JUGAR | CREAR | AVANZAR

International Computing Week
Semana Internacional de la Computación

CENTRO EUROPEO DE EMPRESAS E INNOVACIÓN navarra

NECESIDADES DE SUPERCOMPUTACIÓN EN LAS EMPRESAS ESPAÑOLAS

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CESGA

XUNTA DE GALICIA
CONSELLERÍA DE INNOVACIÓN, E INDUSTRIA

CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

MINISTERIO DE CIENCIA E INNOVACIÓN

FEDER
FONDO EUROPEO DE DESENVOLVEMENTO REXIONAL

Gobierno de Navarra

respuesta digital

Índice

- **What is CESGA**
- **What is supercomputing**
- **Enterprise Supercomputing Uses**
- **Supercomputing and Enterprises**

WHAT IS CESGA?

WHERE IS CESGA?

CESGA

PARTNERS

Board of Trustees

- Regional Government of Galicia
- National Research Council of Spain

XUNTA DE GALICIA

CSIC

Gobierno de Navarra

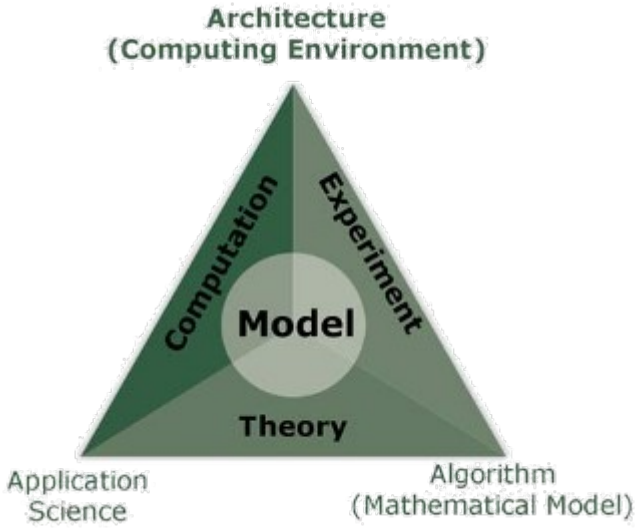
respuesta digital

MISSION STATEMENT

To provide high performance computing and advanced communications resources and services to the scientific community of Galicia and to the Spanish National Research Council (CSIC), as well as, to institutions and **enterprises with R&D activity**.

To promote **high quality research in Computational Science in close collaboration with the research community** from Galicia as well as from other regions or countries all over the world; contributing in this way to the advancement of science, **to transfer technology to industry** and administrations, and as consequence, to the welfare of society as a whole.

COMPUTATIONAL SCIENCE



Computational Science is the field of study concerned with constructing mathematical models and numerical solution techniques using computers to analyze and solve scientific, social scientific and engineering problems.

(Source: Wikipedia)

CESGA's COMMUNITY OF USERS

- **GALICIAN UNIVERSITIES**
- **GALICIAN REGIONAL GOVERNMENT RESEARCH CENTRES**
- **SPANISH NATIONAL RESEARCH COUNCIL (CSIC) CENTRES**
- **OTHER PUBLIC OR PRIVATE ORGANIZATIONS**
  - Hospital R&D Departments
  - **Industries R&D Departments**
  - **Technological & Research Centres**
  - Other Universities worldwide
  - Non-profit R&D organizations

SERVICES

- HPC, HTC & GRID Computing
- User Data Storage
- Training
- Advanced Communications Network
- Video streaming broadcast & on-demand
- Remote Learning & Collaboration Room Network
- e-Learning & Collaboration Tools
- GIS (Geographical Information Systems)
- e-Business Innovation Consulting and Tech. transfer.
- R&D&I Project management

TECHNOLOGICAL EVOLUTION

1993
VP 2400

2,5 GFLOPS

1998
VPP 300 **AP 3000**

14,1 GFLOPS **12 GFLOPS**

1999
HPC 4500 **STORAGETEK**

9,6 GFLOPS **51 TERABYTES**

2001
SVG

9,9 GFLOPS

2002
HPC 320 **BEOWULF**

64 GFLOPS **16 GFLOPS**

2003
SUPERDOME

768 GFLOPS

2004, 2005, 2006
SVG

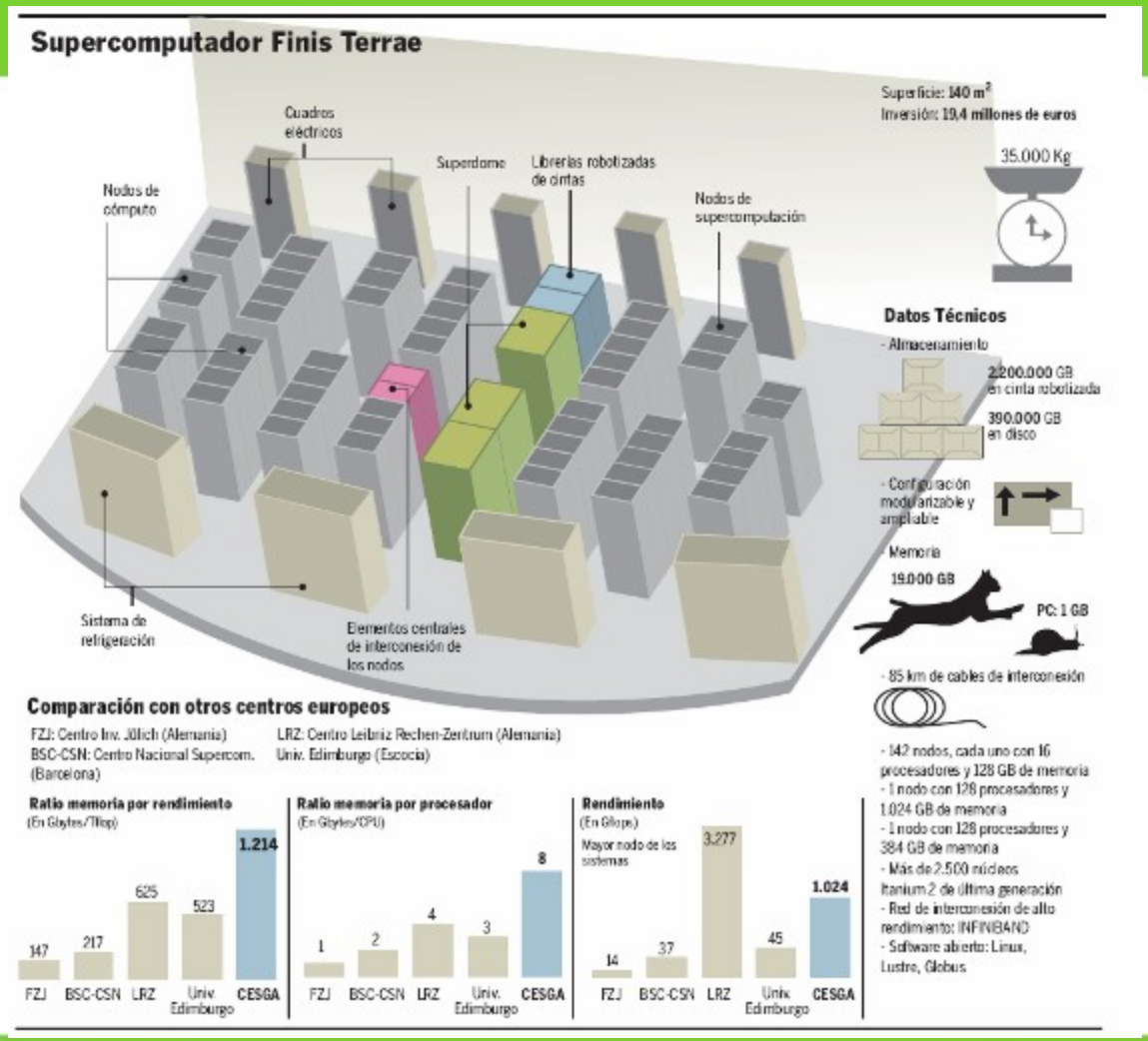
3,142 GFLOPS

2007-8
FINIS TERRAE

16,000 GFLOPS

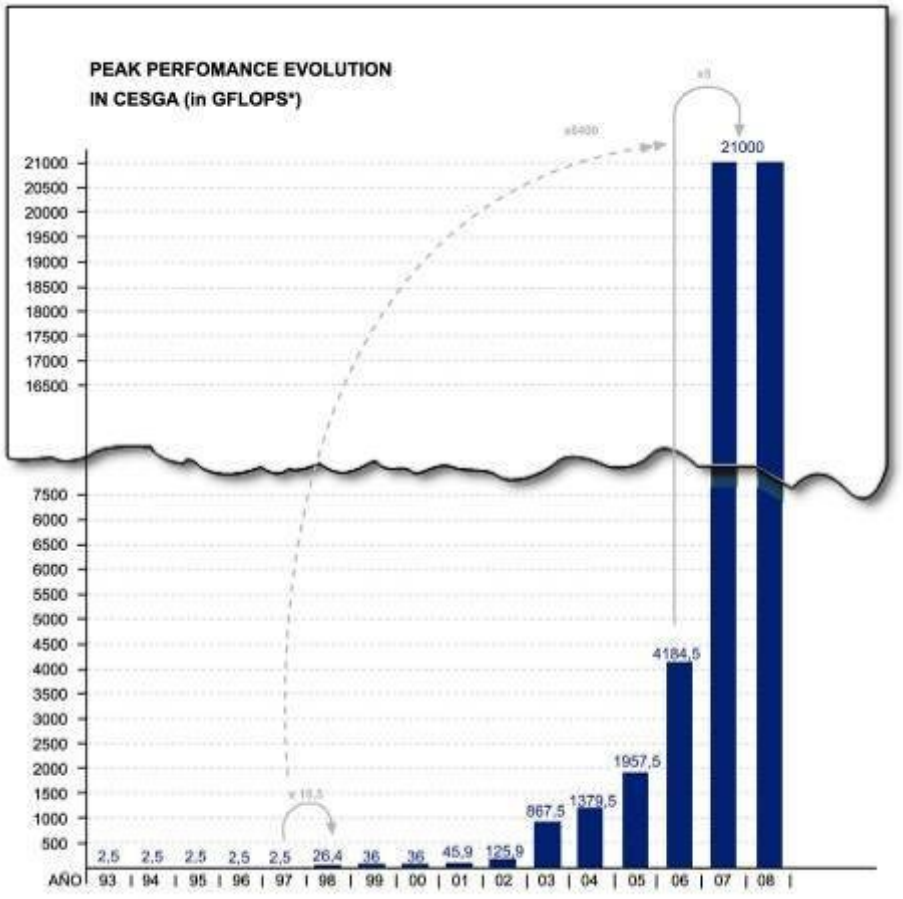
Installation Year	1993	1998	1999	2001	2002	2003	2004	2005	2006	2007
Capacity				SVG			SVG	SVG	2006	
Capability	VP2400	VPP300E AP3000	HPC4500		HPC320	SUPERDOME				FINIS TERRAE

Finis Terrae



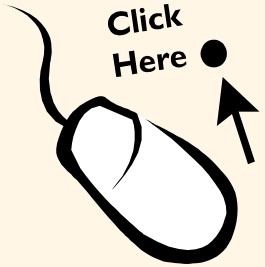
Fuente: El Correo Gallego

CESGA's PEAK PERFORMANCE EVOLUTION



HOW REQUEST HPC, HTC, STORAGE SERVICES (I)

- **Galician University, CSIC or Public Regional Center**

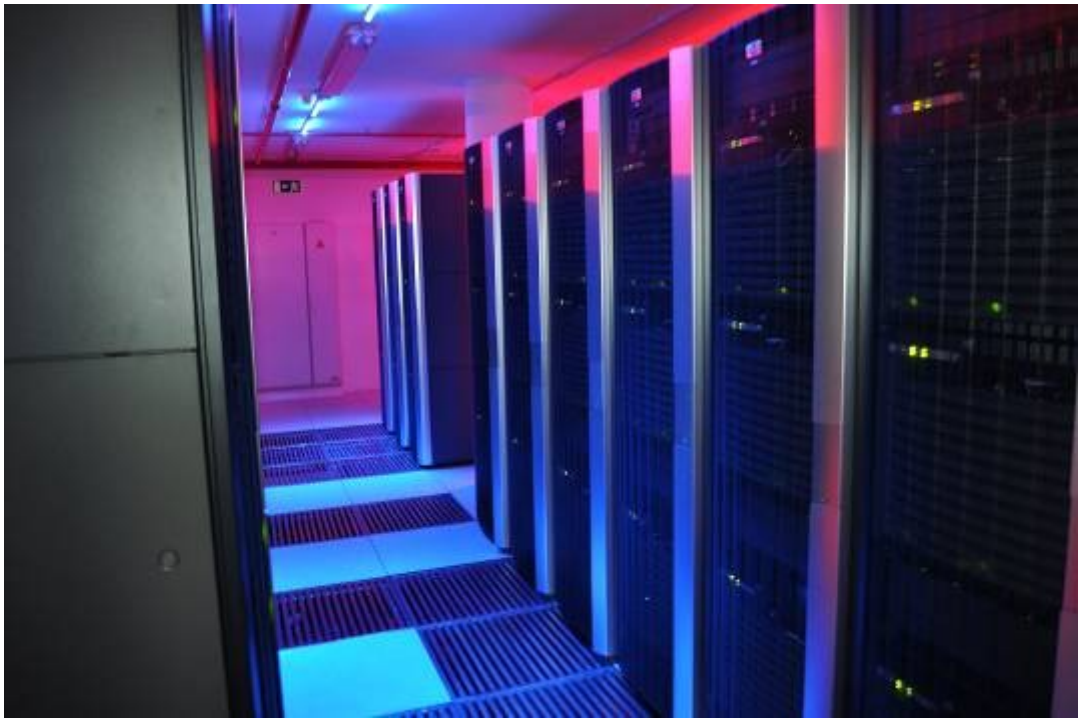


  - **It is FREE, no FEE Except for Special Requirements**
  - **Fill Form**
- **Other Public Organization**
  - **Agreement (It is NOT free)**
  - **Public calls (from Jan. 2009)**

HOW REQUEST HPC, HTC, STORAGE SERVICES (II)

- **Private Organizations & Companies**
  - **ONLY for R&D (maybe &I)**
  - **Small FEE (less 2€/CPU-hour)**
  - **Soft Licenses NOT included**
  - **Contact us for Budget**
  - **Public calls (from Jan. 2009)**
- **Independent Researcher**
  - **Contact us**
  - **Public calls (from Jan. 2009)**

WHAT IS SUPERCOMPUTING?



SUPERCOMPUTER

- A supercomputer is a computer that is at the **frontline of current processing capacity**, particularly speed of calculation.
- Now, mainly aggregate **off-the-shell** computers linked with high performance networks.

SUPERCOMPUTING

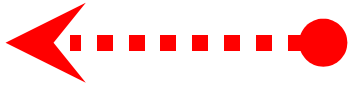
- **Capability computing:** solve a single large problem in the shortest amount of time.
- **Capacity computing:** solve large problems or many small problems.
- **Finis Terrae**: Designed as a mix capacity-capability

TECHNICAL COMPUTING

- **HPC:** High Performance Computing is the use of parallel processing for running advanced application programs efficiently, reliably and quickly.
- **HPC:** High Productivity Computing. The goal is to decrease the **time-to-solution**, which means decreasing both the execution time and development time of an application on a particular system.
- **HTC:** High Throughput Computing. The use many computing resources over long periods of time to accomplish a computational task. Many jobs can be completed over a long period of time.

TECHNICAL COMPUTING

- **FLOPS:** FLoating point Operations Per Second
- **Giga FLOPS:** 10^9 = 1.000.000.000
- **TFLOPS:** 10^{12}= 1.000.000.000.000
- **PFLOPS:** 10^{15}=1.000.000.000.000.000
- **EFLOPS:** 10^{18}=1.000.000.000.000.000.000
- **ZFLOPS:** 10^{21}=1.000.000.000.000.000.000.000



TOP 1:Roadrunner

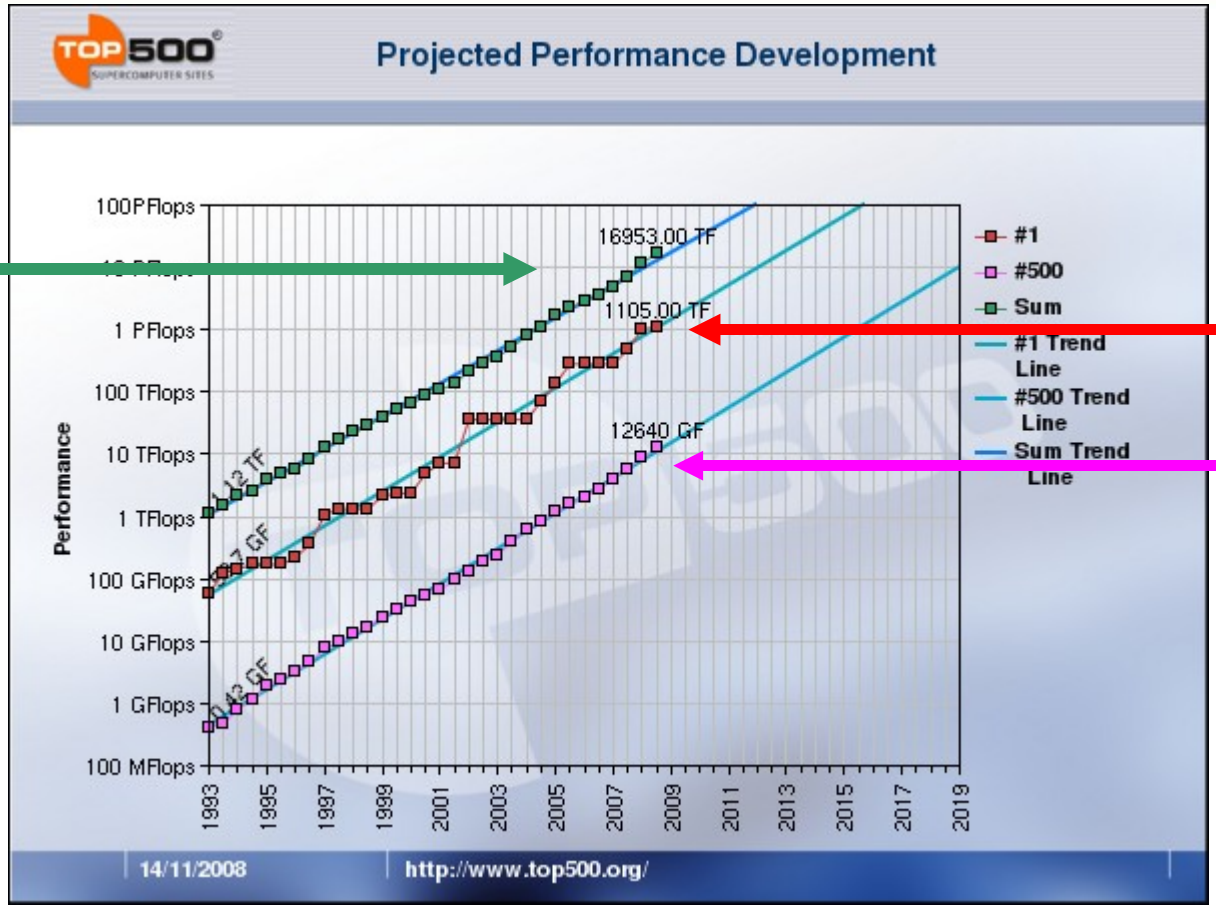
Flops)

1 PERSON x 1 YEAR x 1 FLOP/s

= <u>31.536.000 OPS</u>

1.45 PFLOP
=
1 PERSON 45.979.198 YEARS

TOP500

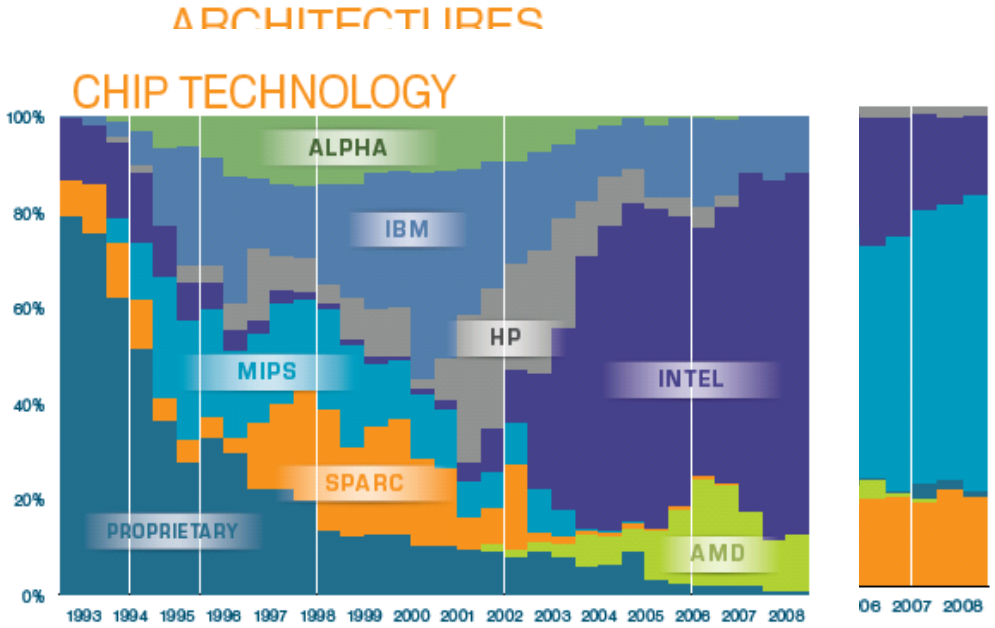


Aggregated

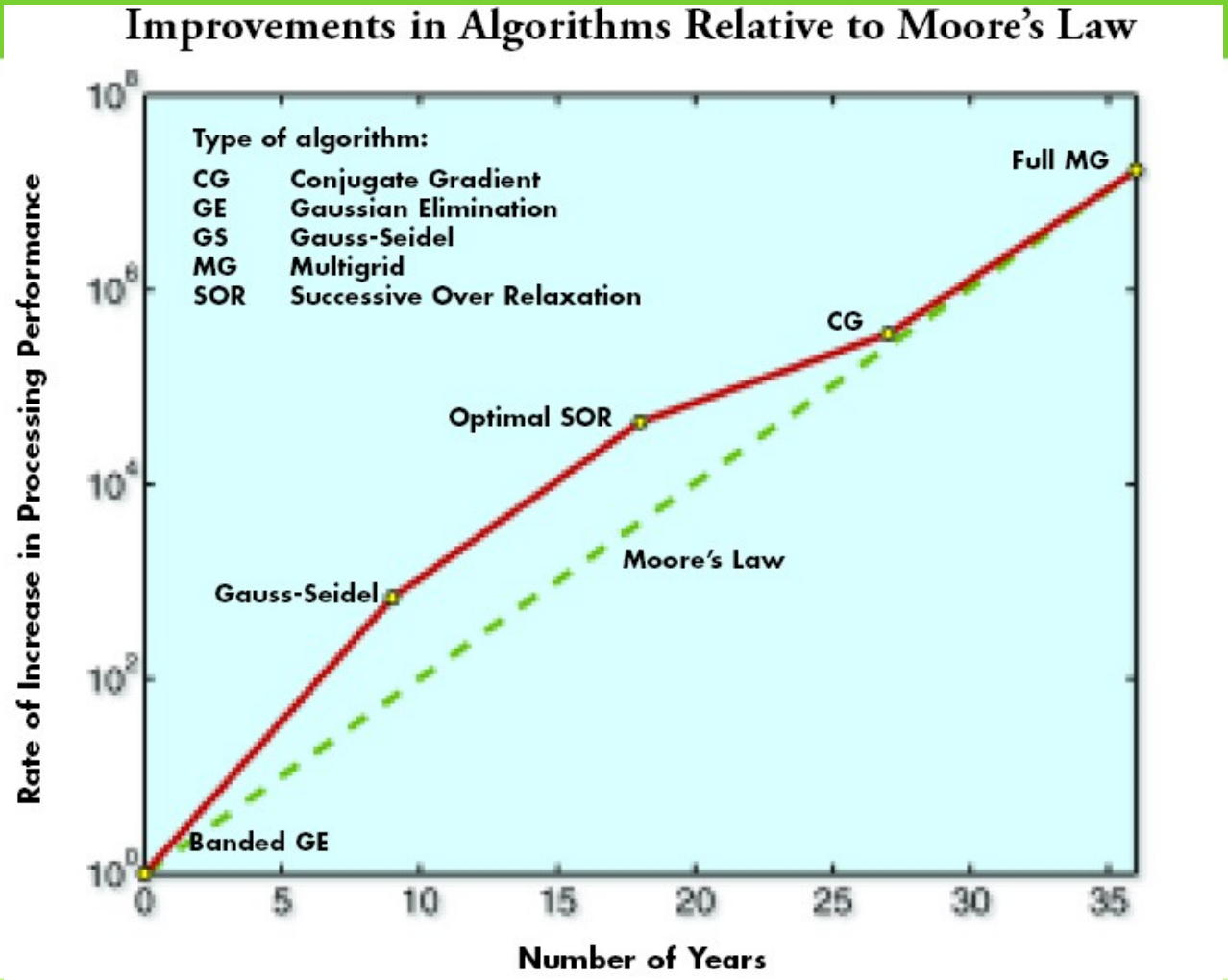
Number 1

Number 500

TOP 500 EVOLUTION



EVOLUTION


Improvements in Algorithms Relative to Moore's Law
Type of algorithm:
CG Conjugate Gradient
GE Gaussian Elimination
GS Gauss-Seidel
MG Multigrid
SOR Successive Over Relaxation
Full MG
CG
Optimal SOR
Moore's Law
Gauss-Seidel
Banded GE
Rate of Increase in Processing Performance
Number of Years
0
5
10
15
20
25
30
35

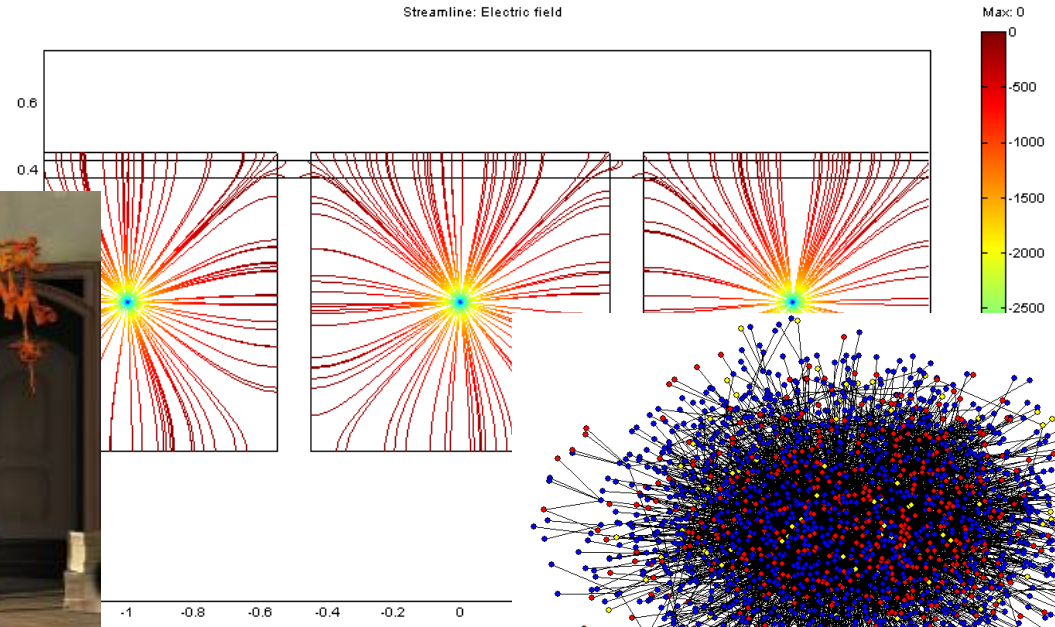
TOP 500 (2008) SPAIN

- 6 Supercomputers
- 153201 GFLOPs

TOP SPANISH SUPERCOMPUTERS

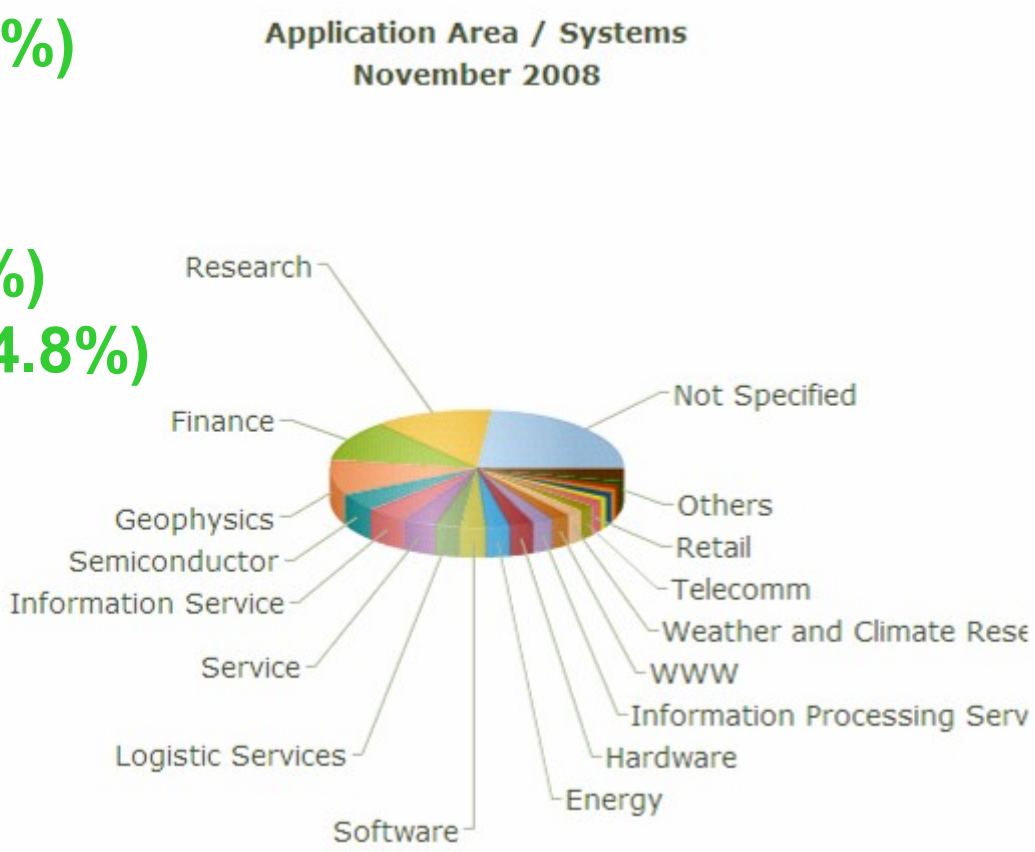
			Cores	Rmax	Rpeak		
40	BSC	BladeCenter JS21 Cluster, PPC 970, 2.3 GHz, Myrinet	10240	63830	94208	68%	Academic
131	Research Institution	[illegible]	[illegible]	[illegible]	[illegible]	78%	Academic
162	Institution (S1)	[illegible] GigEthernet	[illegible]	[illegible]	[illegible]	[illegible]	Industry
335	CeSViMa - BSC	BladeCenter JS20 Cluster, PPC 970, 2.2 GHz, Myrinet	2744	15955,2	24147,2	66%	Academic
376	Bank (S1)	Cluster Platform 3000 BL460c, [illegible]	3040	15212,4	28332,8	54%	Industry
427	CESGA	Integrity rx5670 Cluster Itanium2 1.6GHz [illegible]	2528	14010	16179	87%	Academic

SUPERCOMPUTING ENTERPRISE USES

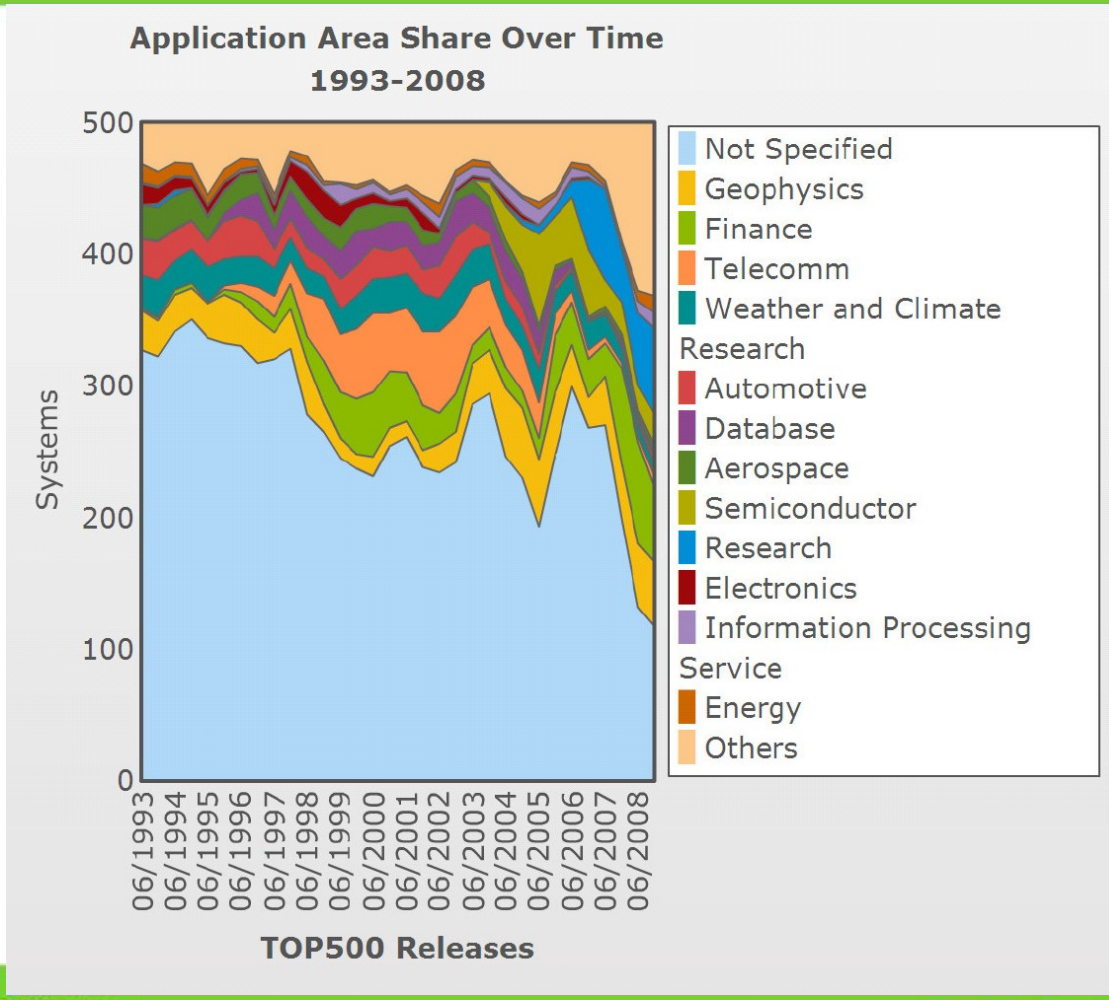


APPLICATION AREA TOP500

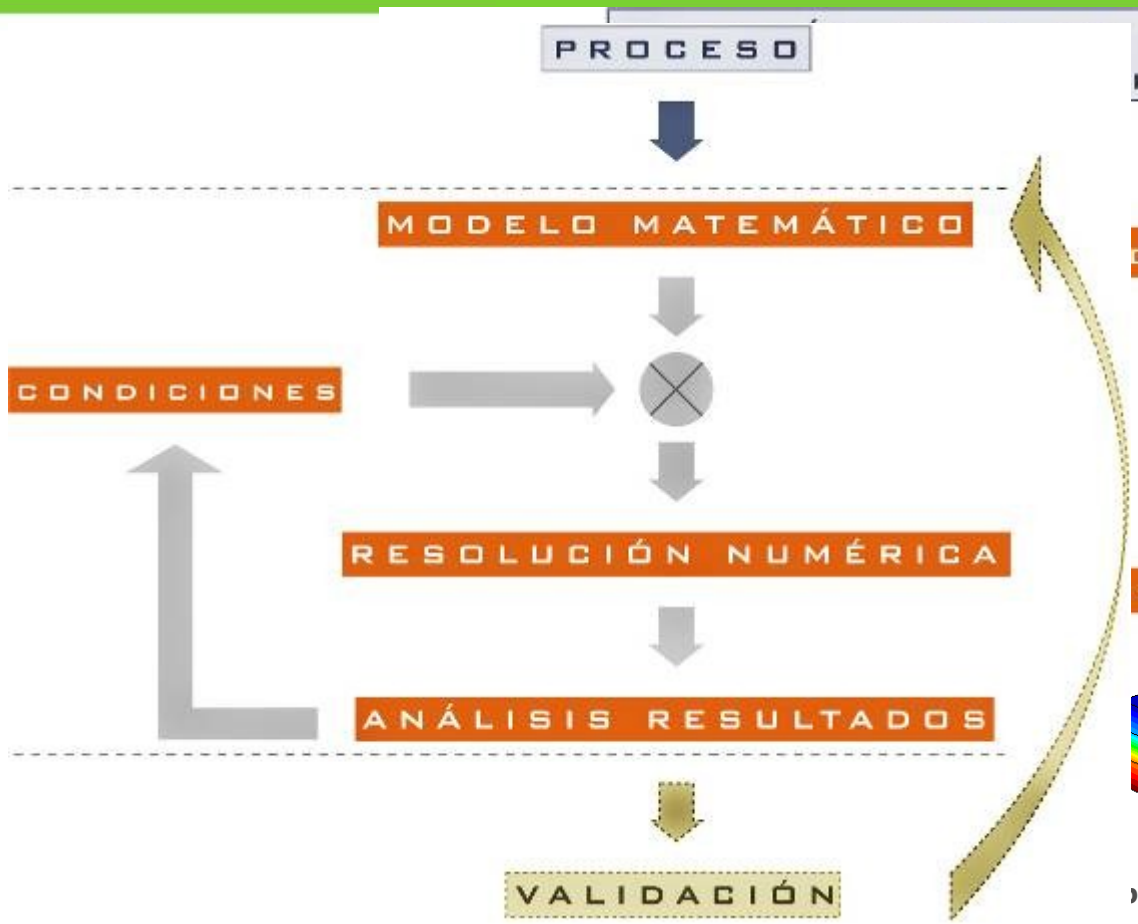
- Not Specified (24%)
- Research (13%)
- Finance (11.2%)
- Geophysics (9.8%)
- Semiconductor (4.8%)

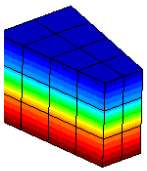


APPLICATION AREA EVOLUTION



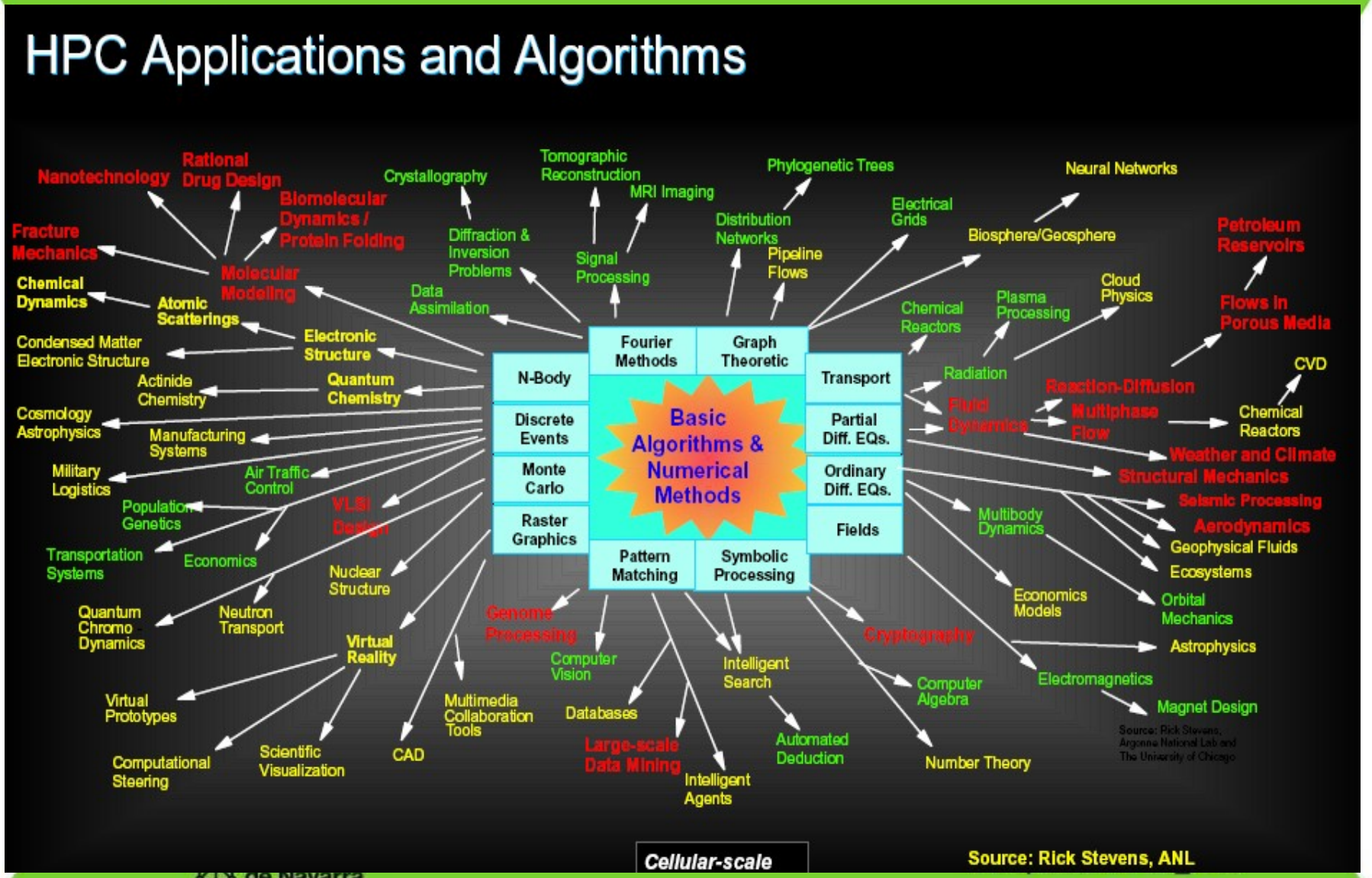
MODELLING & SIMULATION





presiones en el fluido

WHERE

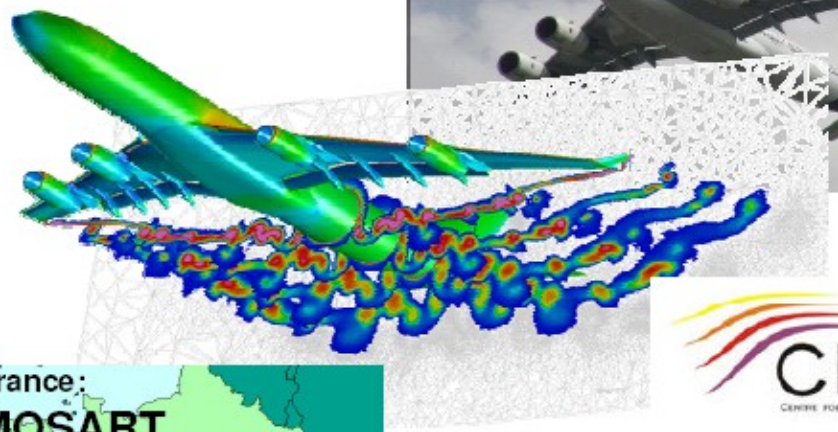

HPC Applications and Algorithms
Basic Algorithms & Numerical Methods
Fourier Methods
Graph Theoretic
N-Body
Transport
Discrete Events
Partial Diff. EQs.
Monte Carlo
Ordinary Diff. EQs.
Raster Graphics
Fields
Pattern Matching
Symbolic Processing
Nanotechnology
Rational Drug Design
Biomolecular Dynamics / Protein Folding
Fracture Mechanics
Molecular Modeling
Chemical Dynamics
Atomic Scatterings
Condensed Matter Electronic Structure
Electronic Structure
Actinide Chemistry
Quantum Chemistry
Cosmology Astrophysics
Manufacturing Systems
Military Logistics
Air Traffic Control
Population Genetics
VLSI Design
Transportation Systems
Economics
Nuclear Structure
Quantum Chromo Dynamics
Neutron Transport
Virtual Reality
Virtual Prototypes
Computational Steering
Scientific Visualization
CAD
Multimedia Collaboration Tools
Genome Processing
Computer Vision
Databases
Large-scale Data Mining
Intelligent Agents
Intelligent Search
Automated Deduction
Cryptography
Computer Algebra
Number Theory
Economics Models
Multibody Dynamics
Electromagnetics
Magnet Design
Orbital Mechanics
Astrophysics
Geophysical Fluids
Ecosystems
Seismic Processing
Aerodynamics
Weather and Climate
Structural Mechanics
Reaction-Diffusion
Multiphase Flow
Fluid Dynamics
Chemical Reactors
CVD
Flows in Porous Media
Petroleum Reservoirs
Radiation
Chemical Reactors
Plasma Processing
Cloud Physics
Biosphere/Geosphere
Neural Networks
Electrical Grids
Distribution Networks
Phylogenetic Trees
Pipeline Flows
Signal Processing
MRI Imaging
Tomographic Reconstruction
Diffraction & Inversion Problems
Crystallography
Data Assimilation
Source: Rick Stevens, Argonne National Lab and The University of Chicago
Cellular-scale
Source: Rick Stevens, ANL

WHERE

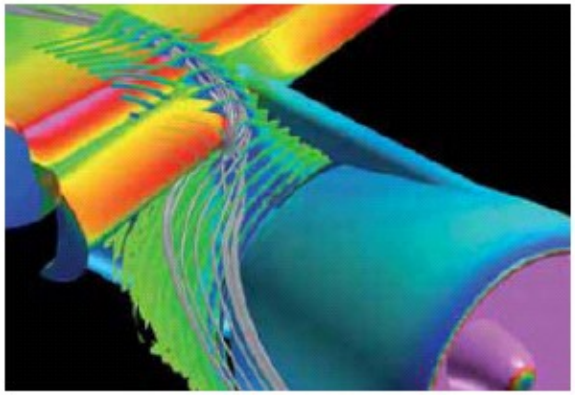
The virtual airplane

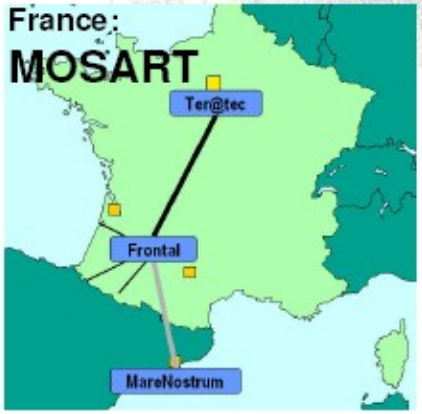
C²A²S²E
Center for Computer Applications in AeroSpace Science and Engineering

AIRBUS DLR Niedersachsen

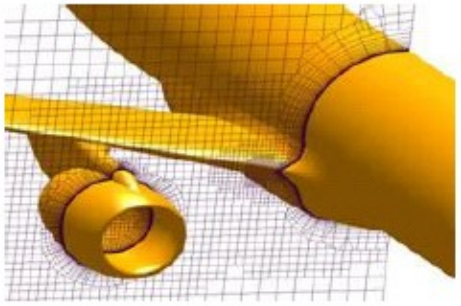


CFMS
CENTRE FOR FLUID MECHANICS SIMULATION





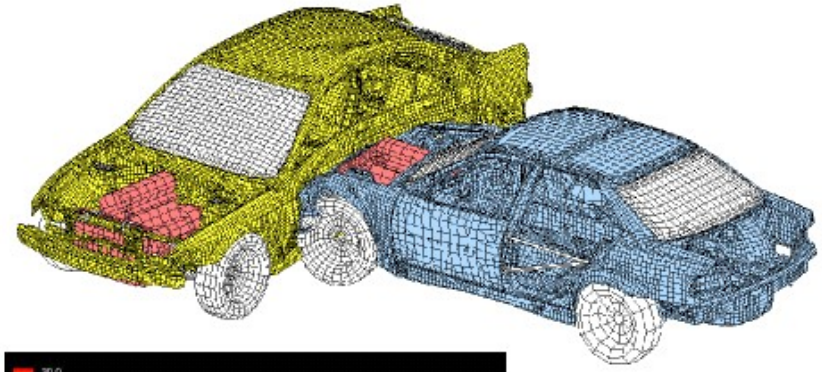
UK

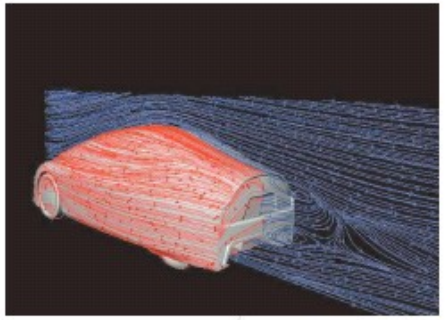


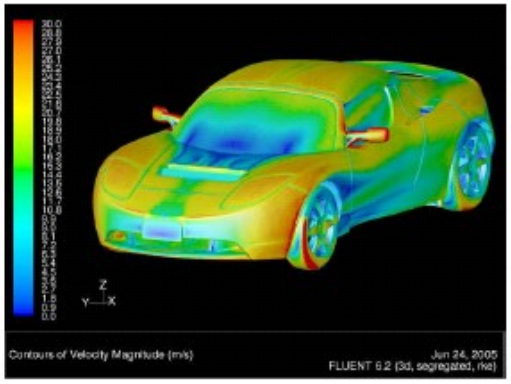
Source: PRACE project

WHERE

HPC in the automotive industry





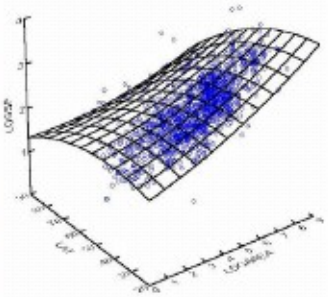


Source: PRACE project

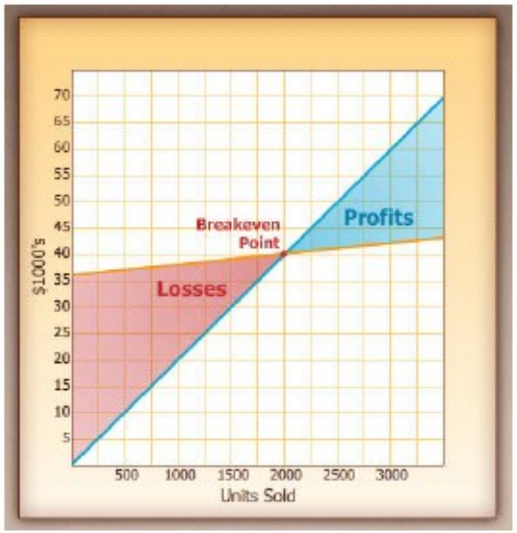
WHERE

HPC and the finance sector

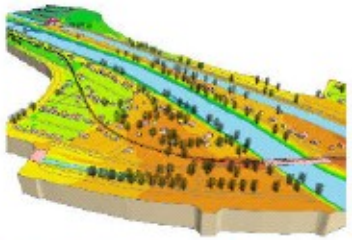
financial modelling

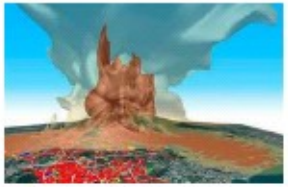


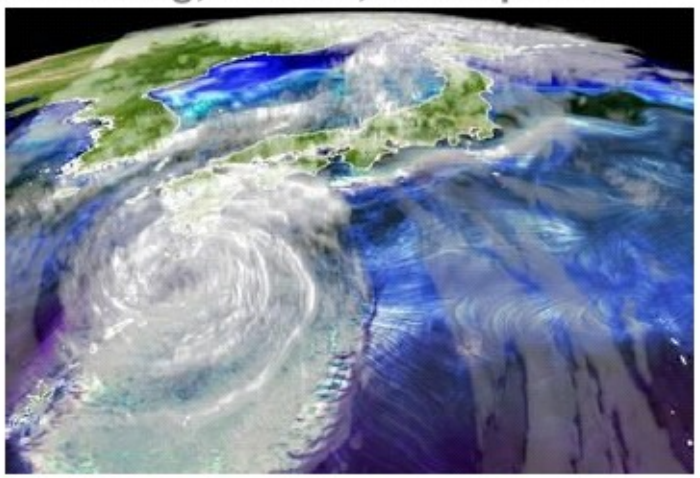
risk simulation



Insurance: simulating a flooding, a taifun, an eruption







Source: PRACE project

WHERE

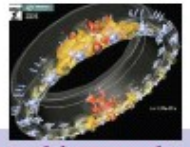
- Weather, Climatology, Earth Science
- Astrophysics, Elementary particle physics, Plasma physics
- Material Science, Chemistry, Nanoscience
- Life Science
- Engineering

Source: HET project . http://www.hpcineuropetaskforce.eu/

WHERE

HET – Scientific Case Engineering

Complete Launcher Simulation for Next Launcher Generation

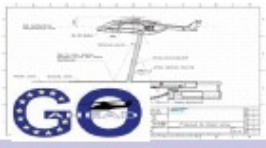


Gas turbine combustors

Green Aircraft

Forest fires

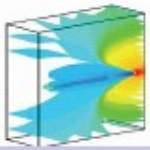
Internal combustion engine



Complete Helicopter Simulation for Next Generation Rotorcraft

Biomedical Flows

Virtual Power Plant

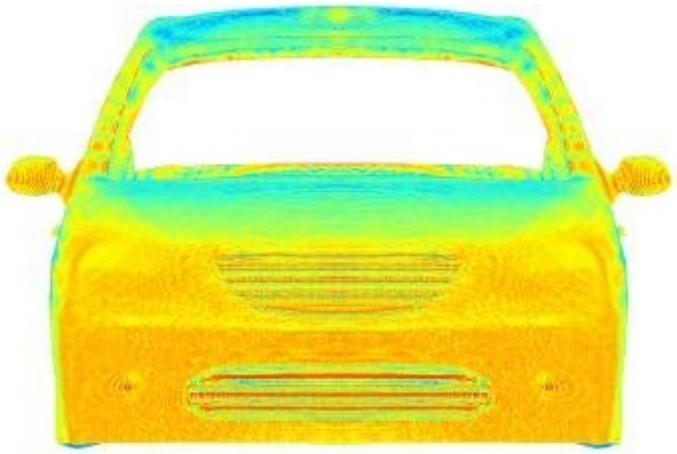


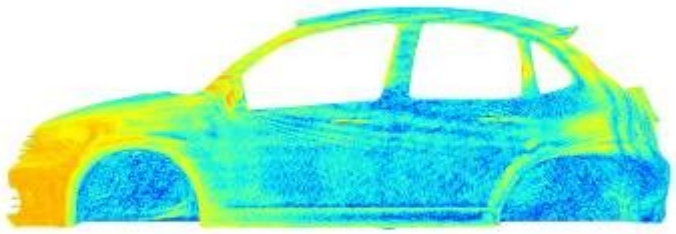
Improving the quality of water resources

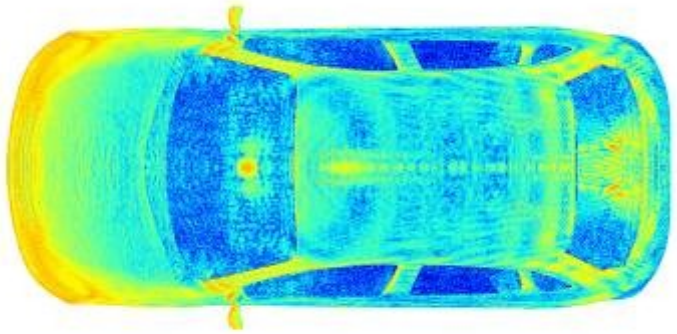
Source: HET project . Jean-Yves Berthou, et. al.
http://www.irisa.fr/ORAP/Forums/GenciOrap/PresentationsGenciOrap/JYBerthouEDF.pdf

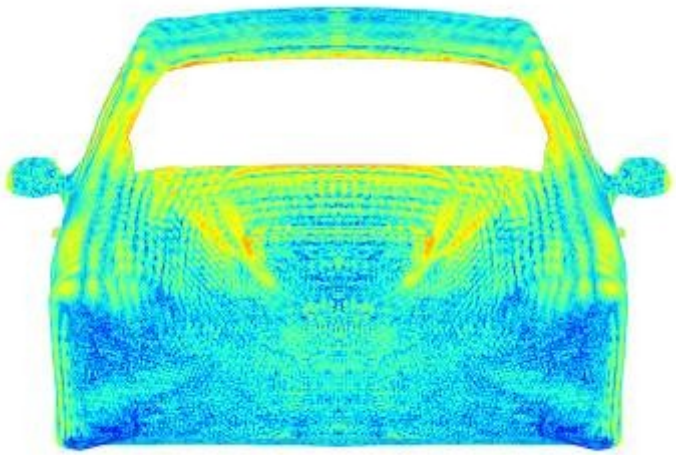
"ELECTROMAGNETIC COMPATIBILITY"

Sphere
Freque
Numb
Group (fine /
Multi (fine /
Numb (fine l
Numb (coars
Num.
Min. /
Total
Num.
Setup









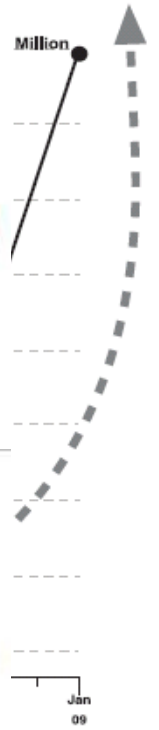
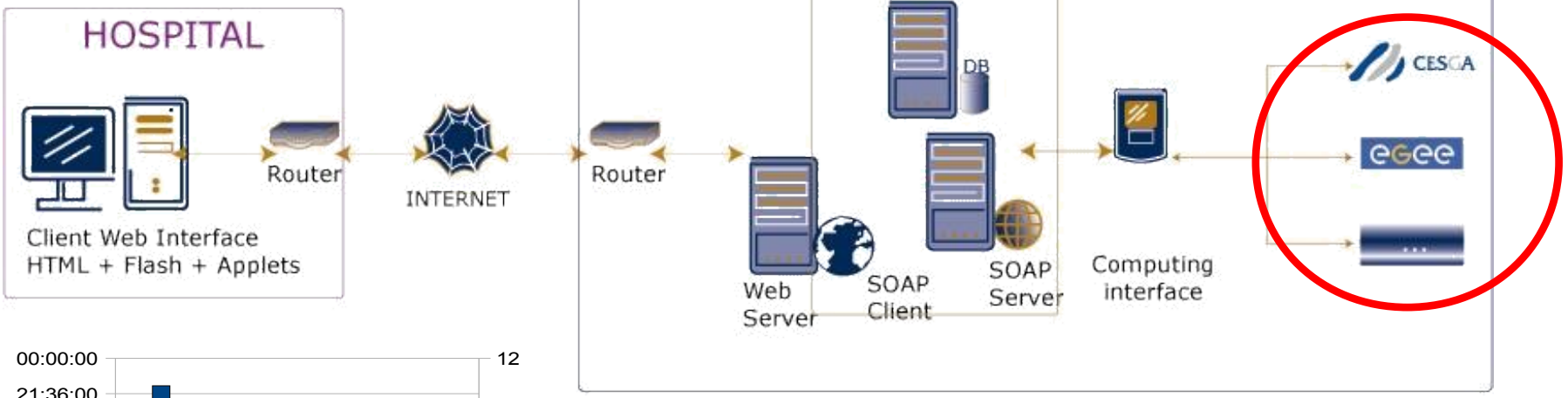
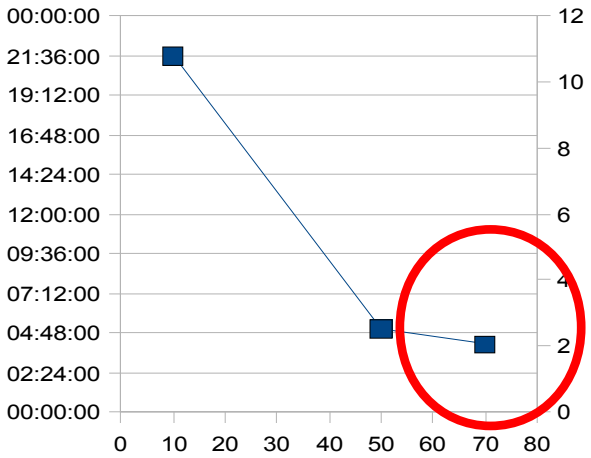
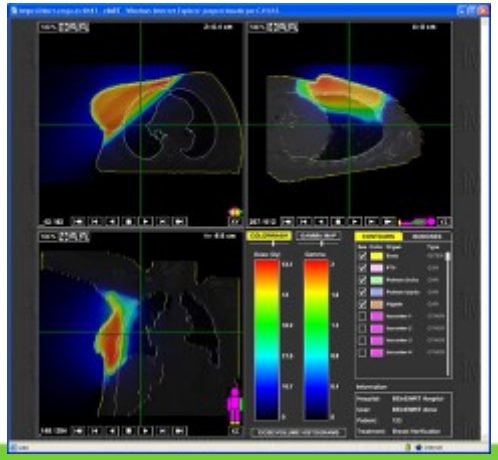


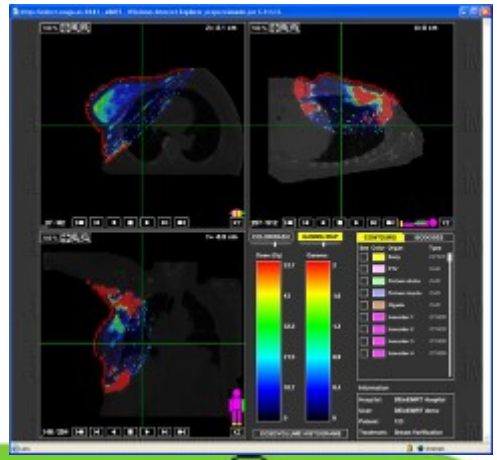
Fig. 1 Induiced currents in an Airbus A380 for an axial incidence of 1,2 GHz, using more tahn 30 million unknowns.

RADIOTHERAPY TREATMENT VALIDATION (e-IMRT)





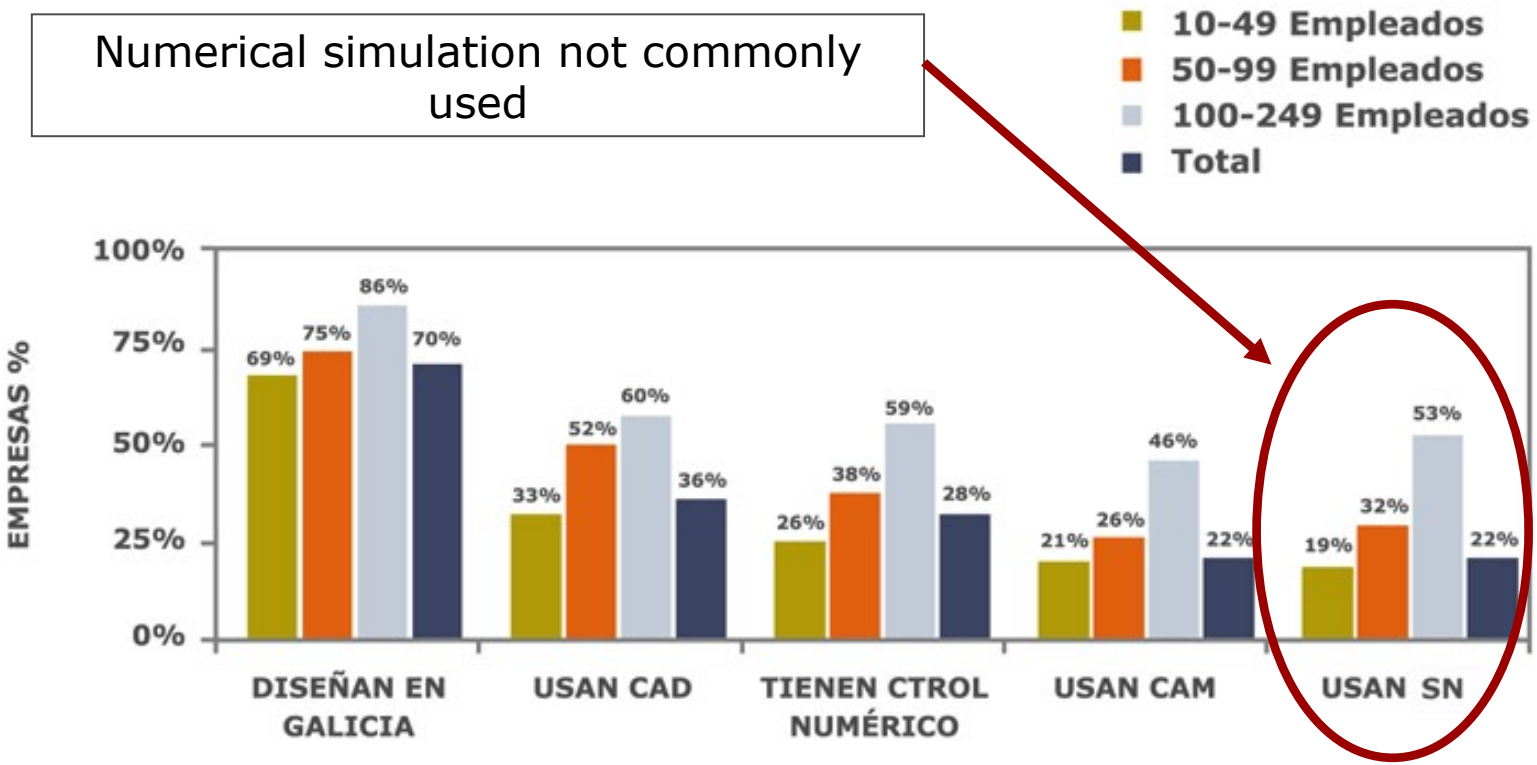




SUPERCOMPUTING & ENTERPRISES

SIMULA (2004)

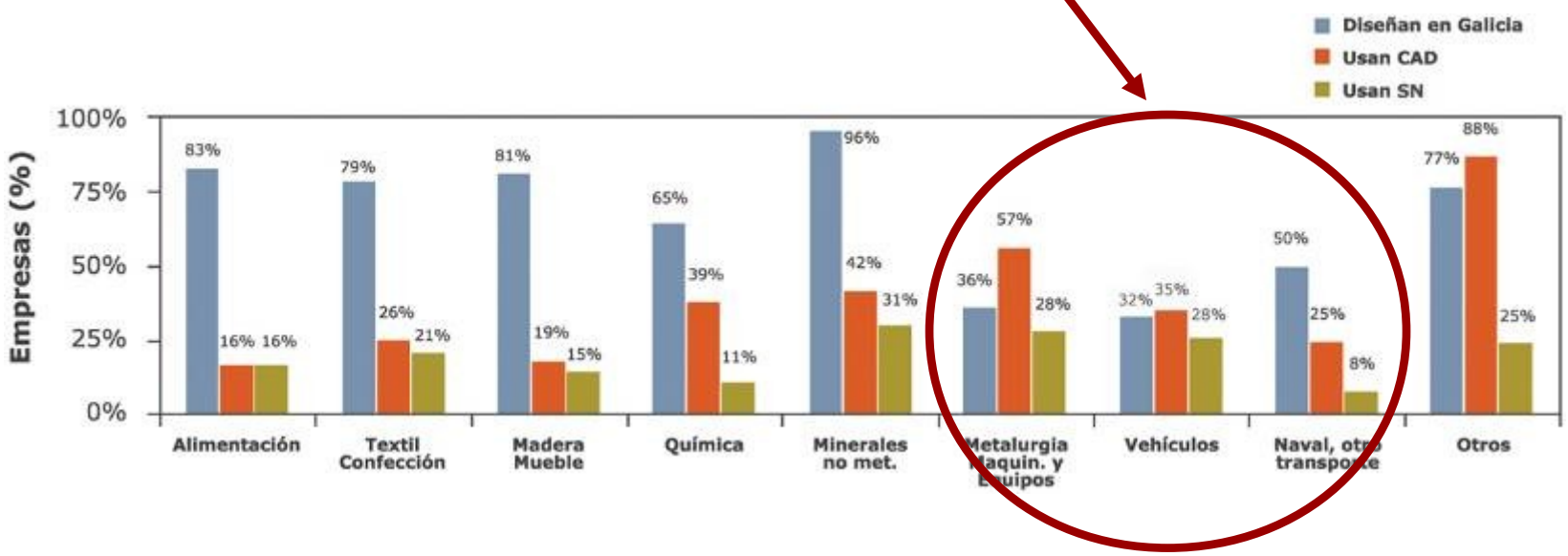
Numerical simulation not commonly used



Base: All. Source: http://simula.cesga.es

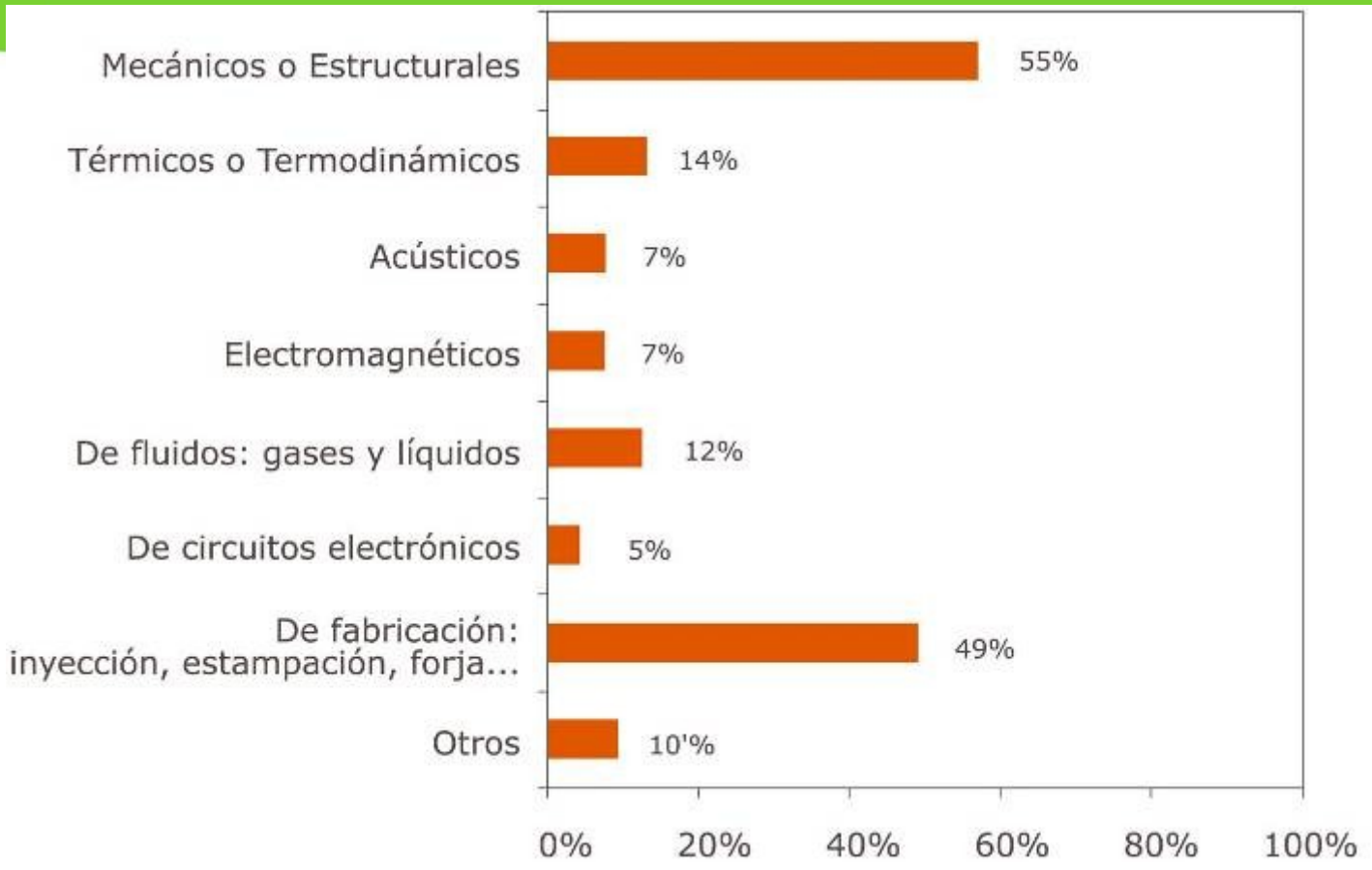
SIMULA (2004)

Not own design



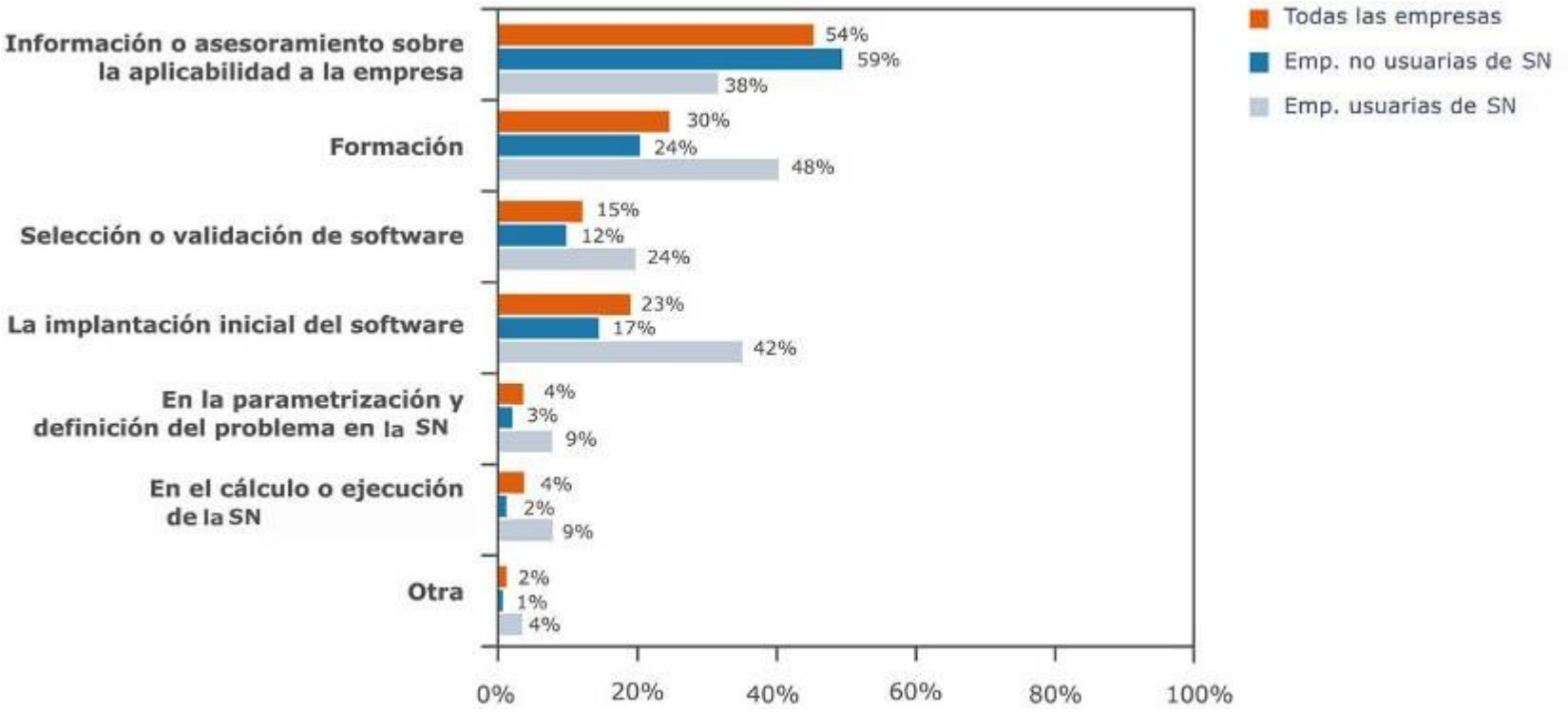
Base: ALL companies. Source: http://simula.cesga.es

SIMULA (2004)

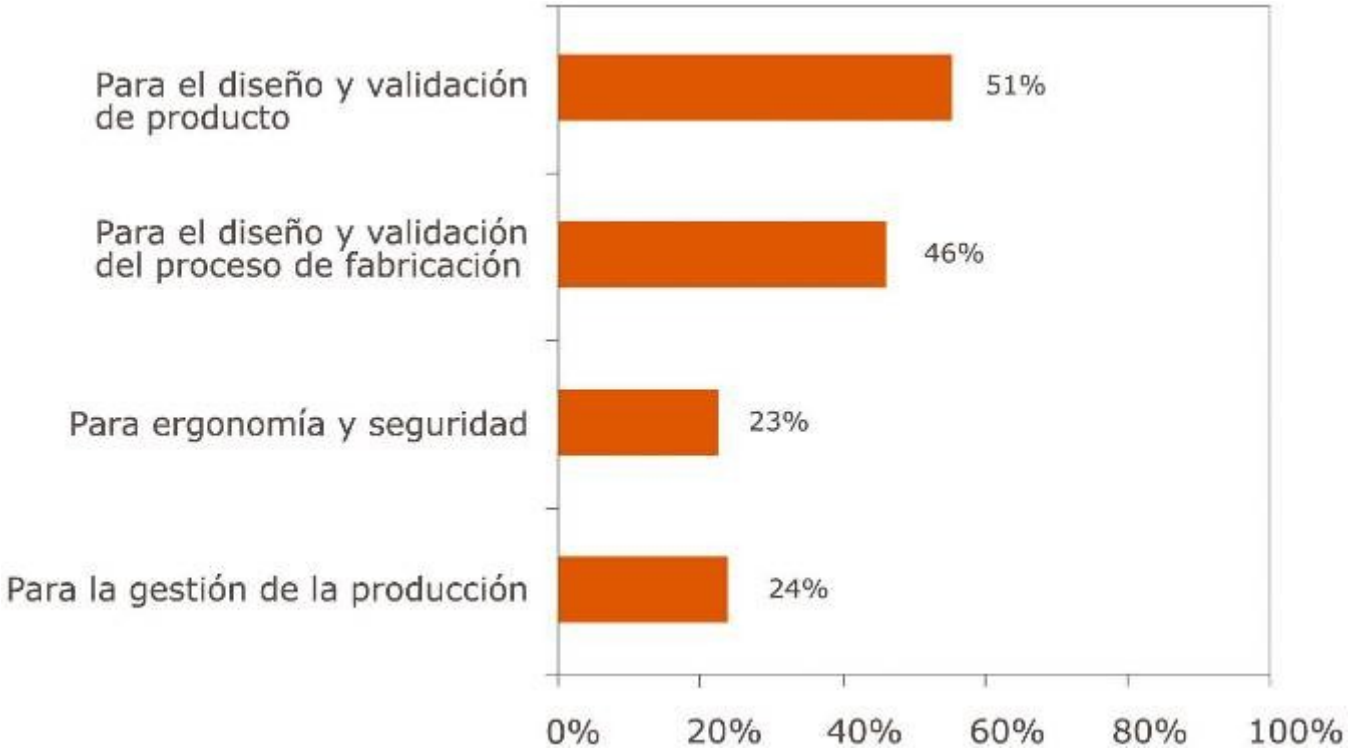


Base: Companies using Numerical Simulation

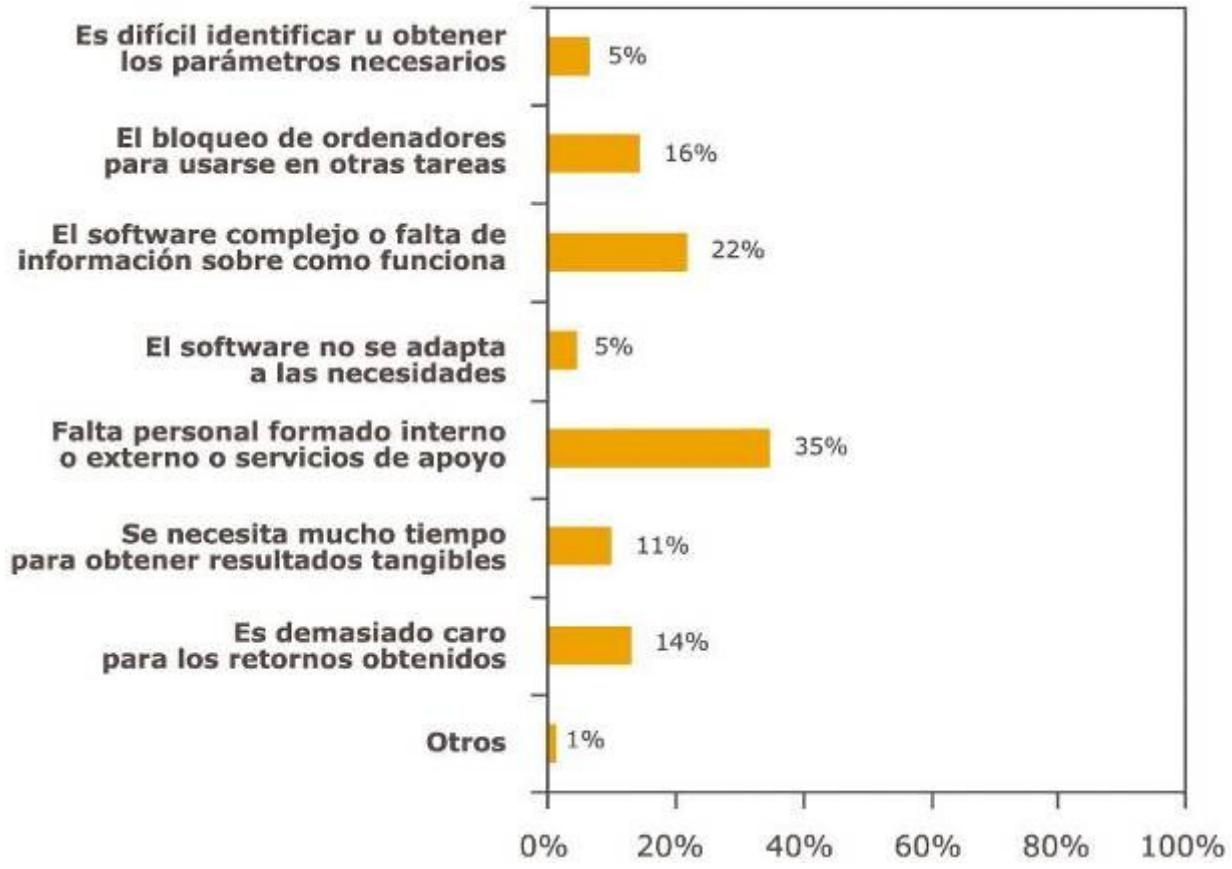
SIMULA (2004)


Información o asesoramiento sobre la aplicabilidad a la empresa
54%
59%
38%
Formación
30%
24%
48%
Selección o validación de software
15%
12%
24%
La implantación inicial del software
23%
17%
42%
En la parametrización y definición del problema en la SN
4%
3%
9%
En el cálculo o ejecución de la SN
4%
2%
9%
Otra
2%
1%
4%
0%
20%
40%
60%
80%
100%
Todas las empresas
Emp. no usuarias de SN
Emp. usuarias de SN

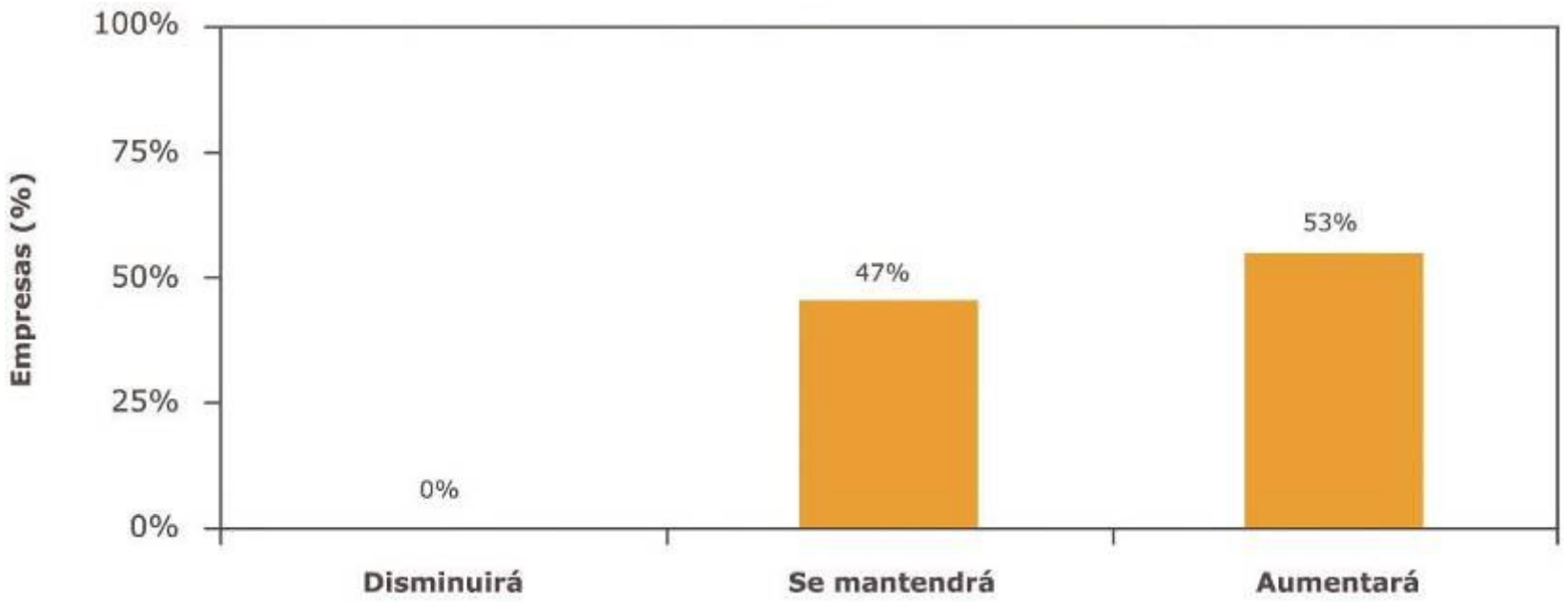
SIMULA (2004)


Para el diseño y validación de producto
51%
Para el diseño y validación del proceso de fabricación
46%
Para ergonomía y seguridad
23%
Para la gestión de la producción
24%
0%
20%
40%
60%
80%
100%

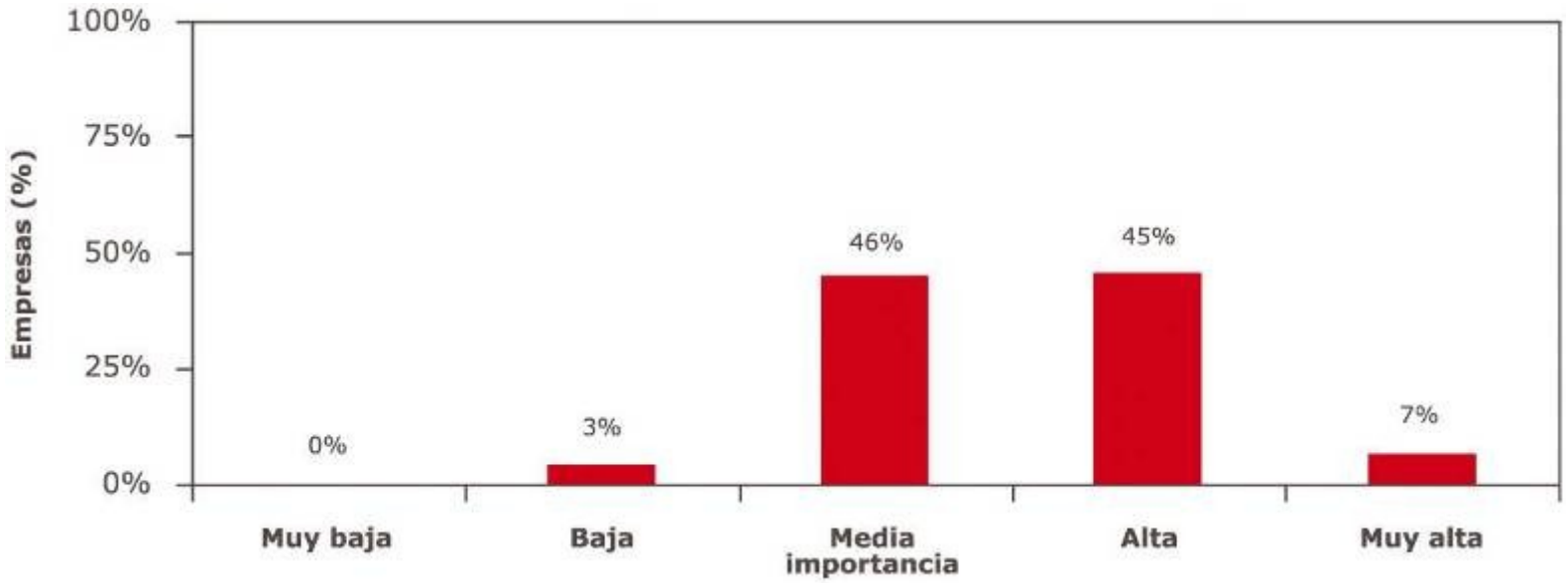
SIMULA (2004)


Es difícil identificar u obtener los parámetros necesarios
5%
El bloqueo de ordenadores para usarse en otras tareas
16%
El software complejo o falta de información sobre como funciona
22%
El software no se adapta a las necesidades
5%
Falta personal formado interno o externo o servicios de apoyo
35%
Se necesita mucho tiempo para obtener resultados tangibles
11%
Es demasiado caro para los retornos obtenidos
14%
Otros
1%
0%
20%
40%
60%
80%
100%

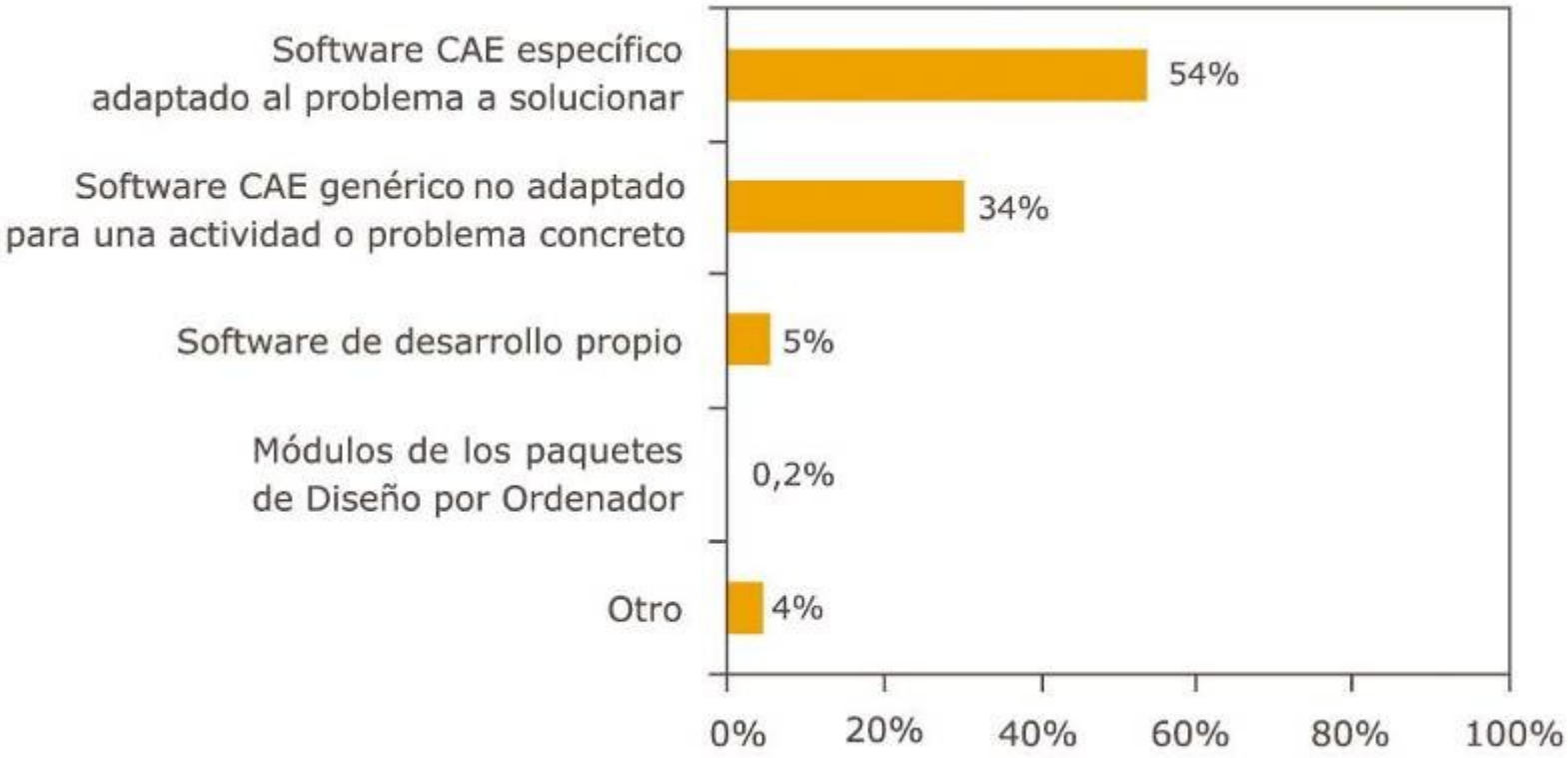
SIMULA (2004)


100%
75%
50%
25%
0%
Empresas (%)
0%
47%
53%
Disminuirá
Se mantendrá
Aumentará

SIMULA (2004)

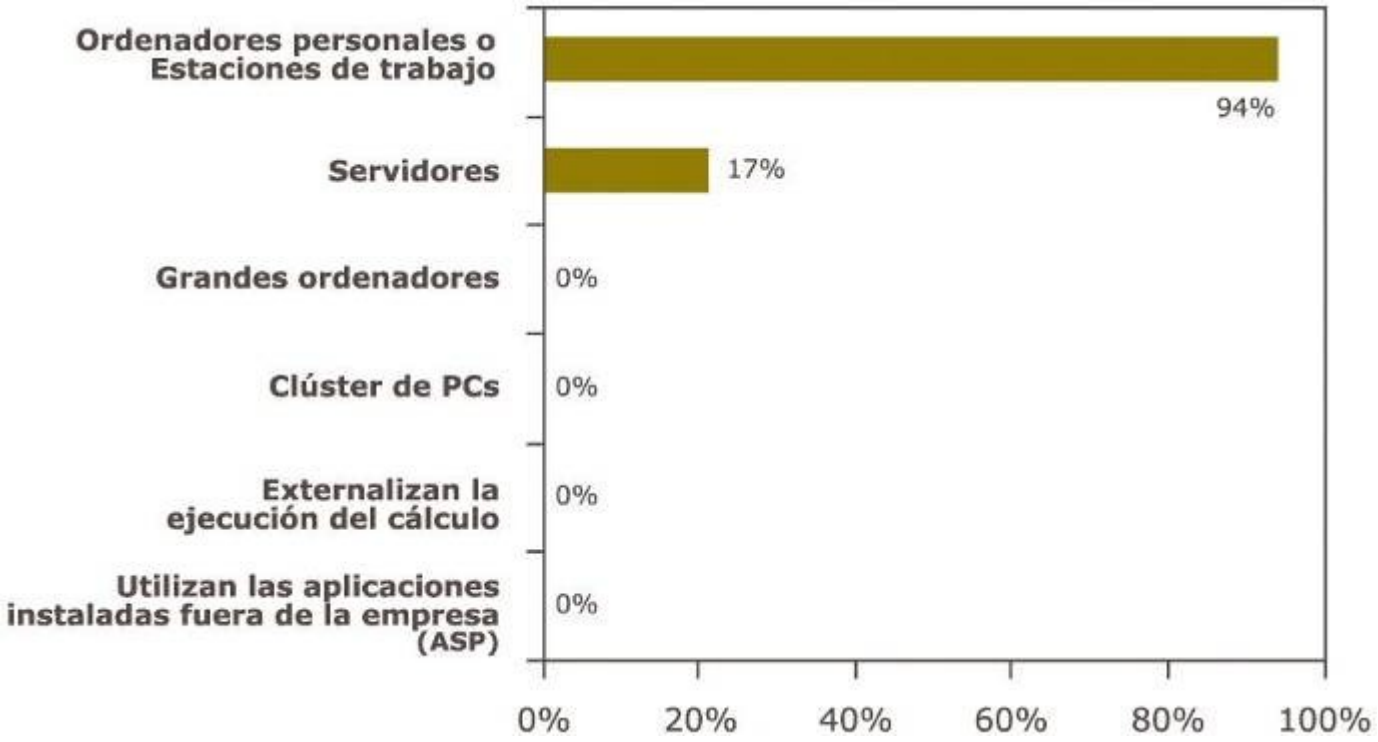

100%
75%
50%
25%
0%
Empresas (%)
0%
3%
46%
45%
7%
Muy baja
Baja
Media importancia
Alta
Muy alta

SIMULA (2004)



Base: Empresas que utilizan Simulación Numérica internamente

SIMULA (2004)



Base: Empresas que utilizan Simulación Numérica internamente

NAVAL (2008)

- **NEEDS:**
  - **90% Internally**
  - **10% Subcontracting of full process.**
  - **Hydrodynamic, turbines or ships.**

- **BARRIERS:**
  - **Confidentiality**
  - **Licenses**
  - **Data movement**

WIND ENERGY (2008)

- **NEEDS:**
  - **Structures**
  - **CFDs**
  - **More accuracy**

- **BARRIERS:**
  - **Confidentiality**
  - **Licenses**
  - **Data movement**

FINANCES (2008)

- **NEEDS:**
  - **NONE. Internal computing**
  - **Data Mining**
  - **Scoring**
  - **Fraud**
  - **Rating**

- **BARRIERS:**
  - **Confidentiality**
  - **Licenses**
  - **Just-in-time. No Queues.**
  - **Data movement**

AUTOMOBILE (2008)

- **NEEDS:**
  - **Only for R&D**
  - **CFD**

- **BARRIERS:**
  - **Confidentiality**
  - **Licenses**
  - **Data movement**

AERONAUTIC (2008)

- **NEEDS:**
  - **ELECTROMAGNETISM**
  - **CFD**
  - **SOUND**
  - **STRUCTURAL**
  - **FLIGHT PHYSICS**

- **BARRIERS:**
  - **Not identified**

SUMMARY (2008)

- **NEEDS:**
  - ELECTROMAGNETISM
  - CFD
  - ACOUSTICAL PHYSICS
  - STRUCTURAL
  - PHYSICS
  - FINANCE
  - NANOTECHNOLOGY

- **BARRIERS:**
  - LICENSES
  - DATA MOVEMENT
  - CONFIDENTIALITY
  - QUEUE TIME
  - EASY-TO-USE

THE SOFTWARE LICENSE PROBLEM

- **Commercial Licenses**

- It is expensive for R&D
- Allow limited innovation
- OK, Obligation in Innovation

- **Solutions**

- We can use your license (if contracted allowed) or
- Rent a new license (likely)

- **Other**

- <u>USE OPEN SOFTWARE in R&D</u>

OPEN SOFTWARE BENEFITS

- Unlimited number of licenses
- Allows faster inclusion of new methods

  - Optimization
  - Solvers
  - Base libraries (BLAS, FFTW,etc)
  - ...

- "Localize" the knowledge
- Allows the production of new soft products easily
- Faster response to new CPU architectures
- As good as commercial software

OPEN SOFTWARE INITIATIVE

- **Joint project of**

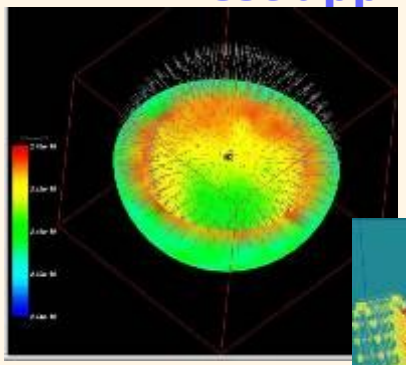

  - **CESGA**
  - **Applied Math Departments (USC, UDC, UVIGO)**

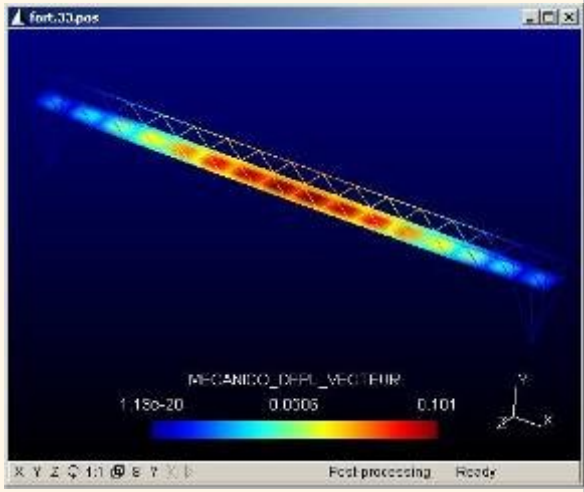
- **Analyze Open Software for CAD/CAE (i.e. CAELINUX)**
- **We have selected:**

  - **SALOME (CAD, PRE-POST)**
  - **CODE-ASTER (Thermo-Mechanic)**
  - **ELMER (Multi-physics)**

OPEN SOFTWARE INITIATIVE

- **Test applications for:**
  - **Well-known academic cases**
  - **Real Industrial cases**





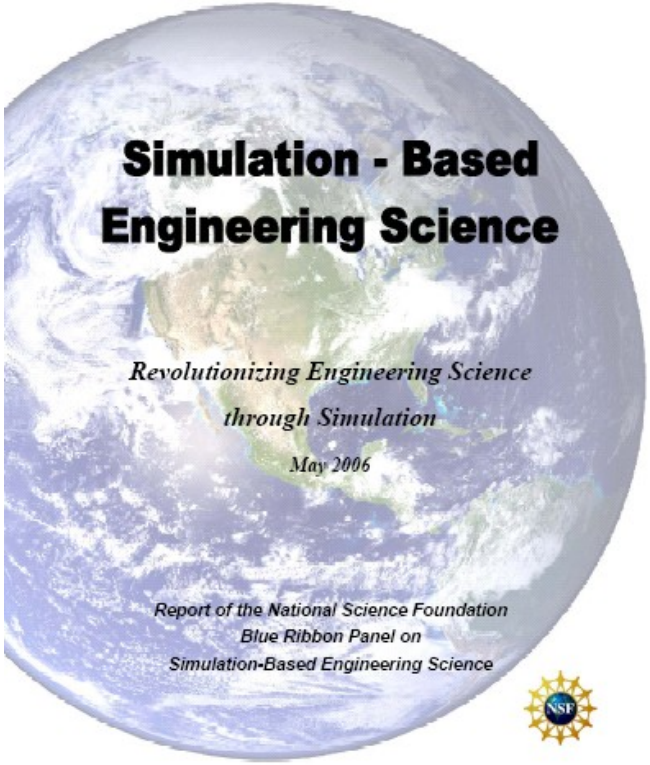
- **Produce Distribution with:**
  - **Software**
  - **Manuals**
  - **Tutorials**

CONCLUSIONS

CONCLUSIONS

- Reduced usage of supercomputers by enterprises (8% INCITE)
- Usually big companies
- Sectors: Energy, Finance, Aeronautic, Automobile
- Main barriers: licenses, confidentiality, data movement
- Technical computing is the starting point
- It is a must for the future

MORE INFO



HET

European High Performance Computing Initiative

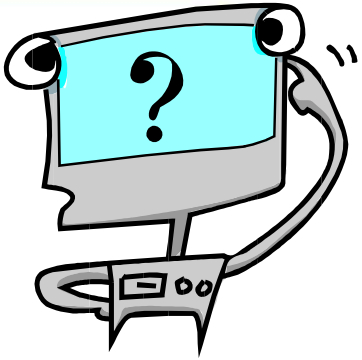
The Scientific Case

for a

European Super Computing Infrastructure

Petascale Computing in Europe

THANK YOU



FOR YOUR ATTENTION

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http://www.cesga.es