



artificial intelligence and hardware innovations

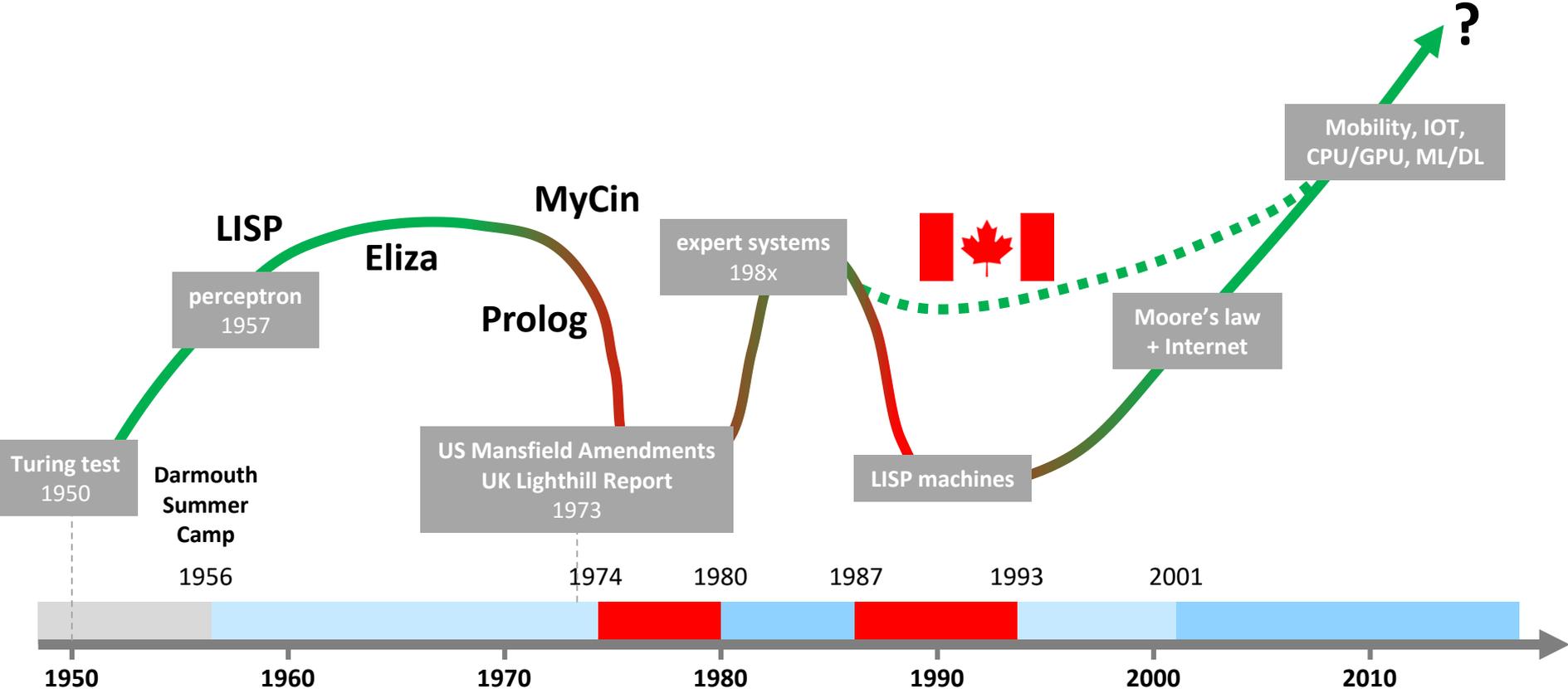
olivier ezratty

consultant and author

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EFCS 2018, Lisbon, November 21st, 2018

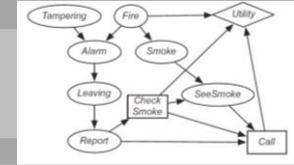
IA winters and summers



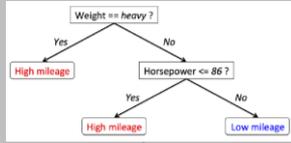


AI

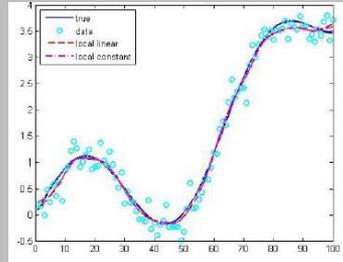
multi agents networks



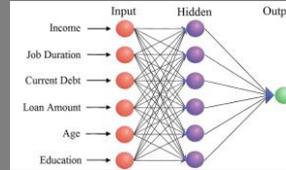
reasoning



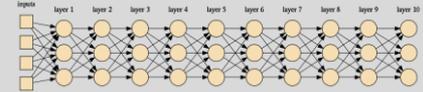
machine learning



neural networks



deep learning



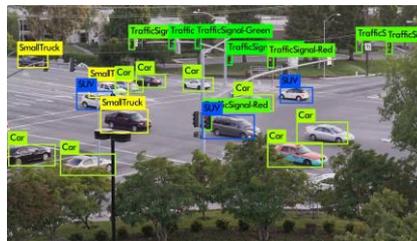
facts, rules and knowledge

structured data

vision

language

the AI toolbox is everywhere ...



home

car

mobility

city

work

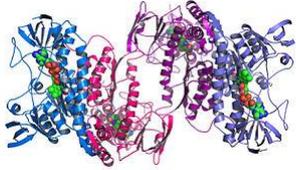


einstein

... and in every market



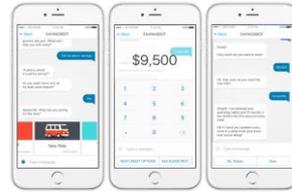
transportation



health



manufacturing



finance



insurance



agriculture



utilities



construction



retail



tourism



legal



media and content



education

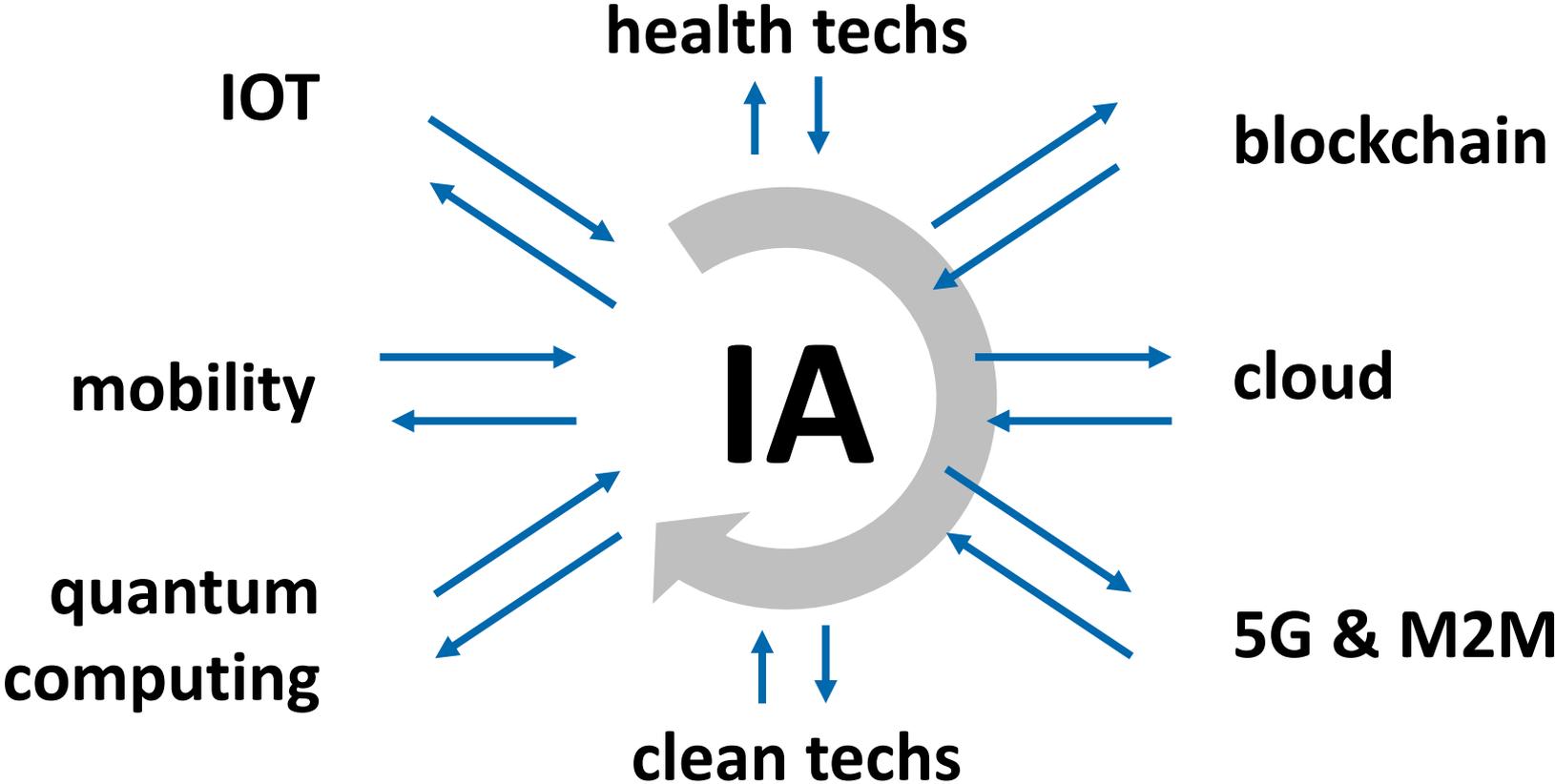


government

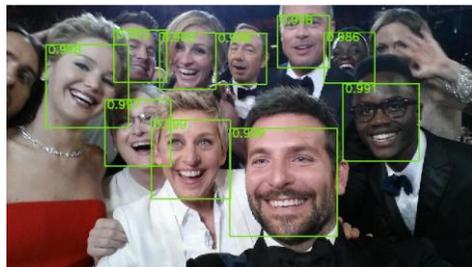


defense and security

IA is the glue linking most technologies



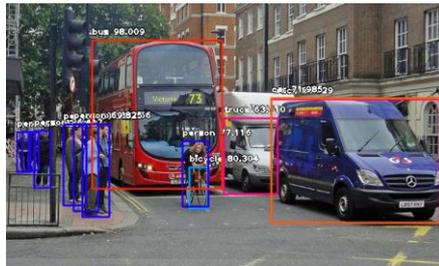
deep learning and vision



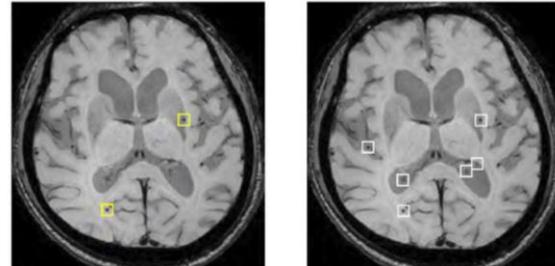
faces



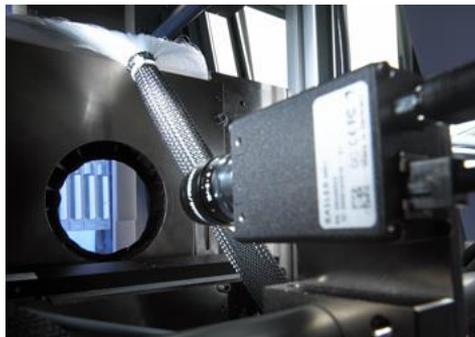
fingerprints



activities



medical imaging



visual inspection



remote sensing



product searches

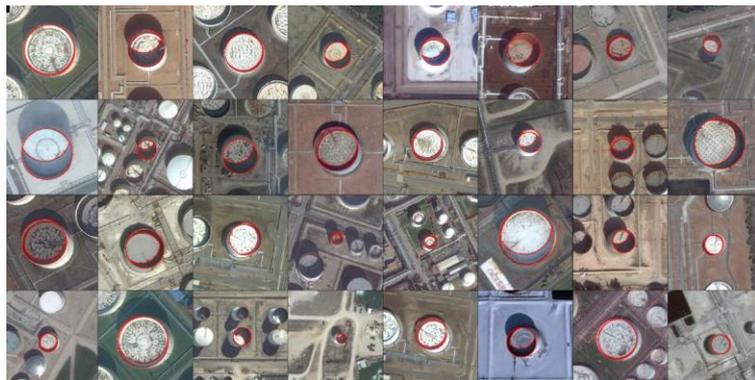
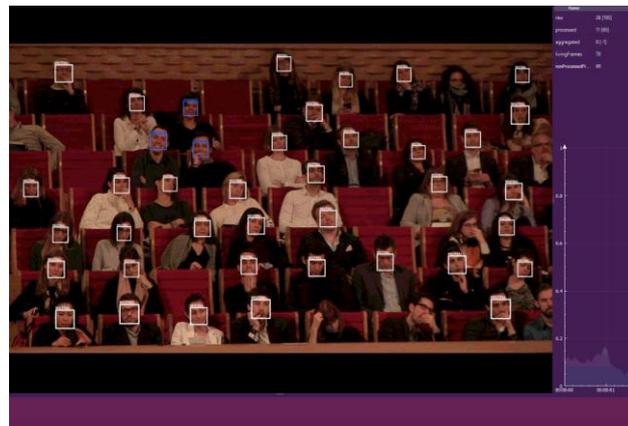


generation



real-time
activities
detection

emotions
detection



thematic
geomapping

automatic
image
coloring

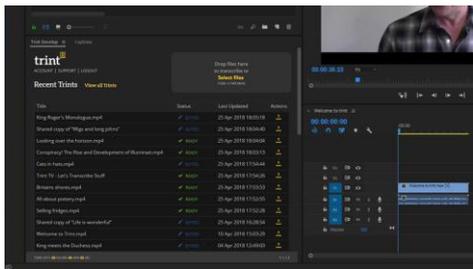


Object Detection

starring

YOLOv3

deep learning and language processing



speech recognition



vocal agent



chatbot



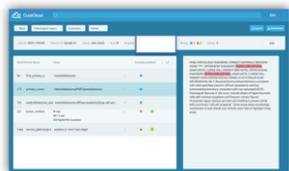
translation



text to speech



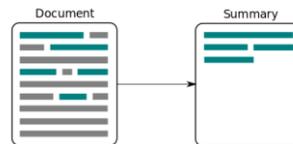
legal search engines



data extraction



sentiment analysis



automatic summary



robot-journalism



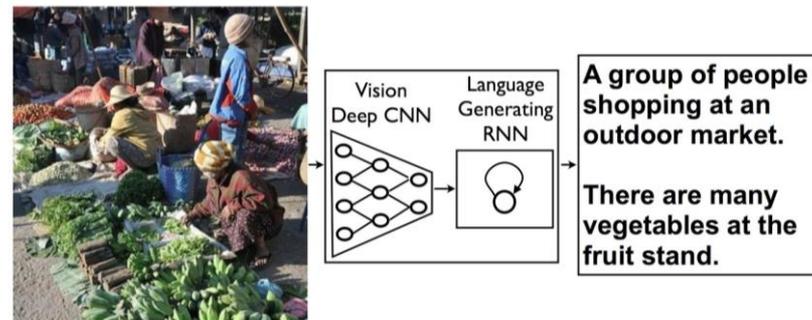
multi-modal AIs

≠ types of data

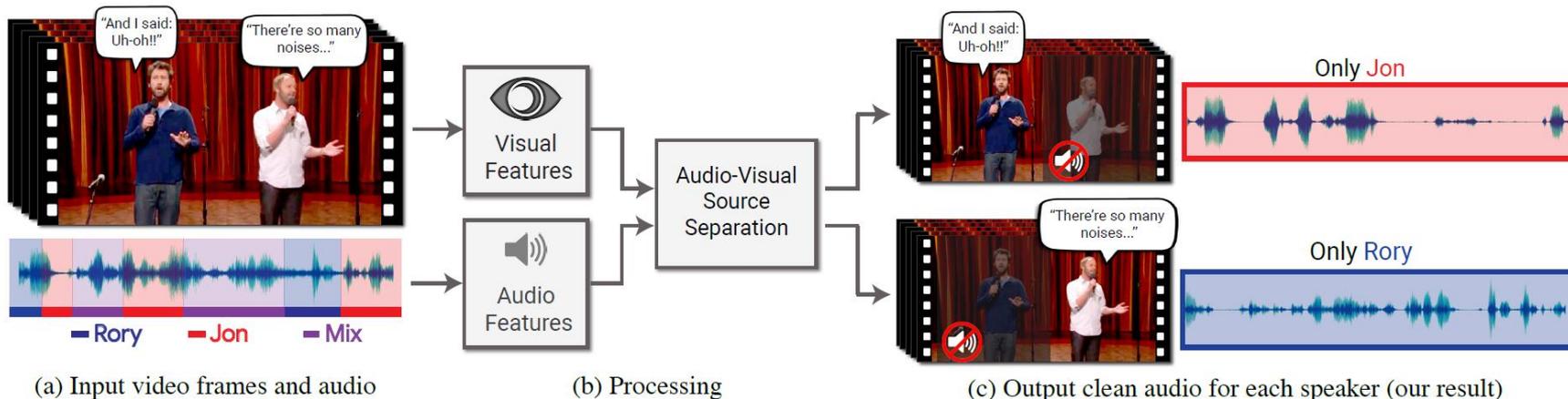
image/video + text => content description

video + audio => better speech recognition

color + depth => object recognition + navigation



<http://arxiv.org/abs/1411.4555> "Show and Tell: A Neural Image Caption Generator"



Source: Miki Rubinstein
Input video (two people speaking together)



Video source: Team Coco, <https://www.youtube.com/watch?v=UT7h4nRcWjU>

towards AI commoditization

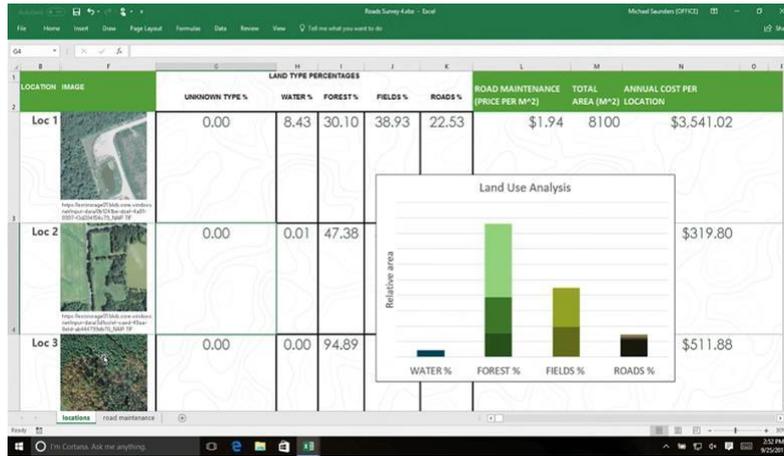
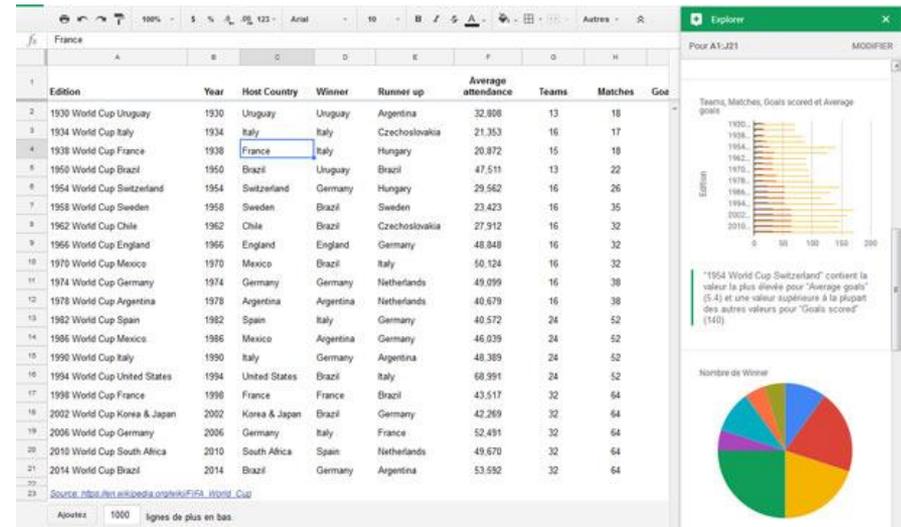
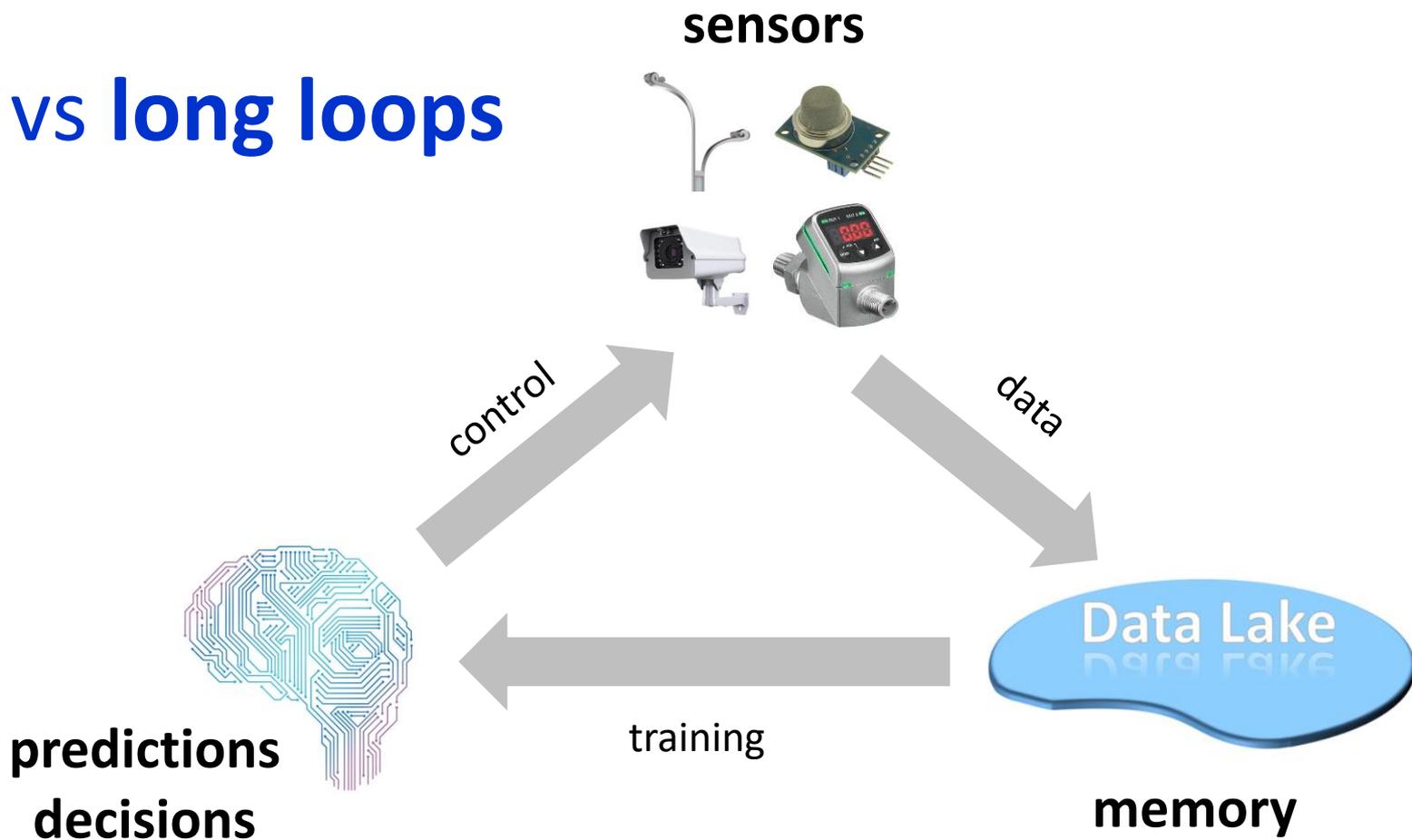


image analysis with Microsoft Azure Machine Learning in Excel

data machine learning
in GoogleDocs



IoT short vs long loops



**“The AI (chipsets) market
is expected to grow
from \$7B in 2018 to \$59B by
2025 at a CAGR of 35,5%”**

Business Wire, 2018

the AI chipsets race is on!



smartphones AI chipsets



Kirin 970 / 980

NPU 10/7 nm

3x3 matrix multipliers

2-4 Tops/s

**in Huawei Mate 10, Pmate 20
et Honor 10 (K970)**



A11, A12

Neural engine 10/7 nm

5 Tops/s

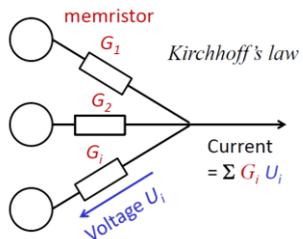
**in iPhone XS, XS Max, XR,
8, X**



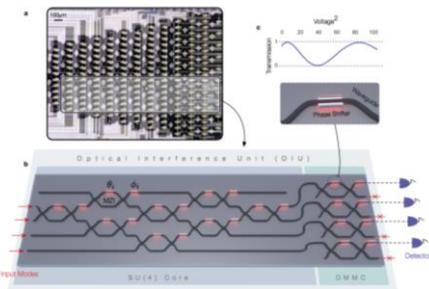
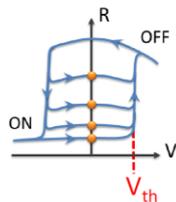
some AI hardware challenges

$$D = \begin{matrix} \text{FP16 or FP32} & \begin{pmatrix} A_{0,0} & A_{0,1} & A_{0,2} & A_{0,3} \\ A_{1,0} & A_{1,1} & A_{1,2} & A_{1,3} \\ A_{2,0} & A_{2,1} & A_{2,2} & A_{2,3} \\ A_{3,0} & A_{3,1} & A_{3,2} & A_{3,3} \end{pmatrix} & \begin{matrix} \text{FP16} \\ \text{FP16} \end{matrix} & \begin{pmatrix} B_{0,0} & B_{0,1} & B_{0,2} & B_{0,3} \\ B_{1,0} & B_{1,1} & B_{1,2} & B_{1,3} \\ B_{2,0} & B_{2,1} & B_{2,2} & B_{2,3} \\ B_{3,0} & B_{3,1} & B_{3,2} & B_{3,3} \end{pmatrix} & + & \begin{matrix} \text{FP16 or FP32} \\ \text{FP16 or FP32} \end{matrix} & \begin{pmatrix} C_{0,0} & C_{0,1} & C_{0,2} & C_{0,3} \\ C_{1,0} & C_{1,1} & C_{1,2} & C_{1,3} \\ C_{2,0} & C_{2,1} & C_{2,2} & C_{2,3} \\ C_{3,0} & C_{3,1} & C_{3,2} & C_{3,3} \end{pmatrix} \end{matrix}$$

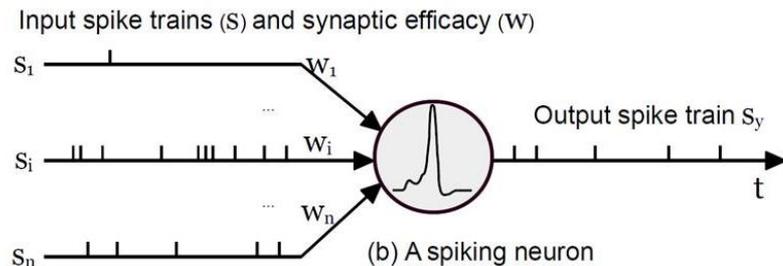
training & inferences
=> tensor units



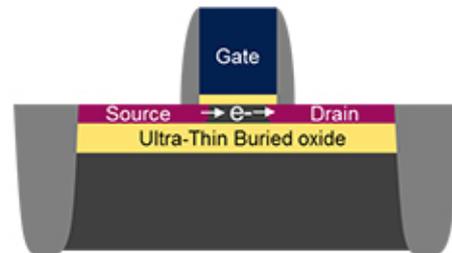
memory speed
=> HMB2, memristors



processing speed
=> photonics, quantum

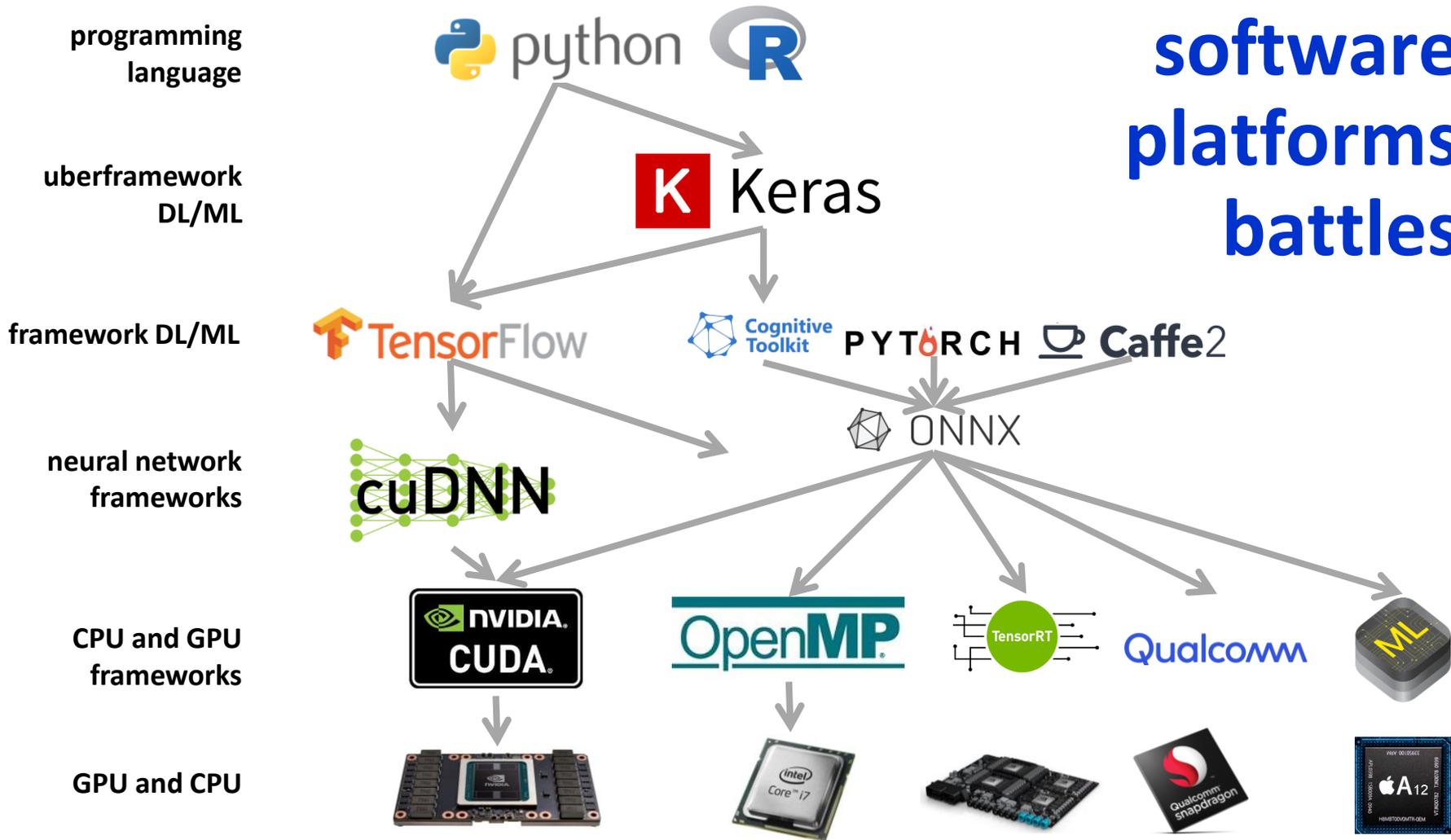


self-training
=> spiking neurons



energy footprint
=> FD-SOI, 10 nm

software platforms battles



programming language



uberframework DL/ML



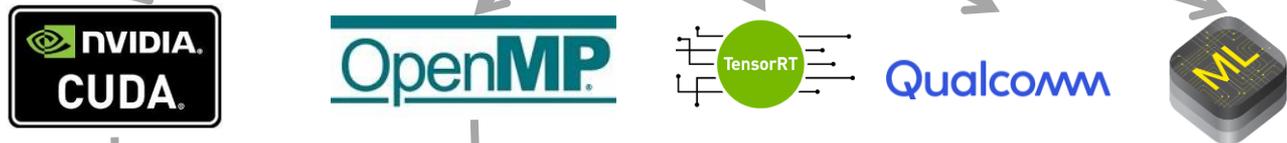
framework DL/ML



neural network frameworks



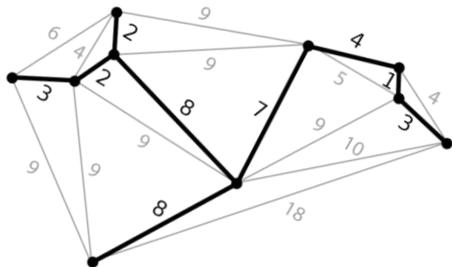
CPU and GPU frameworks



GPU and CPU

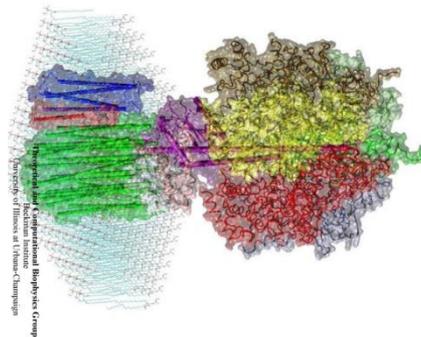


exponential problems



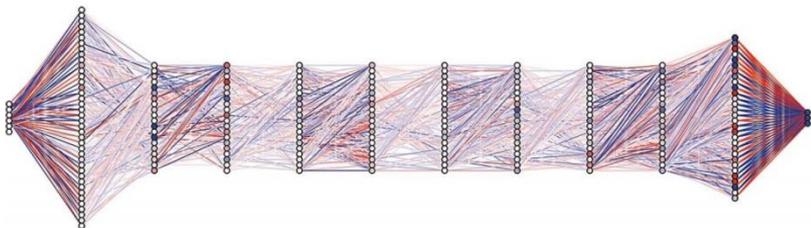
combinatory optimizations

routing, placements, maps, finance



molecular simulations

materials and biology



artificial intelligence

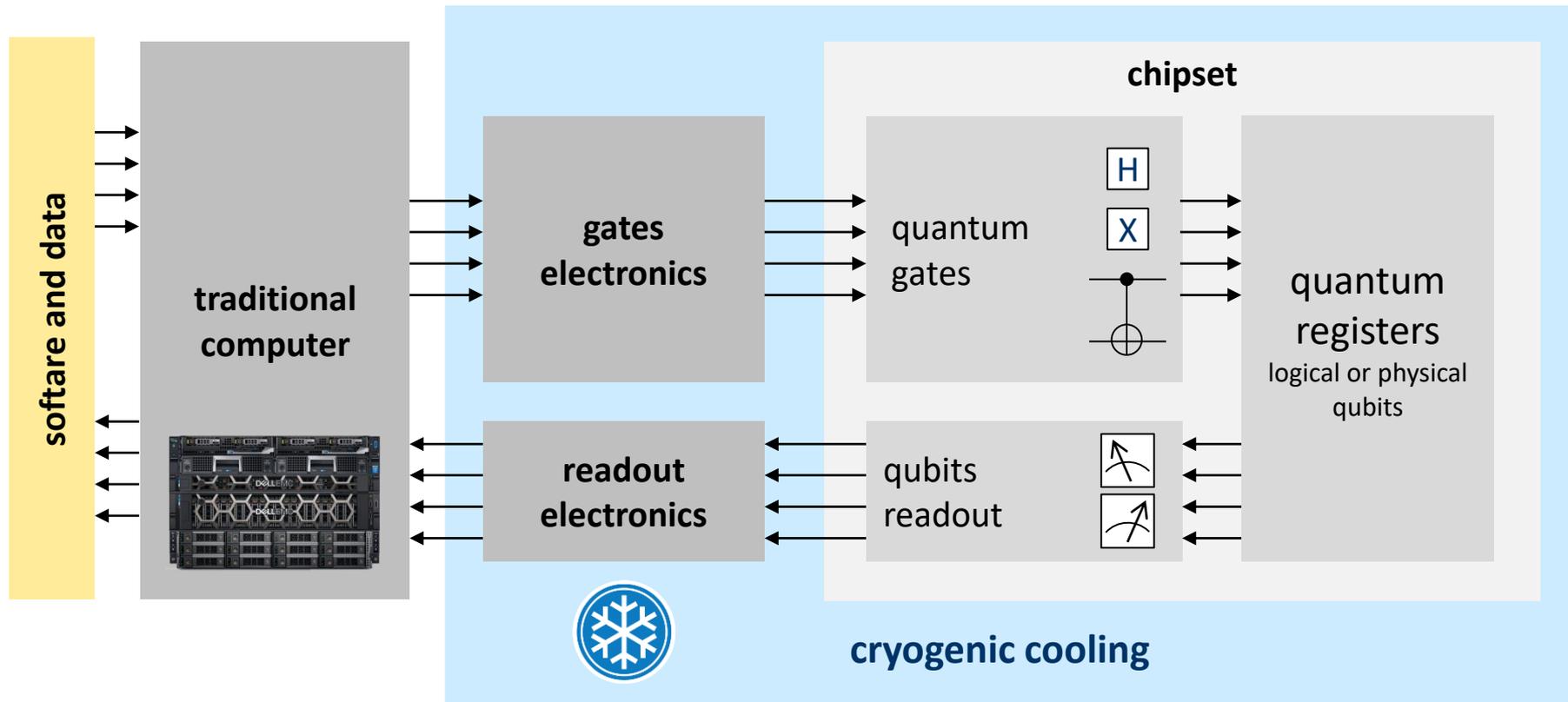
machine learning and deep learning

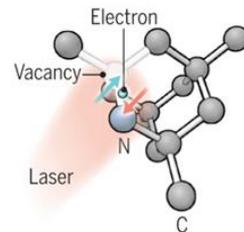
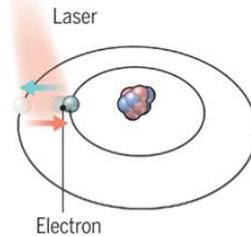
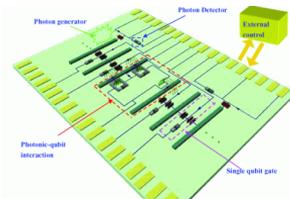
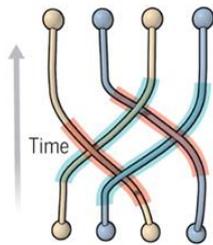
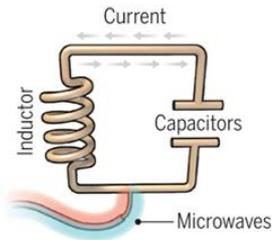
```
44 988 956 872 684 695 711 909 595 661 757 551 737 391 461 381 495 437 962 032 535 214 :  
847 417 212 499 752 572 232 401 732 123 638 539 143 471 977 710 243 318 508 178 915 :  
016 041 310 810 028 749 680 395 948 695 236 435 887 854 444 086 897 885 594 538 713 :  
228 936 606 776 470 635 385 948 772 950 847 349 789 474 010 570 972 468 331 714 191 :  
425 331 349 515 850 718 358 938 779 081 862 288 937 248 229 481 122 957 649 663 638 :  
693 717 318 212 628 476 797 261 511 198 103 510 310 449 611 859 242 271 813 366 566 :  
997 130 602 961 939 610 490 851 433 975 035 584 182 642 678 405 161 190 698 336 347 :  
929 112 811 425 354 268 385 653 335 910 754 799 140 572 752 605 907 751 000 463 584 :  
653 690 396 162 388 451 026 377 547 259 579 743 647 906 554 252 830 020 138 218 006 :  
943 421 190 175 143 130 541 480 857 851 924 532 107 288 336 106
```

factorization

large integer numbers

quantum computers architectures





supraconducting loops

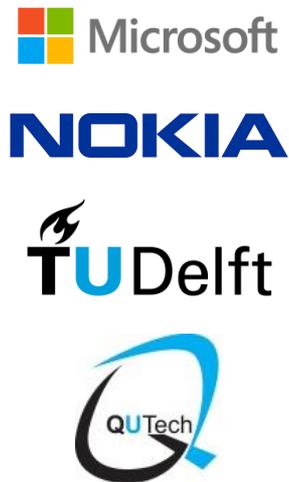
topological qubits

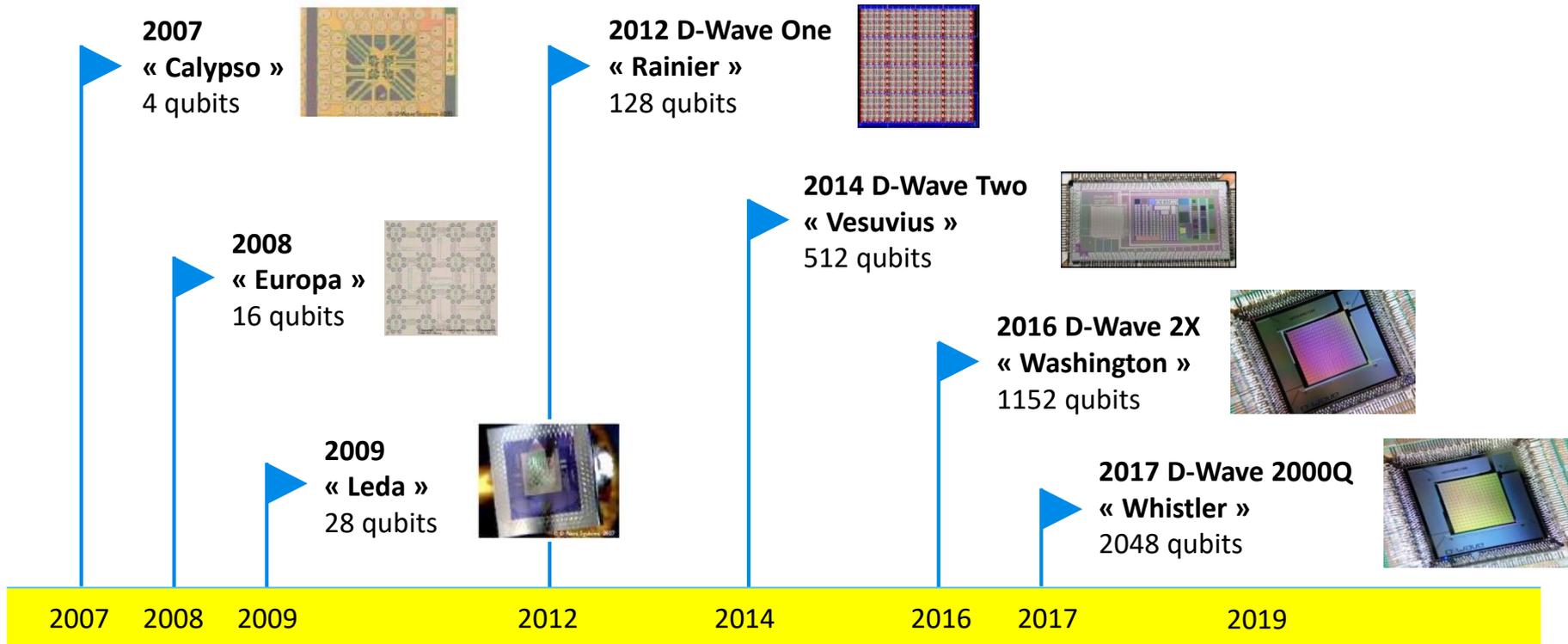
linear optics

silicium quantum dots

trapped ions

diamond vacancies



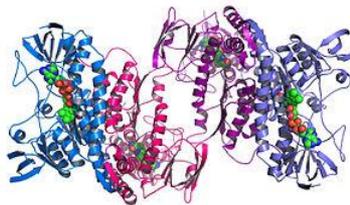


first quantum computing markets



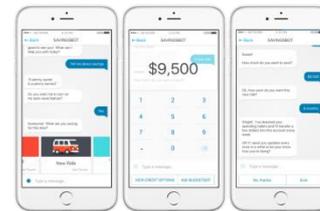
transports and logistics

travel optimization
fleet management



healthcare

molecular simulation
drug discovery
radiotherapy optimization



finance

portefolio optimization
risk assessment
security



energy and chemistry

exploration
batteries and materials



defense and intelligence

cryptography
machine learning



QUANTUM
FLAGSHIP

**European Flagship
Quantum Technologies**



OpenSuperQ

PhoouS
Photons for Quantum Simulation



MicroQC AQTION

PASQuanS

SQUARE

quantum computers

quantum simulators

QMICS



2D-SIPC

macQsimal

PhoG

QRANGE



**QUANTUM
INTERNET
ALLIANCE**

UNIQORN
Affordable Quantum Communication for Everyone

MetaboliQs

iqClock

quantum telecoms / cryptography

quantum sensing

quantum computing WW startups

software



computers



components

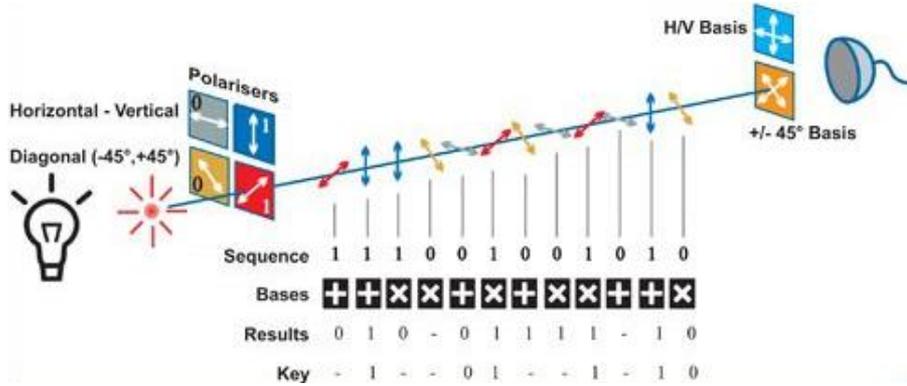




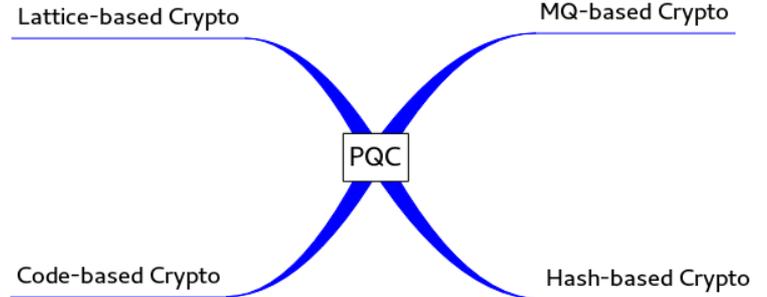
QC Players worldwide



quantum keys QKD / BB84
protects symmetric keys with
optical link (fiber or sat)



post-quantum cryptography
public key cryptography
resisting to quantum algorithms



what



needs

moonshot projects

continous long term bets

and after R&D...

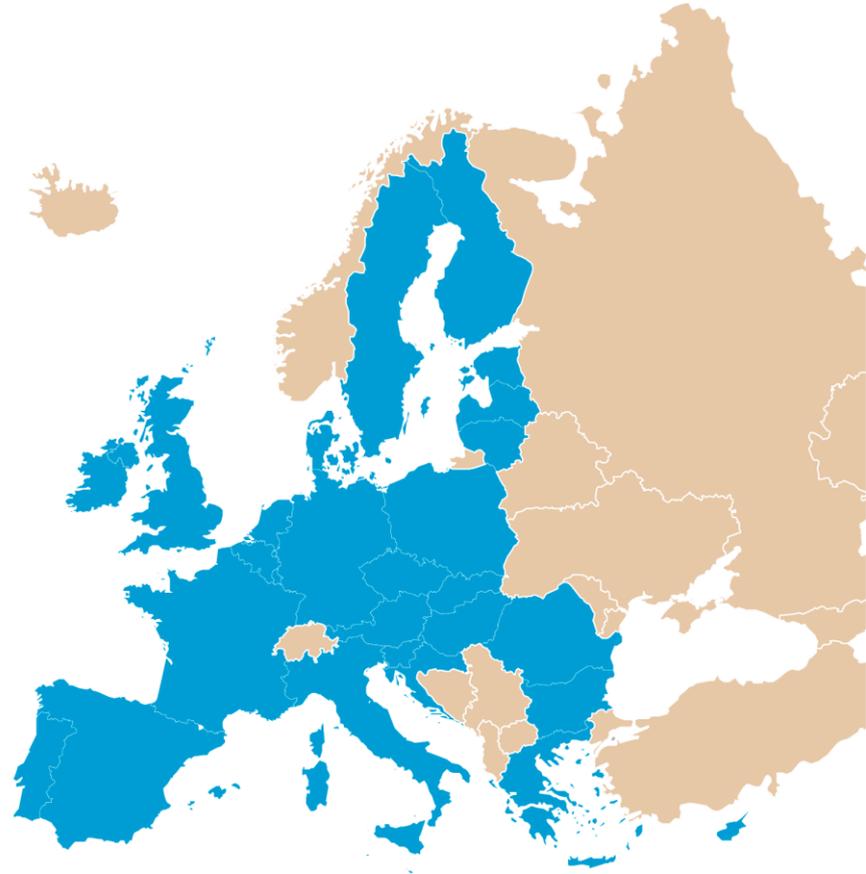
product management skills

target volume markets

international collaboration

from R&D to business

platform creation skills



thank you!