www.bsc.es


**Barcelona Supercomputing Center**
*Centro Nacional de Supercomputación*

# Barcelona Supercomputing Center

## Centro Nacional de Supercomputación

EXCELENCIA
SEVERO
OCHOA

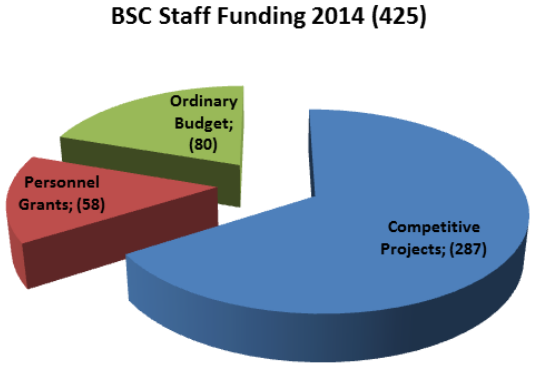
EMIT 2016. Barcelona
June 2nd, 2016

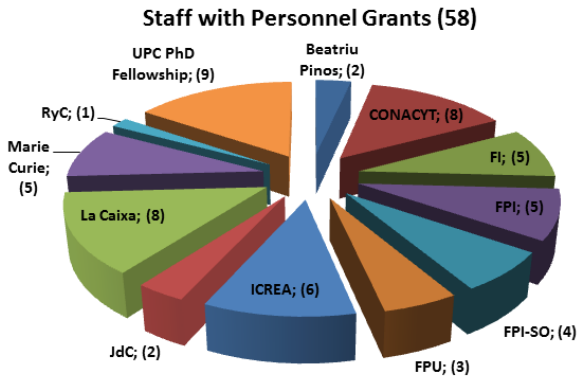
# Barcelona Supercomputing Center
# Centro Nacional de Supercomputación

- BSC-CNS objectives:
  - R&D in Computer, Life, Earth and Engineering Sciences
  - Supercomputing services and support to Spanish and European researchers

- BSC-CNS is a consortium that includes:
  - Spanish Government 60%
  - Catalonian Government 30%
  - Universitat Politècnica de Catalunya (UPC) 10%

- 425 people, 41 countries

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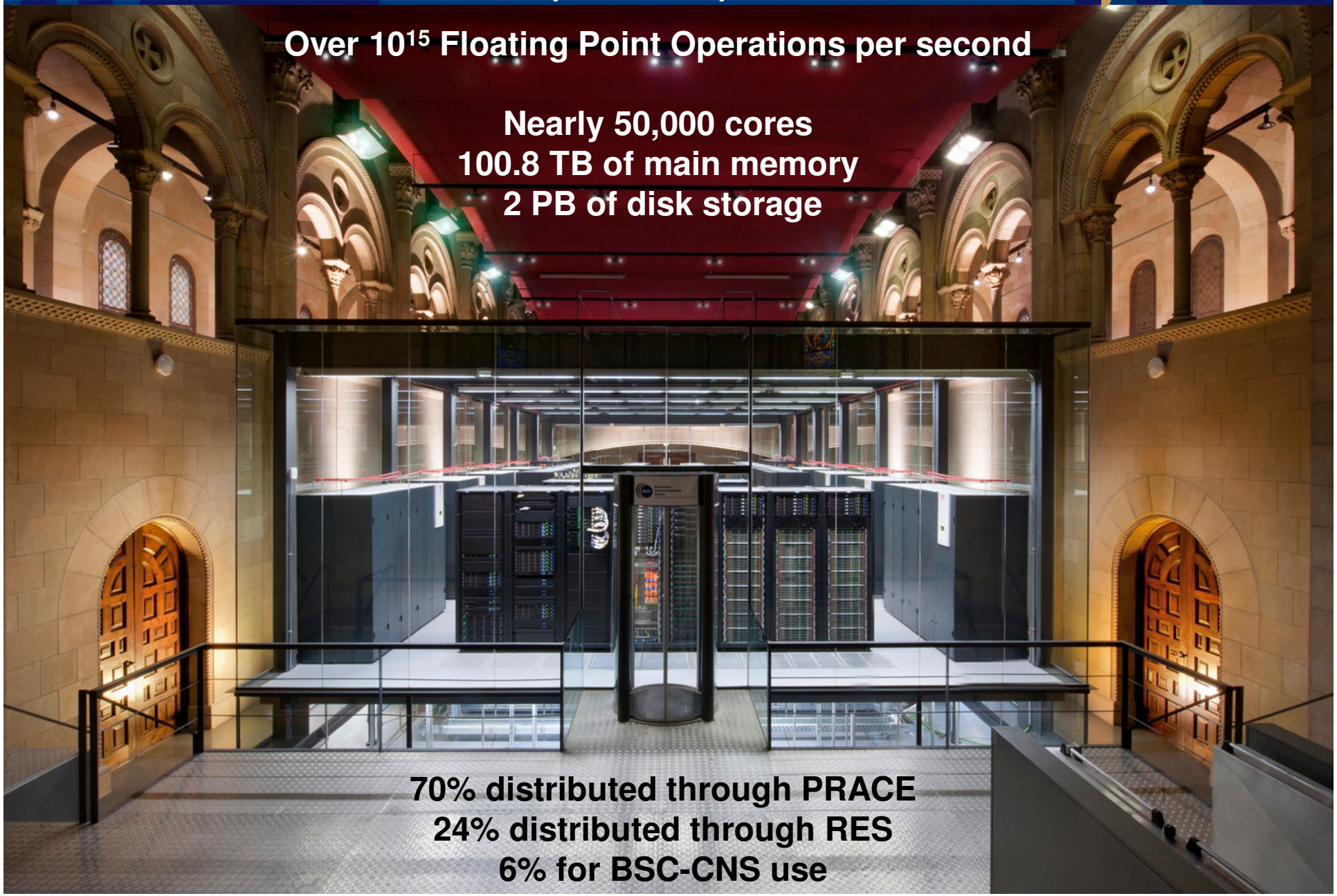
# The MareNostrum 3 Supercomputer

EXCELENCIA SEVERO OCHOA



**Over $10^{15}$ Floating Point Operations per second**

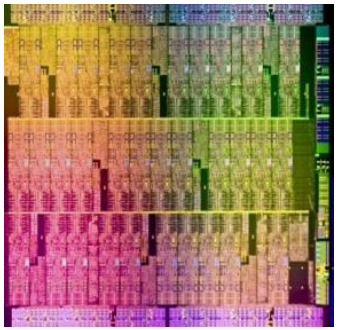
**Nearly 50,000 cores**
**100.8 TB of main memory**
**2 PB of disk storage**

**70% distributed through PRACE**
**24% distributed through RES**
**6% for BSC-CNS use**

# Mission of BSC Scientific Departments

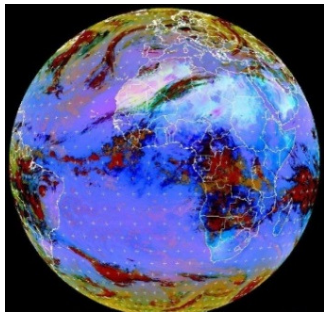
## COMPUTER SCIENCES

To influence the way machines are built, programmed and used: programming models, performance tools, Big Data, computer architecture, energy efficiency



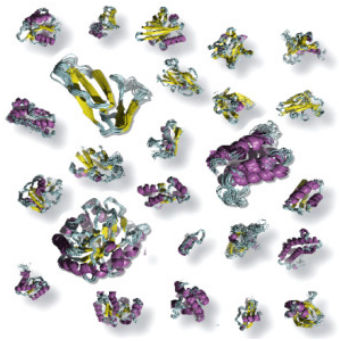
## EARTH SCIENCES

To develop and implement global and regional state-of-the-art models for short-term air quality forecast and long-term climate applications



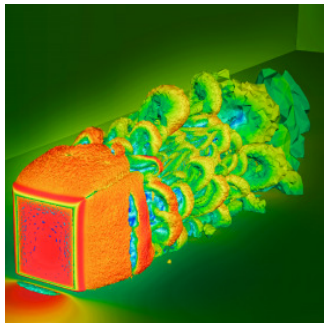
## LIFE SCIENCES

To understand living organisms by means of theoretical and computational methods (molecular modeling, genomics, proteomics)



## CASE

To develop scientific and engineering software to efficiently exploit super-computing capabilities (biomedical, geophysics, atmospheric, energy, social and economic simulations)

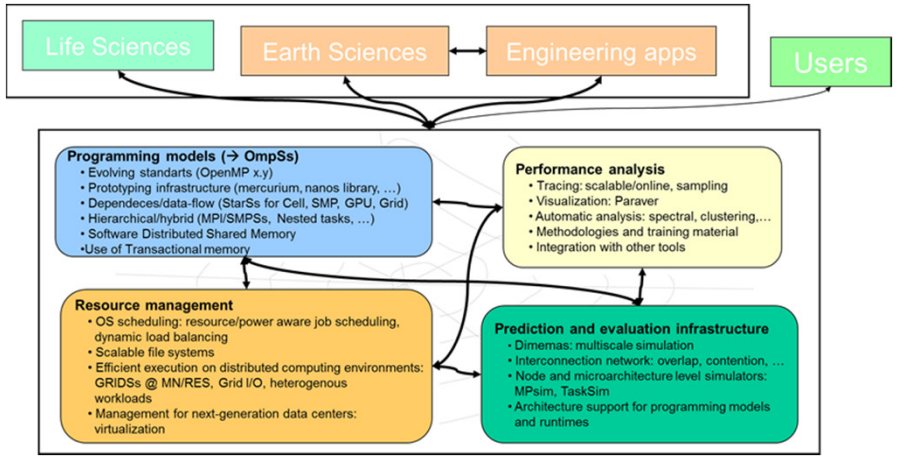


# The BSC-CS project …

Influence the way machines are built …
… programmed …
… and used

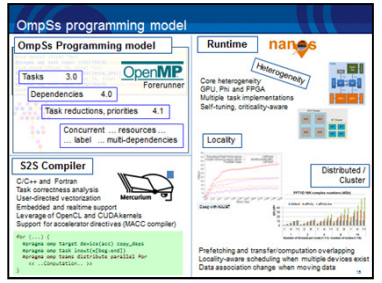
Through
- ideas
- demonstration
- Cooperation with manufacturers & “products”

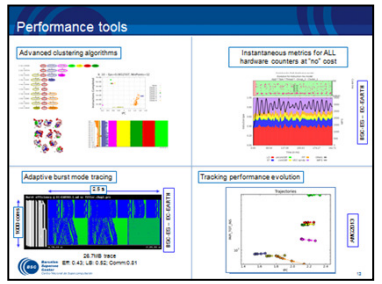
Our strength
- Vision
- Holistic/vertical background
- Technology
- Co-design environment

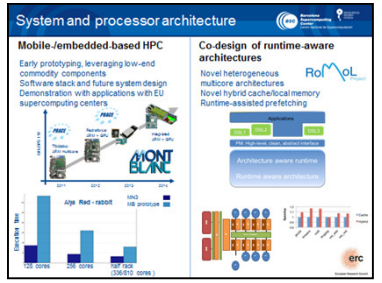


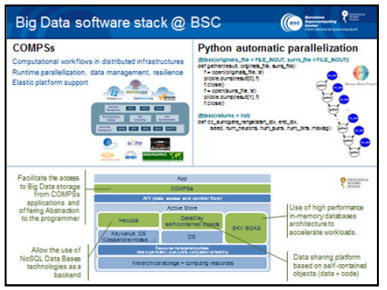
# BSC technologies

- Programming model
  - The StarSs concept (*Superscalar) :
    - Task based, dataflow out of order execution
    - Criticality and locality aware scheduling
  - The OmpSs implementation → OpenMP Standard
  - Dynamic resource management
- Performance tools
  - Trace visualization and analysis:
    - extreme flexibility and detail
  - Performance analytics
- Architecture background
  - Leverage other markets investments
  - Runtime aware architecture
- Big data
  - Integration of
    - Computational workflow models and runtimes
    - Storage architecture and management
    - Dynamic resource management



# POP CoE

## Performance Optimization and Productivity

**A Horizontal Center of Excellence**

Across application areas, platforms, scales

**Providing Performance Optimization and Productivity services**

Precise understanding of application and system behavior
Suggestion on how to refactor code in the most productive way

**For academic AND industrial codes**

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JÜLICH FORSCHUNGSZENTRUM

RWTH AACHEN UNIVERSITY

HLRS

nag®

Ter@tec

**Oct 2015 – March 2018**

**Using both Open Source and Commercial toolsets**

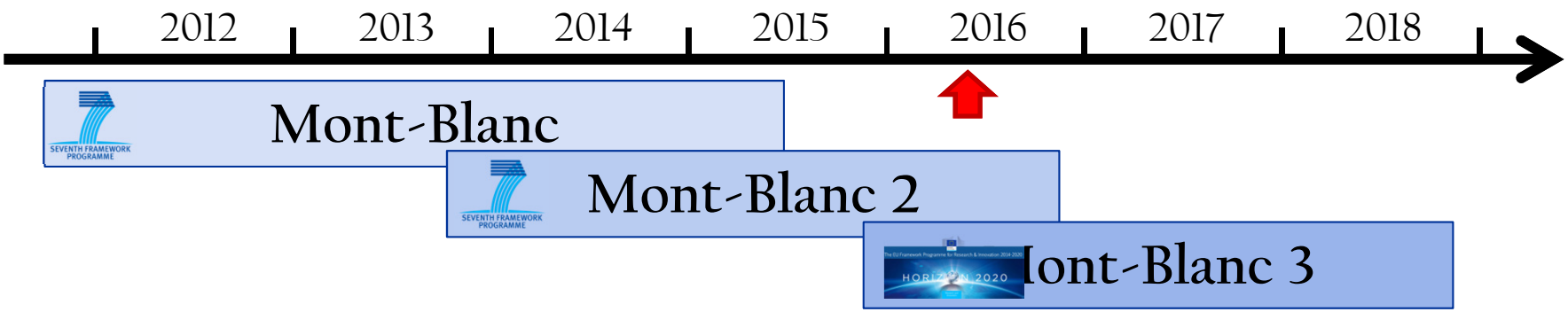
? **Application Performance Audit**
! **Application Performance Plan**
✓ **Proof-of-Concept**

www.pop-coe.eu

Funded by EC's H2020 programme

# Mont-Blanc projects in a glance

**Vision:** to leverage the fast growing market of mobile technology for scientific computation, HPC and non-HPC workload.

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cnrs
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cea
UC UNIVERSIDAD DE CANTABRIA
AVL
UNIVERSITÉ DE VERSAILLES ST-QUENTIN-EN-YVELINES



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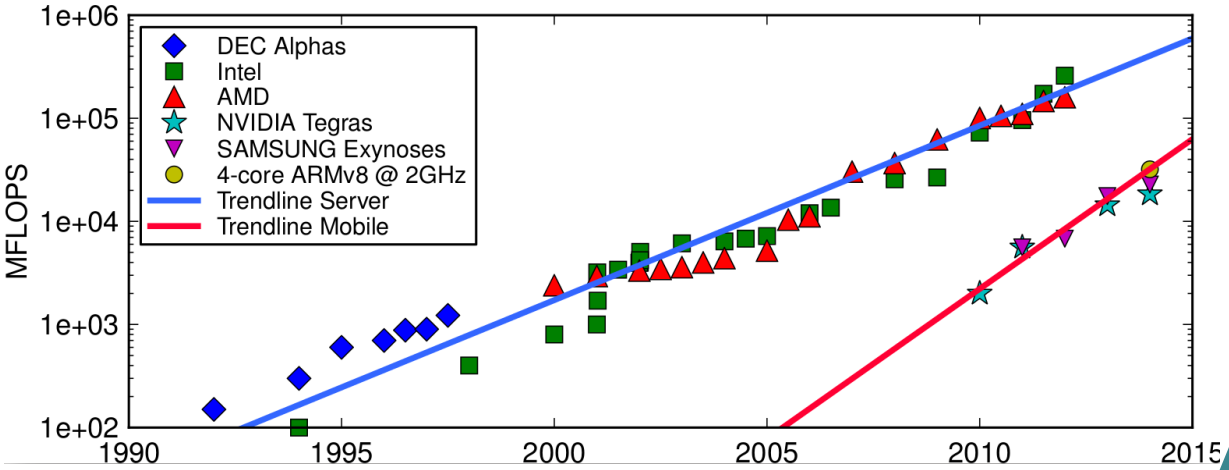
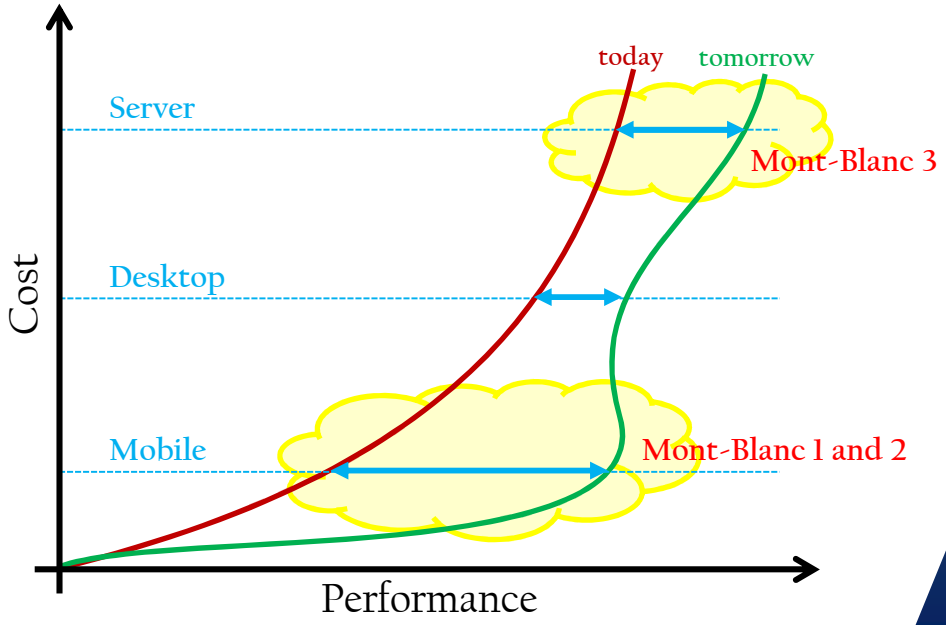
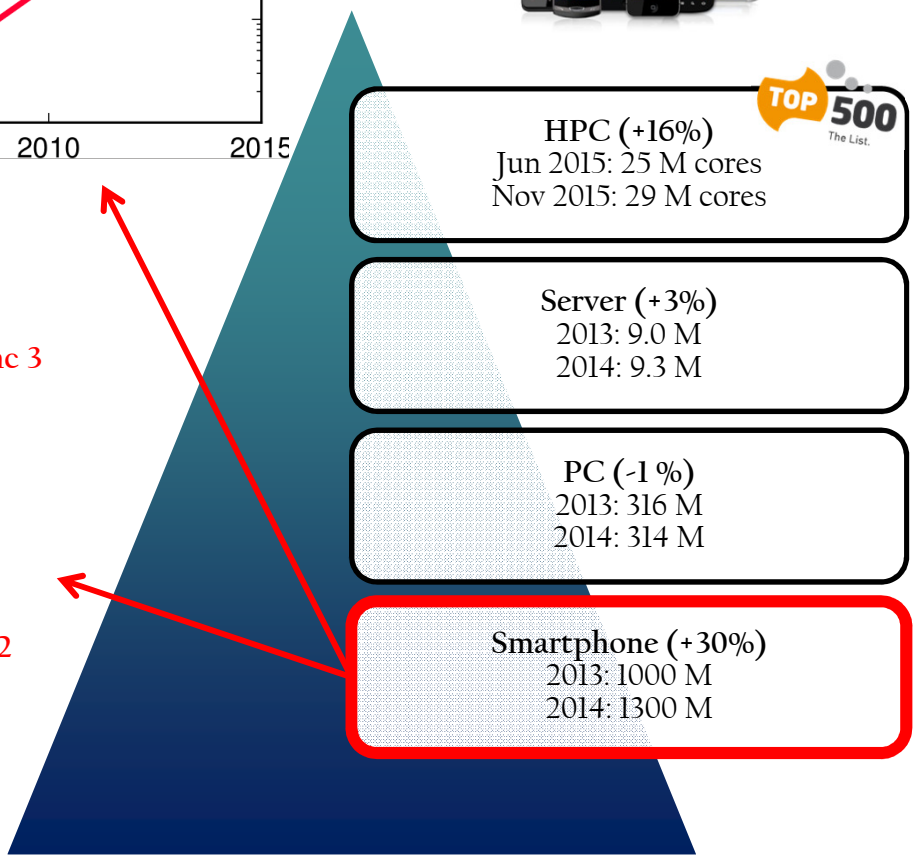
# Leveraging a fast-growing market




...and we are still ignoring tablets: >200M



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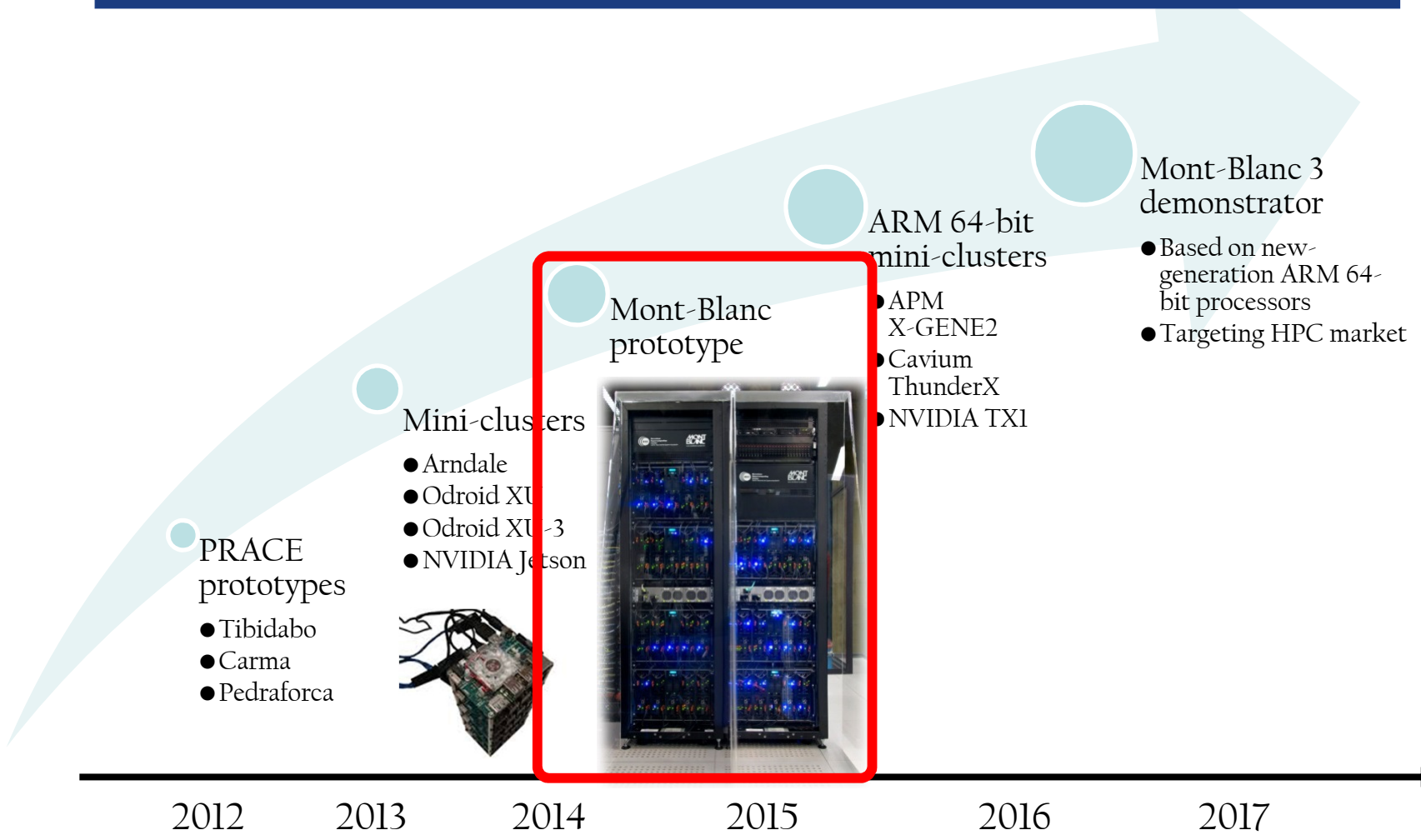
# The Mont-Blanc prototype ecosystem

## Prototypes are critical to accelerate software development

System software stack + applications



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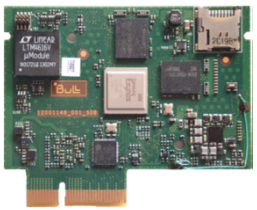
# The Mont-Blanc prototype

**Exynos 5 compute card**
2 x Cortex-A15 @ 1.7GHz
1 x Mali T604 GPU
6.8 + 25.5 GFLOPS
15 Watts
2.1 GFLOPS/W



**Carrier blade**
15 x Compute cards
485 GFLOPS
1 GbE to 10 GbE
300 Watts
1.6 GFLOPS/W

**Blade chassis 7U**
9 x Carrier blade
135 x Compute cards
4.3 TFLOPS
2.7 kWatts
1.6 GFLOPS/W

**Rack**
8 BullX chassis
72 Compute blades
1080 Compute cards
2160 CPUs
1080 GPUs
4.3 TB of DRAM
17.2 TB of Flash

**35 TFLOPS**
**24 kWatt**

A perfect playground for addressing important questions for next-generation architectures:

- Can we take real advantage of HMP?
- Can we survive without ECC?
- Can we scale 'something' with one Gigabit Ethernet network?
- Can we learn 'something' from power profiles?



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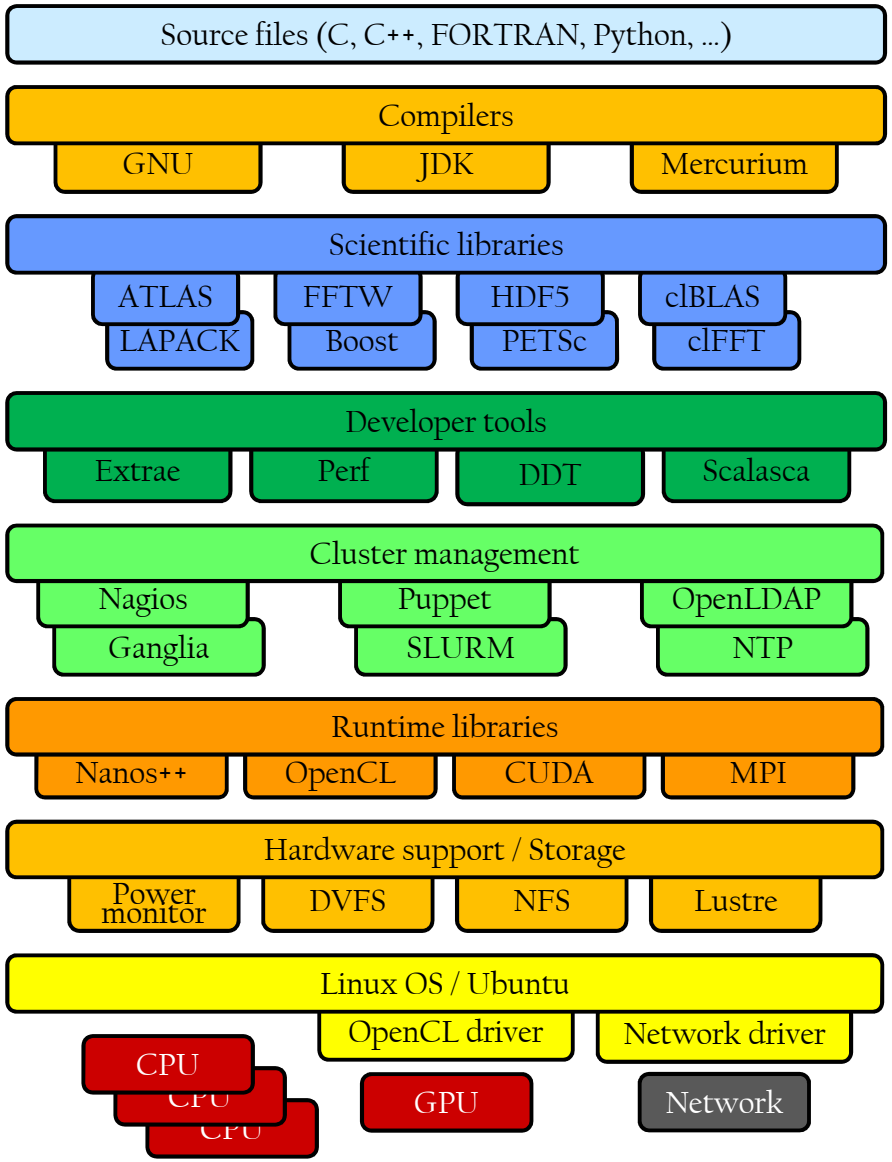
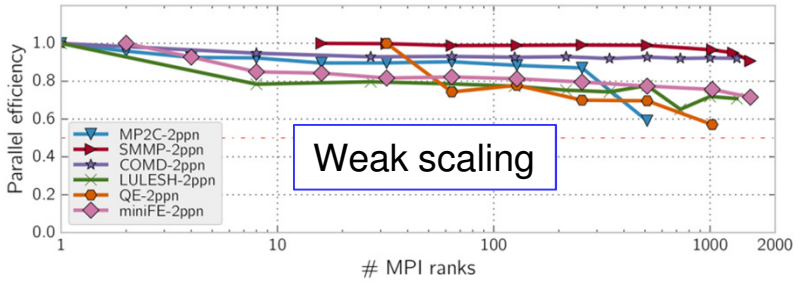
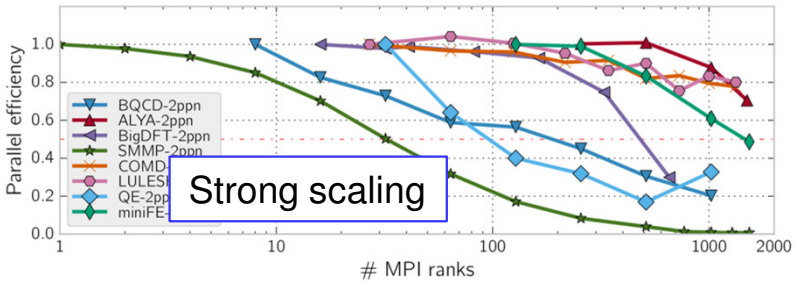
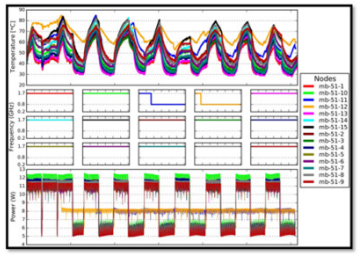
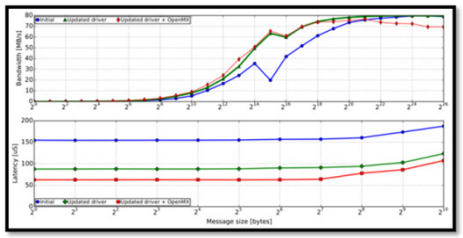
# System software stack and applications

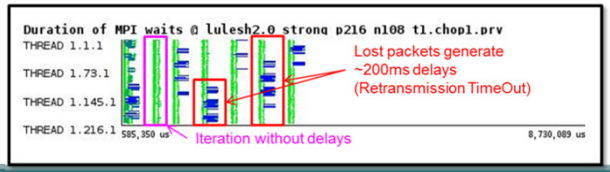






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# Final remarks

- BSC highly active in emerging technologies
- Montblanc 1 and 2
  - Important  role in the move of ARM based system towards HPC
  - Demonstrating the potential to scale with low end components
  - Cost effectiveness: showing the possibility to leverage components and technologies developed by other markets
  - Challenging “established” thinking in the HPC sector
  - A practical approach: design freezes in a very fast moving market but still possible to demonstrate ideas
- Potential
  - To revert to other markets
  - To improve the traditional HPC sector → Montblanc 3
- The real revolution
  - is in the mind of programmers: latency → throughput  mindset
  - Takes time … but unavoidable