

# **IDC Recommendations Report: For EU HPC Leadership In 2020**

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**October 2010**

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# Overall EU Study Strategic Goals

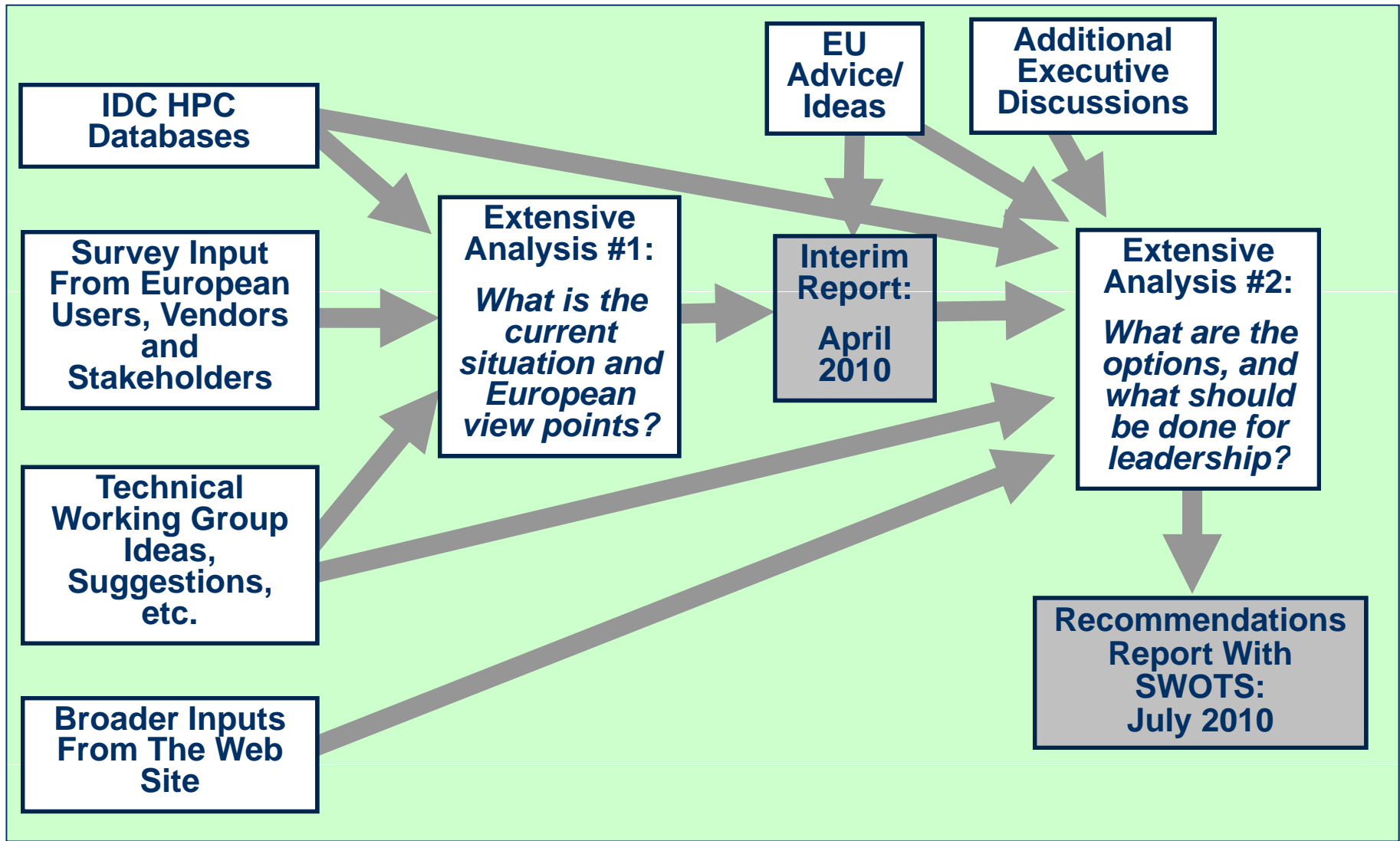


## **Develop a complete strategic agenda to guide EU investments in HPC and to help drive European leadership in using and providing HPC**

- Increase scientific and research competitiveness
- Increase the use of HPC for economic growth
- Bring together users and vendors to help ensure that offerings match users' requirements
- Enlarge/deepen the use of e-Infrastructure computing services to meet the growing demand from academia and industry

Contract Number: 2009/S99-142914  
EU Contract Manager: Bernhard FABIANEK, Performance Computing Officer  
European Commission , DG Information Society , Unit F03 — office BU25 04/087  
25 Avenue Beaulieu, B-1160 Bruxelles

# Overall Study Process Approach



# External Technical Committee

- **Richard Blake**, Acting Director - Computational Science and Engineering Department, Daresbury Science and Innovation Campus, UK
- **Prof. Dr. Arndt Bode**, Chairman of Board of Directors - Leibniz-Rechenzentrum, Germany
- **Dr. Friedel Horst Willi Hossfeld** , Professor Emeritus - Forschungszentrum Jülich, Germany
- **Hervé Mouren**, Managing Director - Teratec, France
- **Christian Saguez**, Teratec, France

# One Reason Action Is Needed: A Concern: Will China Exceed The EU In Supercomputers?



## From:

A June 30, 2010 interview with Jack Dongarra, by Sander Olson

<http://nextbigfuture.com/2010/06/jack-dongarra-interview-by-sander-olson.html>

## Question:

How quickly will China become a major player in the HPC space?

## Dongarra Answer:

China is already a major player. In 2001, China had no machines in the top500 supercomputer list.

They have more computing power than Japan, which is considered a supercomputing powerhouse, and

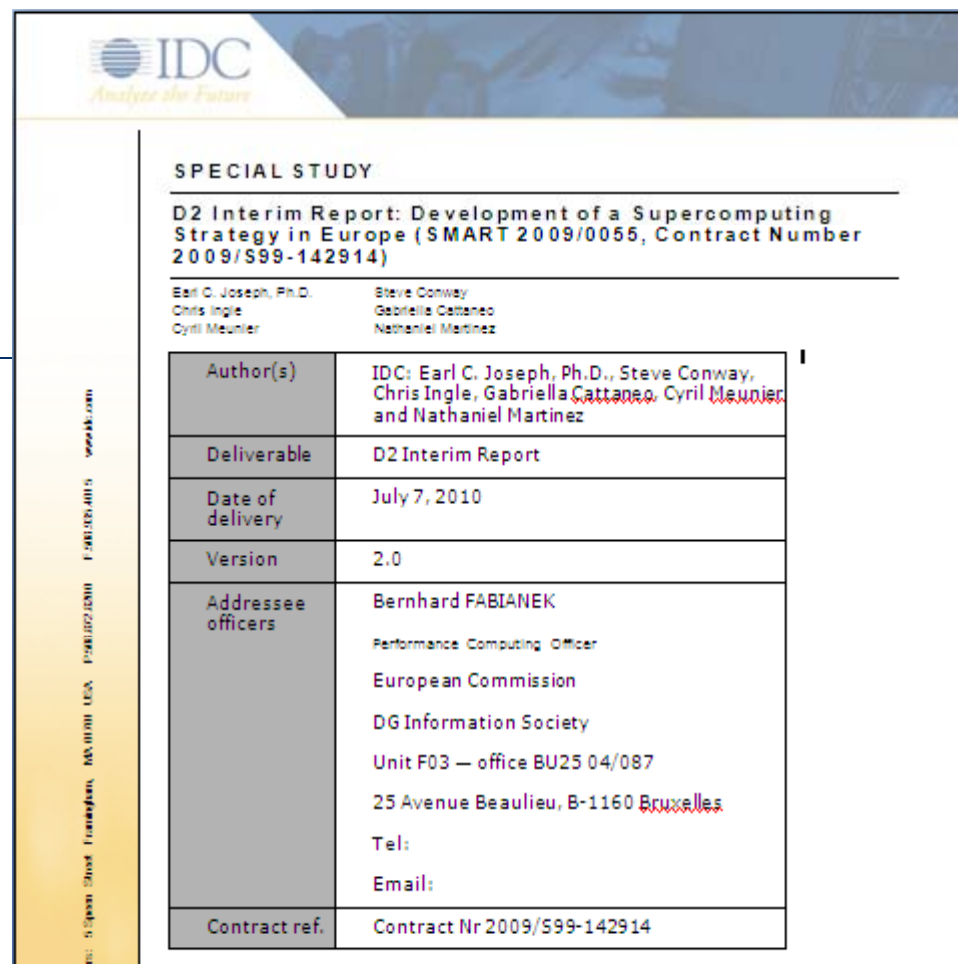
**“I predict that within a year they will have surpassed the entire European Union with its 27 nations.”**


China may soon have the fastest computer on the planet, and should soon have scores of systems in the top500.

# #2 in China: Nebulae's New Home – National Supercomputing Center in Shenzhen, China



# Part 1: Interim Report: Field Research & Analysis




 Analyze the Future

**SPECIAL STUDY**

**D2 Interim Report: Development of a Supercomputing Strategy in Europe (SMART 2009/0055, Contract Number 2009/S99-142914)**

Earl C. Joseph, Ph.D.      Steve Conway  
 Chris Ingle                  Gabriella Cattaneo  
 Cyril Meunier                Nathaniel Martinez

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Addressee officers	Bernhard FABIANEK Performance Computing Officer European Commission DG Information Society Unit F03 — office BU25 04/087 25 Avenue Beaulieu, B-1160 Bruxelles Tel: Email:
Contract ref.	Contract Nr 2009/S99-142914

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- **HPC use is indispensable for advancing both science and industrial competitiveness**
- **Europe is under-investing in HPC, while other nations are growing their supercomputer investments dramatically**
  - Even in 2009, the most difficult year of the global economic recession
- **The transition to petascale and exascale computing creates opportunities:**
  - For Europe to return to the forefront of development for the next generation of research and HPC software/hardware/storage/networking technologies



# HPC Worldwide Market Sizes: Supercomputers (Over \$500K)

**Europe declined from 34.4% in 2007, to 24.8% in 2009**

**TABLE 6**

Worldwide HPC Supercomputer System Revenue (€000) by Region, 2005–2009

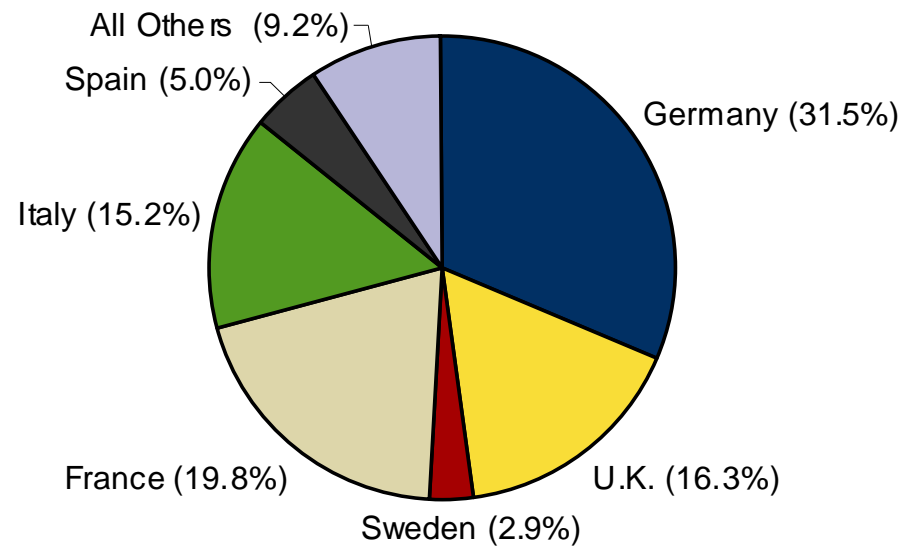
	2005	2006	2007	2008	2009	CAGR (05–09)
Total WW Revenue	2,160,829	1,925,165	2,011,793	2,014,596	2,527,058	4.0%
North America Revenue	1,043,865	903,948	932,183	1,031,201	1,291,493	5.5%
Europe Revenue	614,307	582,989	692,038	592,535	627,732	0.5%
** Percent of WW	28.4%	30.3%	34.4%	29.4%	24.8%	
Asia/Pac Revenue	249,244	204,639	228,972	219,970	226,608	-2.4%
Japan Revenue	231,745	206,965	122,733	137,872	348,448	10.7%
Rest of World Revenue	2,669	8,594	14,464	14,692	13,362	49.6%

Source: IDC, 2010

# HPC Market Sizes: Supercomputers By Country

**FIGURE 2**

EU Total Over \$3M/€2.25M + High-End Supercomputer Revenue Mix by Country, 2009



Source: IDC, 2010

**In 2009, EU spending was greatest for systems in the following application sectors, in order of the amount spent:**

- University/academic (\$370 million)
- Bio-sciences (\$354 million)
- CAE (\$337 million)
- Government labs (\$302 million)
- Defense (\$208 million)

# Interim Report: EU Purchases By Sector



**TABLE 28**

EU Countries HPC Revenue (€000) by Application, 2005–2009

Application	2005	2006	2007	2008	2009	CAGR (05–09)
Bio-Sciences	302,182	331,635	348,304	322,705	265,509	-3.2%
CAE	261,610	294,130	316,270	299,927	252,487	-0.9%
Chemical Engineering	43,681	51,332	57,368	56,064	48,493	2.6%
DCC & Distribution	97,497	102,734	102,900	89,934	69,348	-8.2%
Economics/Financial	42,898	50,917	56,969	55,636	48,018	2.9%
EDA	126,954	141,789	150,907	140,428	115,781	-2.3%
Geosciences and Geo-engineering	107,260	119,138	126,176	117,248	96,894	-2.5%
Mechanical Design and Drafting	38,718	41,583	42,306	37,792	29,774	-6.4%
Defense	131,623	155,652	175,132	174,738	155,639	4.3%
Government Lab	309,590	325,110	324,815	286,797	226,579	-7.5%
Software Engineering	4,472	4,474	4,240	3,520	2,563	-13.0%
Technical Management	22,192	22,058	20,479	16,417	11,285	-15.6%
University/Academic	339,481	365,139	375,398	341,381	278,036	-4.9%
Weather	87,922	93,970	96,225	87,239	70,561	-5.4%
Other	648	2,484	4,422	5,768	6,138	75.4%
<b>Total Revenue</b>	<b>1,916,730</b>	<b>2,102,146</b>	<b>2,201,912</b>	<b>2,035,594</b>	<b>1,677,105</b>	<b>-3.3%</b>

Source: IDC, 2010

# Study Highlights: Successful HPC Programs (As Seen By HPC Experts)

## **Most successful international HPC programs:**

1. U.S. Department of Energy — SciDAC (10)
2. U.S. Department of Energy — INCITE (9)
3. U.S. National Science Foundation – NSF (8)
4. Japan's RIKEN /Keisoku Project (7)
5. U.S. Department of Defense — DARPA (5)
6. U.S. Department of Defense — HPC Modernization Program (3)
7. PRACE (2)
8. IESP (2)

## **Most successful EU HPC Programs:**

1. PRACE (14)
2. DEISA (10)
3. CEA-DAM (4)
4. CERN (4)
5. HPC Europa (4)
6. Blue Brain –EPFL (2)
7. EGEE (2)
8. ESA (2)
9. Forschungszentrum Juelich (2)
10. GEANT (2)

# Study Highlights: Expertise Most Needed



**The survey respondents see the areas of expertise most needed from HPC user organizations as:**

- Expertise in parallel programming for highly parallel HPC systems
- Expertise in creating advanced software algorithms
- The ability to port and optimize applications for new hardware architectures, including heterogeneous architectures that include newer processor types

# Study Highlights: Funding Models Currently Used

**TABLE 58**

What is Your Company/Organization's Current Funding Approach for HPC?

	Respondents	Percentage of Sample
Our internal funding is helped by government funding from within our country	34	65.4%
Our HPC is primarily funded by our own organization	26	50.0%
We receive multi-country funding, but it is less than 20% of our HPC costs	5	9.6%
We have public-private partnership(s) that help to fund our HPC	5	9.6%
We receive multi-country funding, and it is more than 20% of our HPC costs	3	5.8%

Note: Multiple responses were allowed. 52 sites responded to this question.

Source: IDC, 2010

## The survey respondents' ideas for the best funding models to pursue HPC goals in Europe included:

- Provide an EU-wide framework (such as PRACE) to drive toward HPC goals
- Create sustained, multi-year funding
- Focus funding most heavily on a limited number of well-defined scientific and industrial problems, and use a cost-benefit analysis to identify these problem domains
- Focus more on software than hardware
- Base access heavily on grants awarded through peer-reviewed proposals



## **Funding Models That Have Failed in HPC:**

- Models based on short-term goals
- Funding heavily focused on many small projects rather than a few large ones
- Funding procurements that include protectionist measures
- Models that impose overly burdensome bureaucratic requirements to gain access to HPC resources.
- Models that require organizations to pay to use HPC resources
- Models that require countries to "buy their way in"
- Models aimed at developing new HPC system architectures

# From The Interim Report: Top Areas That Stakeholders Said The EU Should Focus On



What are the most important approaches for EU HPC leadership?		
Approach	Number of Responses	Percentage Of Responses
Making world-class HPC resources more widely available to the EU scientific and engineering communities	57	93.4%
Advancing scientific leadership by using HPC to solve some of the world's most challenging problems	50	82.0%
Making HPC more readily available for the first time to small and medium-size businesses (including industrial supply chains, small educational sites, etc.)	33	54.1%
Having many very large supercomputers, e.g., being at or near the top of the Top500 list of the world's most powerful supercomputers ( <a href="http://www.top500.org">www.top500.org</a> )	25	41.0%
Building an EU-based HPC vendor community with world-class capabilities in important areas (hardware, software, storage, networking, etc.)	24	39.3%

# Part 2: Final Report: Strategic Agenda Recommendations



**IDC**  
Analyze the Future

**SPECIAL STUDY**

**A Strategic Agenda For European Leadership In Supercomputing: HPC 2020**  
Final Report Of The HPC Study For The DG Information Society Of The European Commission

Earl C. Joseph, Ph.D.      Steve Conway  
Chris Ingle                  Gabriella Cattaneo  
Cyril Meunier                Nathaniel Martinez

**IDC OPINION**

This is the Strategic Agenda Report (Deliverable D3) of the study "Development of a Supercomputing Strategy in Europe" by IDC EMEA, the multinational market research and consulting company specialized in the ICT markets, on behalf of DG Information Society and Media of the European Commission. This report presents the results of WP3 – Strategic Agenda.

We greatly thank the Technical Strategic Committee contributors for their ideas, insights and suggestions that helped crystallize the findings in the report. External members included: Herve Mouren and Christian Saguez, TER@TEC Richard Blake, STFC Daresbury Laboratory, Arndt Bode and Herbert Huber, Leibniz-Rechenzentrum/LRZ Munich, and Friedel Hossfeld, Forschungszentrum Jülich.

This plan suggests that the EU needs to create and implement a far-reaching vision for HPC leadership, and suggests that it be based on the vision: *Providing world-class HPC tools to make EU scientists, engineers and analysts the most productive in the world in applying HPC to advance their research in the pursuit of scientific advancement and economic growth.*

The results of this plan could provide immense improvements to the EU by 2020:

- Europe would be recognized as the hotbed for new science and engineering research
- The plan would preserve existing jobs and create many new jobs in both science and industry, and cause national economies to grow faster

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# Proposed Vision For EU HPC Leadership

Note: Over 200 HPC experts across the EU have provided ideas, insights and suggestions in the creation of this report and proposal.

# The Proposed Primary Vision For EU HPC Leadership By 2020 and Beyond



***Provide World-Class HPC Expertise and Resources***

***To Make EU Scientists, Engineers And Analysts  
The Most Productive and Innovative In The World  
In Applying HPC To Advance Their Research  
In The Pursuit Of Scientific Advancement And  
Economic Growth***

# Potential Results From The Vision

**By the year 2020, the EU HPC strategy has enabled the following progress to occur:**

- 1. Europe is recognized as a hotbed for new science and engineering research.**
- 2. Europe's leadership in the targeted areas has created many new jobs in science and industry, and has caused the national economies to grow faster.**
  - Europe's move to the forefront of progress in other areas has preserved many existing jobs in both science and industry.
- 3. Europe is the world leader in important high-end HPC technologies.**
  - Europe leads the world in scalable algorithms and software applications, and in tools to make HPC systems easy-to-use and to make researchers highly innovative and productive.

## Vision

**Provide world-class HPC resources**

**To make EU scientists, engineers and analysts**

**The most productive and innovative in the world**

**In applying HPC to advance their research**

**In pursuit of scientific advancement and economic growth**



## Results

- Adds billions of euros a year to European economies by 2020
- Make the EU a hotbed for scientific and engineering research
- Invigorate EU institutions by making EU researchers the most productive in the world
- Expand the HPC ecosystem across the EU creating a vibrant HPC supplier economy

# Actions Required



# Europe Needs To Invest In/Support A Robust HPC Industry With Hardware, Software, Etc.

## Hardware:

- **Develop unique capabilities for use in standards-based systems, e.g. interconnects, system design, packaging, power and cooling, alternative processors, SSDs, etc.**
- **IDC recommends that the EU avoids making any excessively large R&D or NRE investments (in the €1+ billion range) in exotic custom areas**

## Software:

- **Exploit world-class strengths in Europe**
- **Algorithms, compilers, system software, file systems, applications, libraries, etc.**

## Storage:

- **Advanced storage systems and file systems**

## Networking:

- **Internal and external to the exascale system, high-bandwidth, low latency communications, grids and perhaps clouds**

# Overall IDC Recommendations: Actions Required To Achieve The Vision

- 1. First is the need for expanding the number and size of HPC resources across the EU (including broader access to the tools by all EU researchers).**
  - *An expanded PRACE can address this requirement.*
- 2. Second is to provide broader access to industrial HPC users.**
- 3. Third is to make HPC users more productive by creating the world's best tools, training and development environment.**
  - *Requires a new initiative (HPC development labs/test-beds).*
- 4. Fourth is to attract more students into scientific, engineering and HPC fields and to attract more experts around the world to join in EU projects.**
  - *Requires additional funding and a "Magnet" program.*
- 5. Fifth is the need to increase funding in developing next generation Exascale software.**
- 6. Sixth is to target a few strategic application areas for global leadership.**

# Actions Required To Achieve The Vision: Enhancing And Expanding PRACE

## Recommended Enhancements to PRACE:

- 1. First is increasing funding to provide for more very-large systems and for more systems across the EU.**
- 2. Second is increasing access to researchers in science and industry.**
  - And to include more countries.
- 3. Third is the enhanced charter and perhaps a new name:**
  - Expand the mission, stature and funding of the PRACE program to make it the central EU organization responsible for pursuing the mainstream system acquisition and operating EU HPC strategy on behalf of, and in collaboration with, the member states.
  - The creation of an EU HPC system strategy elevates HPC to an appropriate, larger role within Europe.
  - An expanded central organization is needed to pursue the strategy and to signal the EU's increased commitment to HPC leadership.

# Actions Required To Achieve The Vision: HPC Development Labs/Test-bed Centers



**These new HPC development labs/test bed centers are needed to address these weaknesses in HPC today:**

- **Most large HPC systems are very hard to use by all but the most talented experts.**
- **The productivity in using highly parallel systems is very low, no matter which metric ones uses:**
  - Time to get an application up and running vs. the usefulness of the results.
  - Time to optimize codes vs. the speed-up obtained.
  - Percentage of the system that can be effectively used by a user's job.
- **There are a limited number of scientists, engineers and analysts in the EU.**
  - While other countries like China and India have strong growth in graduates, making the productivity of these experts a critical deciding factor in the advancement of science and research.

# Actions Required To Achieve The Vision: HPC Development Labs/Test-bed Centers



**What the new HPC development labs/test-bed centers could look like:**

- **These would be dedicated HPC centers with the goals of helping users, researchers and companies make their codes and products highly scalable and highly productive.**
- **These HPC systems would only be used in a test and development mode.**
  - They may crash hourly as new algorithms, new codes or even new hardware is being tested, optimized and made resilient.
- **The systems need to be large, but not extremely large.**
- **The HPC development test-beds should have major training and teaching responsibilities. They should offer classes in advance HPC, again with a focus on making users and products more productive.**
  - This requires a strong technical staff, along with teachers and HPC experts across multiple domains.

# Actions Required To Achieve The Vision: HPC Development Labs/Test-bed Centers



**What the new HPC development labs/test-bed centers could look like:**

- **To support individual users and researchers across the EU.**
  - *For example, if a scientist has an idea on how to make their codes run at a larger scale, they could make use of the test-bed systems and staff to figure out new algorithms, test them at scale, make improvements and then take the results back to their home organization.*
- **They would also support the broader EU vendor community and ecosystem.**
  - *For example if a vendor like Bull decides to research a new interconnect for exascale systems, they could use these HPC development test-beds for testing out the new interconnects by physically installing the new hardware, and the running tests, debugging and making their product more resilient.*
- **The EU should help support the broader HPC ecosystem by making these resources free to all, for development and testing work only.**

# Actions Required To Achieve The Vision: A new “Magnet” Program

**To accomplish the major objective on making Europe the hotbed for scientific research, the EU needs to fund a number of "Magnet" programs to attract top scientists, recent graduates, and other researchers to European institutions.**

## **The magnet program should include:**

- Funding of highly prestigious positions/seats at top EU educational institutions. These need to include sizeable research grants to attract the top talent.
- Create a new degree-like position between a Ph.D. and a professor. And invite selected top researchers and top new graduates to attend these degree programs at no cost.
- Broad incentives should be used including prestigious positions and titles, open access to leading scientific projects, etc.
- These positions need an exciting title and full press coverage.

**The goal should be to start ASAP with 10's of these new positions, growing quickly to 100's per year.**

# Actions Required To Achieve The Vision: Purchase vs. Develop Exascale Systems

- **IDC recommends that the EU buys the 4<sup>th</sup> or 5<sup>th</sup> exascale system, and does not invest in developing the first 1, 2 or 3 exascale systems in the world.**
  - This strategy could save a billion plus euros
  - → that can be used in buying more systems and making EU researchers more productive.
- **Europe could save even more by instead aiming to purchase a near-exascale system in this timeframe, but 1 year later.**
  - We estimate that this would substantially reduce the technical challenges (e.g., hardware/software scaling) and associated costs.
  - Such that an investment on the order of €150 to €200 million per system would likely suffice.
  - The resultant near-exascale supercomputer would still sustain unrivaled performance in the targeted application domain, and still attract the best researchers and collaborations.



# Investments Required

It is recommended that the EU and the nations make HPC a higher priority and step up to either the “Full leadership level” or at least the “Funding to reach major goals level” scenario level.

- ***This would require a net new investment reaching 600 million euros a year within five years.***

# Investments Required And Scenarios

**TABLE 4**

Alternative HPC Funding Scenarios: Yearly Funding ADDITIONS By Year Five  
*(Millions of euros added per year)*

	Full Leadership Funding Level	Funding To Reach Major Goals Level	Partial Funding Level	Minimal Increase Funding Level
HPC System Funding Increases	250	210	120	50
HPC Development Test-beds (H/W)	50	40	25	0
HPC Development Test-beds (People)	75	60	35	0
Exascale Software Development	150	125	55	25
Scientific Talent Magnet Program	75	60	25	0
<b>Total Yearly Funding Increase</b>	<b>600</b>	<b>495</b>	<b>260</b>	<b>75</b>

Note: These figures include HPC funding paid by the EU, by member nations and contributions by vendors.

Source: IDC, 2010

# In Summary: Actions → Vision → Results

## Actions → Vision → Results

- Expand the number, size and access to HPC resources across the EU
- Add a focus on industrial users
- Create a set of HPC development labs/test-bed centers
- Attract more students and experts from around the world to join in EU projects
- Fund development of next generation Exascale S/W
- Target strategic application areas for global leadership

**Provide world-class HPC resources**

**To make EU scientists, engineers and analysts**

**The most productive and innovative in the world**

**In applying HPC to advance their research**

**In pursuit of scientific advancement and economic growth**

- Add billions of euros a year to European economies by 2020
- Make the EU a hotbed for scientific and engineering research
- Invigorate EU institutions by making EU researchers the most productive in the world
- Expand the HPC ecosystem across the EU creating a vibrant HPC supplier economy

# The Project's Web Site: [www.hpcuserforum.com/EU](http://www.hpcuserforum.com/EU)



The screenshot shows the website for 'HPC In Europe'. The header includes the 'HPC USER FORUM' logo on the left and the 'IDC Analyze the Future' logo on the right. Below the header is a navigation bar with links for 'HOME', 'HPCUSERFORUM.COM', 'IDC.COM', and 'CONTACT'. The main content area features a central headline: 'Help develop a common vision for the future of HPC in Europe!'. Below this headline is a large grey box with the text: 'This now has the interim report and will soon have the final report -> and will ask for feedback'. To the right of the main content is a sidebar with a list of 'IDC HPC Reports and Studies', including 'IDC Press Releases on EU HPC Contract', 'Top 2010 HPC Predictions', 'HPC Petascale Report', 'DARPA HPCS Phase 2 White Paper', 'US HPC Reports and Information', 'NSF HPC Report', 'DARPA ExtremeScale', 'WTEC Panel Report', 'Cyberinfrastructure Workshop', 'DARPA sHPC Report', 'FITAC HPC Report', 'Department of Energy Report', 'The Role of High Performance Computing in Industry', 'JASON Executive Summary', and 'FITAC Report'. Below the main content area, there are two sections: 'Market Structure and Business Models' and 'Implementing the HPC Agenda: successful public/private partnerships'. Each section has a brief description and two buttons: 'Click Here To Comment' and 'Read Existing Comments'.

**We greatly thank the following for all of the great ideas, feedback, suggestions and advice:**

- *EC (Kostas Glinos, Bernhard Fabianek, et al.)*
- *The Technical and Strategy Committee*
- *All of the members of broader EU HPC Community that contributed to this study*

**Questions?**

# Questions?

Please email:  
[hpc@idc.com](mailto:hpc@idc.com)

Or check out:  
[www.hpcuserforum.com](http://www.hpcuserforum.com)  
[www.idc.com](http://www.idc.com)

