06 February 2014

The nanoworld of IC manufacturing:

smaller, faster, and more accurate

Patrick de Jager
Director New Business

Agenda

- Chips are everywhere
- Introducing ASML
- Business update
- ASML’s place in the industry
- Lithography, the driving force behind Moore’s Law
- Technology
- How do we do it?

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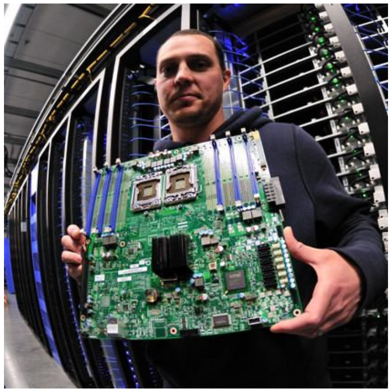
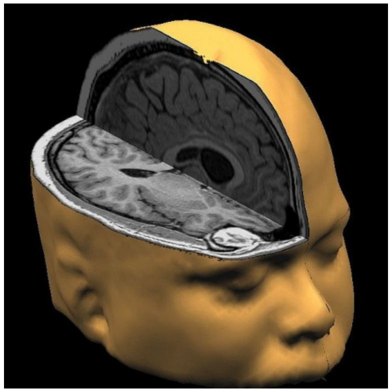
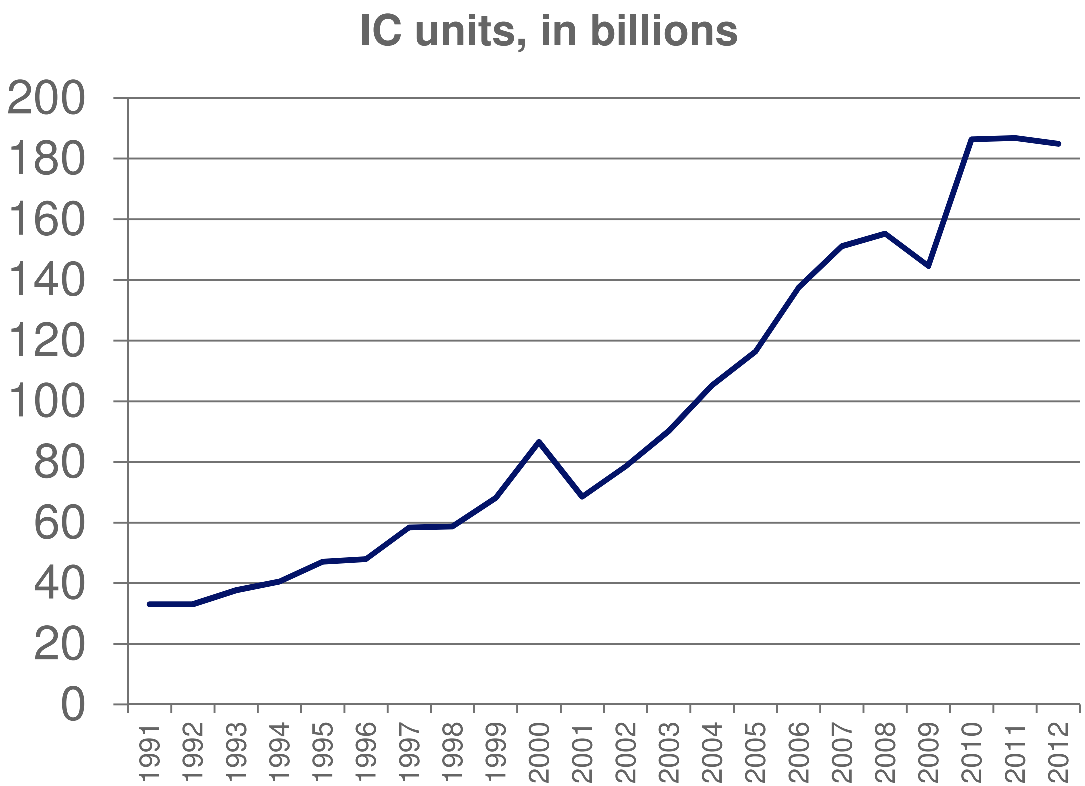
It’s hard to imagine a world without chips





More than 180 billion chips are made every year



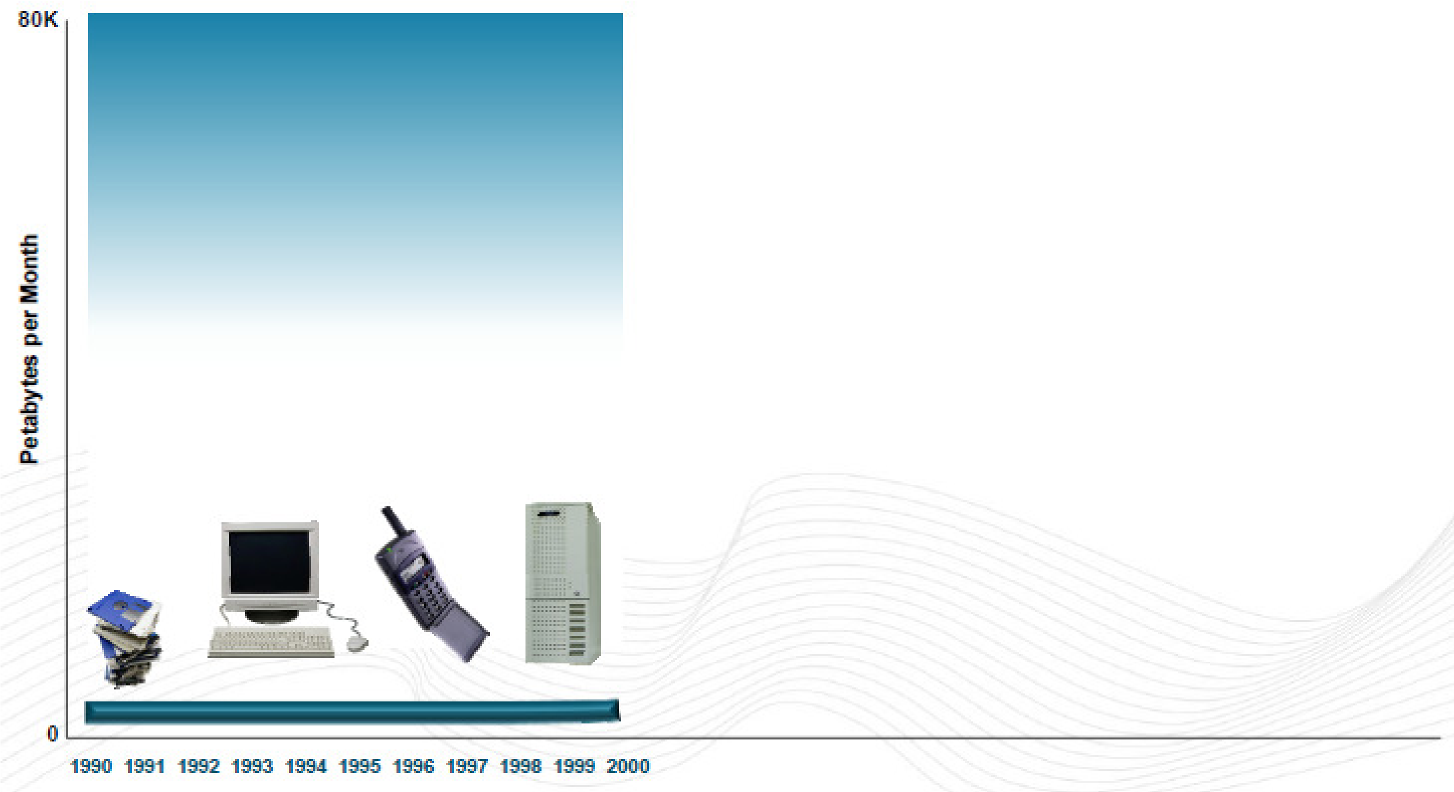
In 2012, 185 billion chips were produced — 27 for every man, woman and child on the planet.

Global semiconductor industry sales were about $300 billion.

Data: WSTS

Content consumption drives traffic growth

> 100% CAGR since 1990

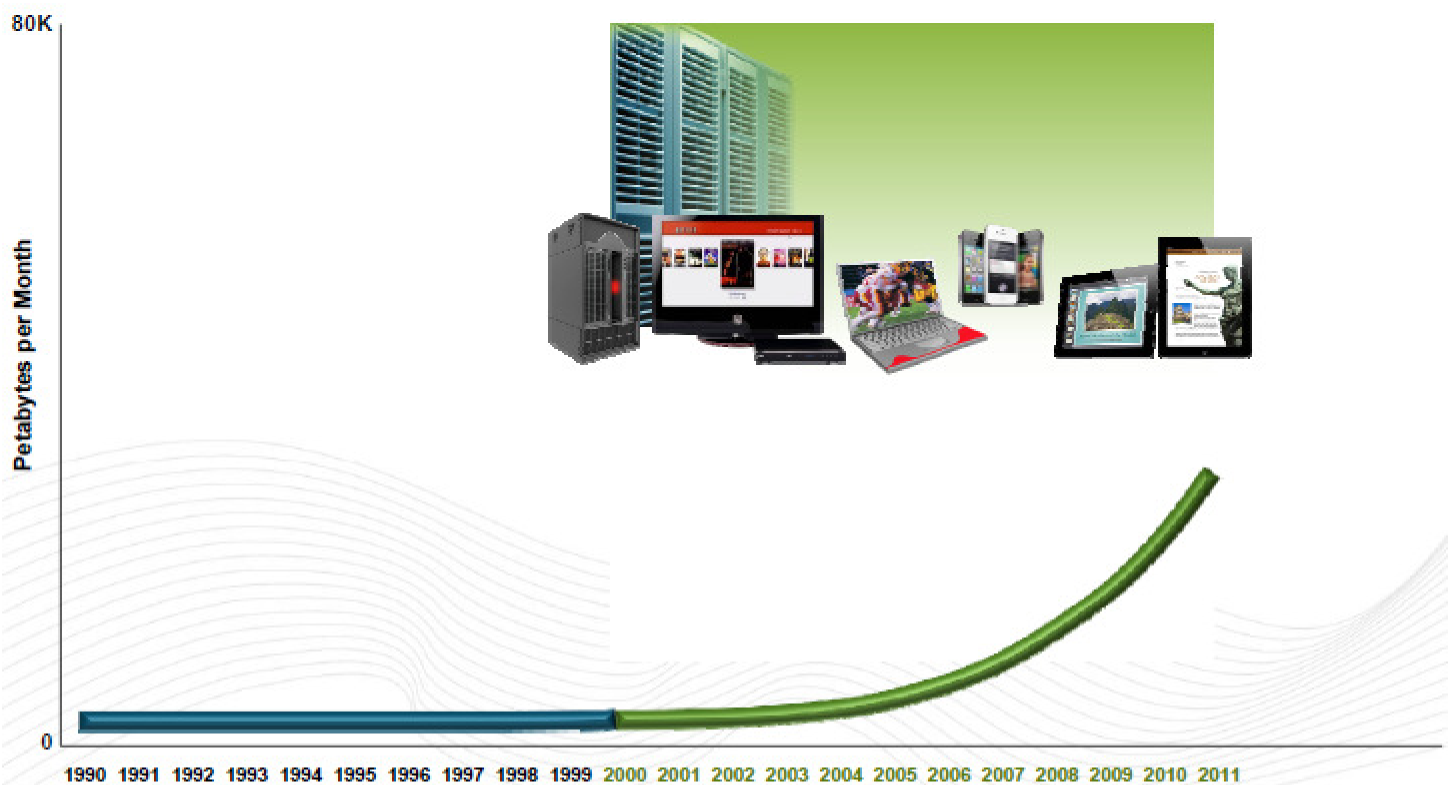


Content consumption drives traffic growth

> 100% CAGR since 1990

ASML

Confidential



Content consumption drives traffic growth

> 100% CAGR since 1990

Source: Pieter Vorenkamp, Broadcom, IMEC Technology Forum, may 2012

ASML

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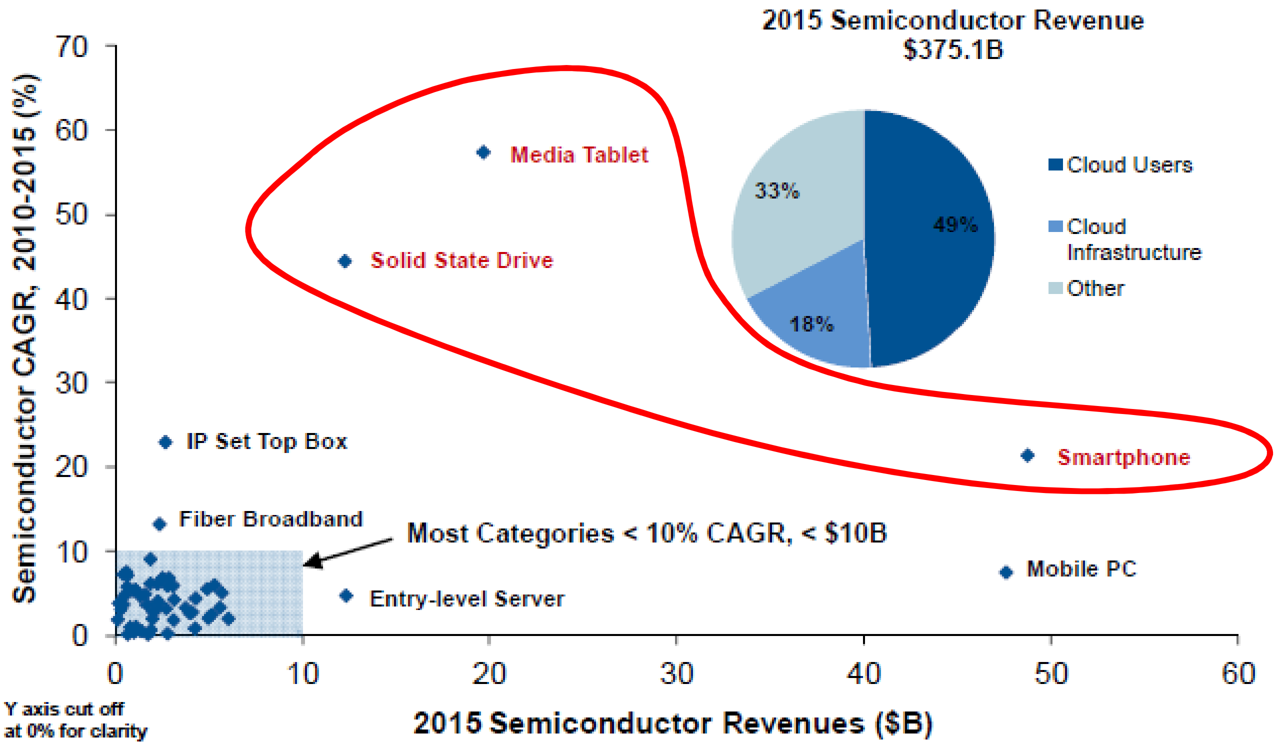
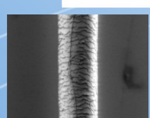
Market driven by mobile devices and Solid State Drives

Mobile drives cloud, cloud drives infrastructure, driving servers and SSD

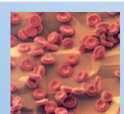


Bob Johnson, Gartner, ISS jan 2012

A chip up close: smallest details <20nm

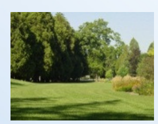


Hair: 50.000nm
Grows 8nm/sec



Red bloodcell:
7,500nm

Bacteria: 800
to 1,000nm



Grass grows:
33nm/sec

Rino virus: 20nm

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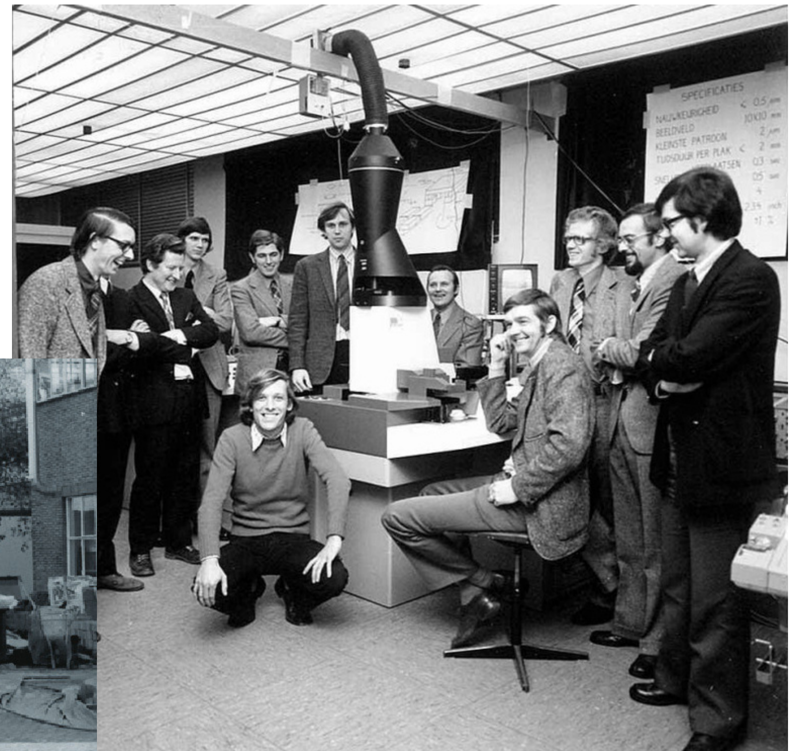
ASML makes the machines for making those chips

- Lithography is the critical tool for producing chips
- All of the world's top chip makers are our customers
- 2013 sales: €5.2 bln
- Payroll: about 10,400 FTEs

Founded in 1984 as a spin-off from Philips



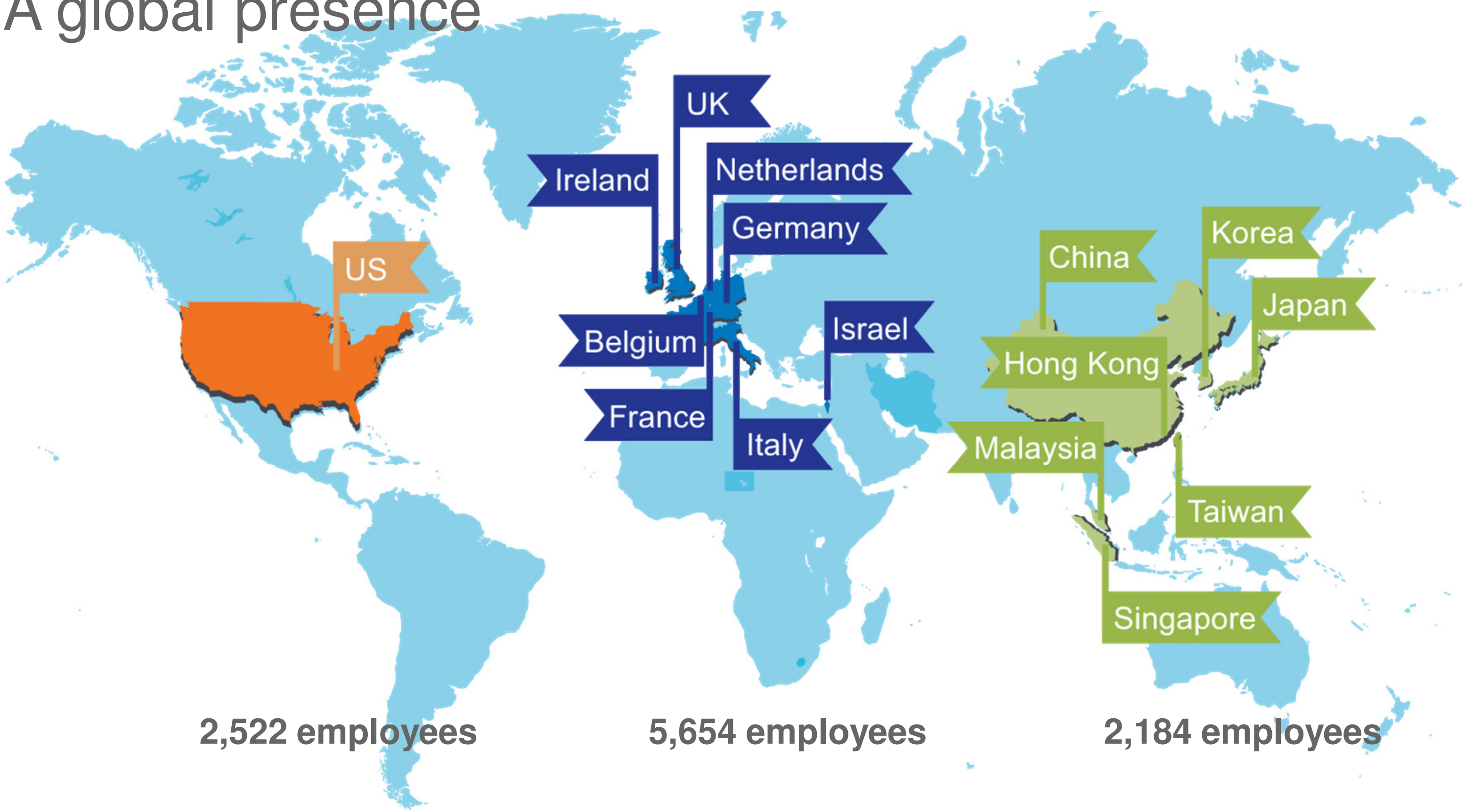
ASML

Public

Slide 14

22 Januar!2014

A global presence



Over 70 sales and service offices located worldwide

Source: ASML Q4 2013

A global presence

Wilton (CT)

San Diego(CA)

Korea

Veldhoven

Chandler (AZ)

Taiwan

A market of 12 large ASML customers

tsmc
Technology Collaboration Award

intel
Preferred Quality Supplier Award

TOSHIBA
'Good Partner' Award

VLSIresearch 10 BEST SUPPLIERS Customer Satisfaction 2013
For the 10th consecutive year, top five of VLSI's "Best Wafer Processing" suppliers

Company	2013 semi capex (estimate, $M)
Intel	10,500
TSMC Group	9,750
Samsung	9,500
GlobalFoundries	4,000
SK Hynix	2,730
Toshiba (incl. SanDisk)	2,580
Micron Technology	1,800
United Microelectronics Group	1,500
SMIC	805
Infineon	640
Sony	617
STMicroelectronics	500

Source: Gartner, Q4 2013

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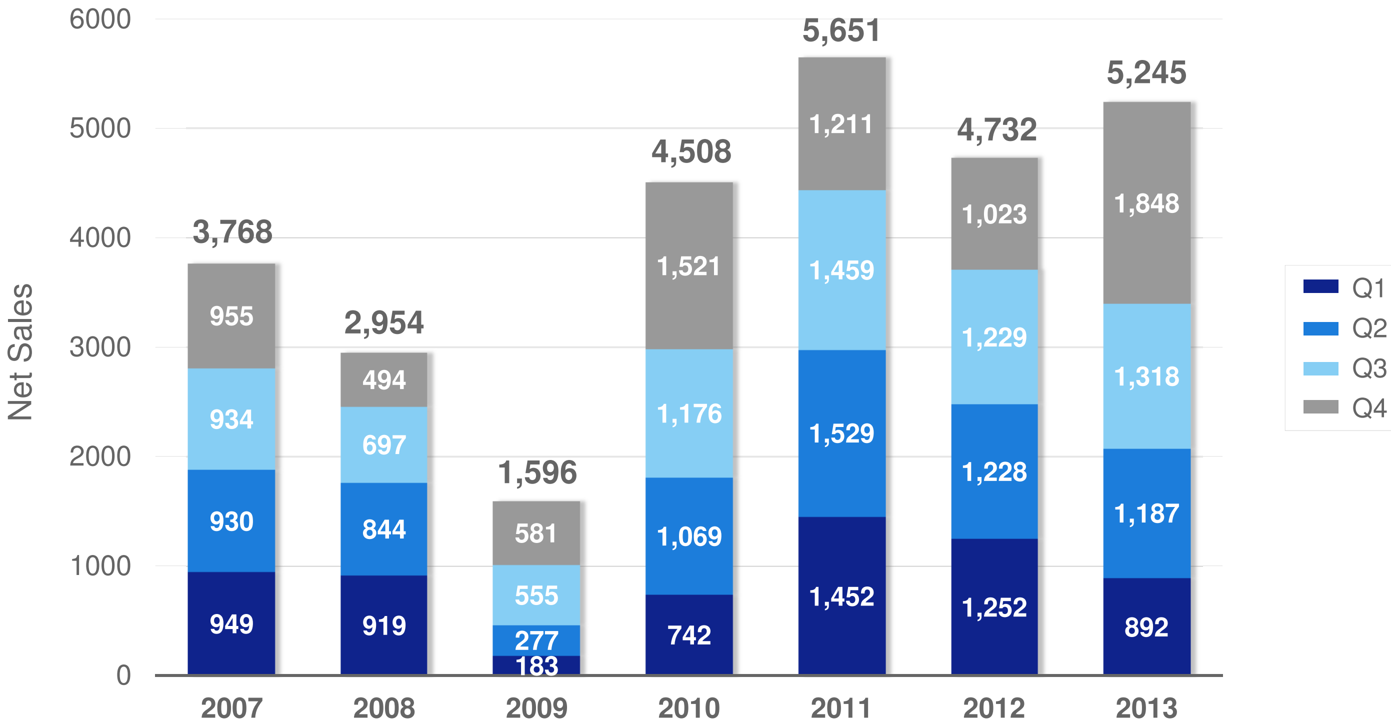
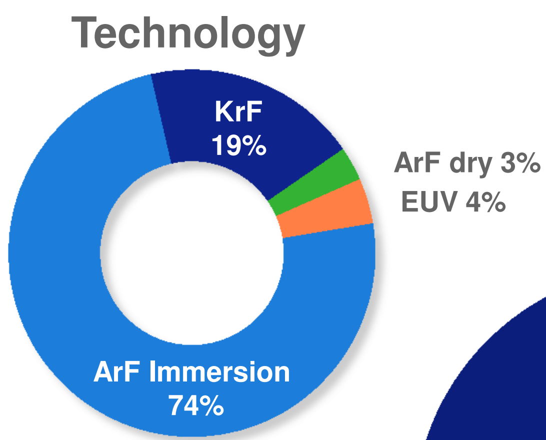
Total net sales M€

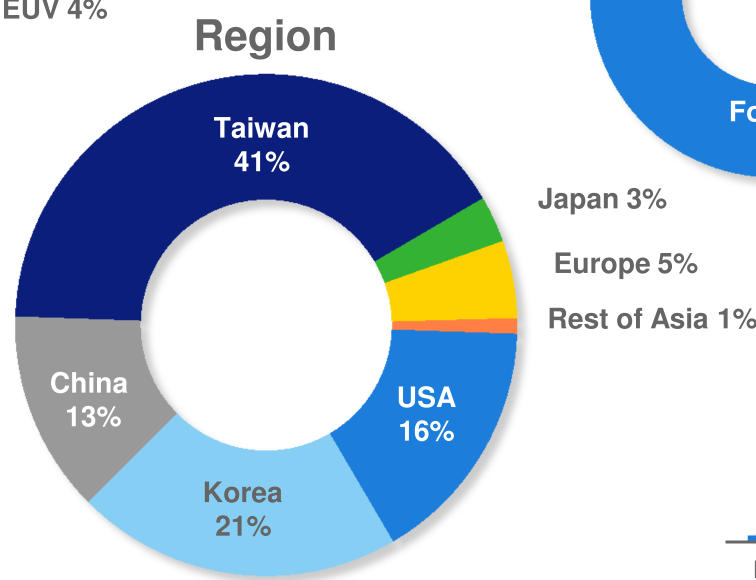


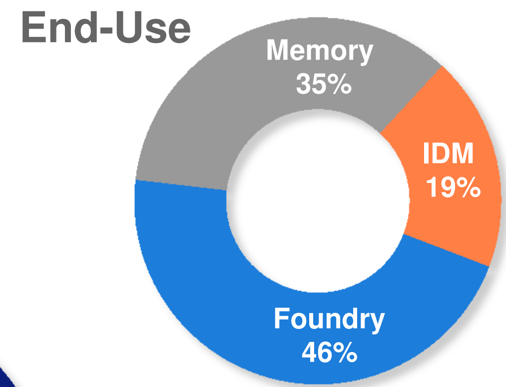
Numbers have been rounded for readers' convenience

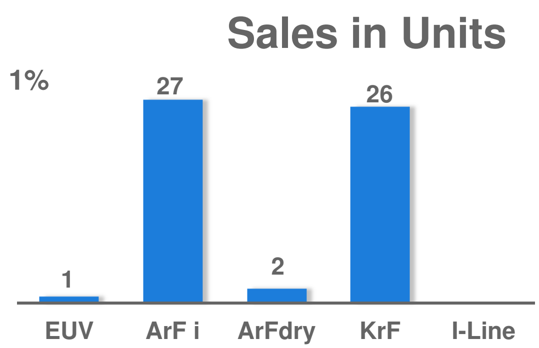
Net system sales breakdown in value: Q4 2013

Total value is € 1,441 million









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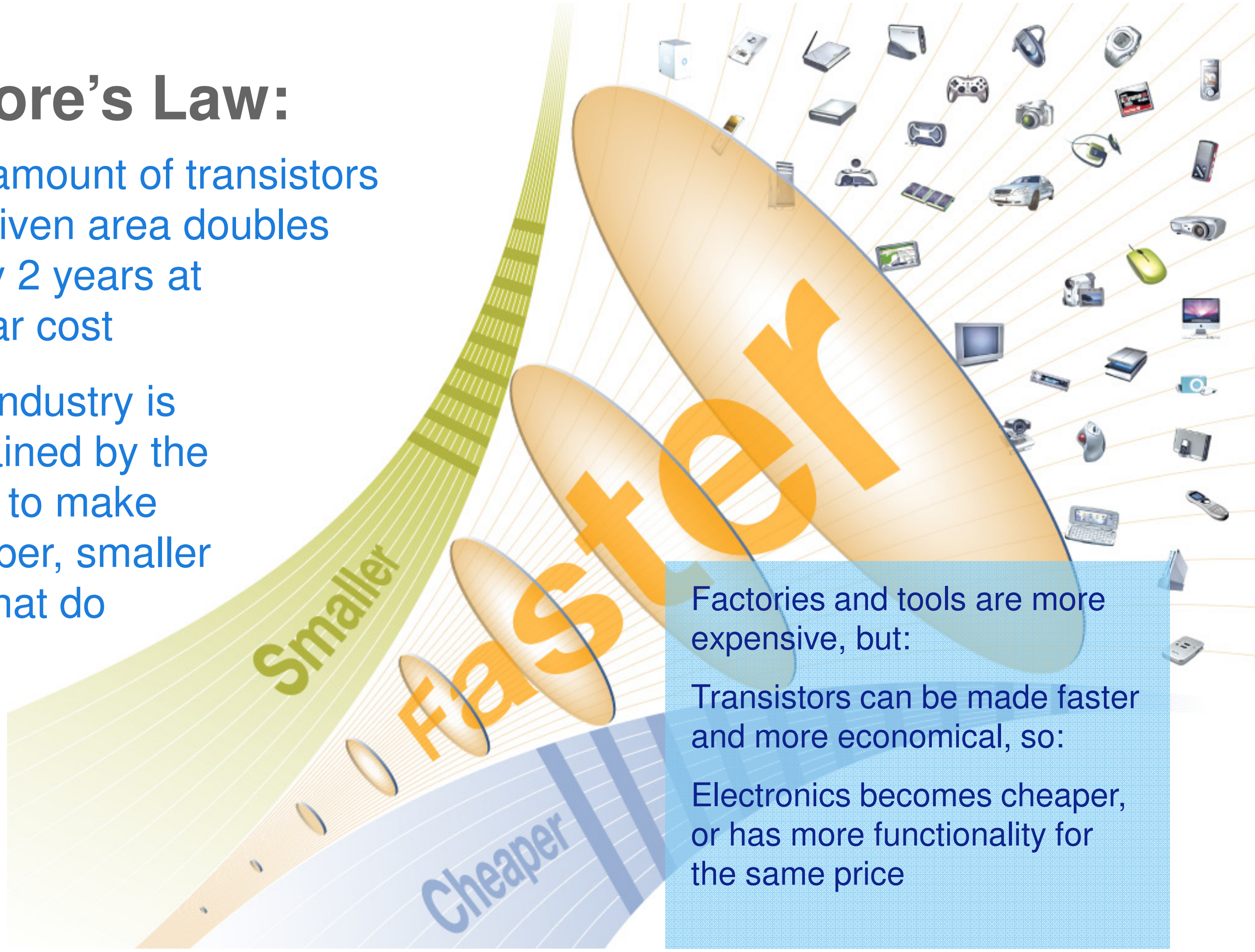
Moore’s Law:

The amount of transistors per given area doubles every 2 years at similar cost

The industry is sustained by the need to make cheaper, smaller ICs that do more



Factories and tools are more expensive, but:

Transistors can be made faster and more economical, so:

Electronics becomes cheaper, or has more functionality for the same price

Driving the semiconductor industry: Moore's Law

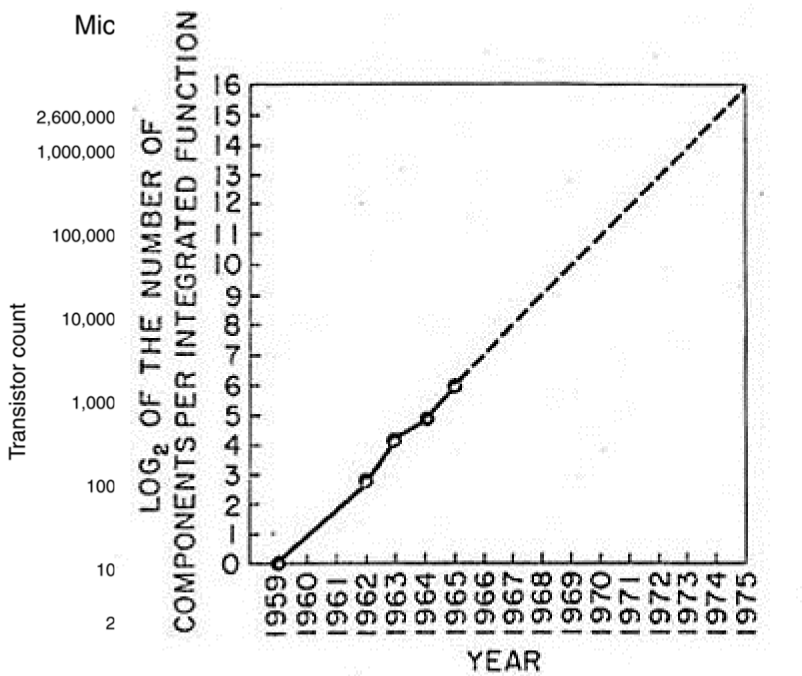
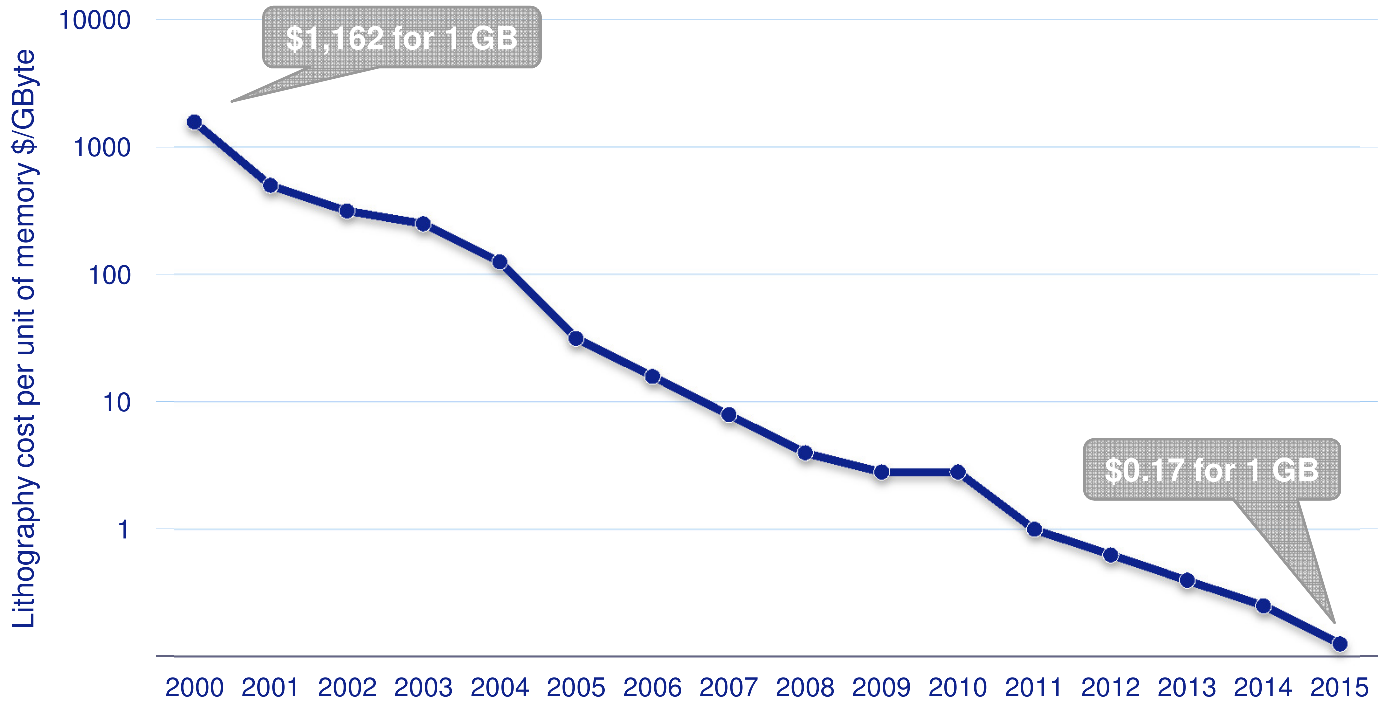


Fig. 2 Number of components per integrated function for minimum cost per component extrapolated vs time.

Gordon Moore (1965): Number of transistors per chip doubles every year.

Later adjusted to two years, the trend has held for more than four decades.

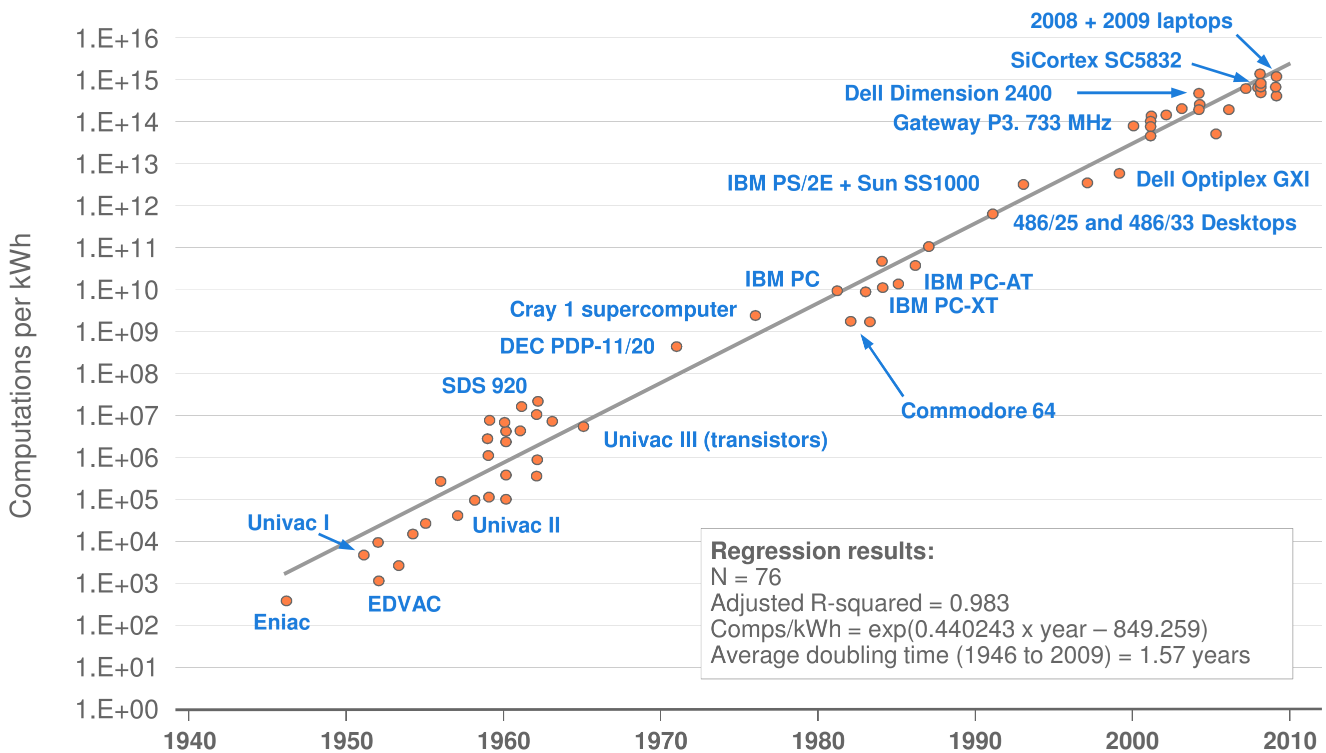
Moore's Law makes chips cheaper…



Source: Gartner. High quality Flash

… and more energy-efficient

Computations per Kilowatt hour double every 1.5 years



Source: Jonathan Koomey, Lawrence Berkeley National Laboratory and Stanford University, 2009

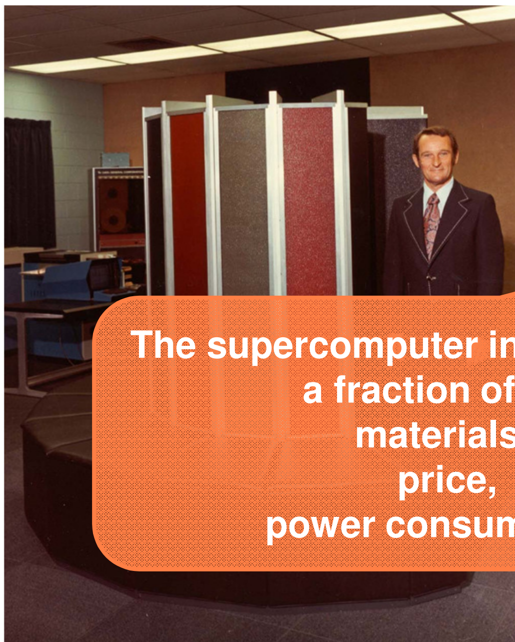
Moore's Law means doing more with less

1976

Cray 1: The first supercomputer

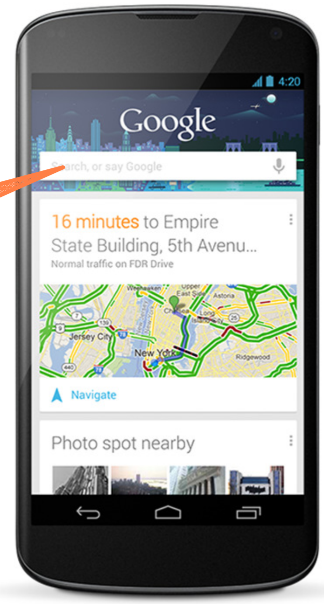
- 8 megabytes of memory
- 5.5 tons
- 150 kilowatt power supply
- "Innovative Freon cooling system"
- $8.8 million ($30 million in today's dollars)

Moore’s Law means doing more with less



**The supercomputer in your pocket:
a fraction of the
materials,
price,
power consumption**

1976



2013

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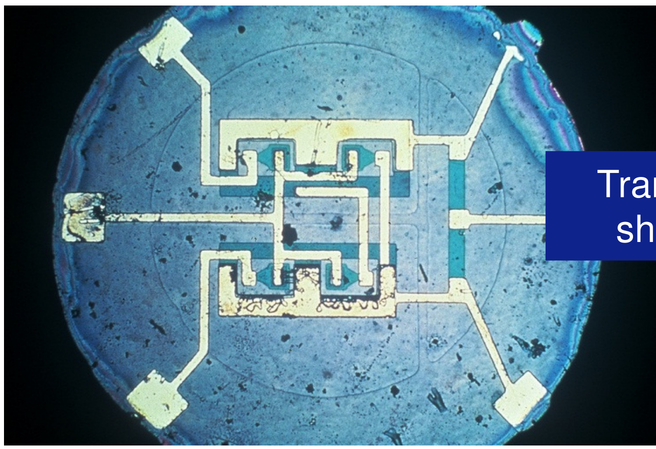
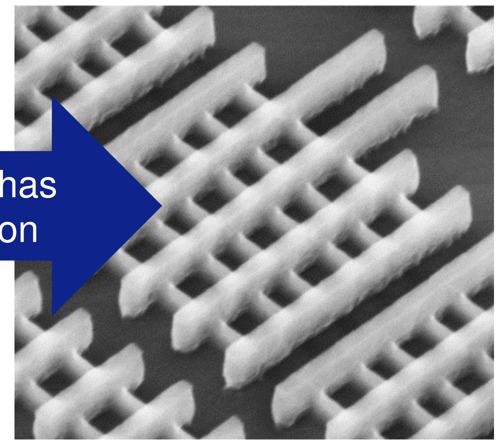
Key to Moore's Law: Making smaller transistors



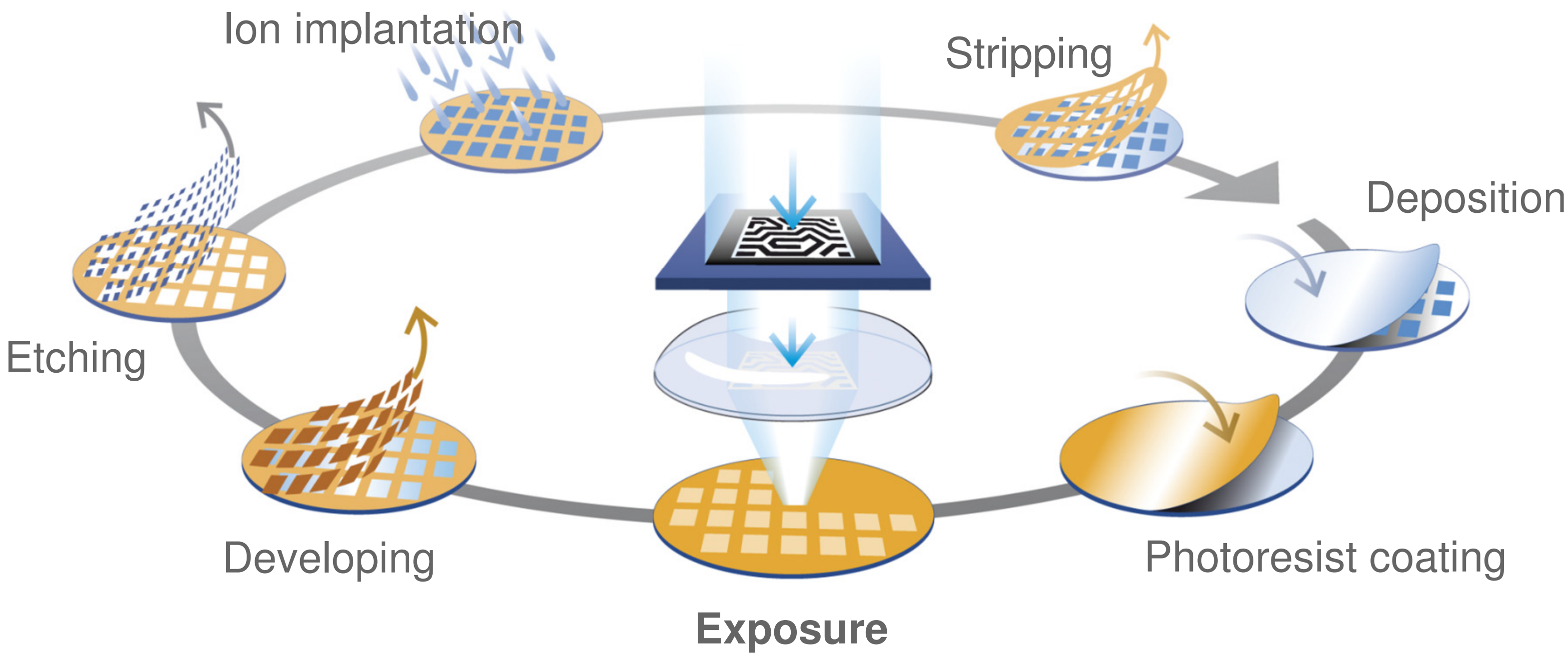
Transistor length has shrunk by a million



The first integrated circuit on silicon, on a **wafer the size of a fingernail**
(Fairchild Semiconductor, 1959)

Today: **More than a billion transistors on the same area**
(Intel, 2012)

The manufacturing loop



How a lithography system works

Keeping up with Moore's Law

PAS 2500

ASML's first successful stepper, 1986

NXT:1970Ci

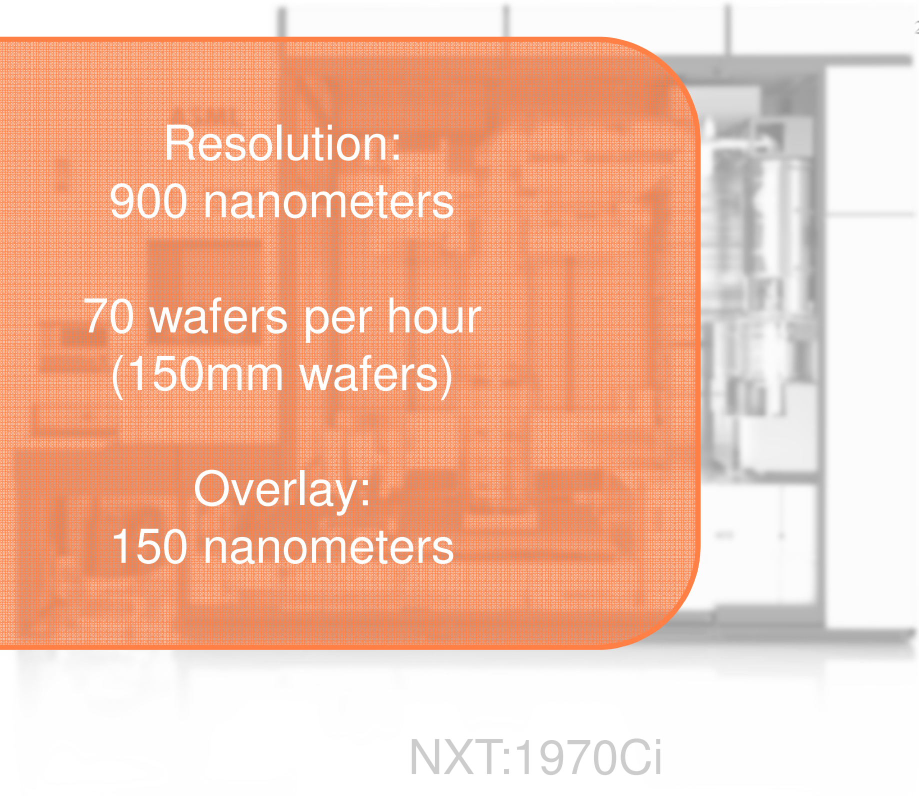
First shipped in Q3 2013

Keeping up with Moore’s Law

Resolution:
900 nanometers

70 wafers per hour
(150mm wafers)

Overlay:
150 nanometers



PAS 2500

ASML’s first successful stepper, 1986

NXT:1970Ci

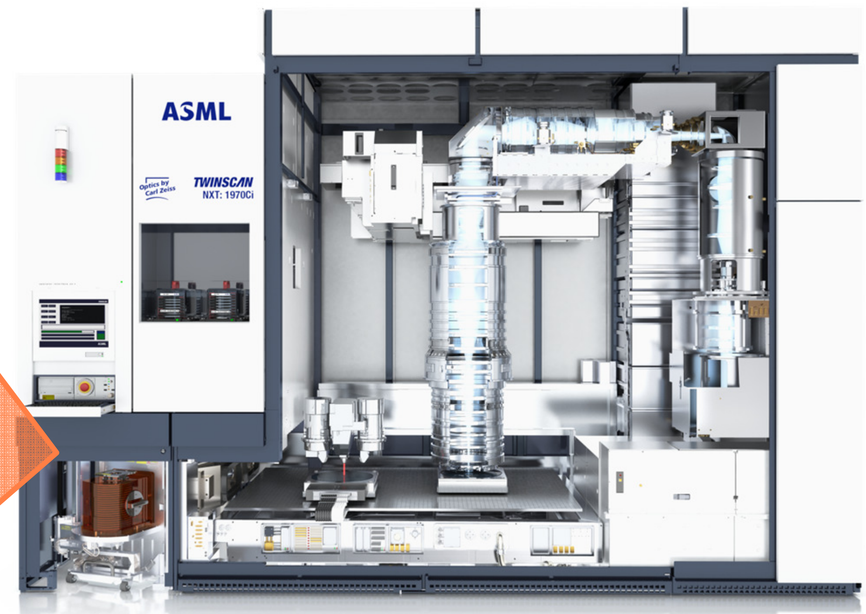
First shipped in Q3 2013

Keeping up with Moore's Law

Resolution:
38 nanometers

250 wafers per hour
(300 mm wafers)

Overlay:
As little as 2 nanometer



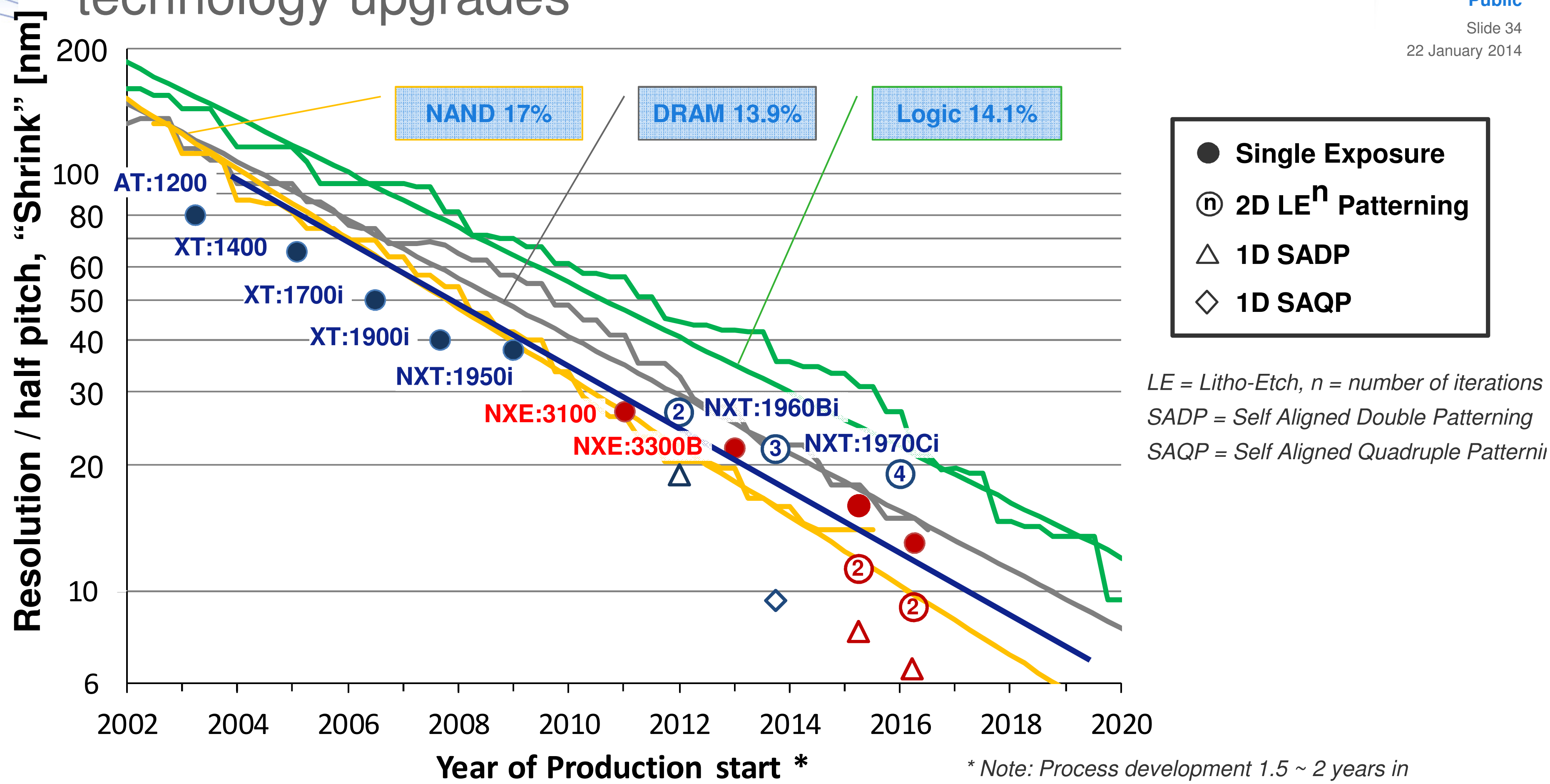
PAS 2500

ASML's first successful stepper, 1986

NXT:1970Ci

First shipped in Q3 2013

Keeping up with Moore's Law requires constant technology upgrades



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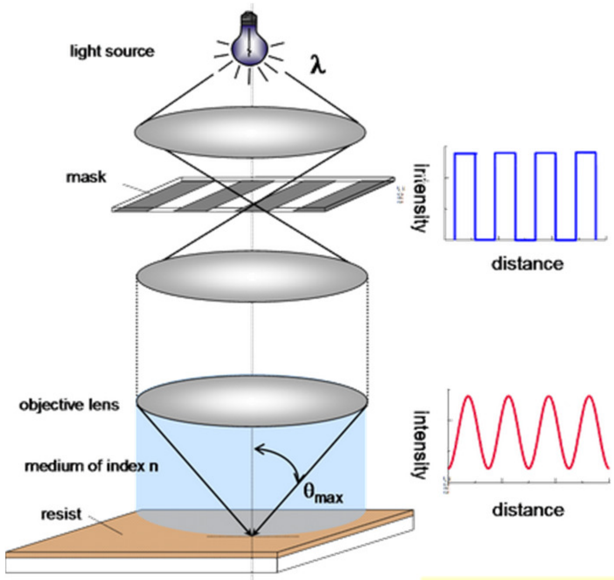
The challenge of ASML engineers

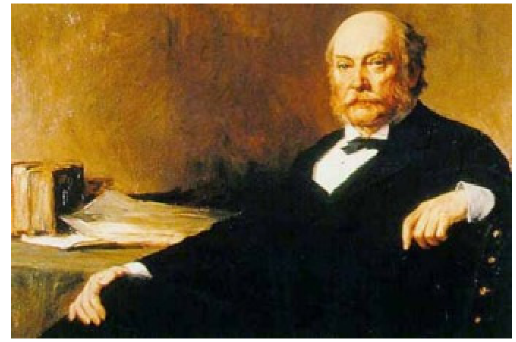
- Make small structures that are all equal within nanometers
- Do that lightning fast
- And put 30 to 40 layers on top of each other within nanometers

AND all at the same time !

The basic rule of lithography



Schematic diagram of the optics of a projection exposure lithography system



John William Strutt, lord Rayleigh

Resolution:

$$R = k_1 \frac{\lambda}{NA}$$

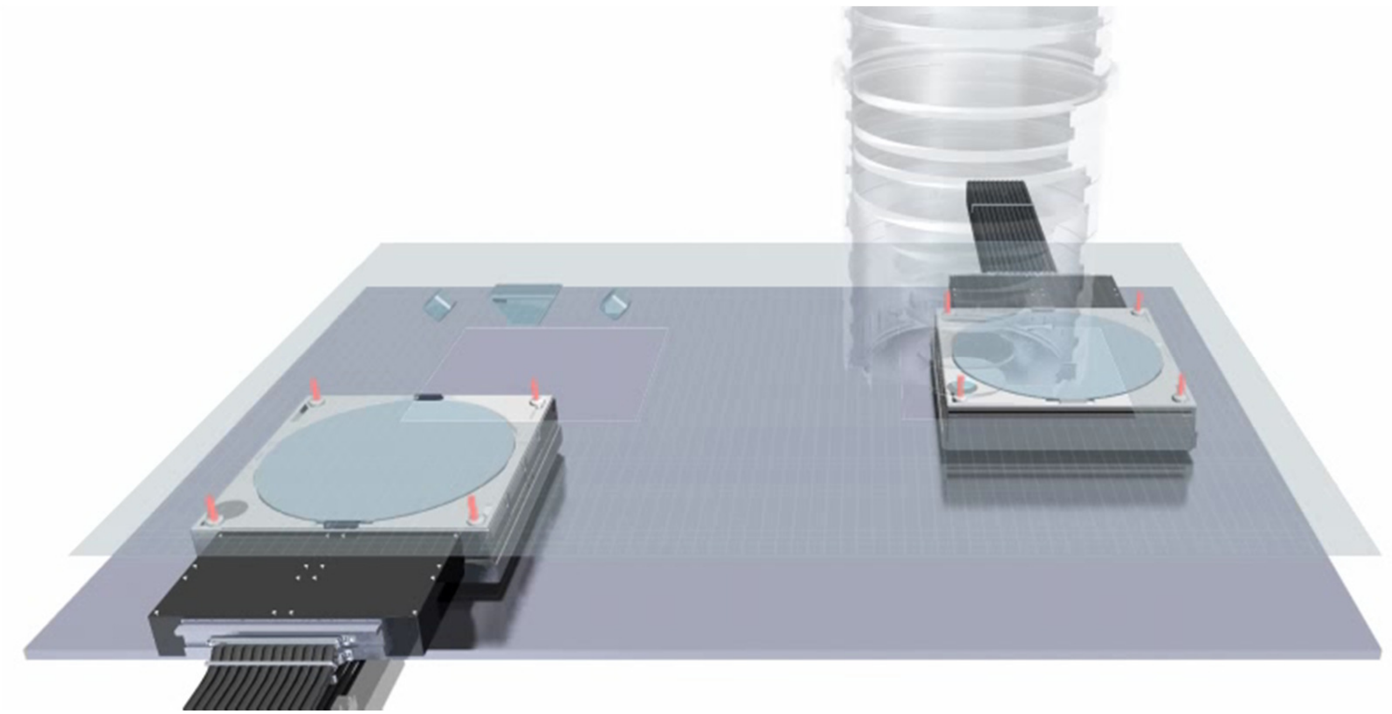
Numerical aperture:

$$NA = n \sin(\Theta)$$

State of the art in production

- Smallest feature: 38nm
- Wavelength: 193nm
- Increase NA: 1.35
- k1: 0.265

Key innovation: TWINSCAN



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ASML

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High R&D spending to sustain technology leadership

1984:
PAS 2000
Resolution:>1µm
overlay: 250 nm

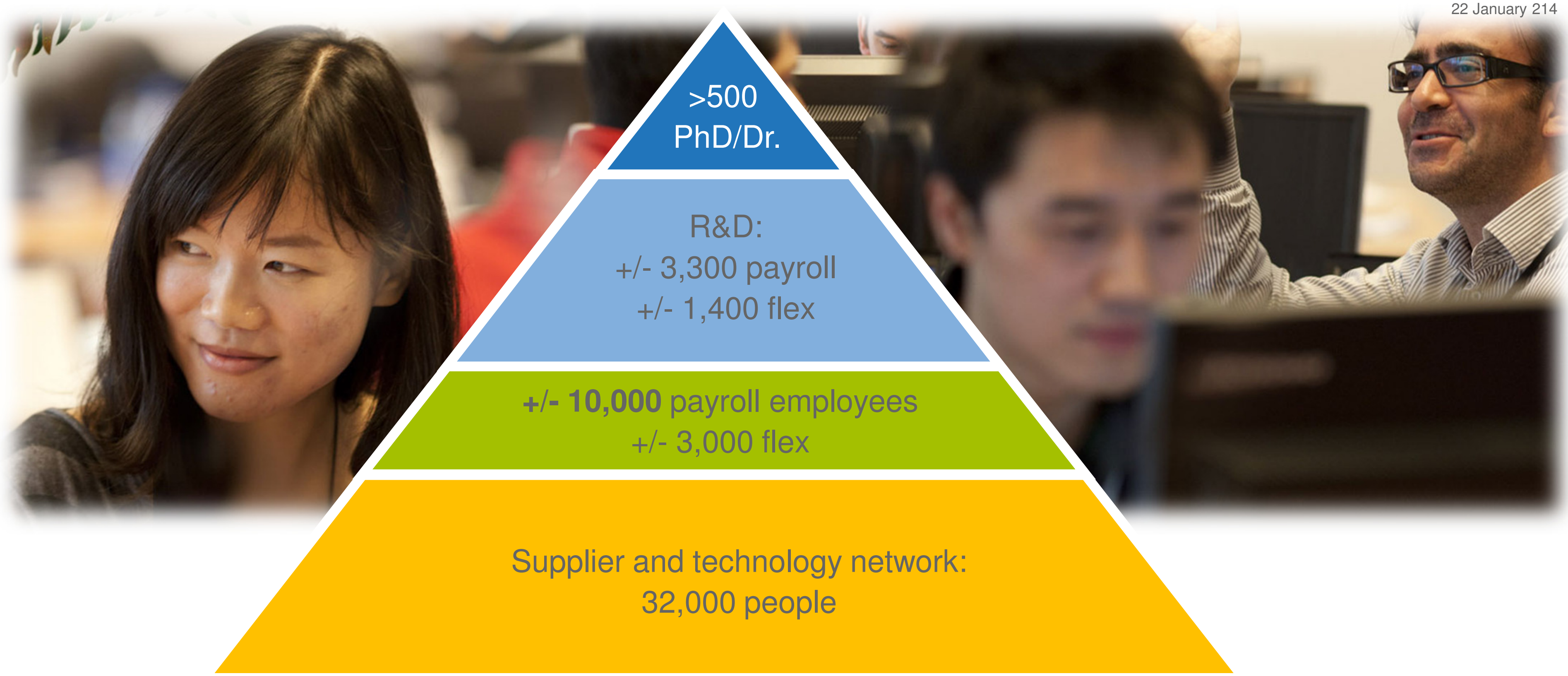
1989:
PAS 5000
Resolution: <500 nm
overlay: 100 nm

1990s:
PAS 5500 (step/scan)
Resolution: 400 to 90 nm
overlay: 100 to 12 nm

2000s:
TWINSCAN
Resolution: 100 to 38 nm
overlay: 20 to 2 nm

2010s:
NXE EUV systems
Resolution: 32 to <18 nm
overlay: <3 nm

Great people in an integrated supply chain



Open Innovation makes complexity and cost manageable

Customers

Technology partners

Suppliers

Academia

ASML