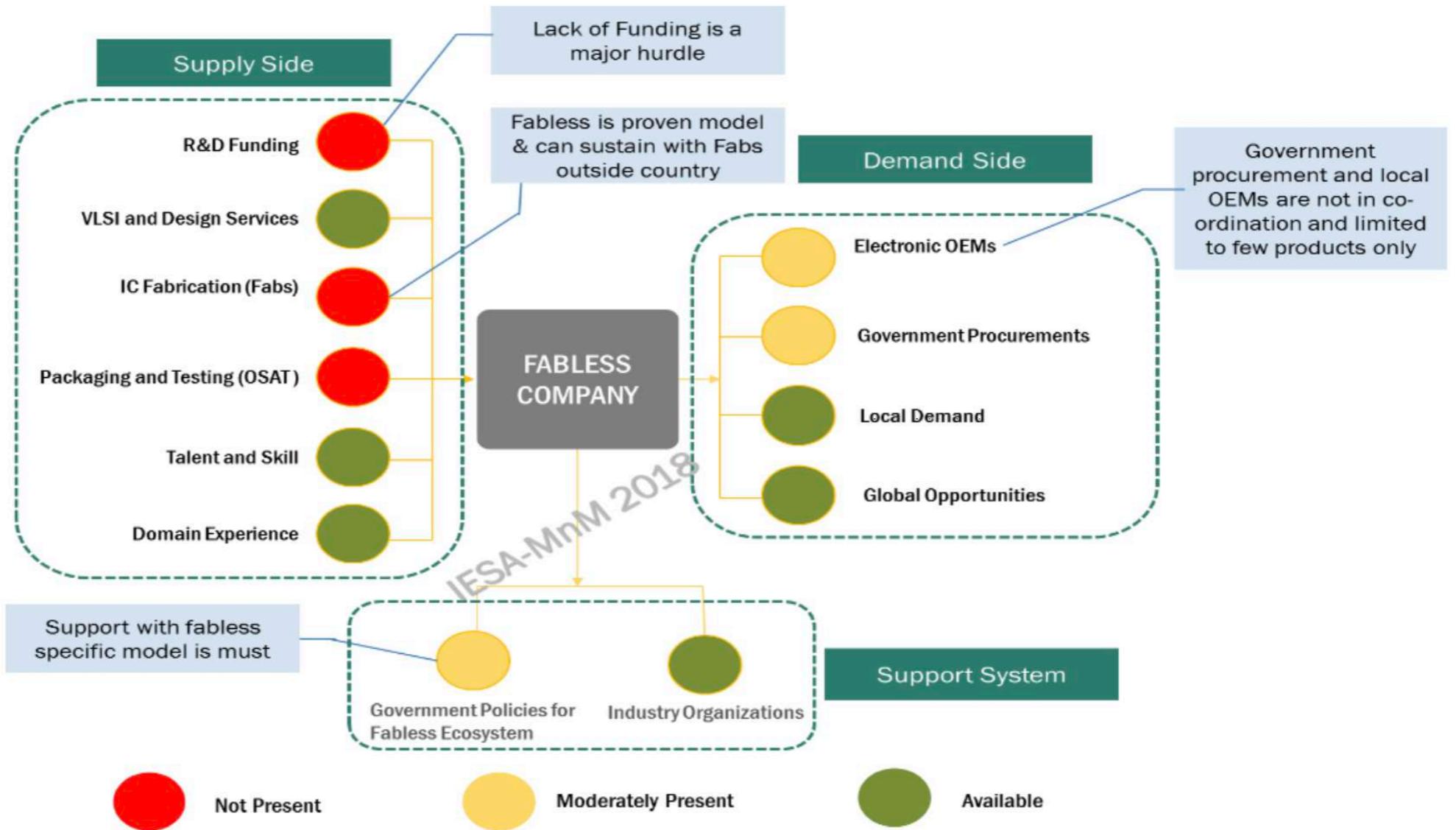


India Semiconductor Opportunity

Indian Electronics & Semiconductor Association

FIGURE 1

STATUS OF INDIAN FABLESS ECOSYSTEM



Source: Secondary, Company Websites, and IESA-MarketsandMarkets Analysis

Indian Electronics & Semiconductor Association

TABLE 1 KEY OPPORTUNITIES FOR SEMICONDUCTOR COMPANIES IN INDIA

| Key Trends | Key Products | Driving Factors |
|-----------------------------|--|---|
| Smart Industrial Automation | <ul style="list-style-type: none">• PLC• DSC• Transmitters• Sensors | <ul style="list-style-type: none">• Need for mass production and connected monitoring• Government initiatives toward pollution control |
| Defense | <ul style="list-style-type: none">• Weapons• Munitions | <ul style="list-style-type: none">• Need for more efficient arms and armaments, and military weapons |
| Rural Broadband | <ul style="list-style-type: none">• Modem• Fiber optic components | <ul style="list-style-type: none">• Encourage telecommunication spread in rural areas and increase literacy |

Source: IESA-MarketsandMarkets Analysis

Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS)

**Incentives
(INR 3,285 crore)**

Financial Incentive of 25% on Capital Expenditure, on reimbursement basis

Tenure

3 Years for Filing Applications, 5 Years for Investment

Coverage

Electronic components, semiconductor/ display fabrication units, ATMP units, specialized sub-assemblies and capital goods for manufacture of aforesaid goods. (Electronics Products such as Mobiles and Consumer Goods excluded)

Eligible Capex

Plant, Machinery, Equipment, Associated Utilities and Technology including R&D (Land and Building excluded)

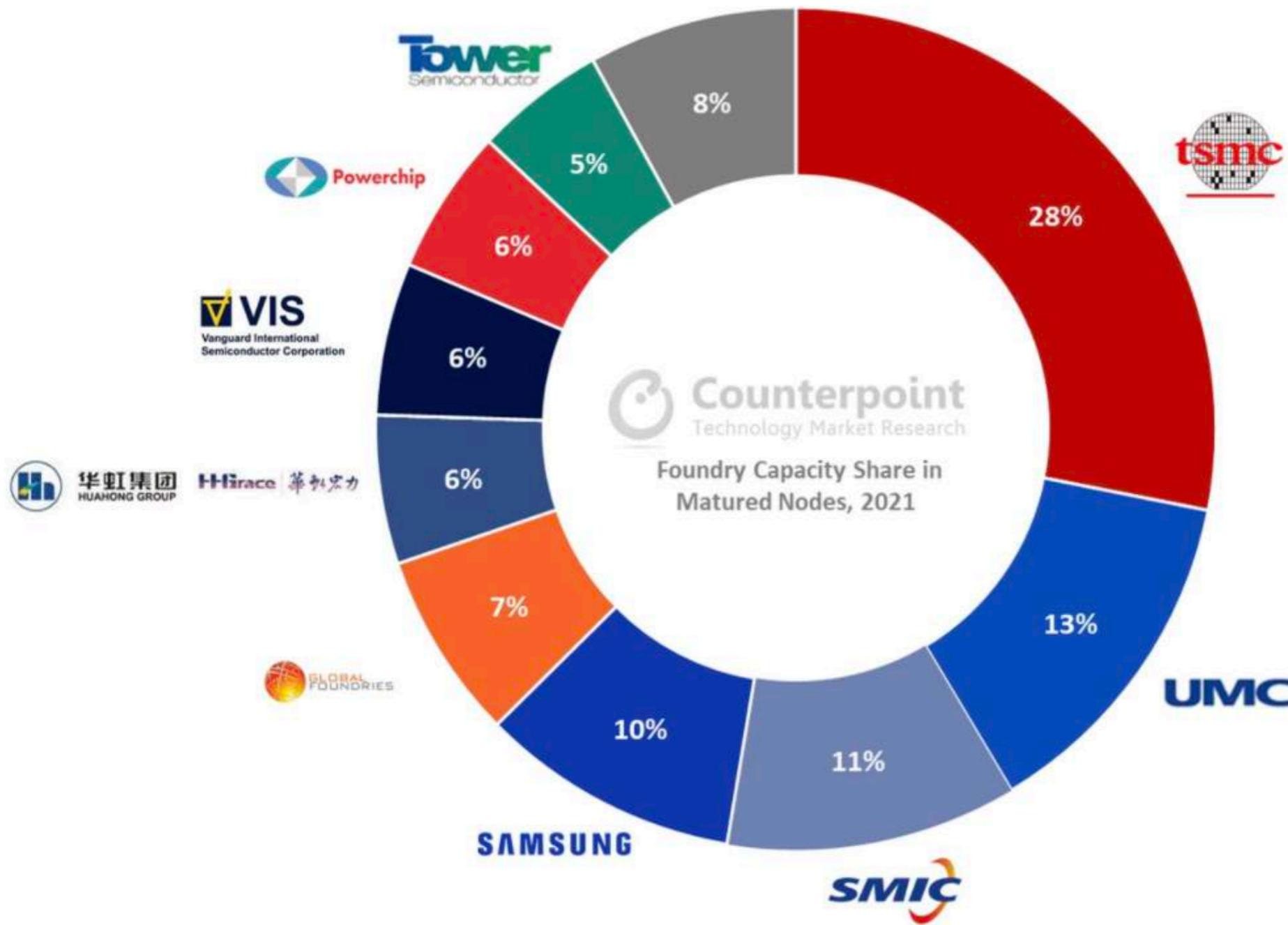
Eligibility

Investments in new and expansion of capacity / modernization and diversification of existing units

Minimum Investment Threshold

Ranges from INR 5 crore to 1,000 crore (Will encourage Domestic Players)

Exhibit 2: Foundry Capacity Share in Matured Nodes (40-nanometer and below, including 8-inch), 2021



Source: Counterpoint Research

Conclusion

A very interesting space to track

- Delicately Balanced Supply Chain
- Close integration between vendors
- Winners Take Most
- Profitable but Intensely Competitive
- Economies of Scale Matter
- Organic Growth of Digital Products & Semi Penetration
- Engineering and R&D Services Growth
- Directly Enables Software & Technology Services Businesses

Helpful Sources

- Books mentioned
- Youtube for everything to get a visual context
- Podcast & Youtube interviews with Company Managements
- Whitepapers from NZS Capital & Jon Bathgate Interview
- Asianometry Youtube Channel & Substack
- Long listing history & good quality filings & disclosures

Thank You