Design Challenges Ahead

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Centre SI
Integrated Systems Centre

EPFL
ÉCOLE POLYTECHNIQUE
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IBM

DOME
The Ultimative Big Data Challenge

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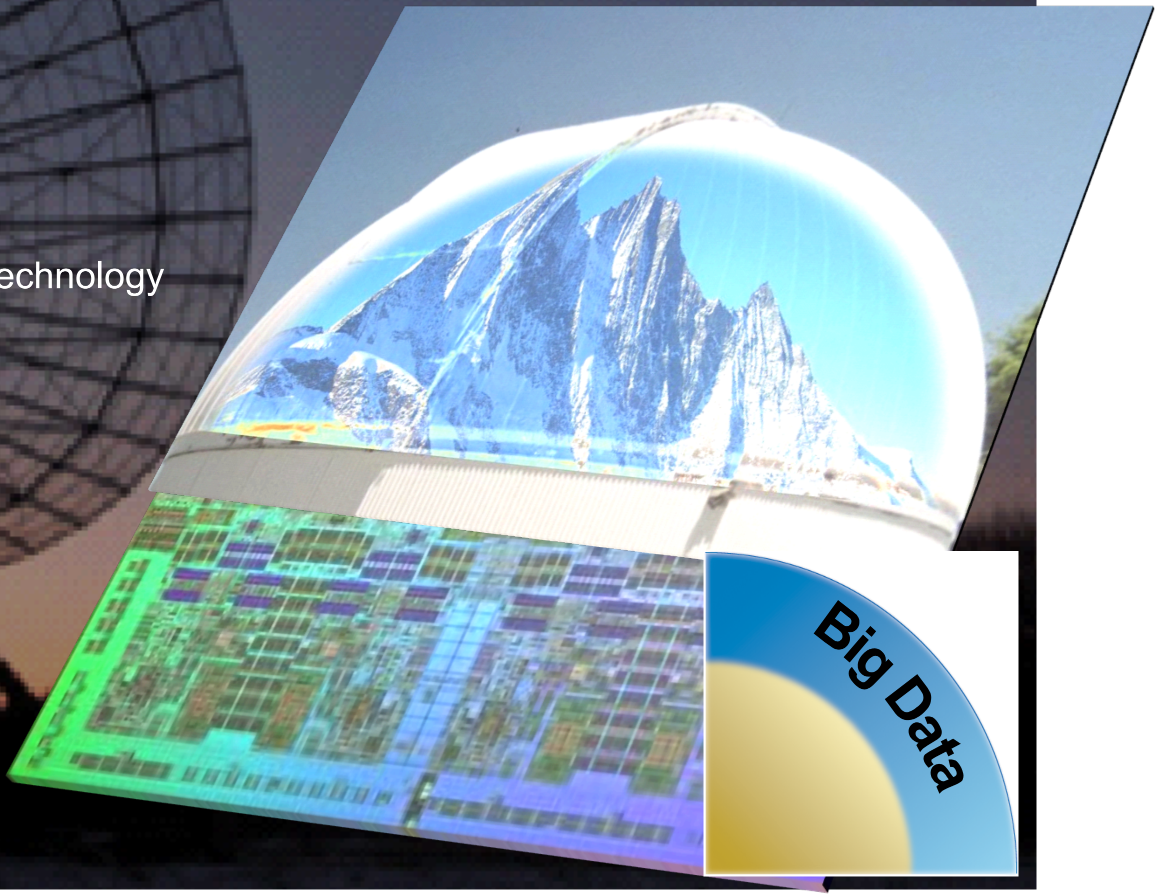
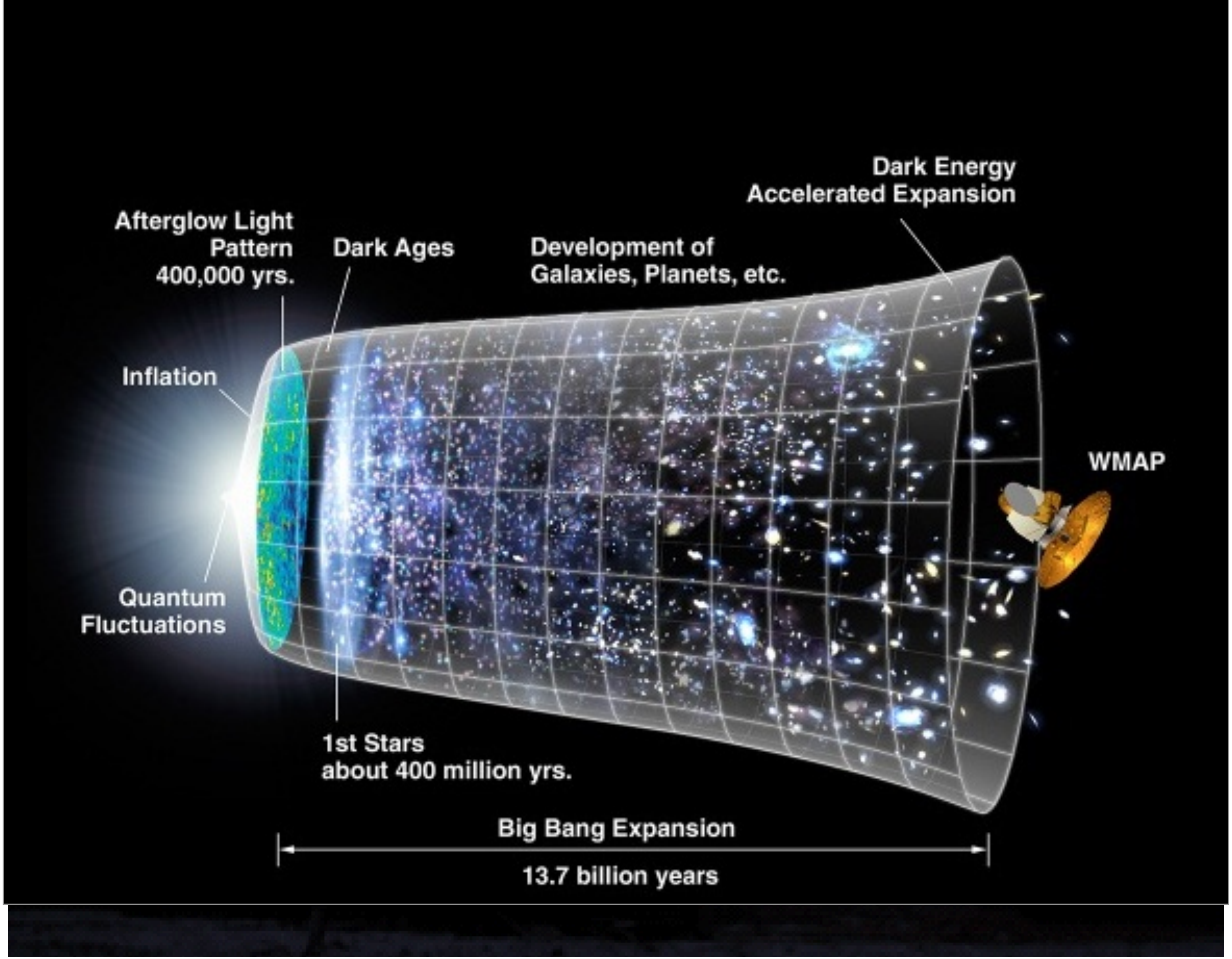
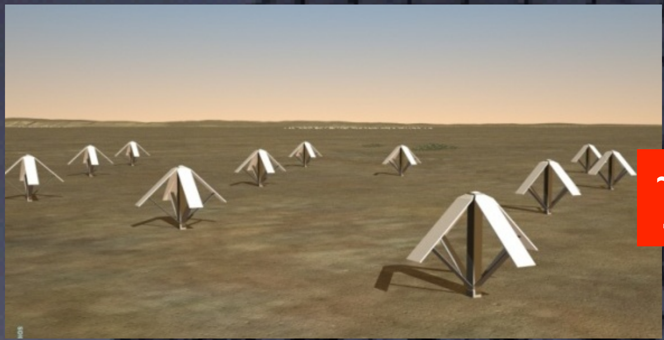




Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
400,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
WMAP
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.7 billion years

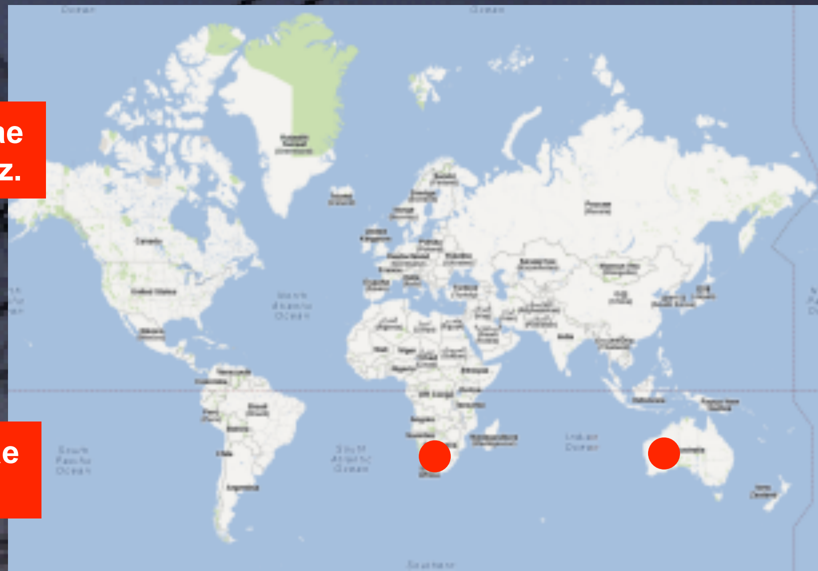
SKA 1-2: What is it?



~0.25M Antennae
.07GHz-0.45GHz.

~0.25M Antennae
.5GHz-1.7GHz.

~3000 Dishes
3GHz-10GHz.



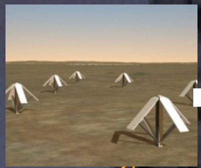
Next generation radio astronomy:

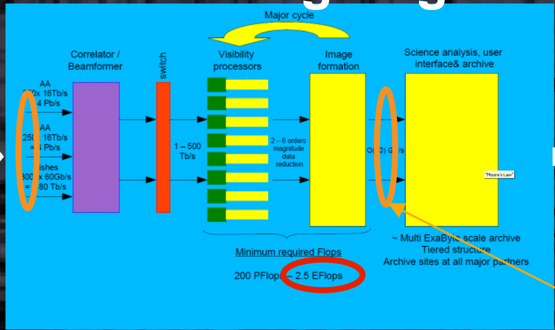
SKA-1: Start of deployment 2020
SKA-2: Start of deployment 2022+

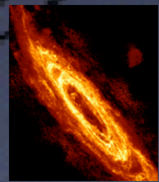
SKA = Square Kilometer Array

SKA: Data Processing?

Processing Engine







~ 10 Pb/s

↓

86'400 sec/day

↓

14 ExaByte/day

~ 1 PB/Day.

↓

330 disks/day

↓

120'000 disks/yr

1. 10^9 samples/second * .25M antennae: 0.25 10^{15} samples/sec.

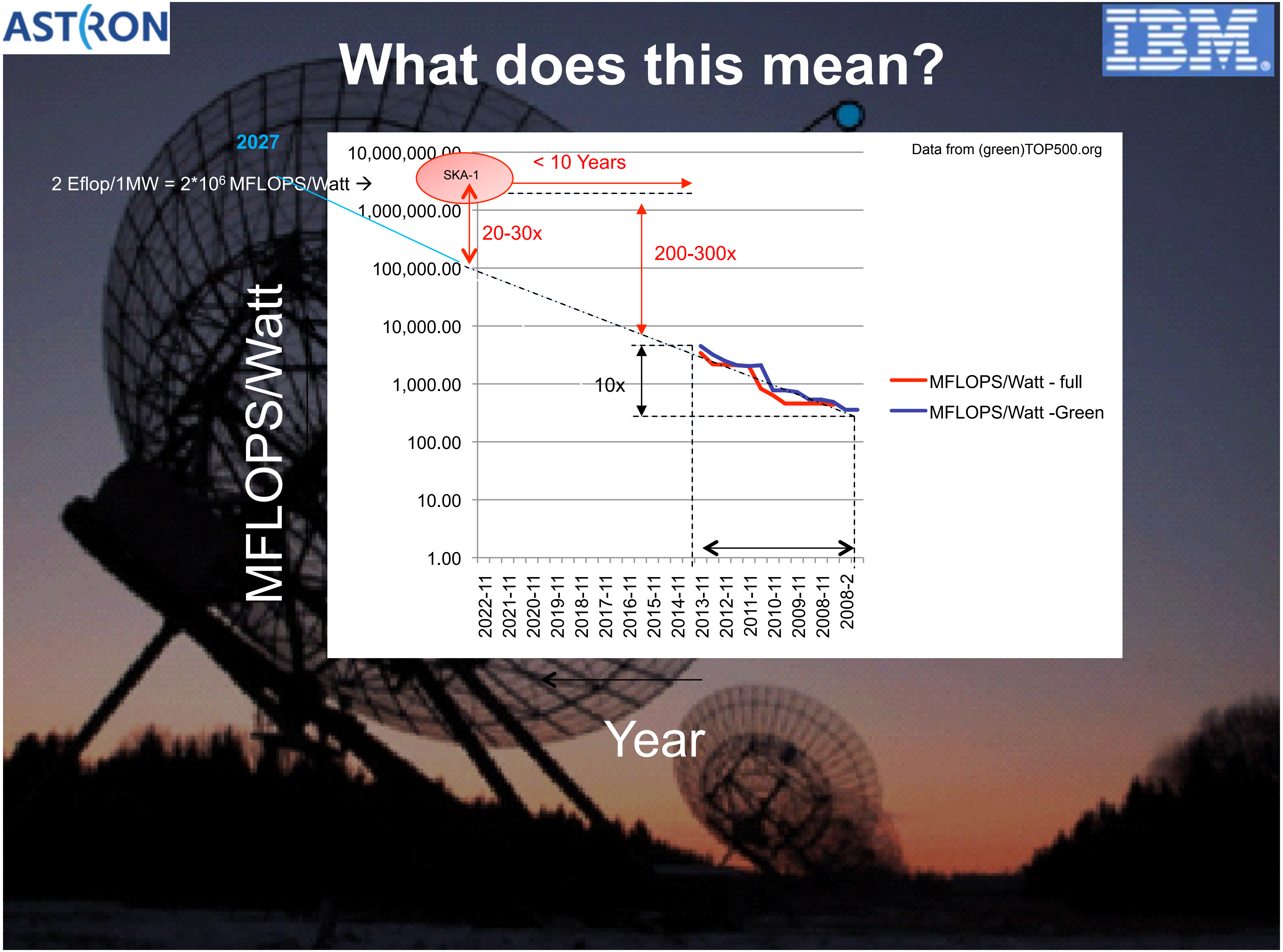
2. 3.5 10^9 samples/second * .25M antennae: 0.9 10^{15} samples/sec.

3. 2 10^{10} samples/second * 3K antennae: 6.10^{13} samples/sec

Sum = 10^{15} samples/second @ 86400 seconds/day:

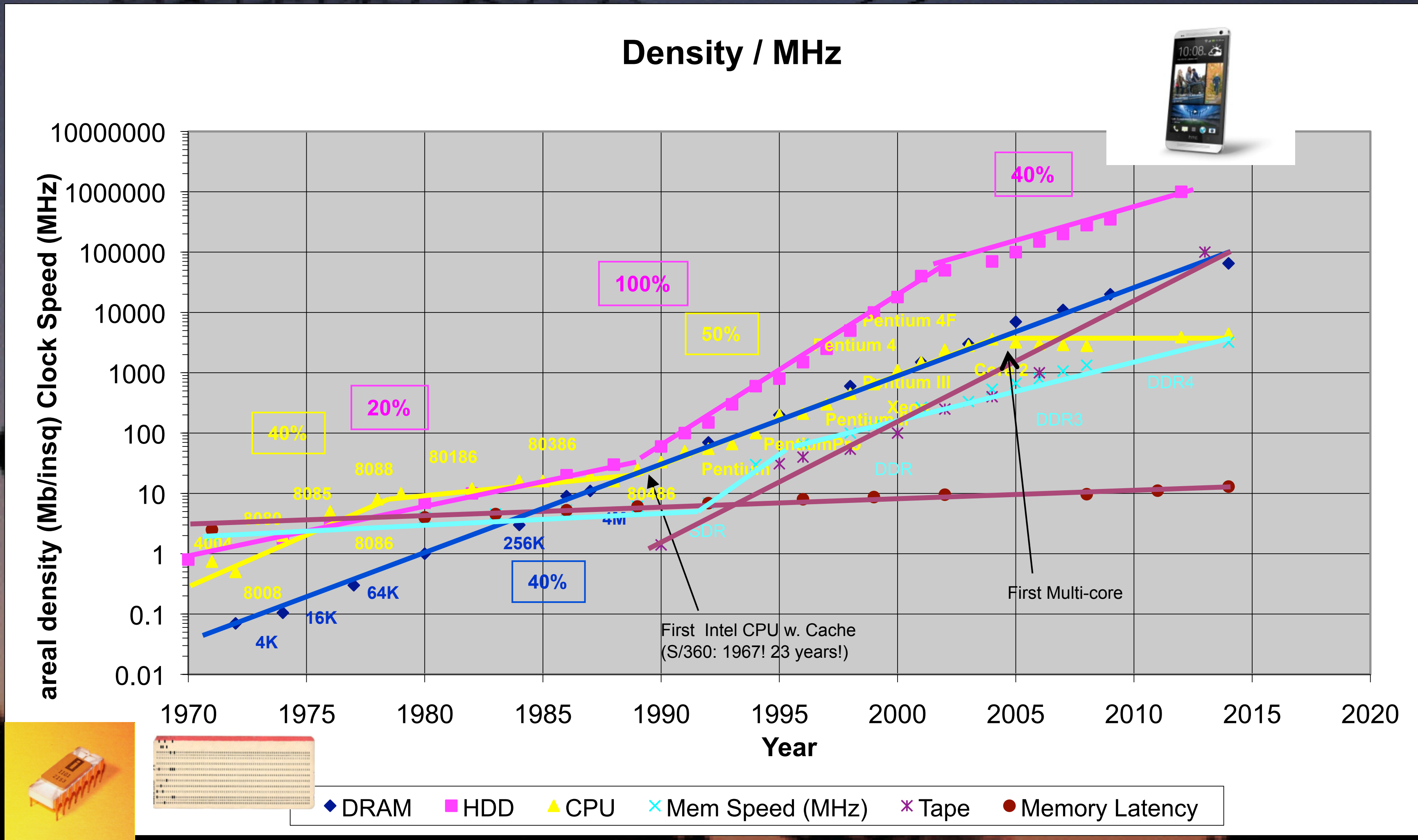
86 10^{18} (Exa) samples/day. - Assume 6x reduction @antenna:

14 Exabytes/day (minimum).

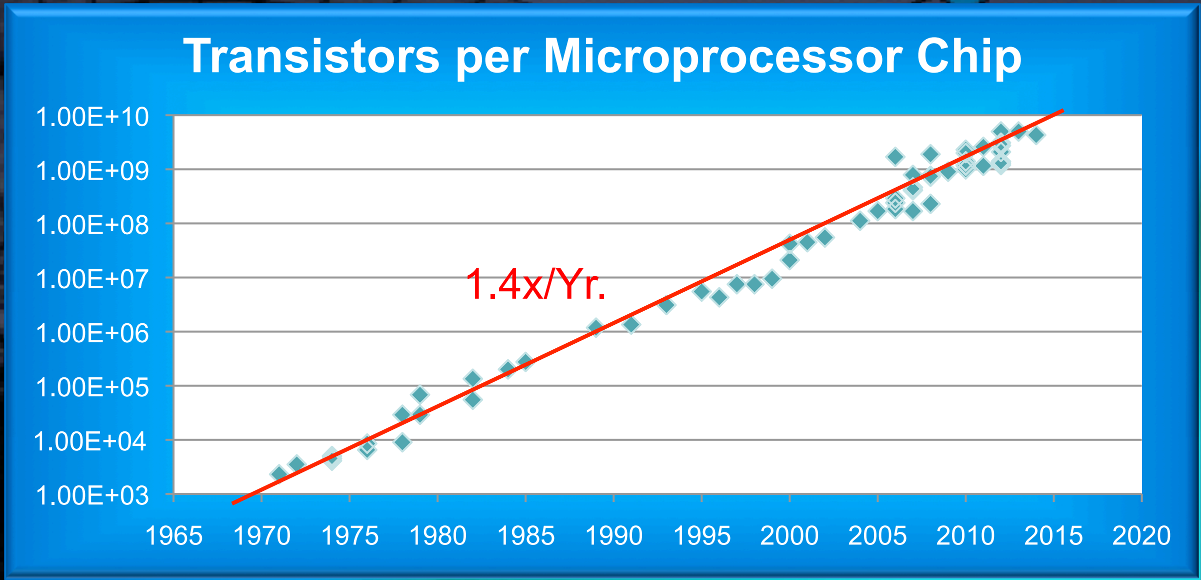


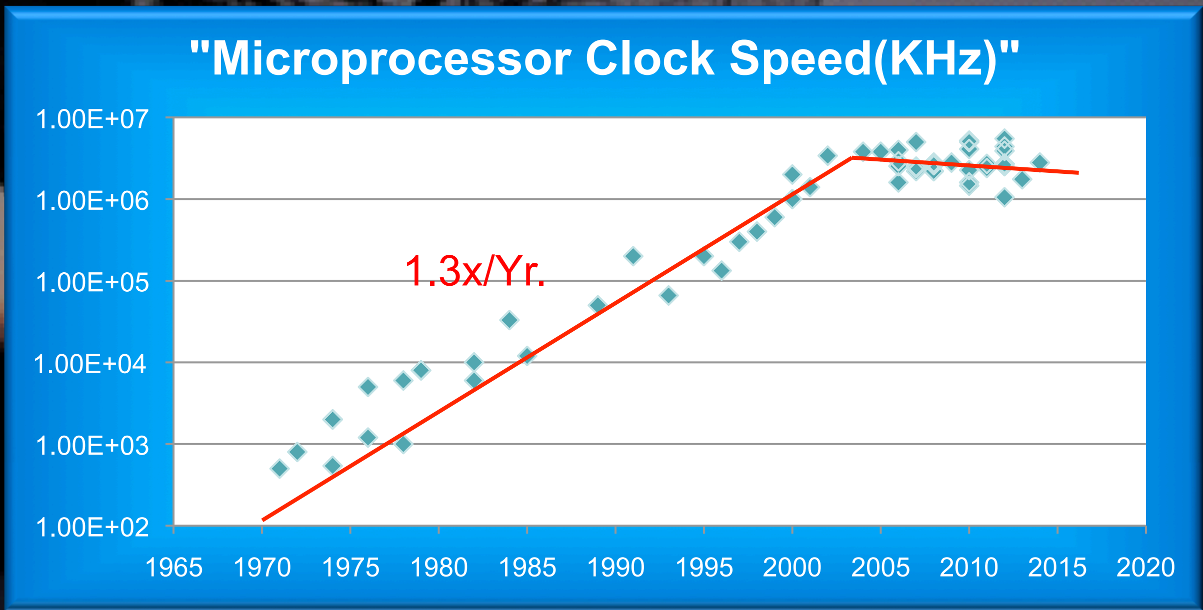
What does this mean?
Data from (green)TOP500.org
2027
2 Eflop/1MW = 2*10⁶ MFLOPS/Watt →
SKA-1
< 10 Years
20-30x
200-300x
10x
MFLOPS/Watt
10,000,000.00
1,000,000.00
100,000.00
10,000.00
1,000.00
100.00
10.00
1.00
2022-11
2021-11
2020-11
2019-11
2018-11
2017-11
2016-11
2015-11
2014-11
2013-11
2012-11
2011-11
2010-11
2009-11
2008-11
2008-2
MFLOPS/Watt - full
MFLOPS/Watt -Green
Year

A bit of IT- & Technology History...

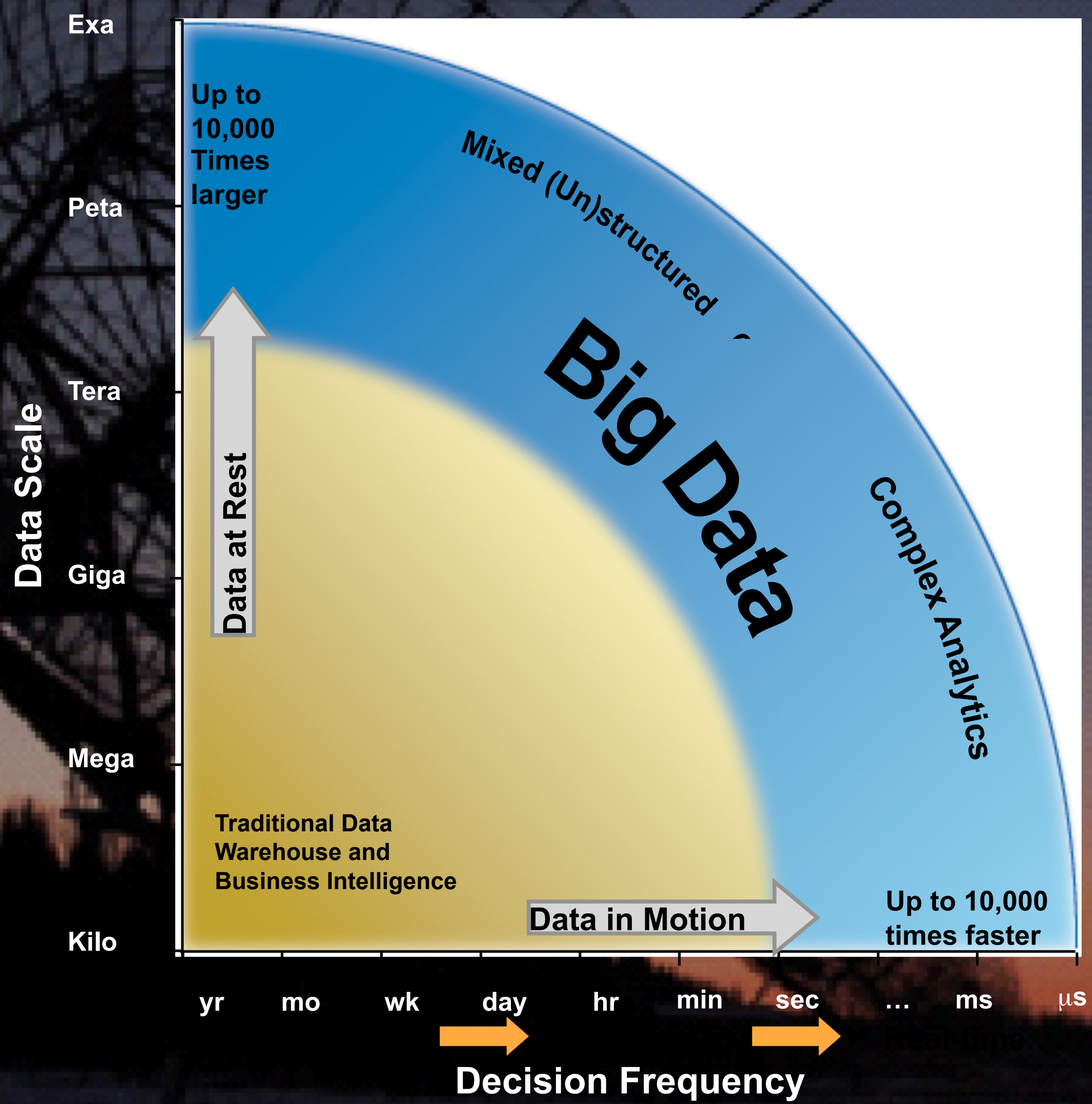


A bit of IT- & Technology History...



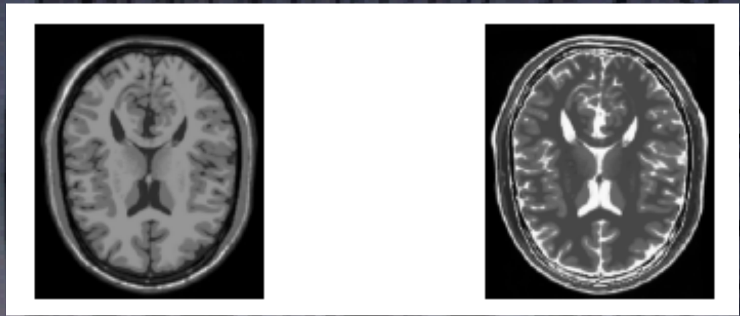


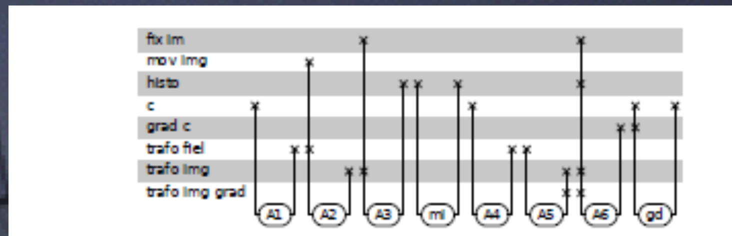
Big Data:


Data Scale
Exa
Peta
Tera
Giga
Mega
Kilo
Up to 10,000 Times larger
Mixed (Un)structured
Big Data
Complex Analytics
Data at Rest
Traditional Data Warehouse and Business Intelligence
Data in Motion
Up to 10,000 times faster
yr
mo
wk
day
hr
min
sec
…
ms
µs
Decision Frequency

Parallelism

(“the end of software developers paradise”)



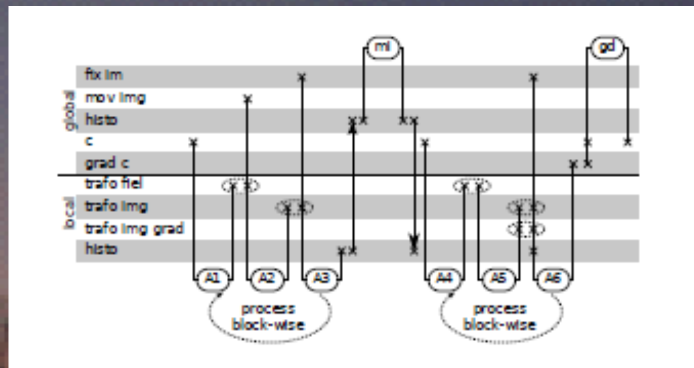


Description	Xeon 3.6 GHz	Core2 3.2 GHz	Cell/B.E.
ITK	62678.5	28698.1	-
Restructuring	3326.3	1067.6	-
Temp buffering	2552.6	813.6	-
Field grouping	2075.5	642.5	-
Gradient grouping	1259.8	407.9	-
Image LUT	1083.4	351.0	1806.3
Manual vectorization	789.9	243.6	669.5
Optimized load	-	-	333.8
Parallelism 1 Chip	-	63.3	43.5
Parallelism 2 Chips	401.4	-	23.14
Double Buffering	-	-	23.11

~500x

3000x !

Tab. 6.1: Runtime per voxel and iteration in nanoseconds depending on optimizations and platform. The Intel Xeon processor was manufactured in 90 nm technology like the Cell/B.E. processor. The Core2 is a more recent x86 processor of the 45 nm generation.



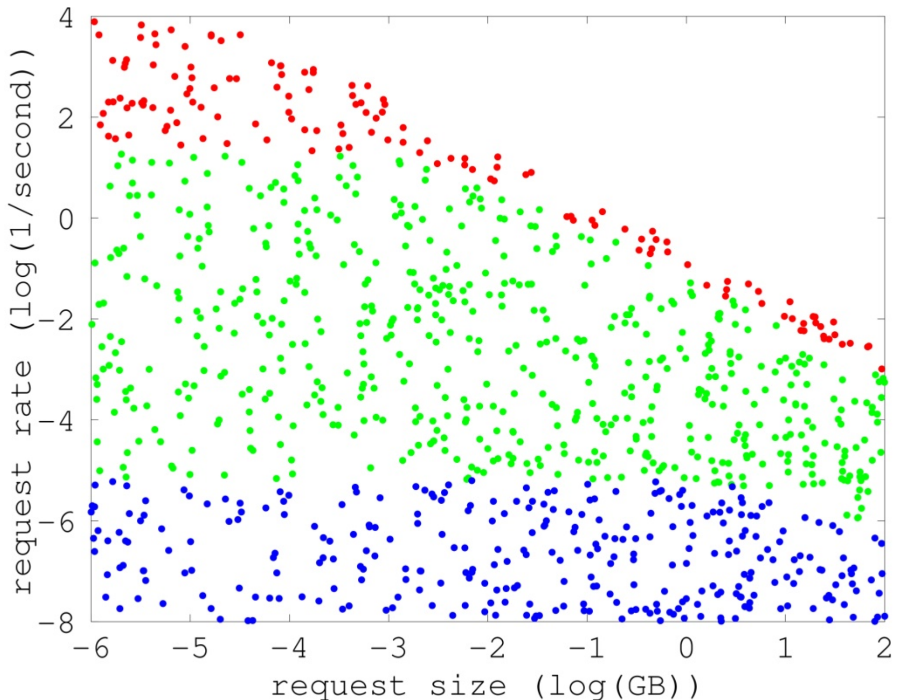
Storage tiers:

Data units assignment example (1000 100GB chunks)

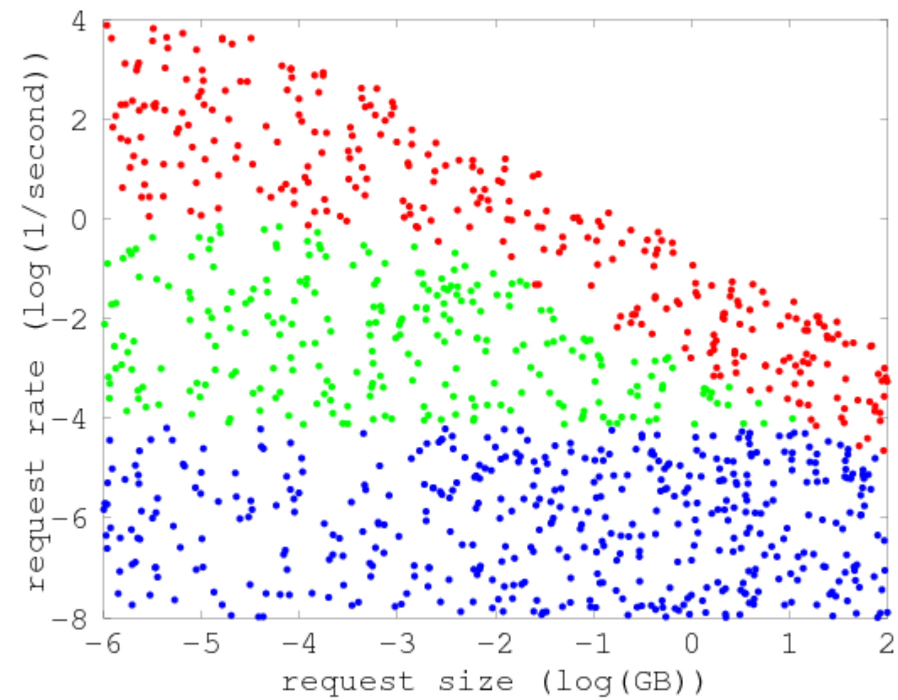
("the end of system developers paradise")

- Red: SSD
- Green: HDD
- Blue: Tape

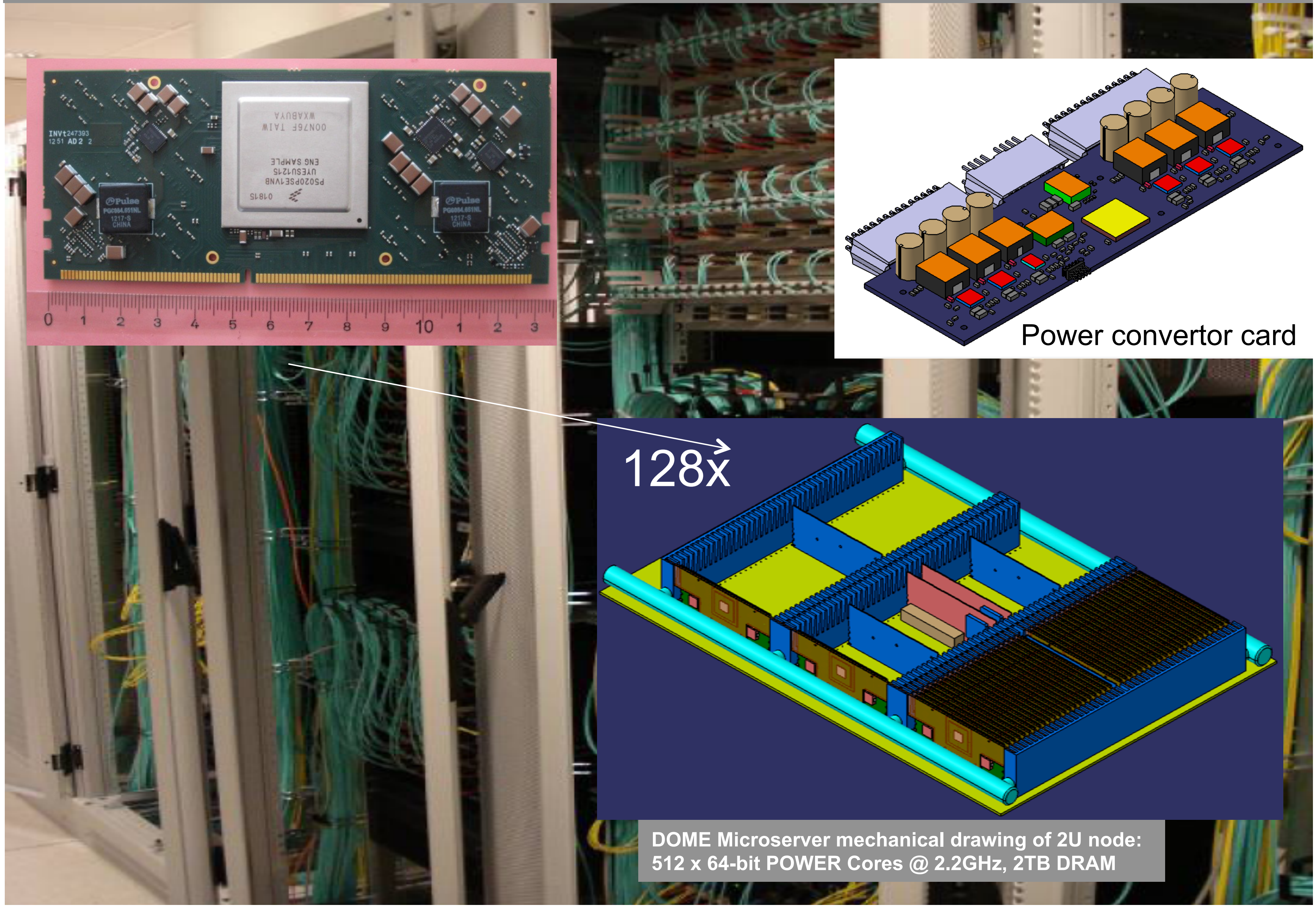
Budget = $23,000
Mean Response = 0.27 sec



Budget = $35,000
Mean Response = 0.0017 sec



μ-server: ("the end of hardware developers paradise")



DOME Microserver mechanical drawing of 2U node:
512 x 64-bit POWER Cores @ 2.2GHz, 2TB DRAM

The Problem:

Contemporary Microprocessor: 2000 Page manual

FD-SOI, RRAM, MRAM, TDS, 3DICS, 3D, SAR, CNT, SRAM, DRAM, DDRx, STRAM, SDRAM, NVRAM, OxRAM, PCRAM, CBRAM, SSD, HDD, TAPE,.....

➔We need more formalism enforcing tools to deal with this!
➔(as the average engineer can keep 4-5 “things” in his head.)

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DESIGN CHALLENGES AHEAD

My lesson learned and guidelines

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What is Italian Angels for Growth (IAG)

IAG

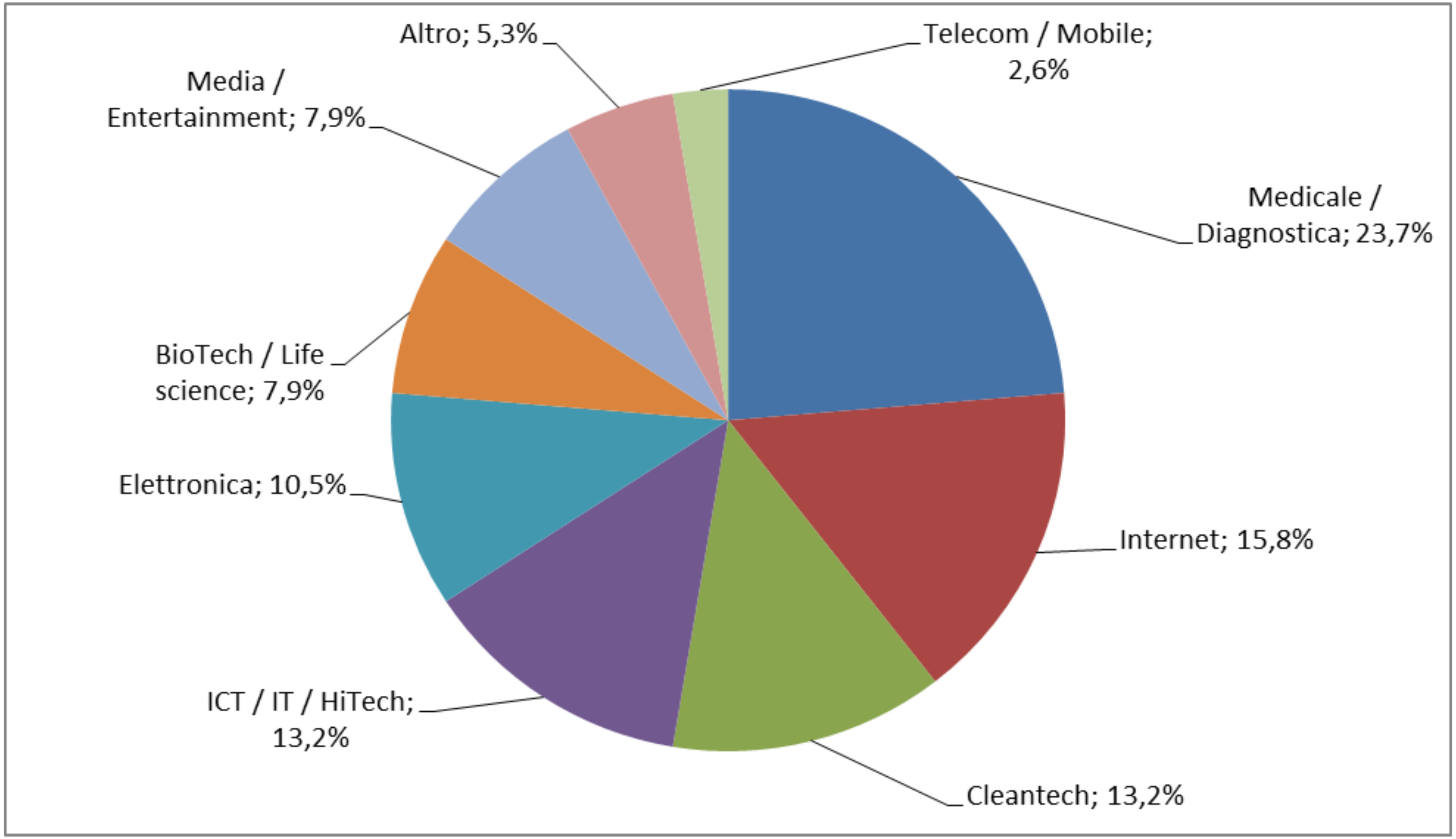
Italian Angels for Growth (IAG), the largest ***Business Angel Group*** in Italy, born in 2008 as a non profit association with 9 founder members. Today it counts **120 investors.**

Achieved

We screen 300+ investment opportunities a year from 5 European countries so far. Closed 41 investments. 24 startup in our portfolio. Raised 22,3 M€, invested 11M€, co-invested 21M€.

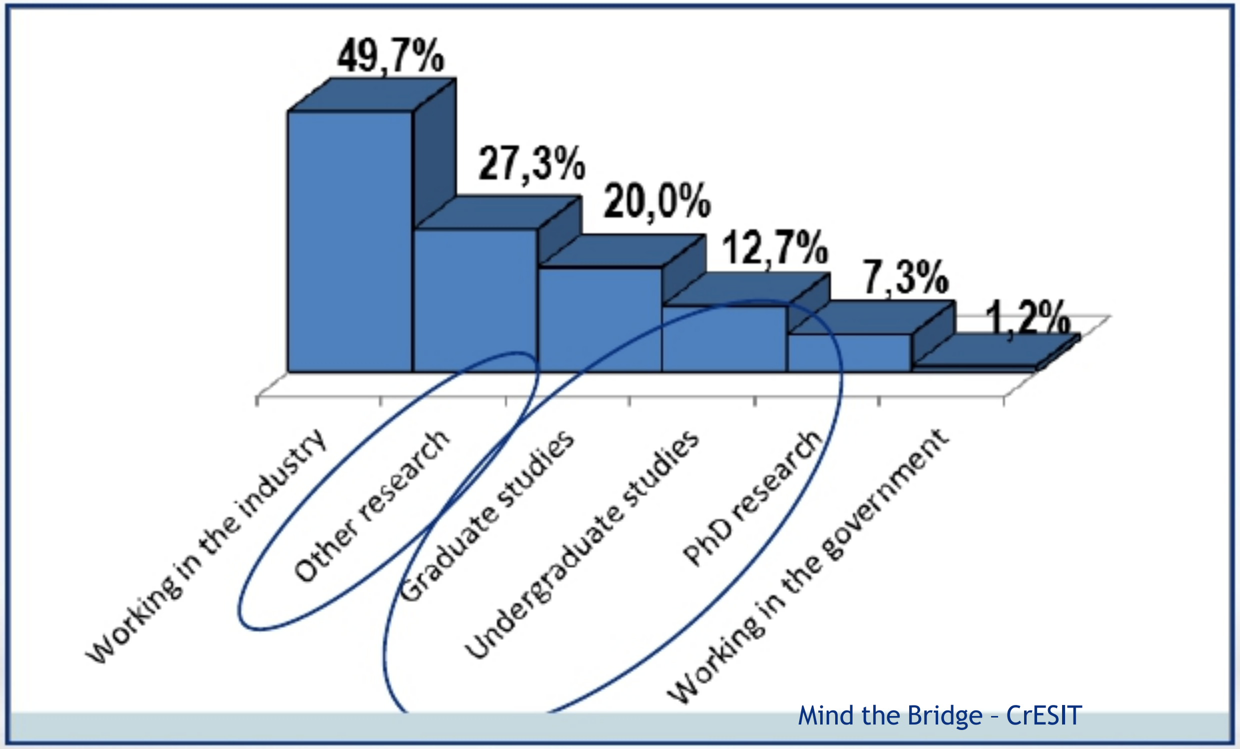
IAG is managed only by individual investors.

Portfolio by sector



Update March 2014

Where startup ideas get started



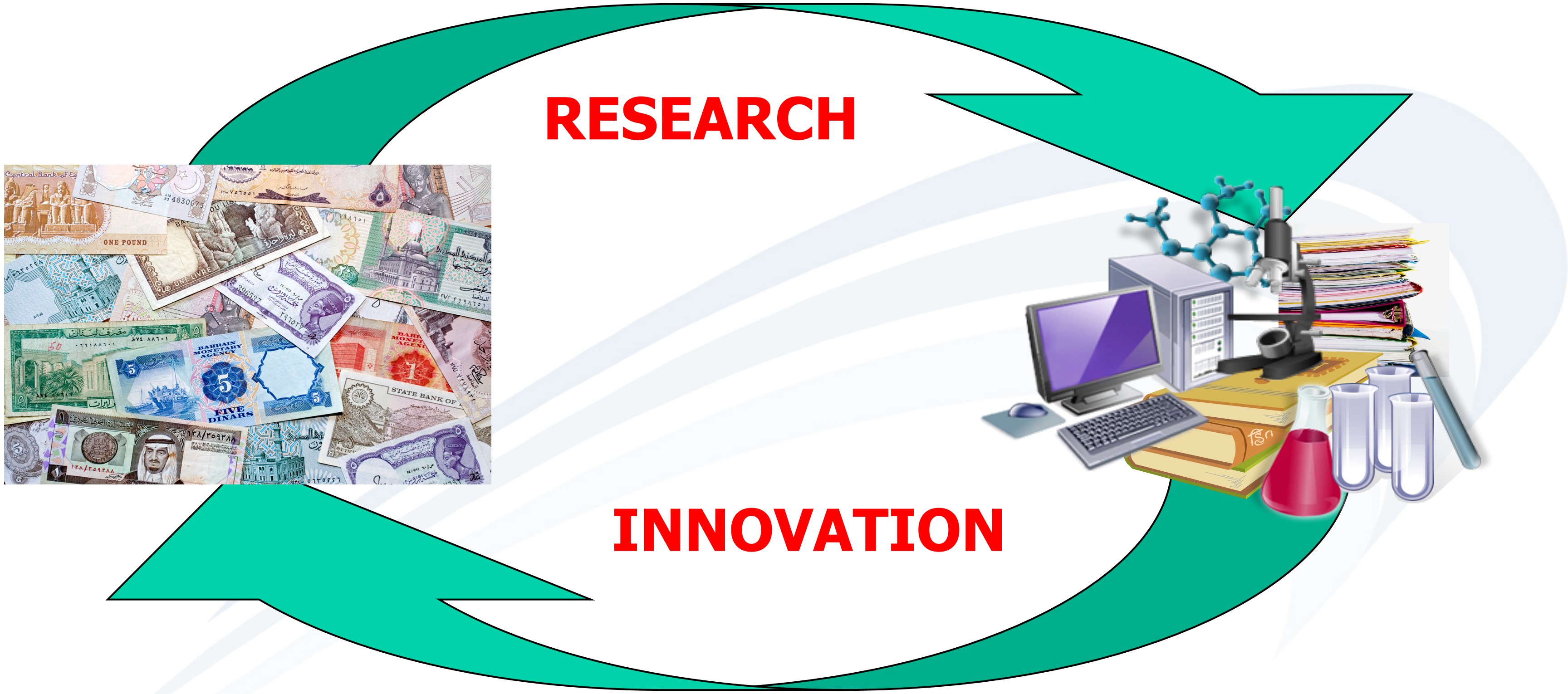
67%+ of startup ideas exit in some way from universities or applied research centers.

How to be more efficient and effective?

MR. STARTUPPER, WHO ARE YOU?

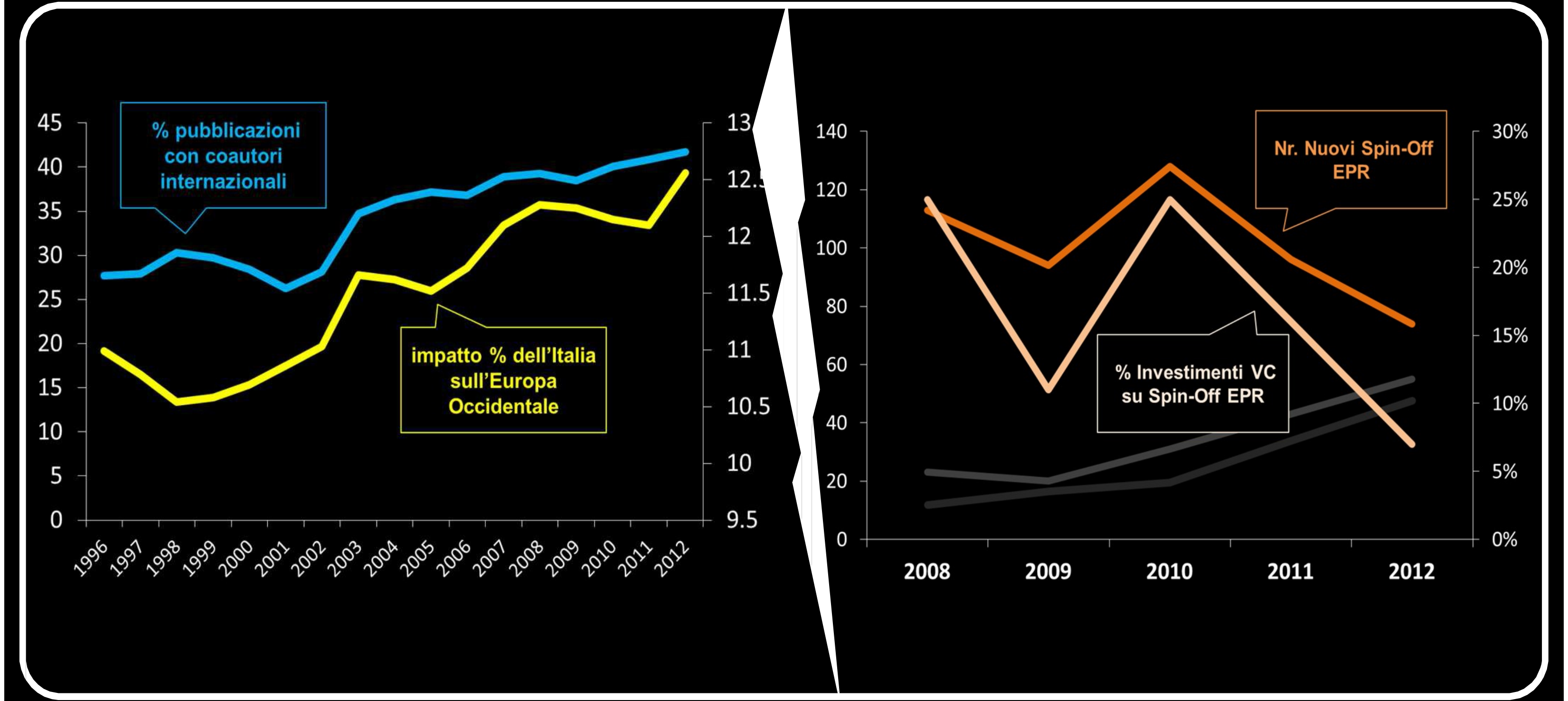
EDUCATION

Research and Innovation



It is rather easy to convert good money into good research,
Much more difficult to convert good research into good money

We are not able to value our technologies and people



ITALY: KEY ISSUES – EUROPE?

- **Issues I've seen in my last five years in IAG, limiting the birth of innovative high tech startups in Italy:**
  - Too much technology focus, business is not made by technology, technology enables in some cases good business, there is no direct connection between good technology and good business
  - Lack of a real entrepreneurial approach and of a sound risk taking attitude
  - Lack of company culture and market approach in our R&D teams
  - Difficult to create the starting team with the necessary credibility
  - Quality of pitch and business plans
  - Lack of management expertise to support Execution
  - Obstacles in Exits due to lack of a large company substrate and of a modern stock market

Some Final Personal Recommendations

- Close or strongly reduce the large existing gap between research and market deployment; apply much more market oriented **filters** to the development of technological projects;
- build **product manufacturing** experience, very often innovative products do not find a market path due to too expensive manufacturing requirements;
- develop and promote **cost sensitivity** in research/design engineers; too often research engineers and managers are used to ask for money for their own research activity as if money would be a "given" that needs, under any circumstances to be spent for the technology development;
- identify, facilitate and develop **entrepreneurial thinking** in our students and research teams, this being overall the very first missing skill in our technical people, specifically in Europe. They are not or too rarely with the right entrepreneurial skill and risk taking attitude.

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My lesson learned and guidelines

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