



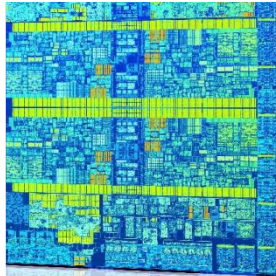
Future Computing Technology part 1 of 3

CERN Academic Training – Oct 2015

Andrzej Nowak

tik. technology
innovation
knowledge

Outline



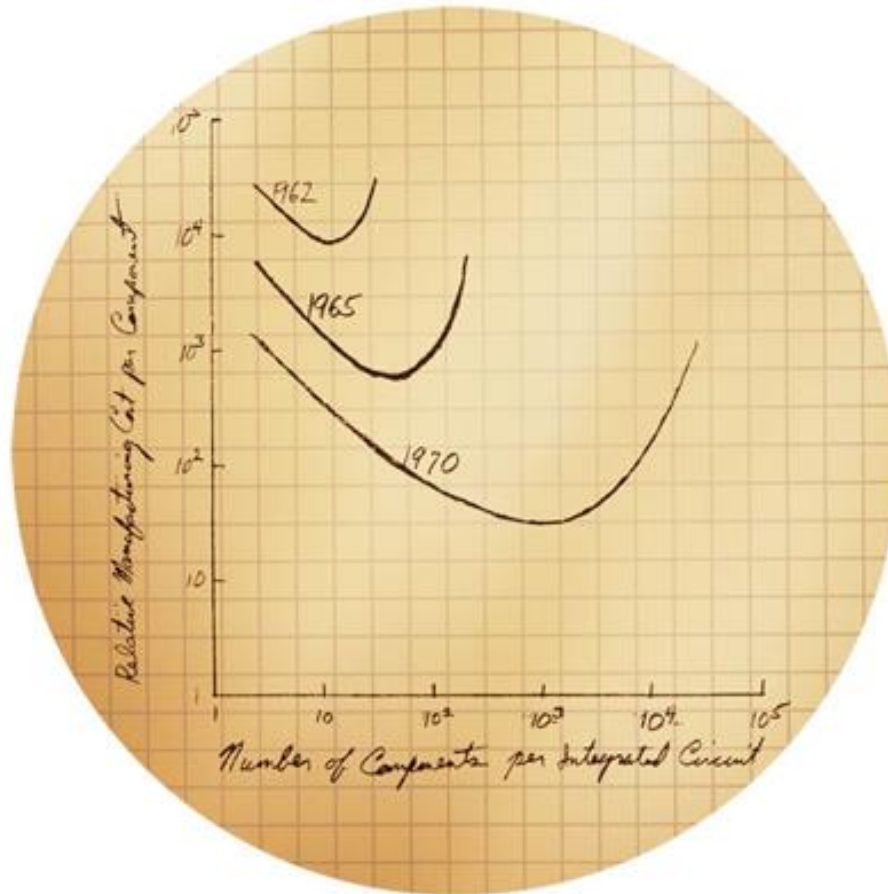
Day 1: Technology

Day 2: Ubiquity



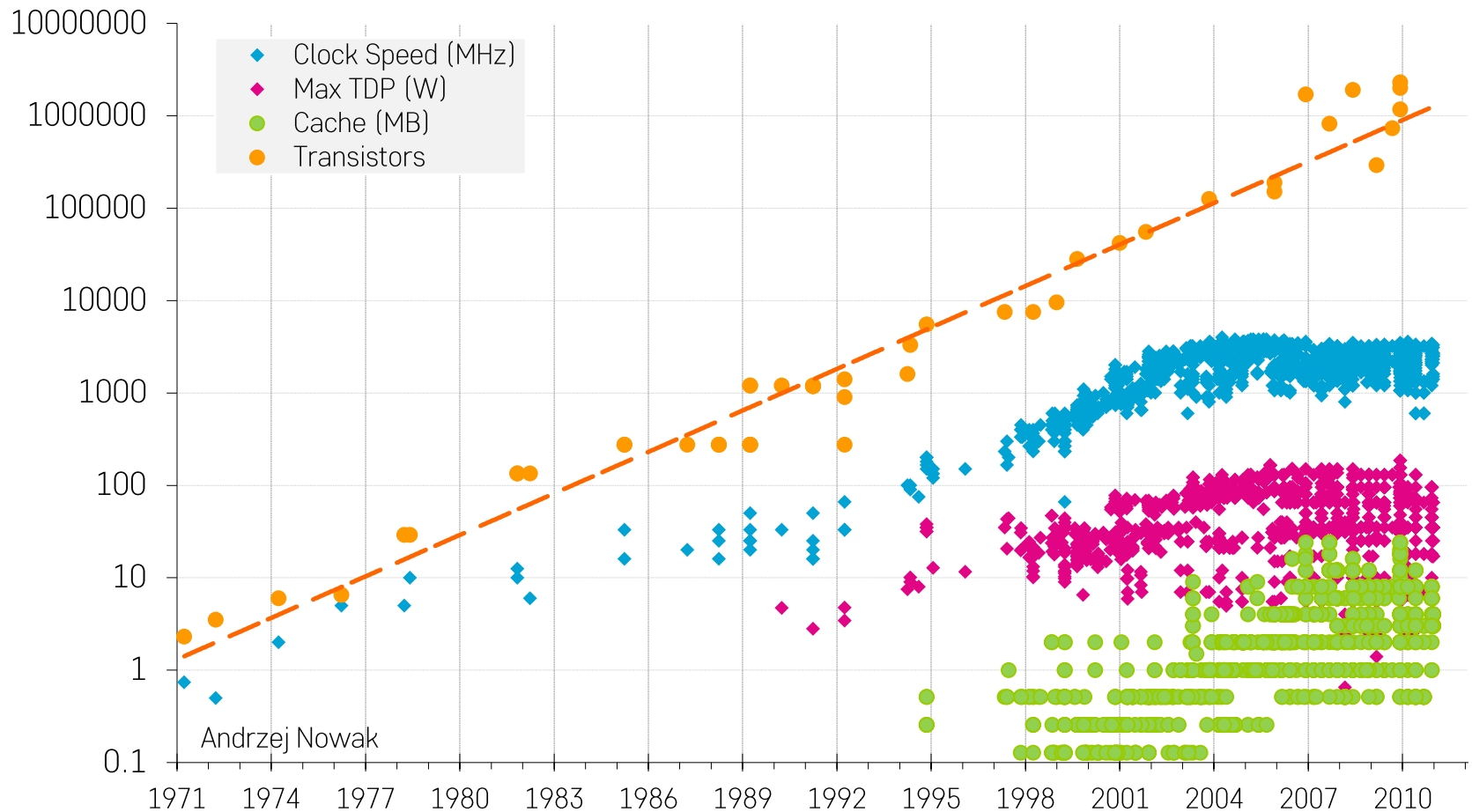
Day 3: Society

Moore's Law



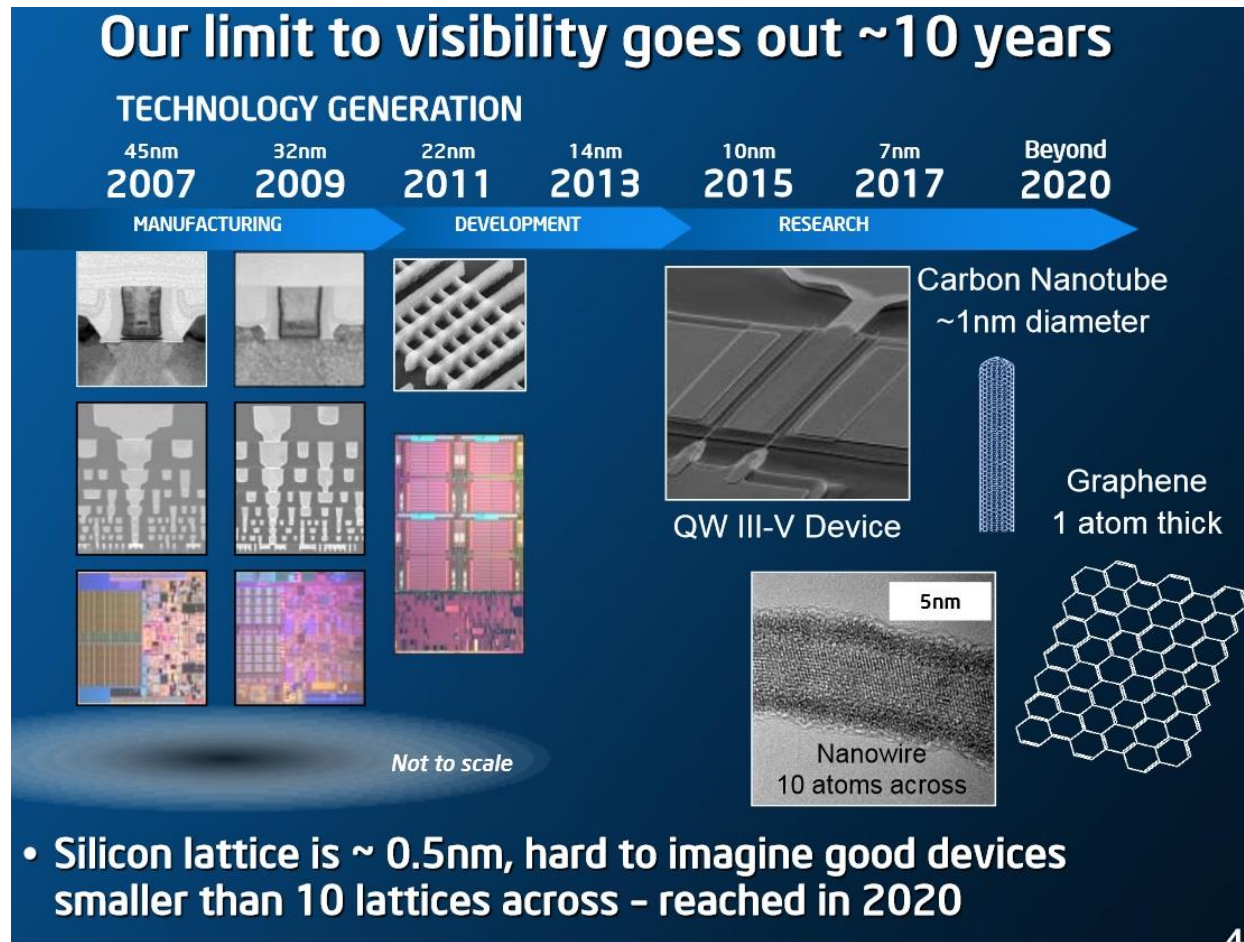
Moore's Law in action

Since 1971 – based on 1'700 Intel CPUs



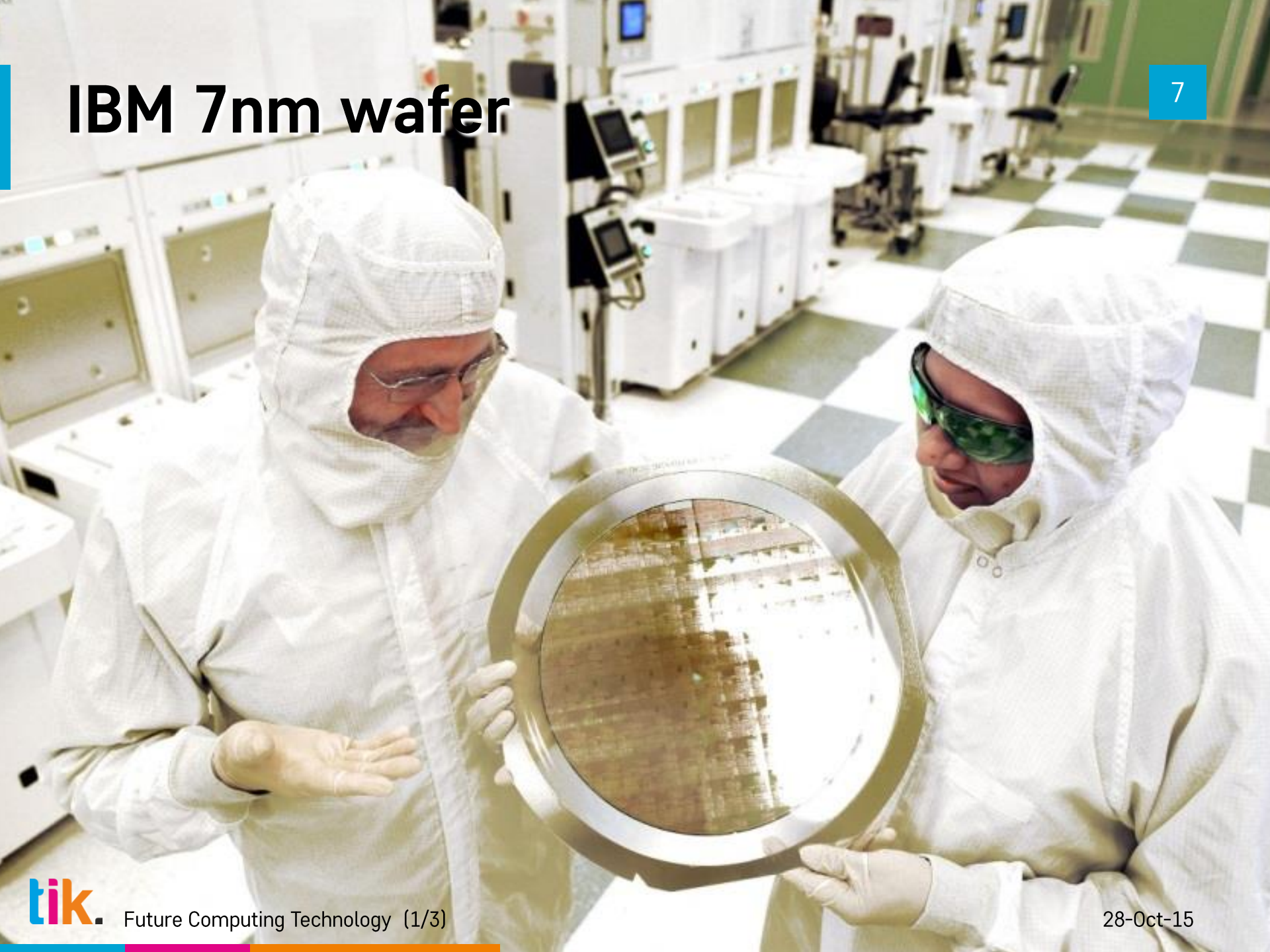
Process technology

A view from Intel from 2010

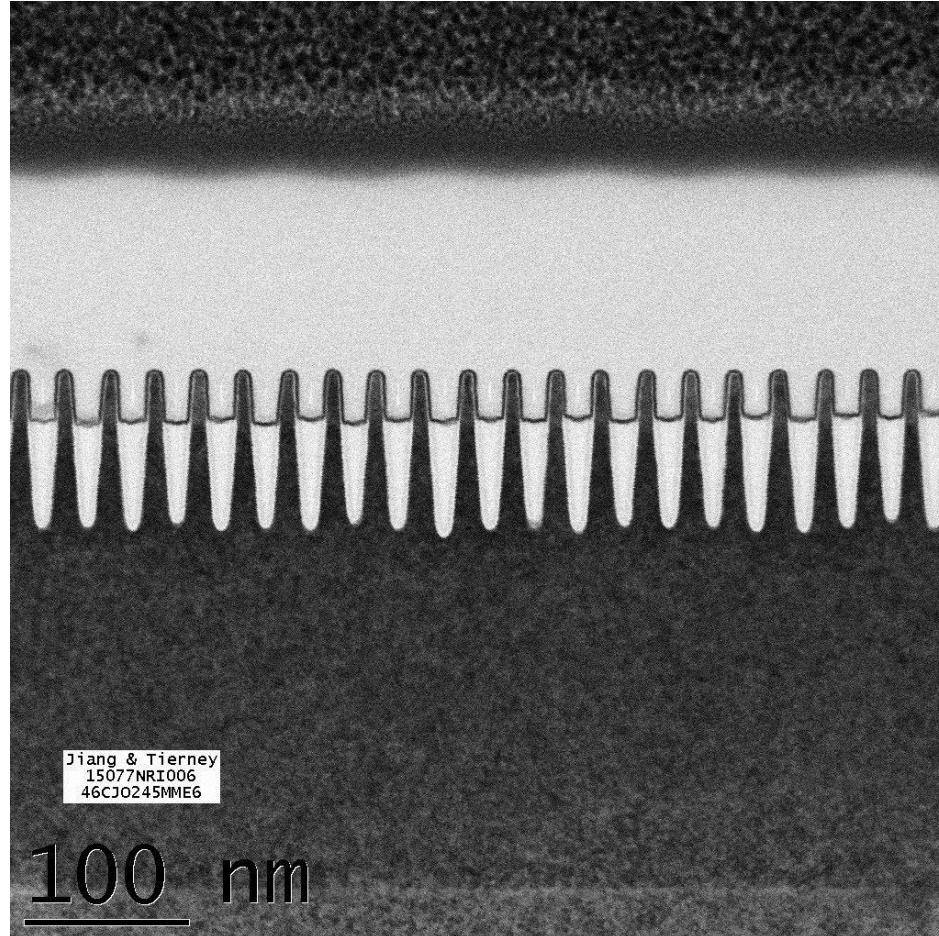


IBM 7nm wafer

7

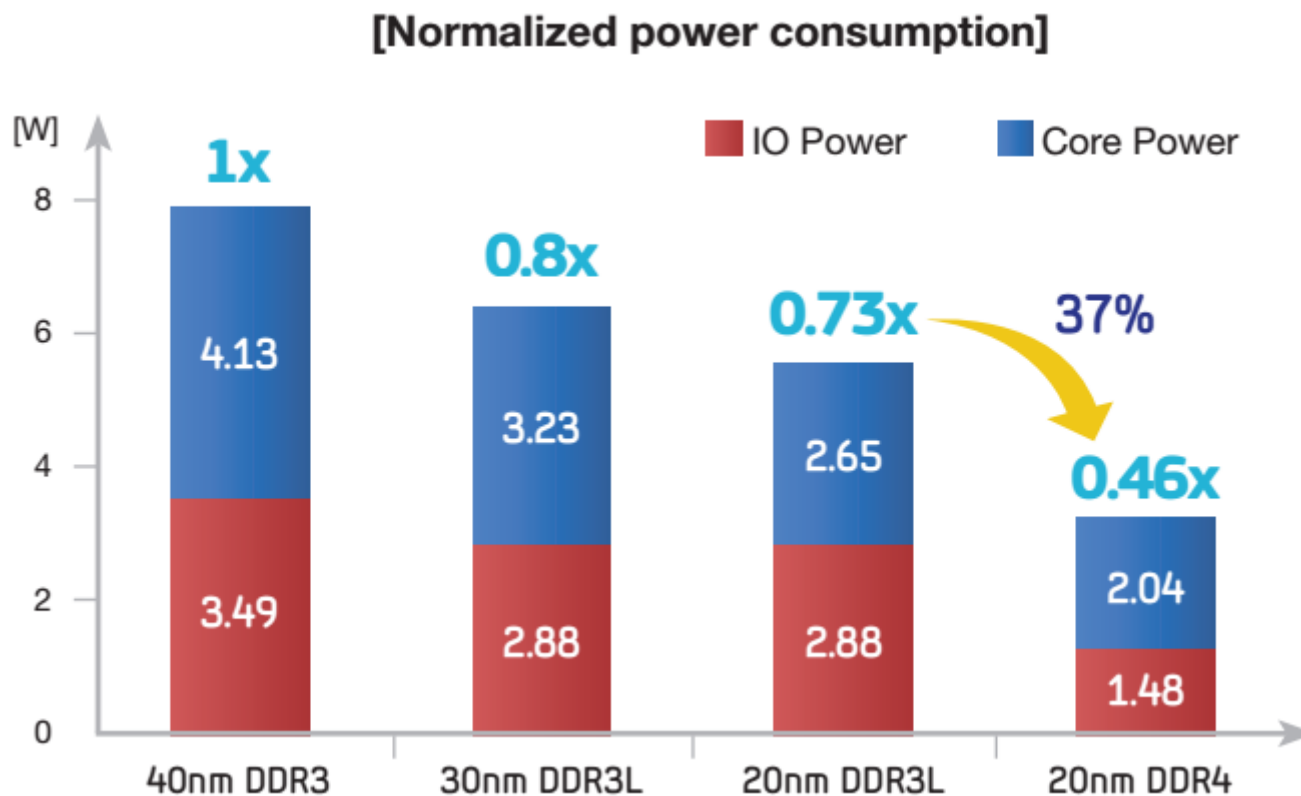


IBM 7nm transistors



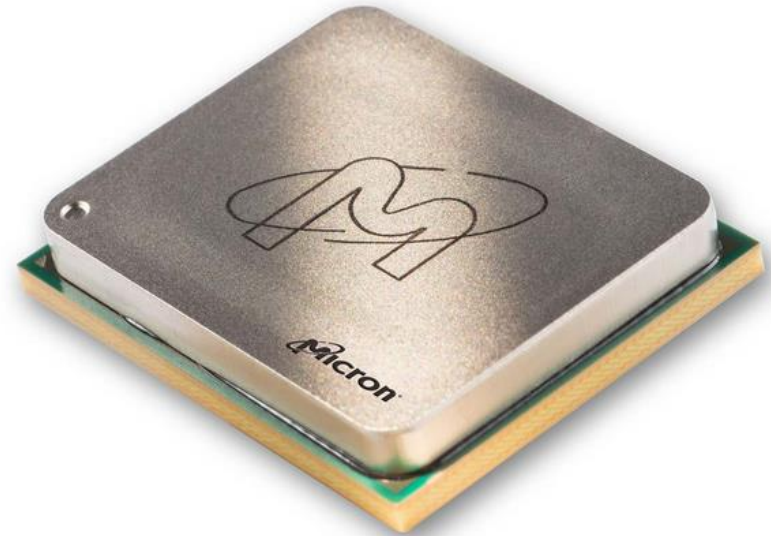
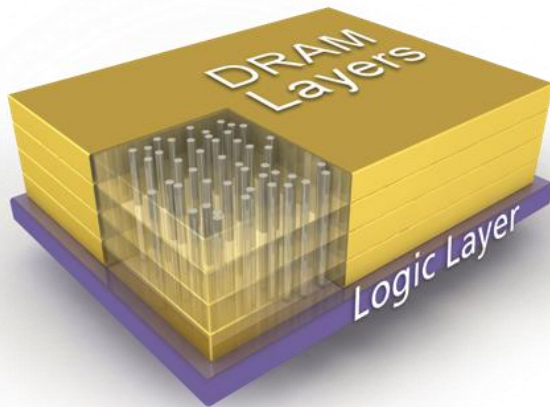
Memory evolution

According to Samsung

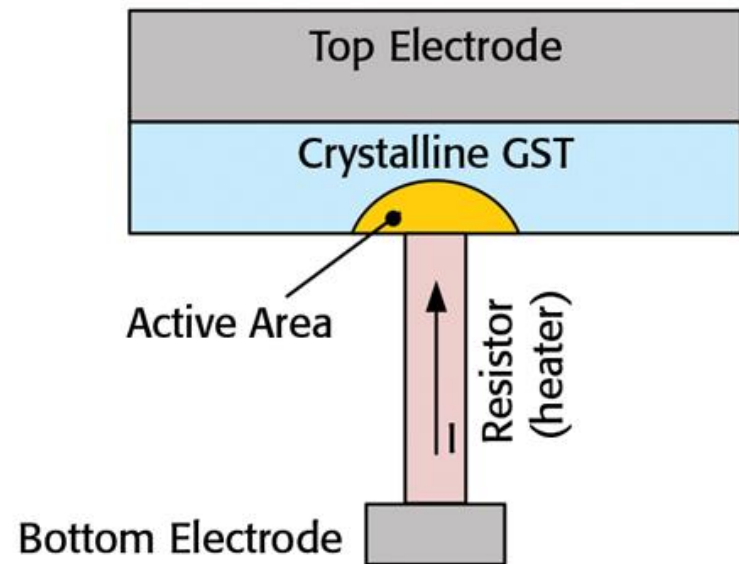
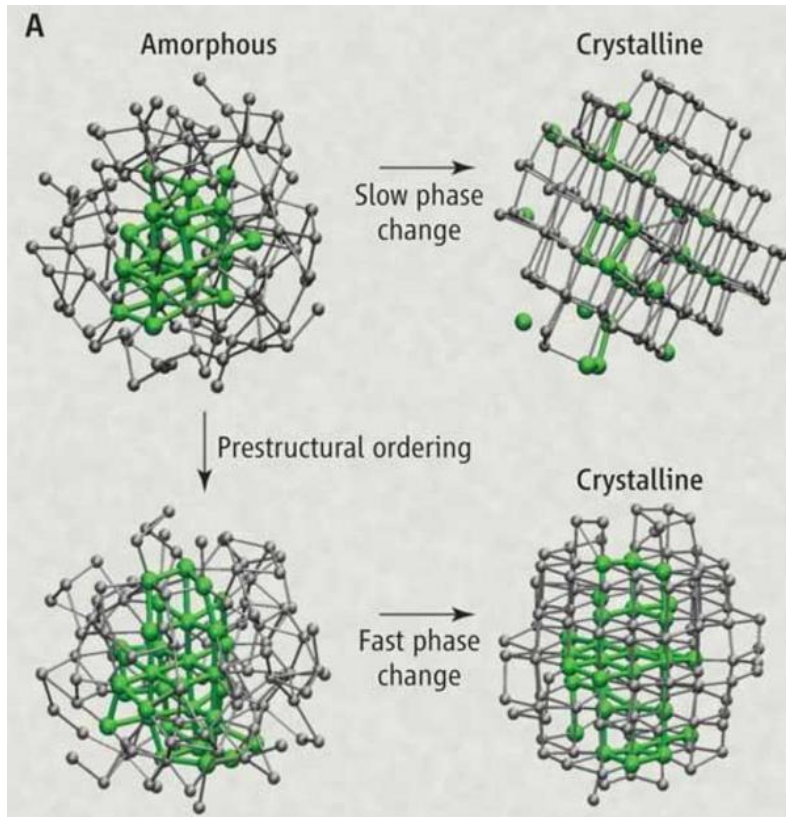


Micron Hybrid Memory Cube

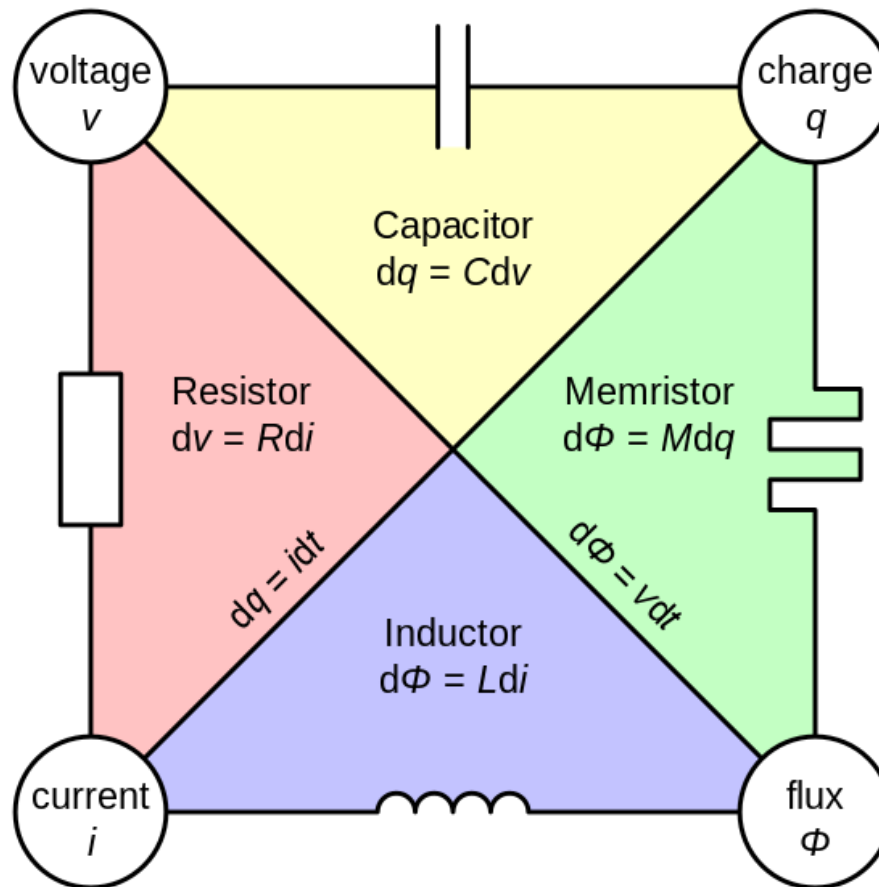
6x more bandwidth, 3x less power vs DDR4



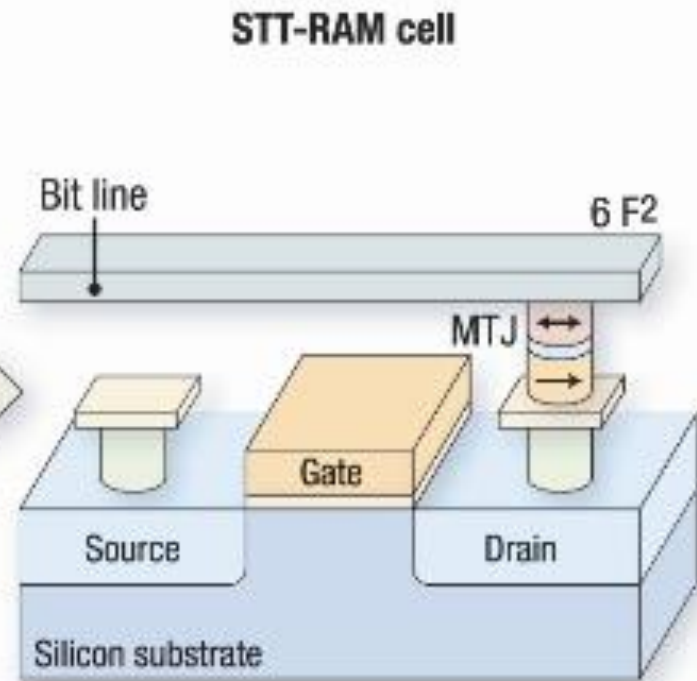
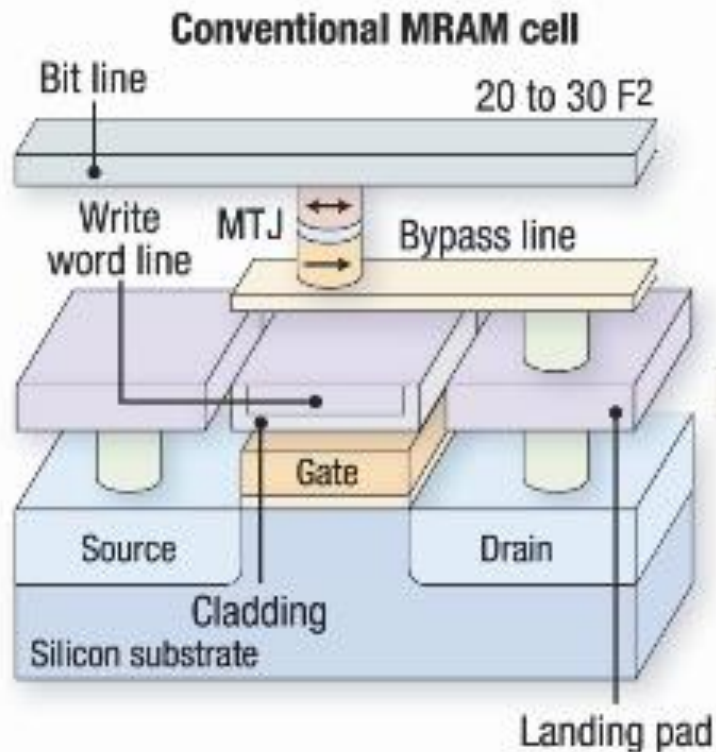
Phase-change Memory



Memristors



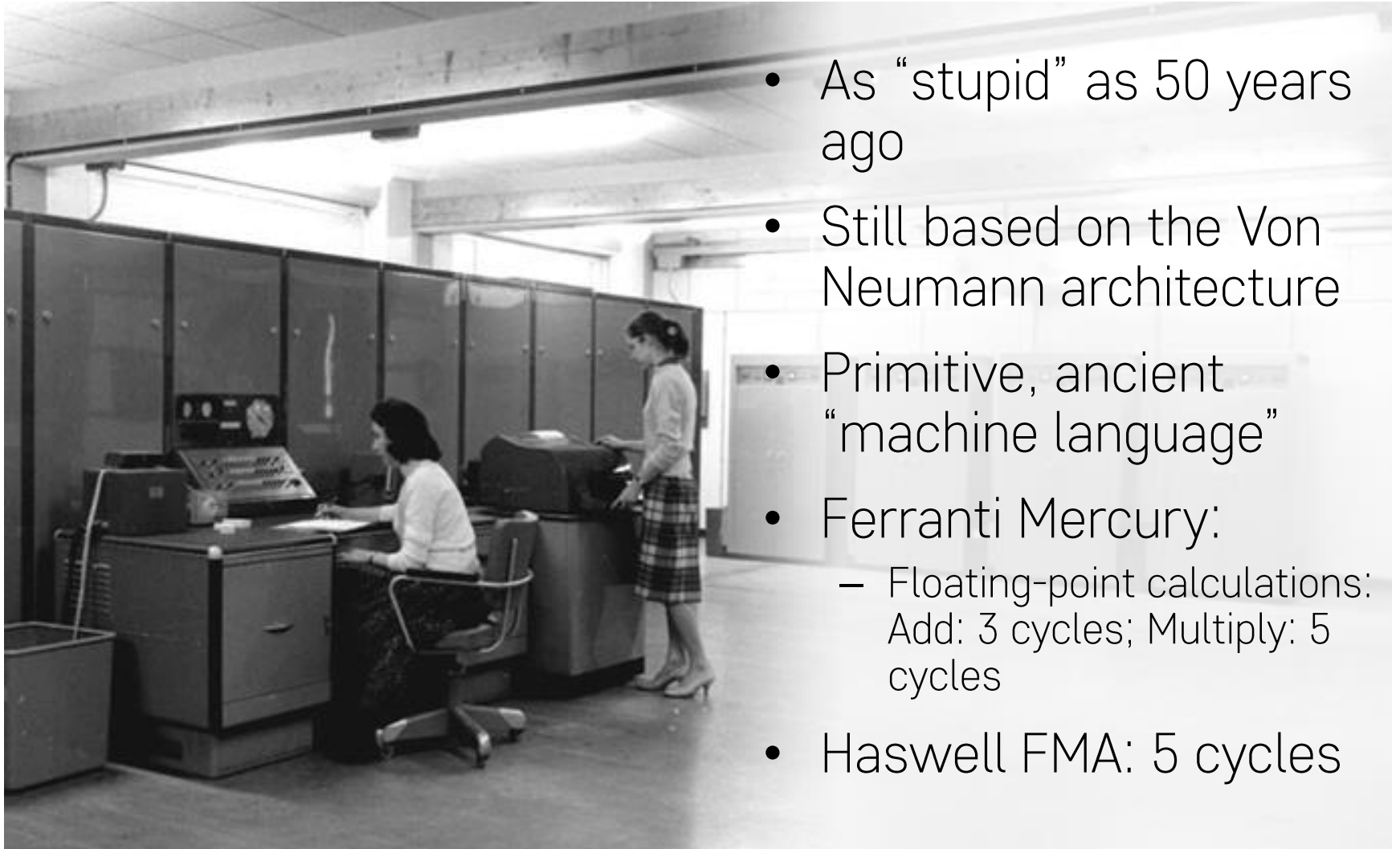
MRAM/STT-MRAM



Source: Grandis

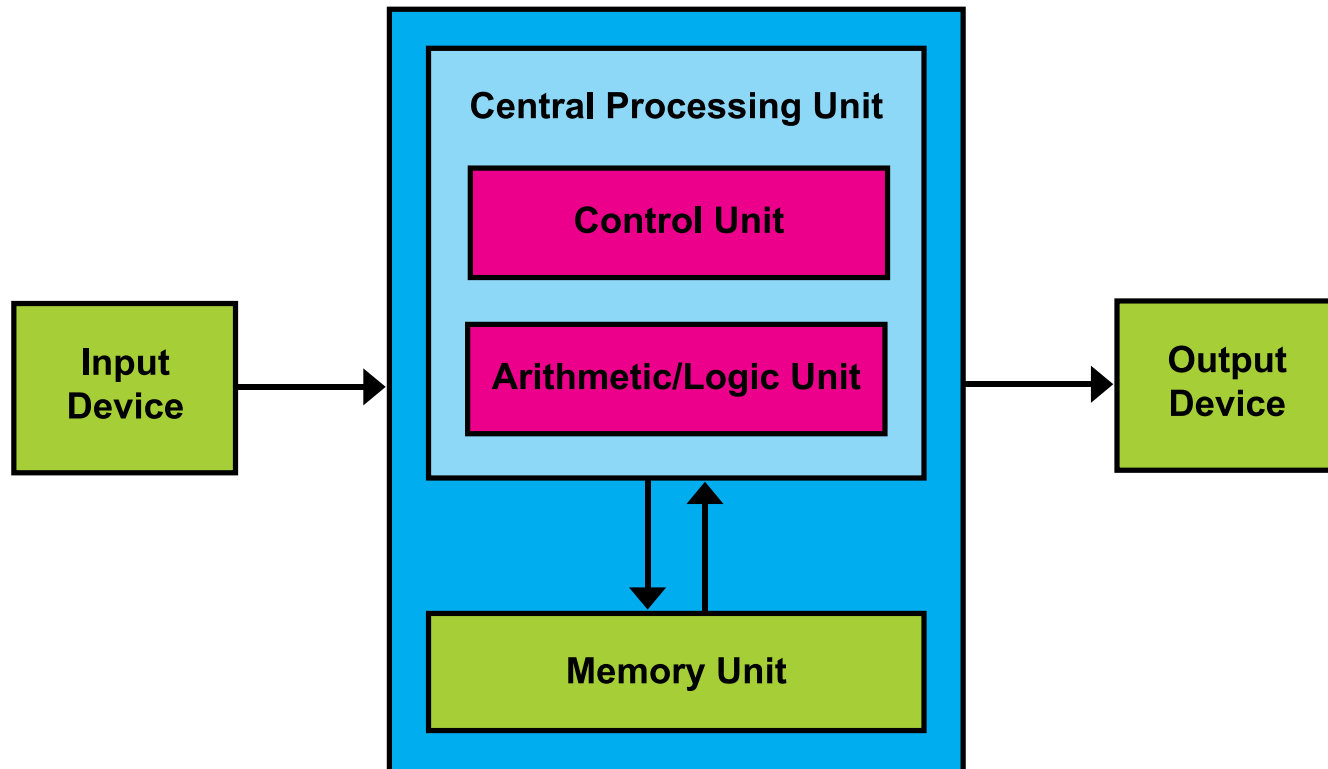
Computers today

14



- As “stupid” as 50 years ago
- Still based on the Von Neumann architecture
- Primitive, ancient “machine language”
- Ferranti Mercury:
 - Floating-point calculations:
Add: 3 cycles; Multiply: 5 cycles
- Haswell FMA: 5 cycles

Von Neumann model



Processors are still growing

More cores

COD Mode for 18C E5-2600 v3

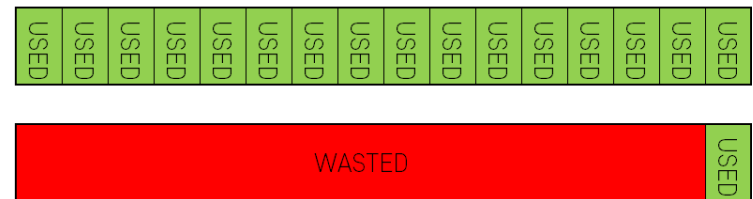


More data parallelism

Earlier

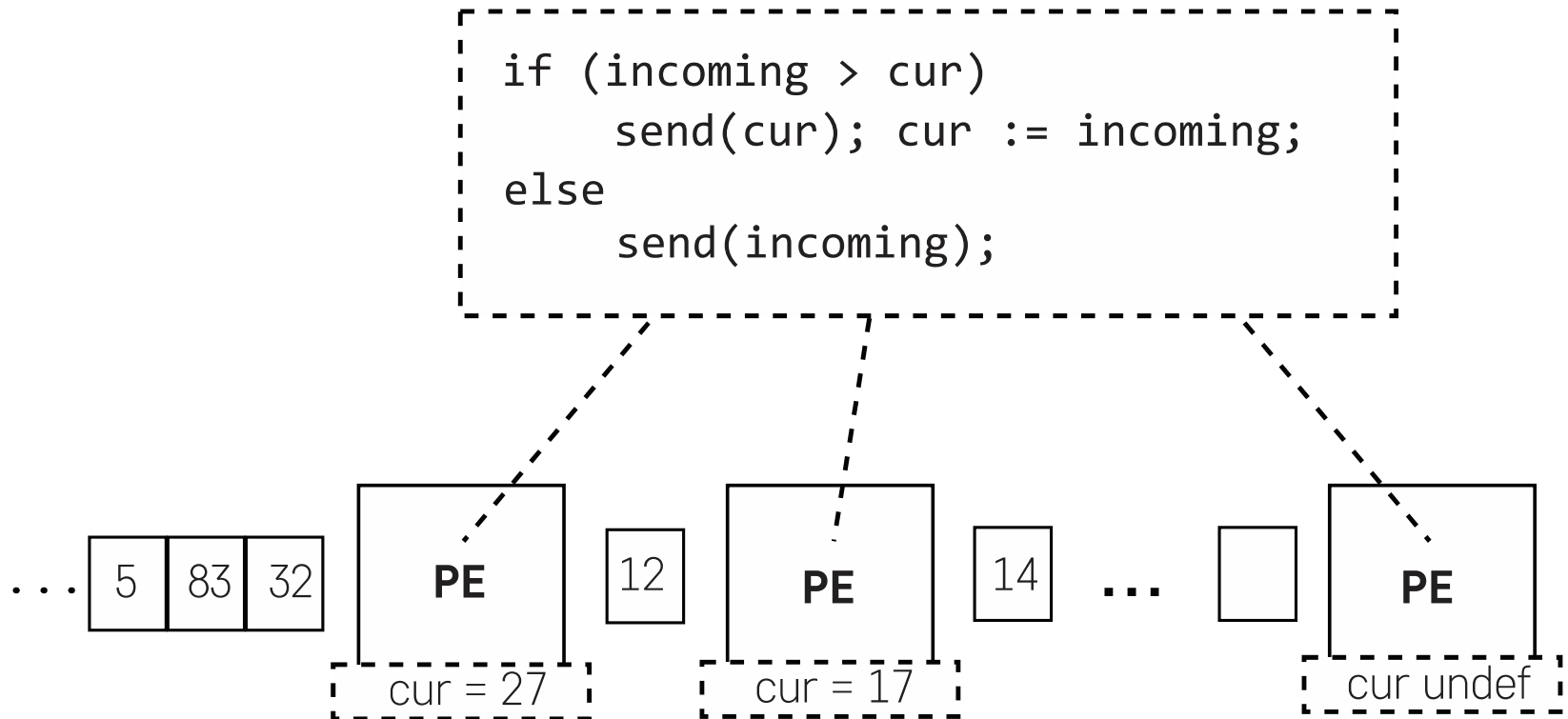


Now



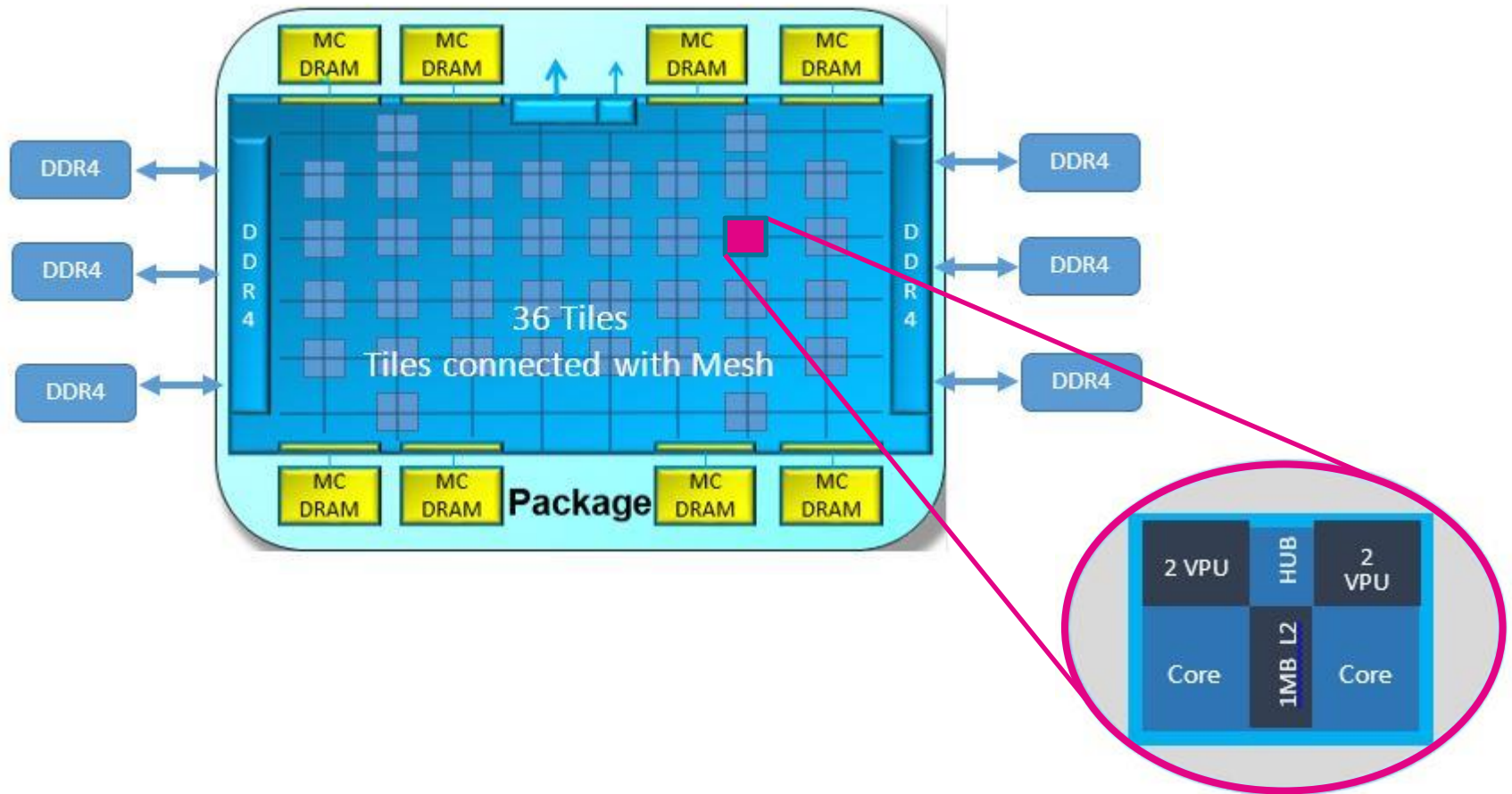
Spatial architectures

Triggered instructions



Intel Xeon Phi

“Knights Landing” a.k.a. x200

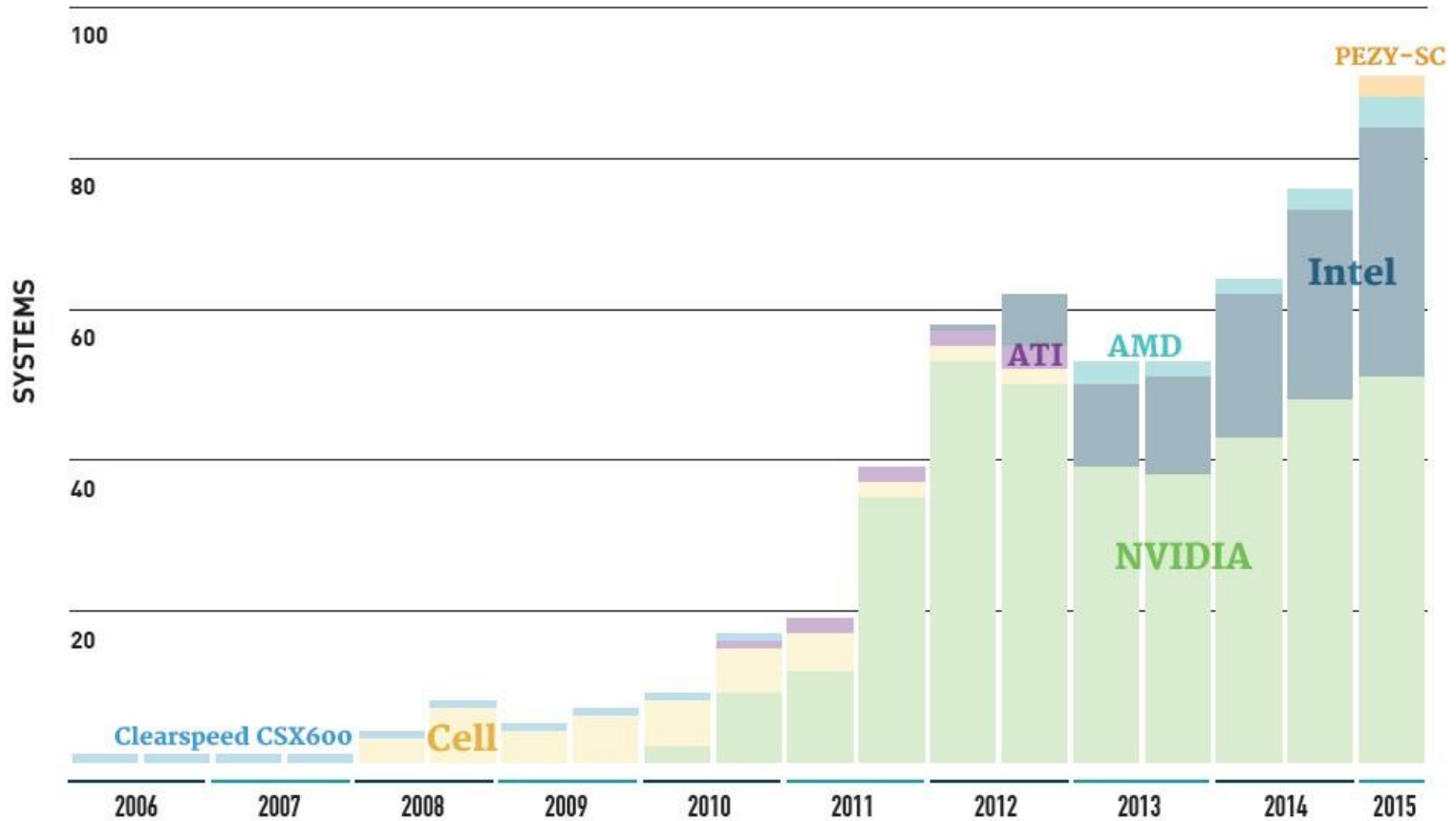


Images: Intel Developer Zone

28-Oct-15

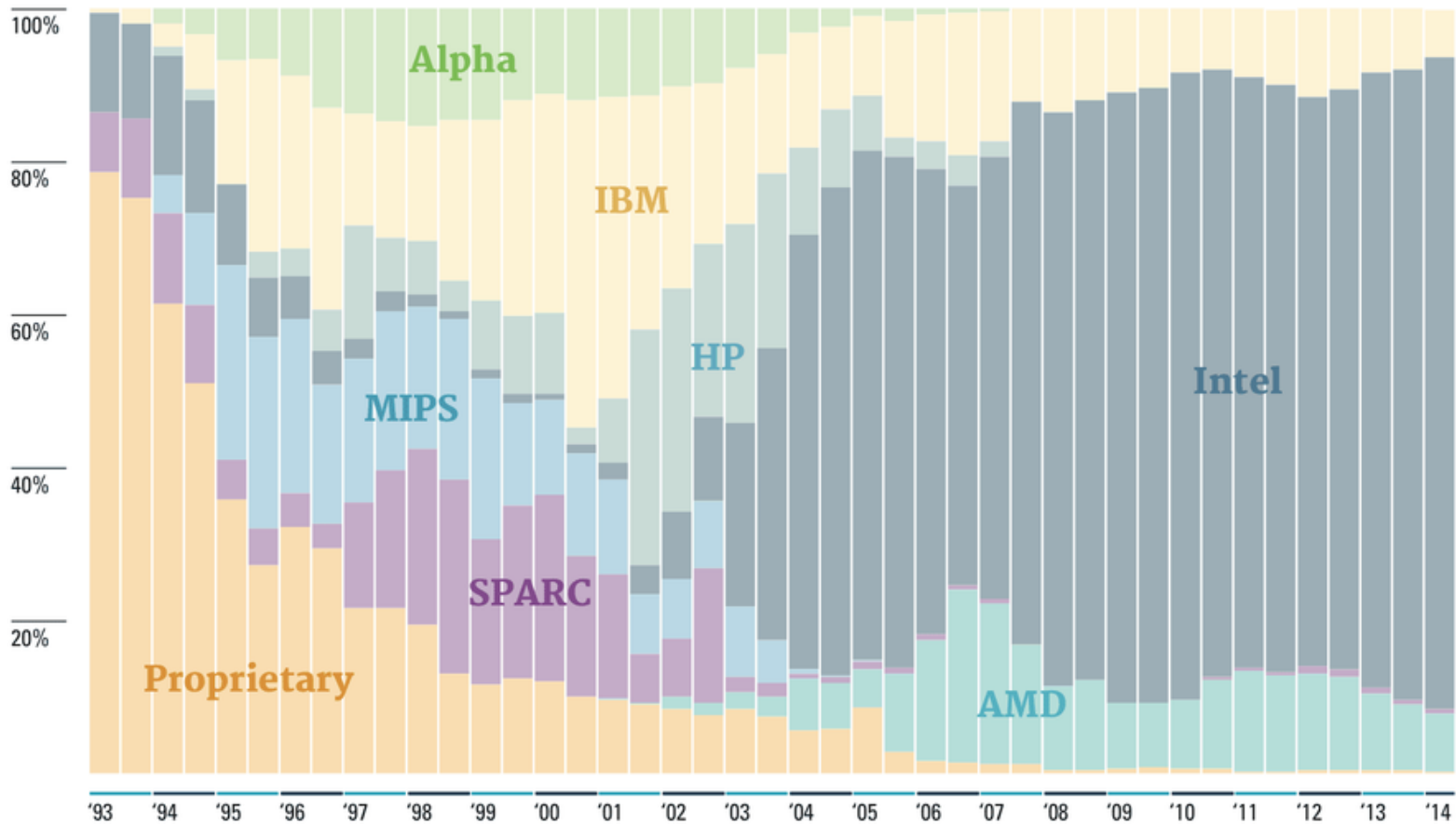
Top500 Accelerators

ACCELERATORS/CO-PROCESSORS



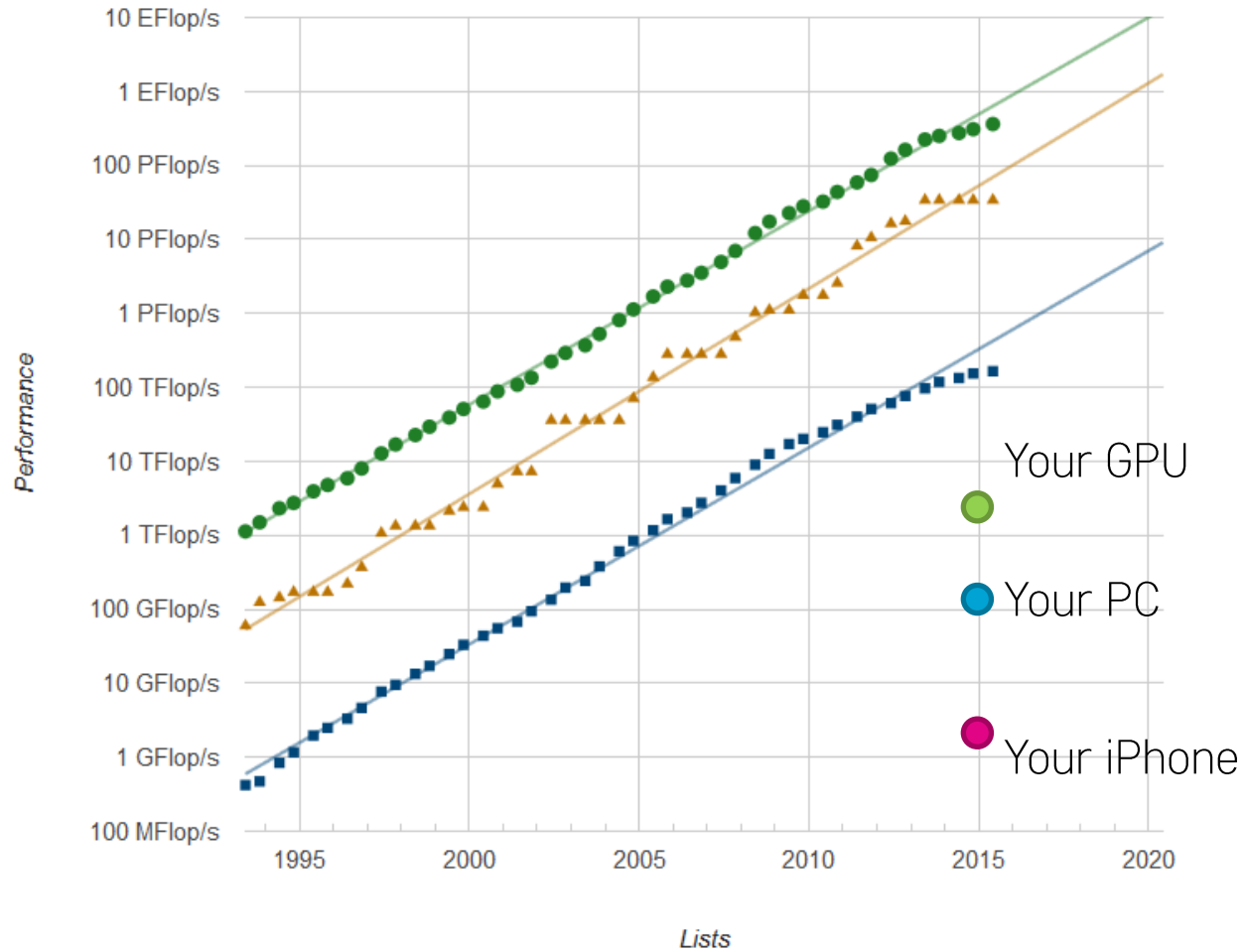
Top500 Manufacturers

CHIP TECHNOLOGY



Top500

Projected Performance Development



Supercomputers



EDITION: ▾

ZDNet 🔍

CENTRAL EUROPE MIDDLE EAST SCANDINAVIA AFRICA UK ITALY SPAIN MORE ▾ NEWSLETTERS ALL WRITERS 👤

Obama orders creation of exascale supercomputer

Can the president's executive order prompt the development of computer systems capable of running at 1 exaflops?

 By [Charlie Osborne](#) for [Between the Lines](#) | July 30, 2015 -- 07:56 GMT (08:56 BST) | Topic: [Innovation](#)



RELATED STORIES



Government : AU
Government launches first of five AU\$225m Growth Centres



Innovation
Ringly review: Handy little messenger that passes as a ring



Microsoft
Surface Book suffers from launch day bugs



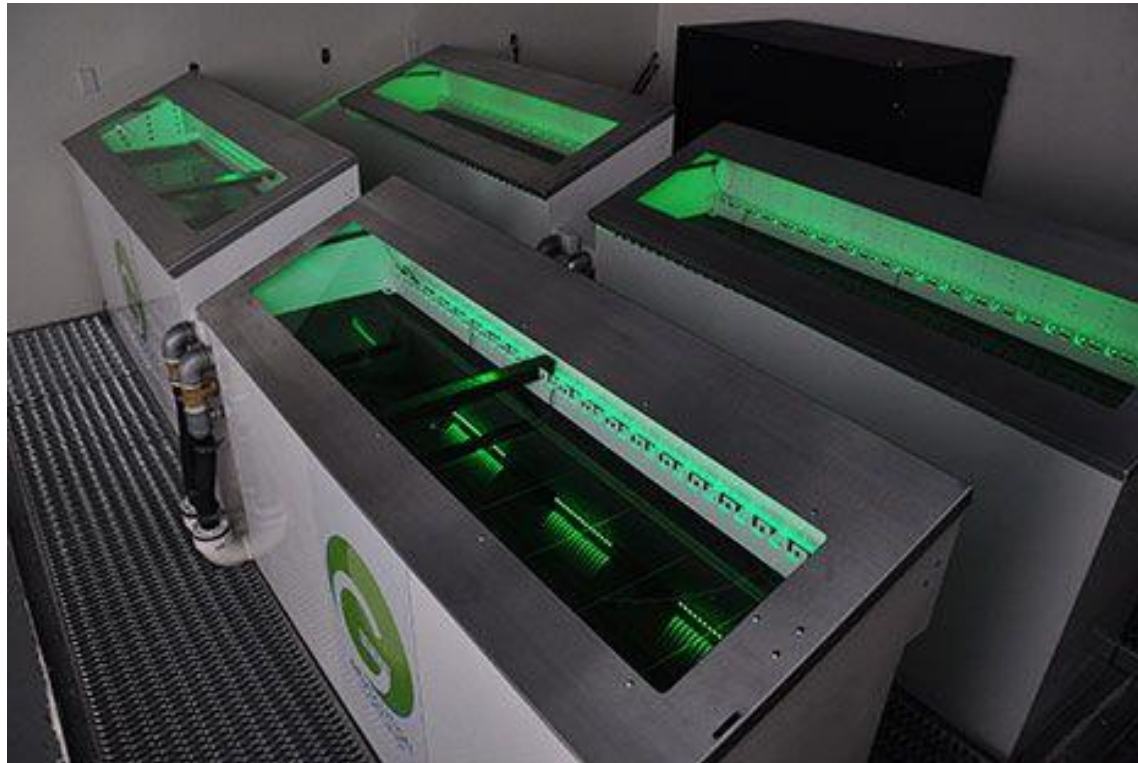
Big Data Analytics
Moaning about medicine on Twitter? How those tweets could help scientists

NEWSLETTERS

Datacenters of the future

Submersion cooling

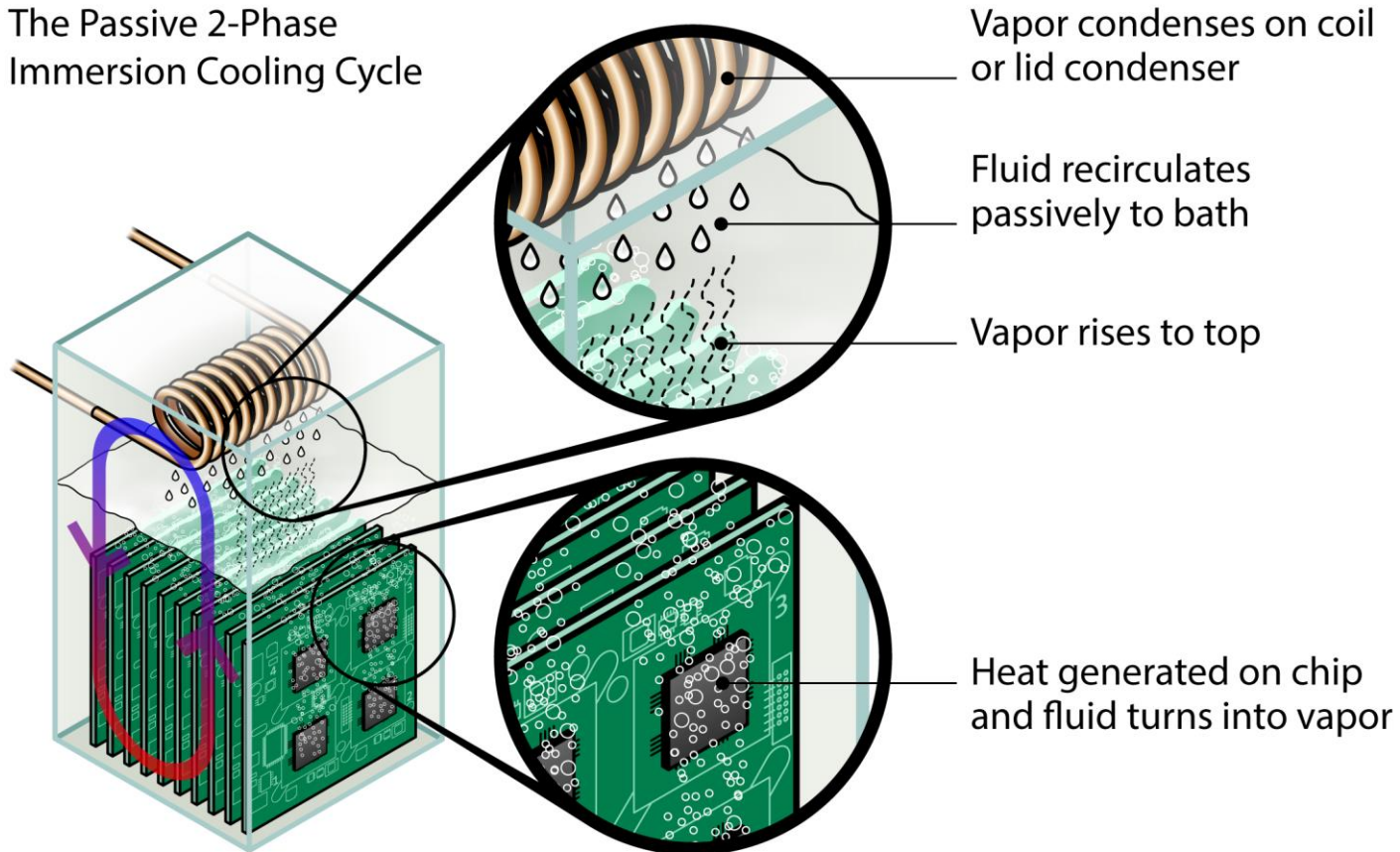
24



Datacenters of the future

Submersion cooling

The Passive 2-Phase
Immersion Cooling Cycle



© 2013 Copyright Allied Control, all rights reserved.

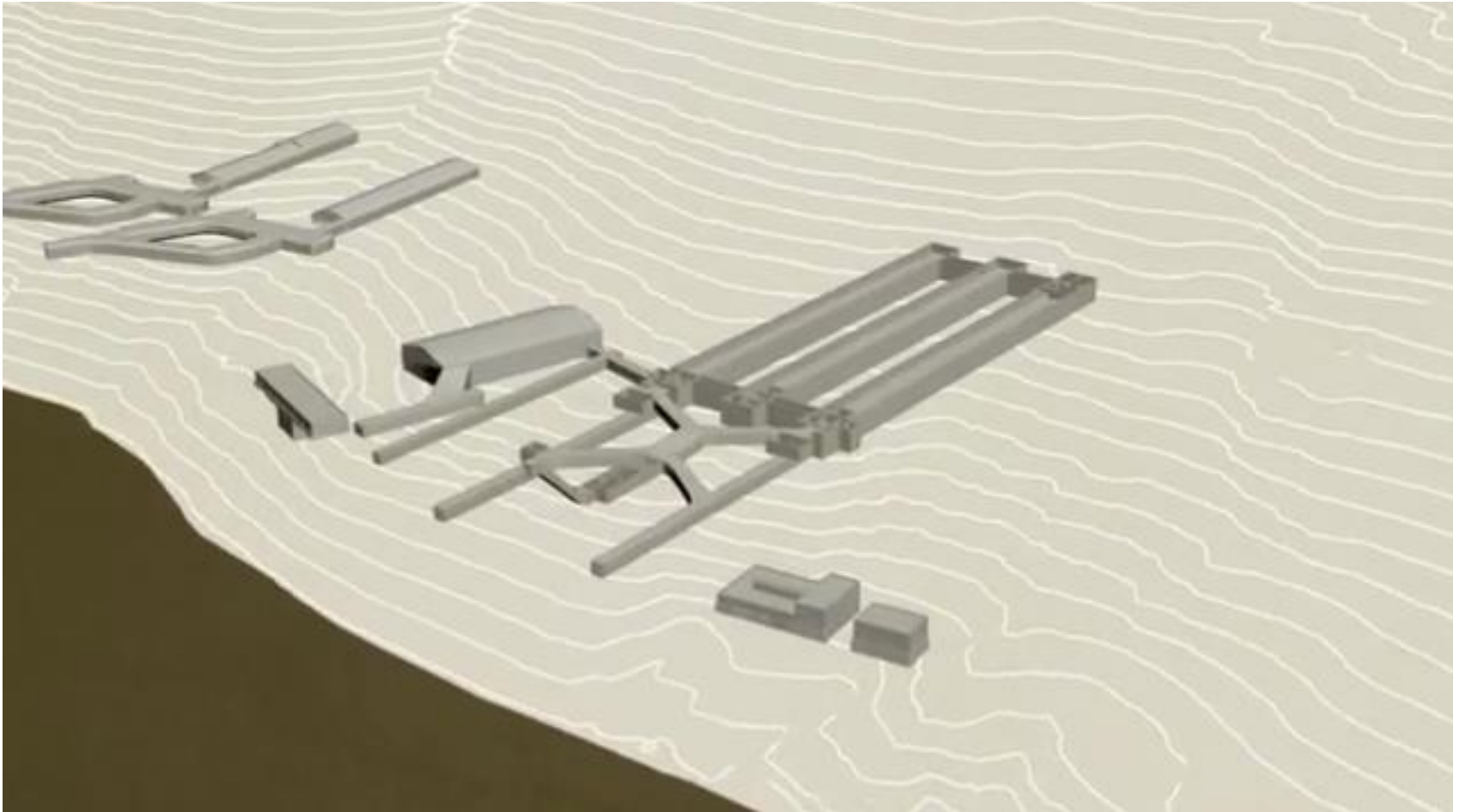
Datacenters of the future

Climate change

26

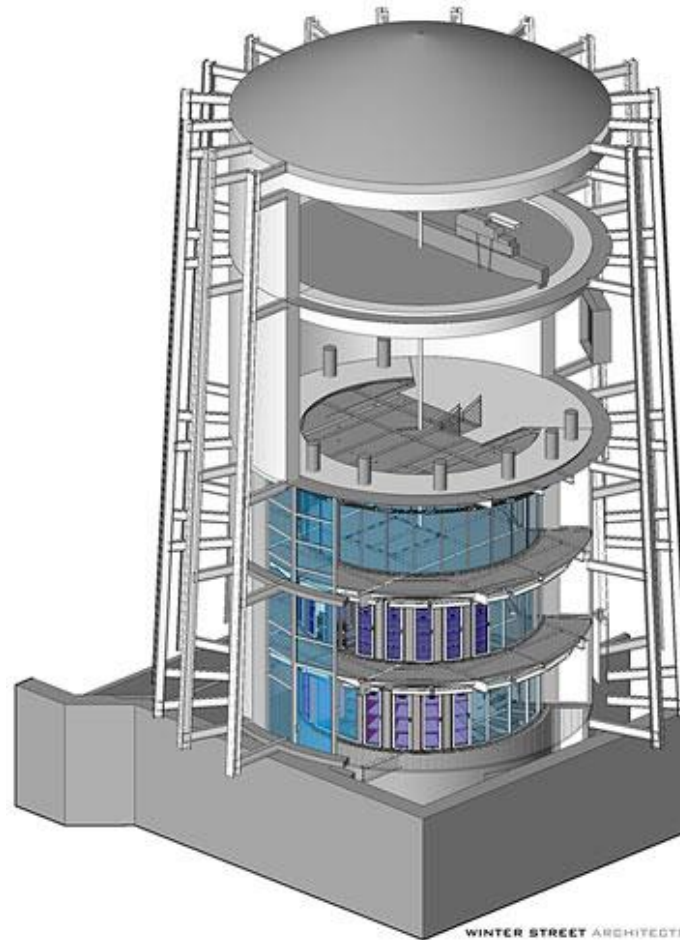


Datacenters of the future



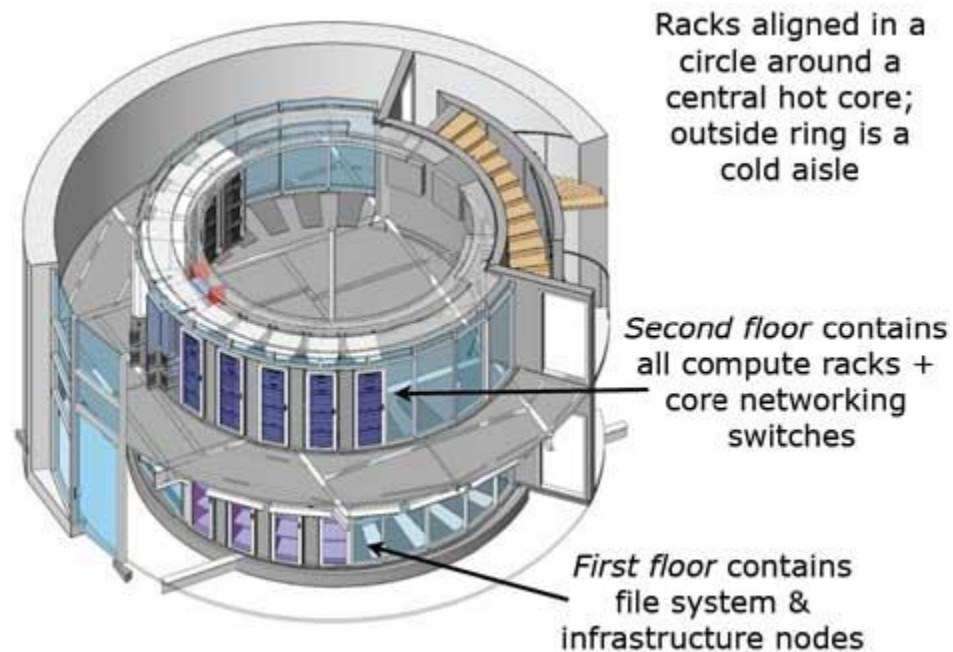
Datacenters of the future

Silo...computing



Datacenters of the future

Silo... computing

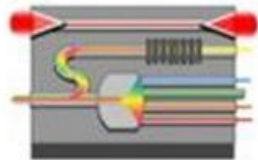


Optical components

Light Source



Guide Light



Modulator

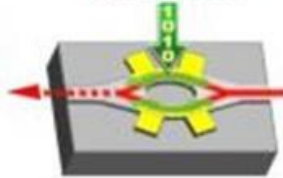
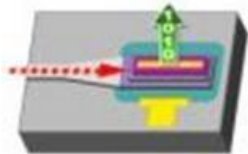
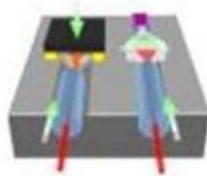


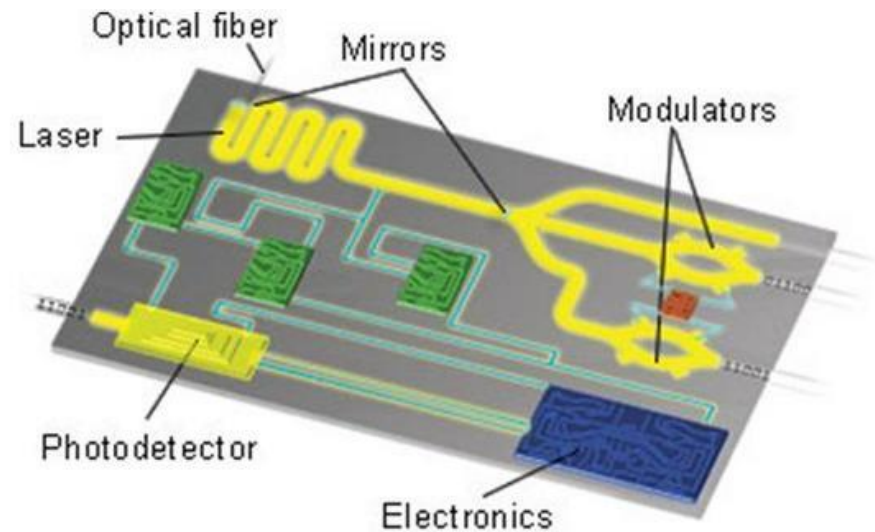
Photo-detection



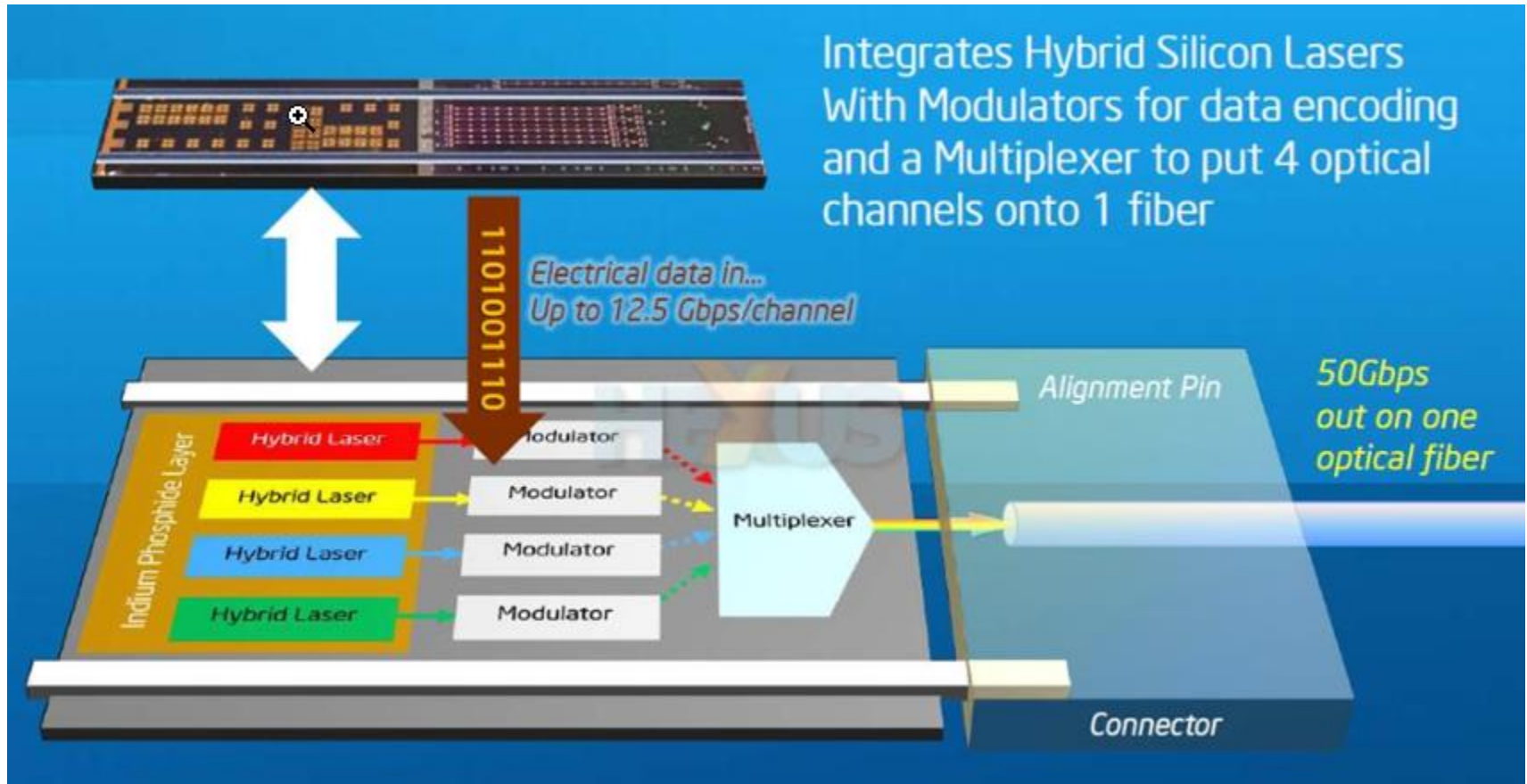
Low-cost Assembly



Intelligence

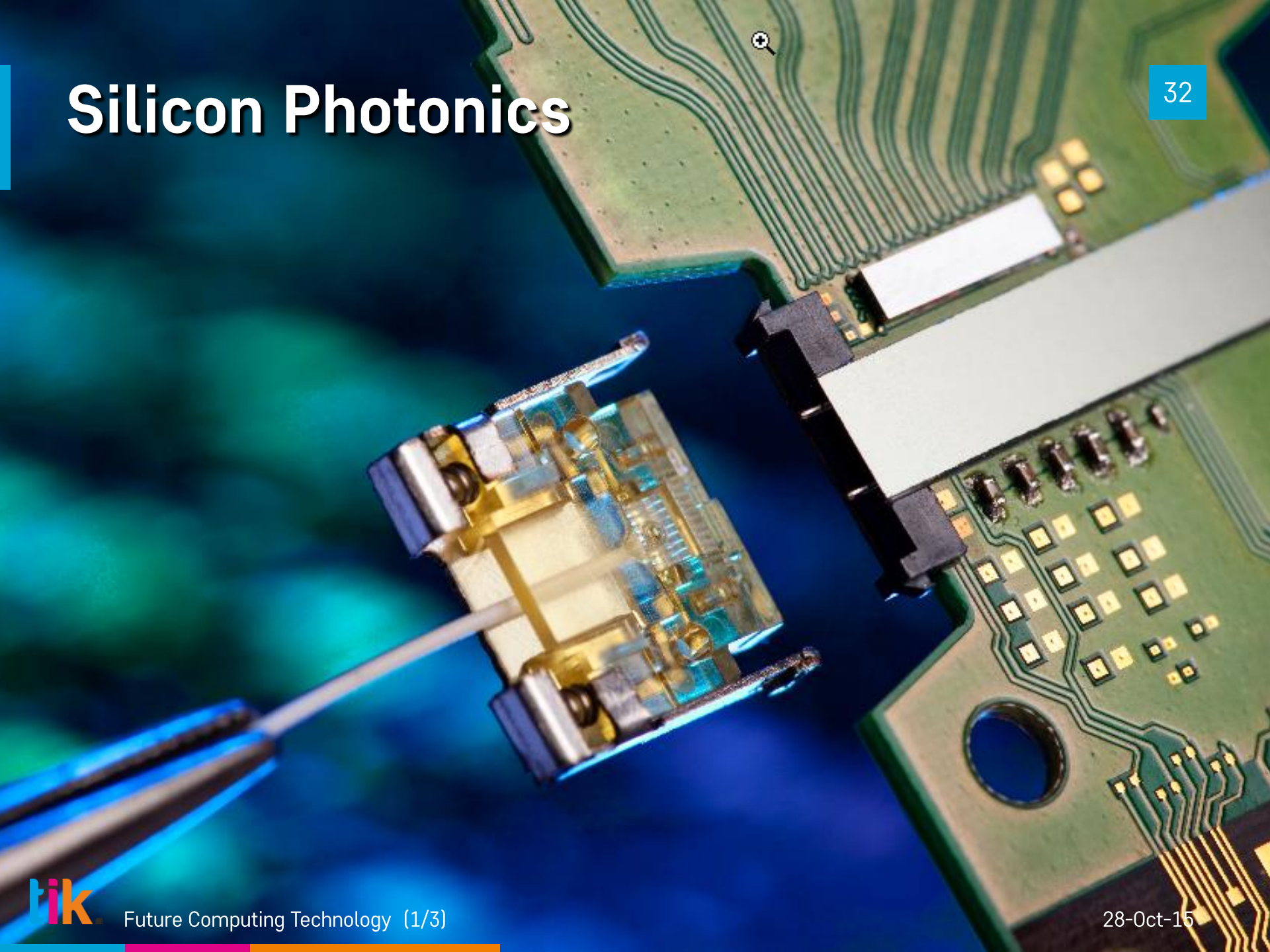


Silicon Photonics

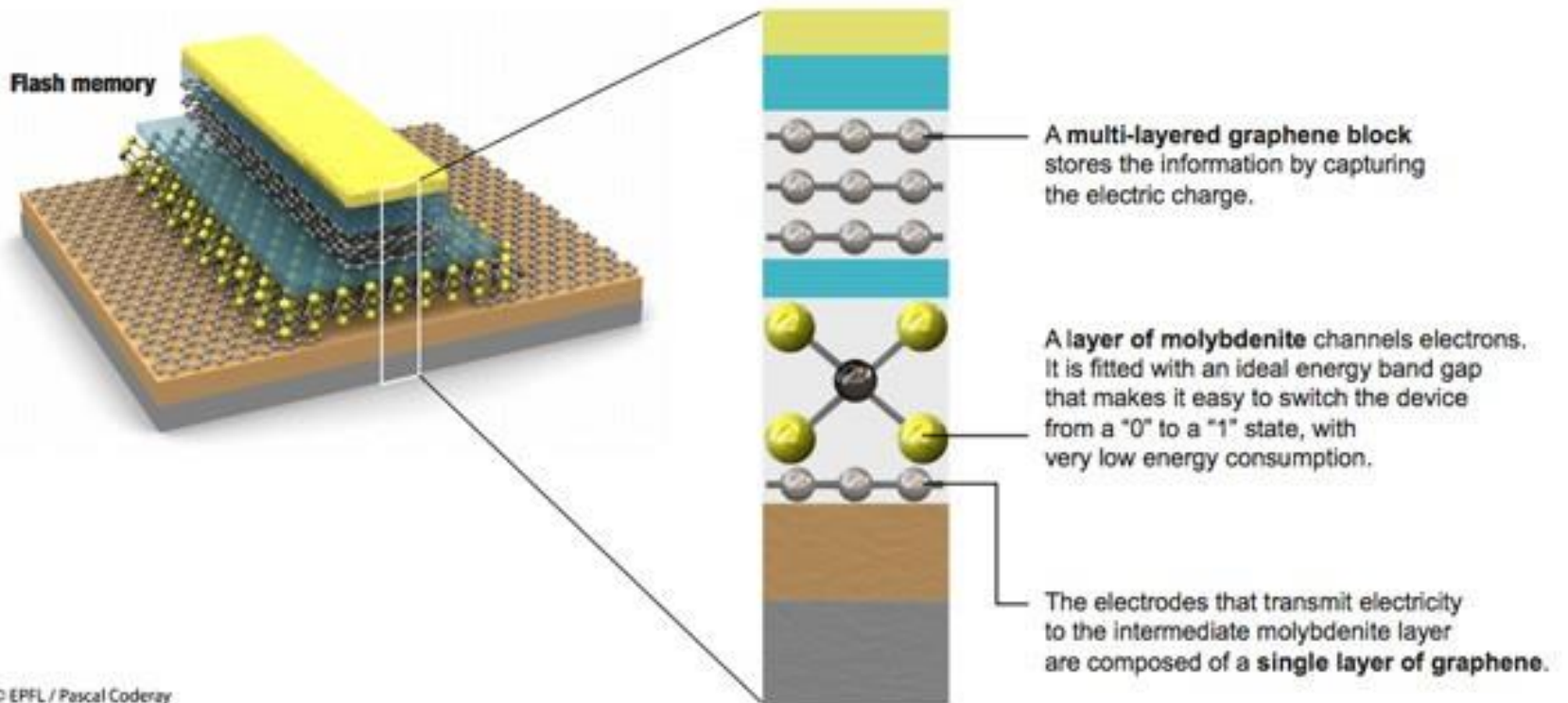


Silicon Photonics

32



Graphene



© EPFL / Pascal Coderay

Biomolecular computing

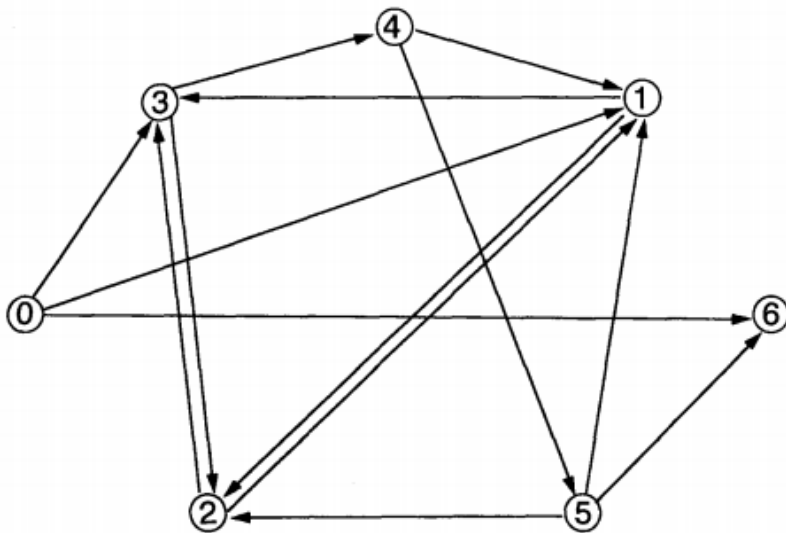


Fig. 1. Directed graph. When $v_{in} = 0$ and $v_{out} = 6$, a unique Hamiltonian path exists: $0 \rightarrow 1$, $1 \rightarrow 2$, $2 \rightarrow 3$, $3 \rightarrow 4$, $4 \rightarrow 5$, $5 \rightarrow 6$.

O_2 TATCGGATCGGTATATCCGA

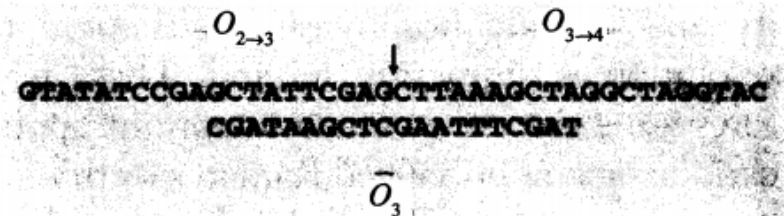
O_3 GCTATTCGAGCTTAAAGCTA

O_4 GGCTAGGTACCAGCATGCTT

$O_{2 \rightarrow 3}$ GTATATCCGAGCTATTCGAG

$O_{3 \rightarrow 4}$ CTTAAAGCTAGGCTAGGTAC

\bar{O}_3 CGATAAGCTCGAATTTCGAT



Thank you

e-mail: an@tik.services

<http://tik.services>

tik.



All content which is original in this work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.