HPC Supercomputing Trends

Futurists Meeting
March 2013

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What Is HPC?

IDC uses these terms to cover all technical servers used by scientists, engineers, financial analysts and others:

- HPC
- HPTC
- Technical Servers
- Highly computational servers

HPC covers all servers that are used for computational or data intensive tasks

IDC HPC Activities

- Track all HPC servers sold each quarter
- 4 HPC User Forum meetings each year
- Publish 45 plus research reports each year
- Visit all major supercomputer sites & write reports
- Assist in collaborations between buyers/users and vendors
- Assist governments in HPC plans, strategies and direction
- Assist buyers/users in planning and procurements
- Maintain 5 year forecasts in many areas/topics
- Conduct special research studies

2013 IDC HPC Research Areas

New And Potentially Disruptive Technologies:

- The future of supercomputing: Exascale
- How HPC can impact ROI and innovation
- Big data – High Performance Data Analysis
- Co-processors and new types of flash/SSDs
- New software solutions
- Government programs to help bring to market new capabilities
- Emerging markets including China, Russia, etc.
- SMB and SMS research
- The evolution of clouds in HPC
- Scaling of software – issues and solutions
- Worldwide Petascale and Exascale Initiatives

Top Trends in HPC

The global economy in HPC is growing again:

- 2010 grew by 10%, to reach $9.5 billion
- 2011 grew by 8.4% to reach $10.3 billion
- HPC revenue for first half of 2012 was $4.9B
  - **Q3 2012 was the largest quarter ever in HPC**
- We are forecasting ~7% growth over the next 5 years

Major challenges for datacenters

- Power, cooling, real estate, system management
- Storage and data management continue to grow in importance

Software hurdles continue to grow

The worldwide Petascale Race is in full speed

2011 HPC WW Market Results: By Competitive Segments

	2008	2009	2010	2011	CAGR '10/'11
Supercomputer	2,686,128	3,342,073	3,475,577	4,361,336	25.5%
Divisional	1,395,817	1,078,575	1,268,735	1,245,541	-1.8%
Departmental	3,167,096	2,783,518	3,279,219	3,480,676	6.1%
Workgroup	2,522,809	1,409,979	1,474,792	1,212,505	-17.8%
Grand Total	9,771,849	8,614,145	9,498,323	10,300,058	8.4%

2011 HPC WW Market Results: By System Units Sold

IDC Analyze the Future

	2008	2009	2010	2011	CAGR '10/'11
Supercomputer	1,863	2,067	2,560	2,893	13.0%
Divisional	4,054	3,596	3,914	3,739	-4.5%
Departmental	20,105	17,098	19,868	20,770	4.5%
Workgroup	148,069	82,293	93,502	84,149	-10.0%
Grand Total	174,091	105,054	119,844	111,551	-6.9%

Why Is HPC Becoming So Important To Nations?

High performance computing (HPC) is important for national economies, because HPC, also called supercomputing, has been firmly linked to economic competitiveness as well as scientific advances

In one worldwide IDC study, 97% of companies that had adopted supercomputing said they could no longer compete or survive without it – As the US COC puts it: To out-compute is to out-compete

Worldwide political leaders increasingly recognize this trend:

- **In his 2006 State of the Union address, U.S. President George W. Bush promised to trim the federal budget, yet urged more money for supercomputing**

- **In 2009, Russian President Dmitry Medvedev warned that without more investment in supercomputer technology, "Russian products will not be competitive or of interest to potential buyers."**

Why Is HPC Becoming So Important To Nations? (Continued)

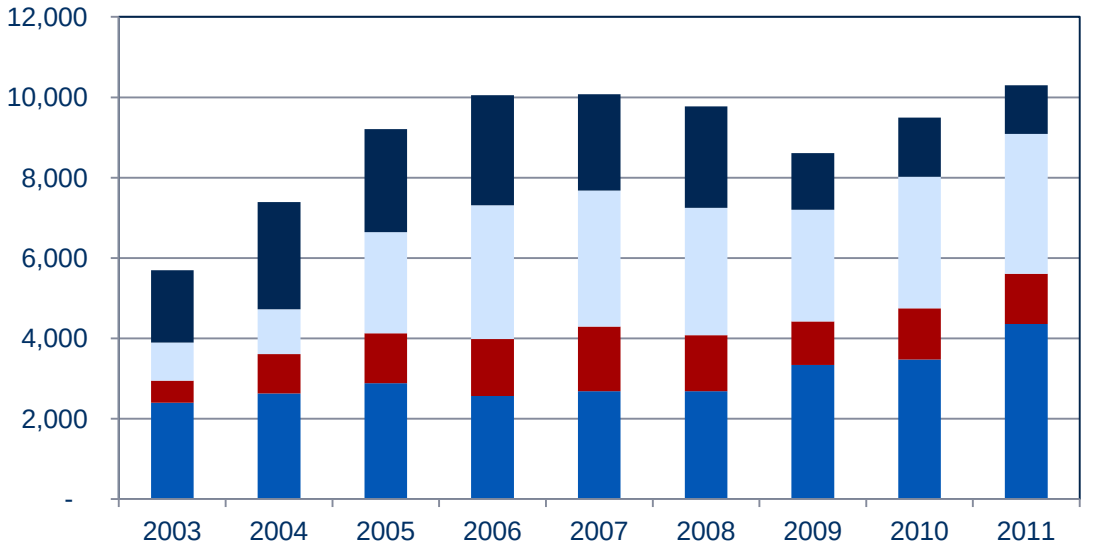
Worldwide political leaders increasingly recognize this trend:

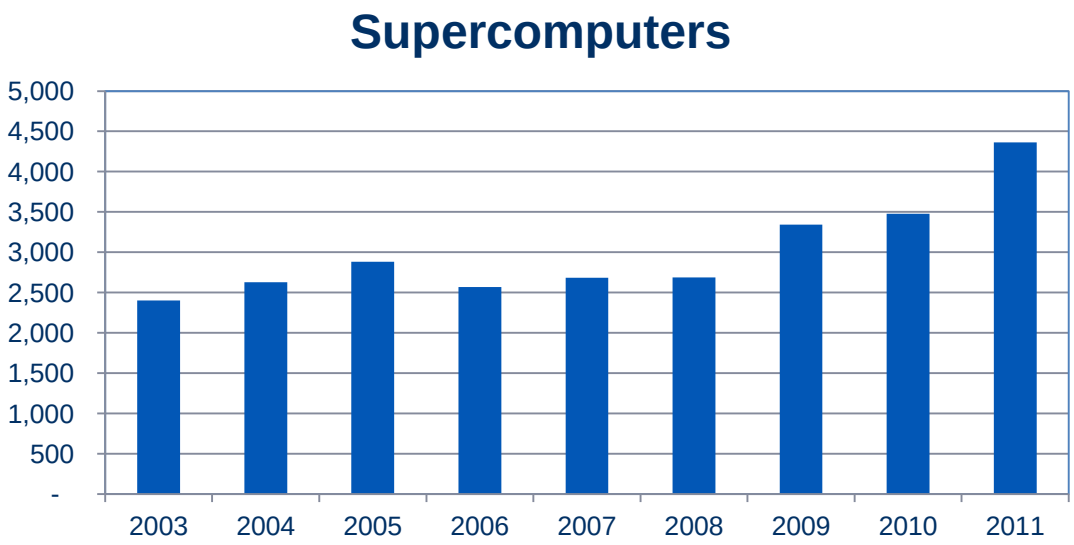
- **In June 2010, Rep. Chung Doo-un of South Korea's Grand National Party: "If Korea is to survive in this increasingly competitive world, it must not neglect nurturing the supercomputer industry, which has emerged as a new growth driver in advanced countries."**

- **In his 2011 State of the Union address, President Obama noted China's rapid progress in HPC and said that the U.S. Department of Energy's Oak Ridge National Laboratory is "using supercomputers to get a lot more power out of our nuclear facilities."**

- **In February 2012, the European Commission announced that it has adopted a plan to double spending on HPC to €1.2 billion, with much of that money aimed at the installation of additional petascale supercomputer systems**

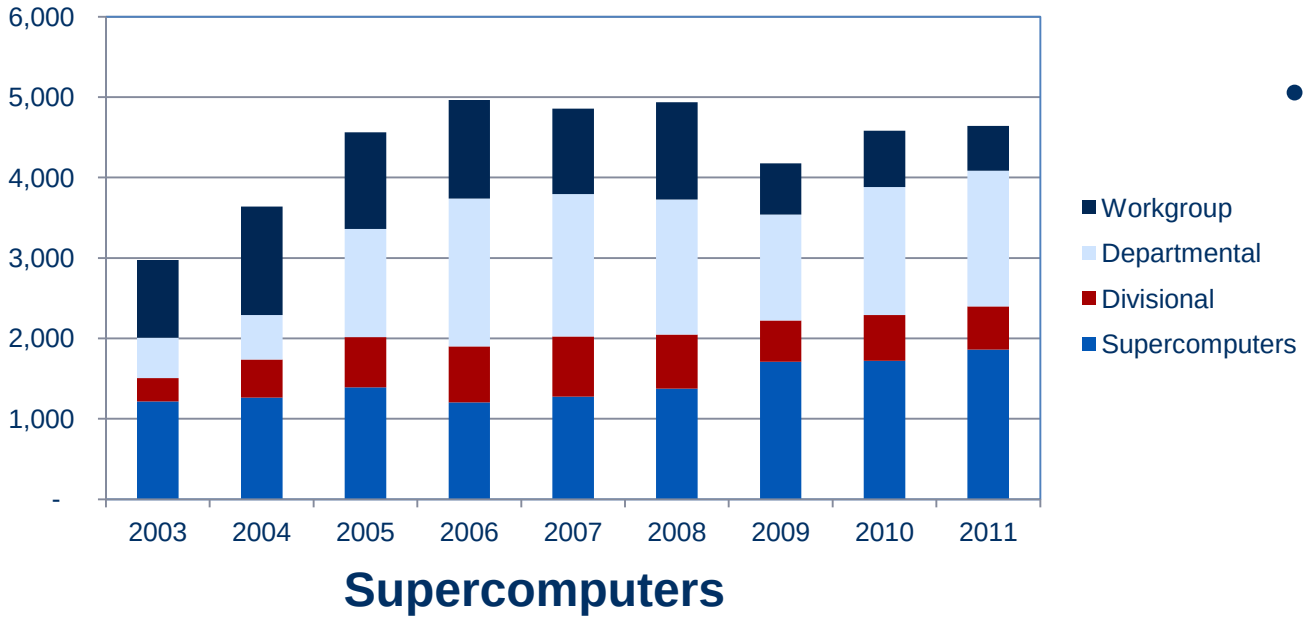
Supercomputer WW Growth Is Reshaping The Market

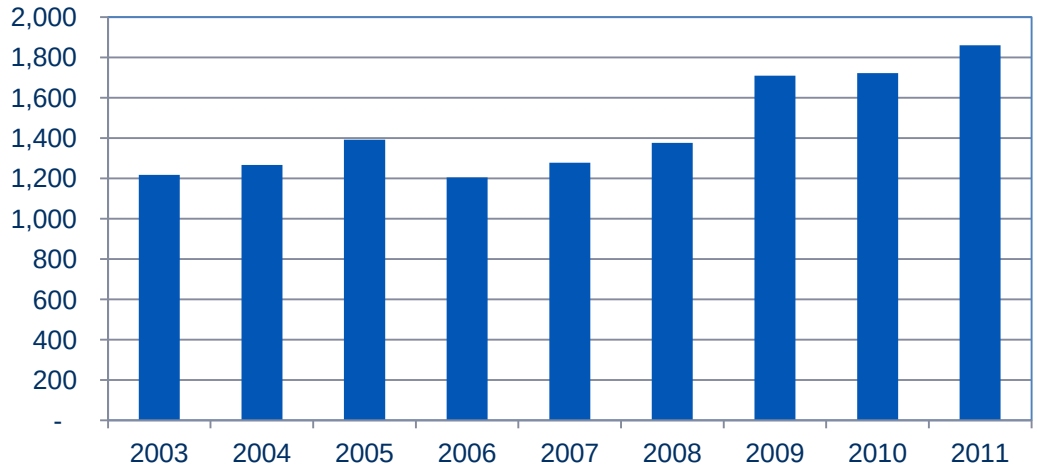




- **The overall HPC market was hard it by the recession, and has now fully recovered**
- **The worldwide supercomputer segment went into a major growth cycle – from 2008 to 2011**

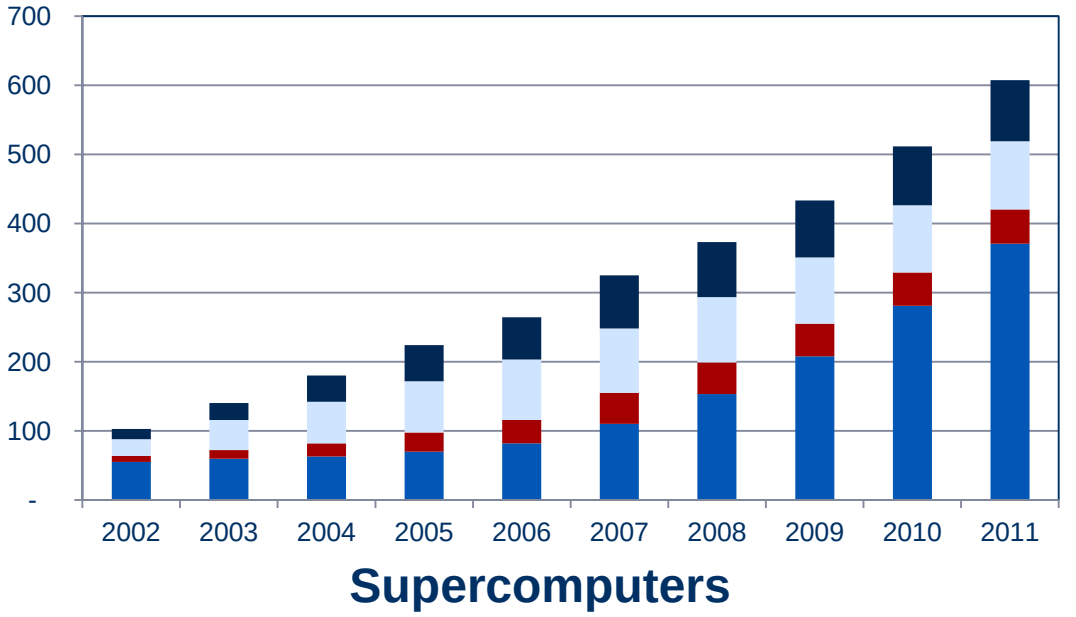
USA Supercomputer Growth



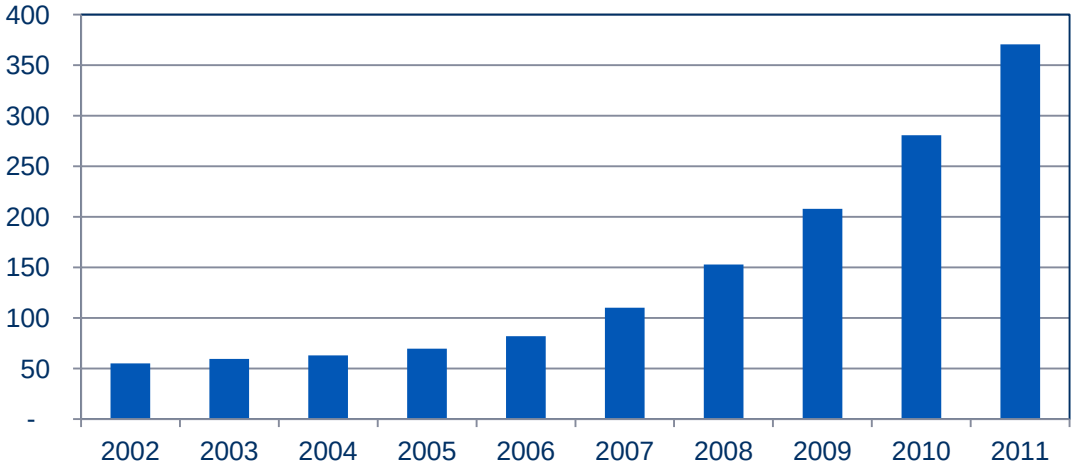


- **The USA HPC market was hard it by the recession, and still hasn't fully recovered**
- **The USA supercomputer segment grew some, but at a lower rate**

China Supercomputer Growth

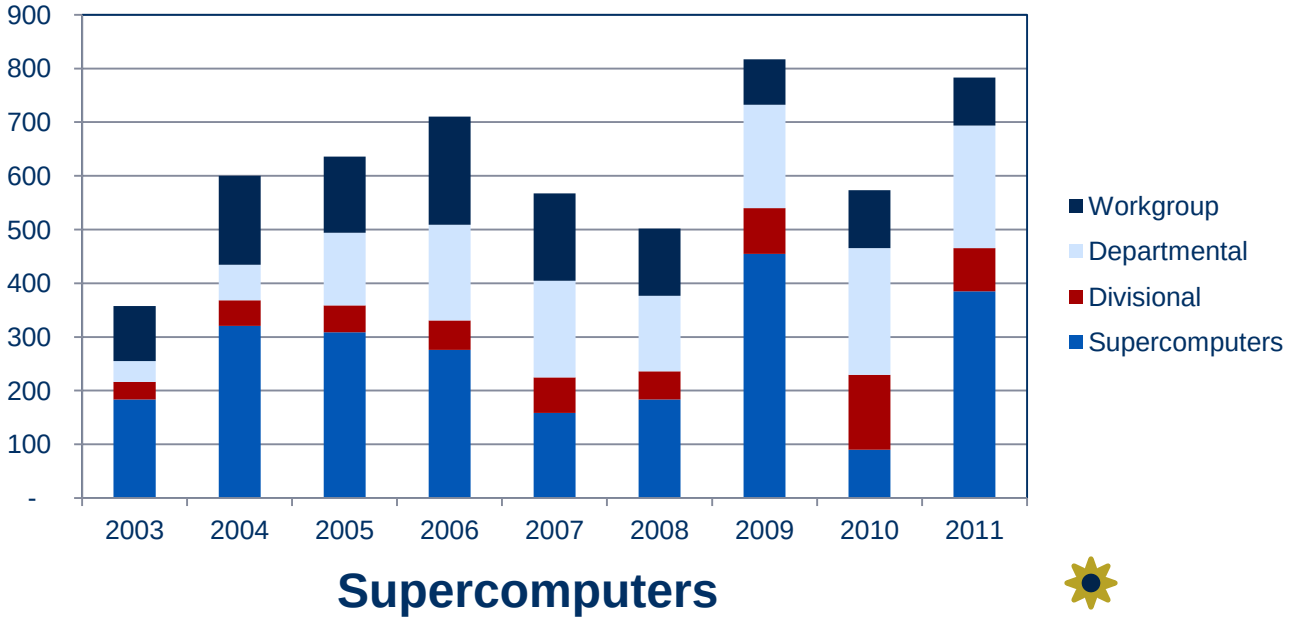


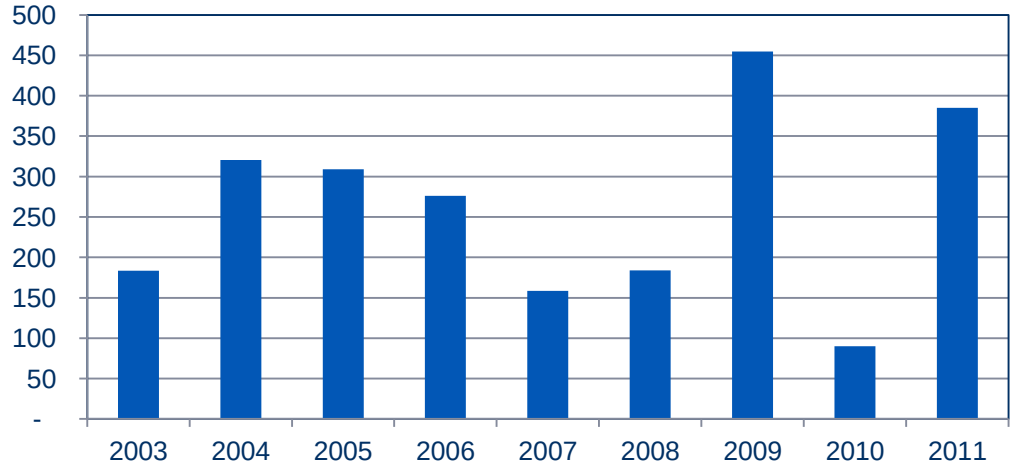
Supercomputers



- **The China HPC market wasn't impacted by the recession, and is well underway to reach $1 billion in 5 years**
- **The china supercomputer segment grew the most, heavily since 2007**

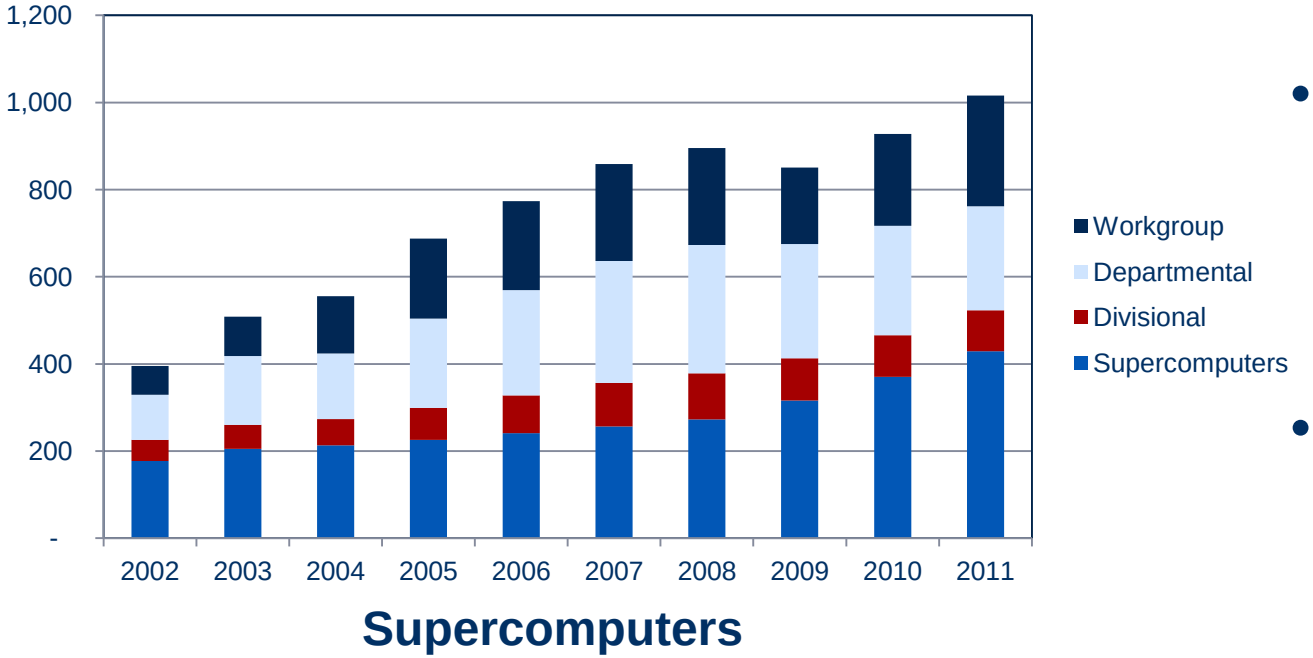
Japan Supercomputer Growth



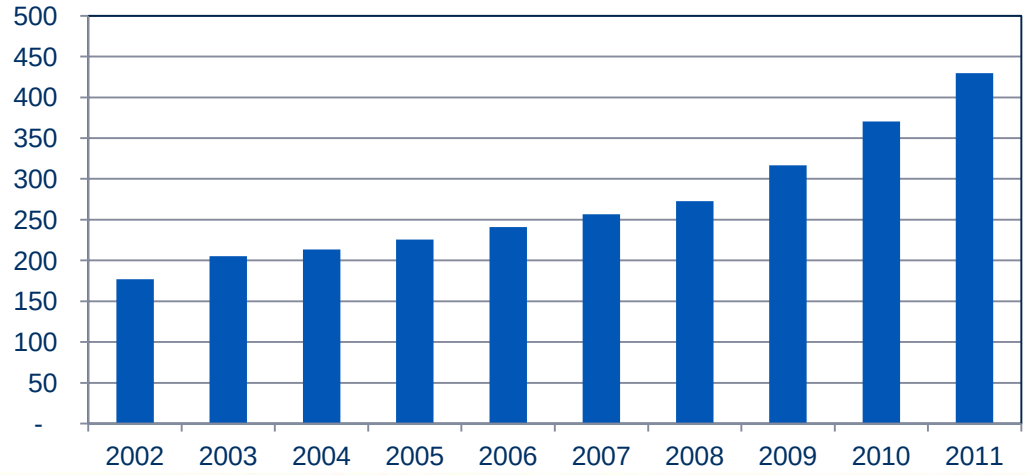


- **The Japan HPC market was hard it by the recession**
- **The Japan supercomputer segment is very up and down (Riken will make 2012 very large)**

German Supercomputer Growth



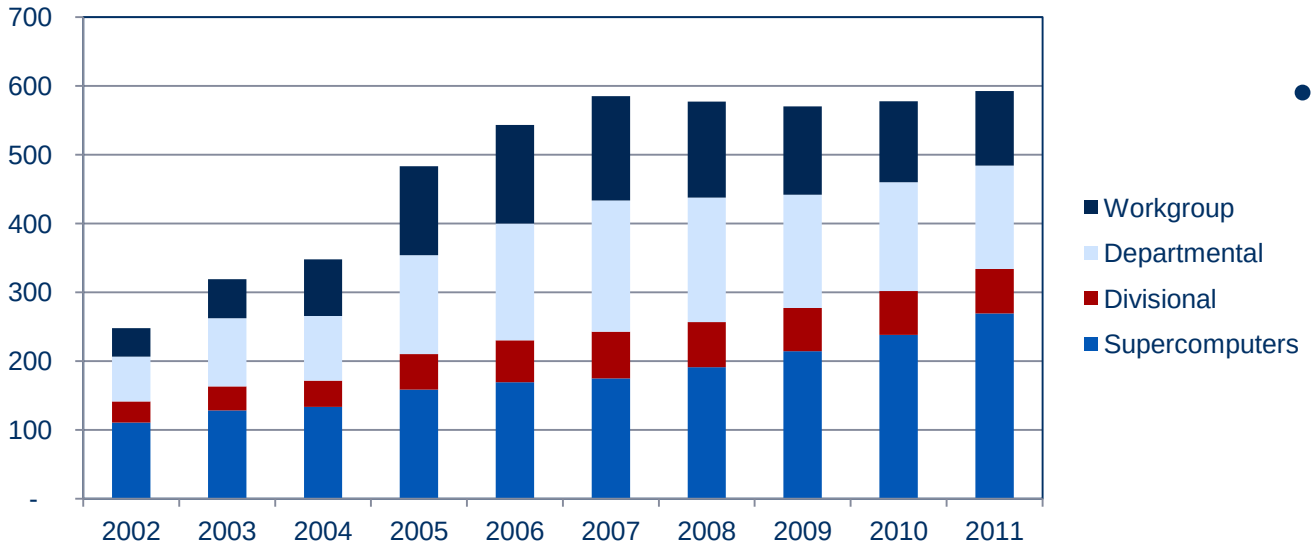
Supercomputers



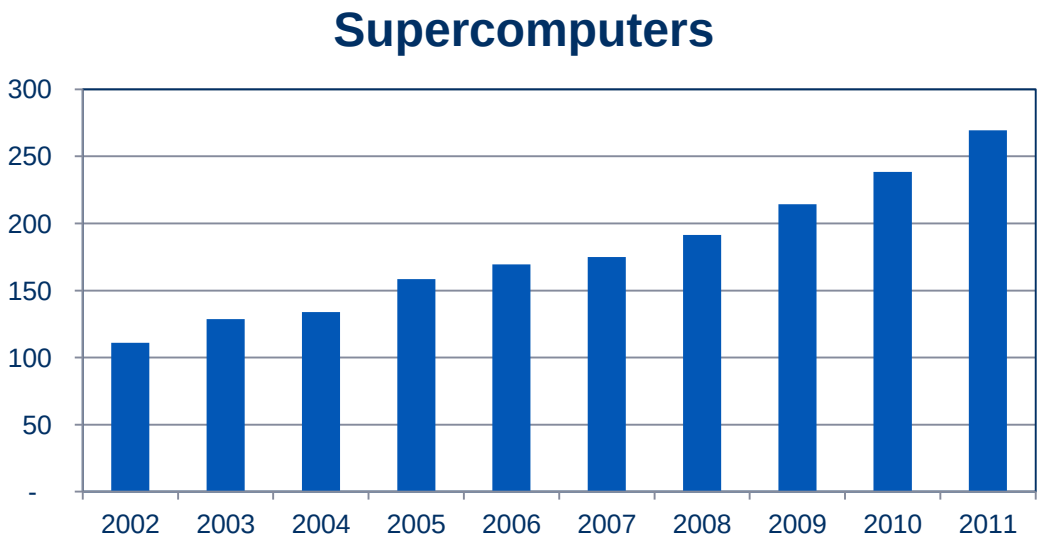
- **The German HPC market wasn't hit as much by the recession**
- **It just reached $1 billion in 2011**

- **The German supercomputer segment is growing well**

French Supercomputer Growth

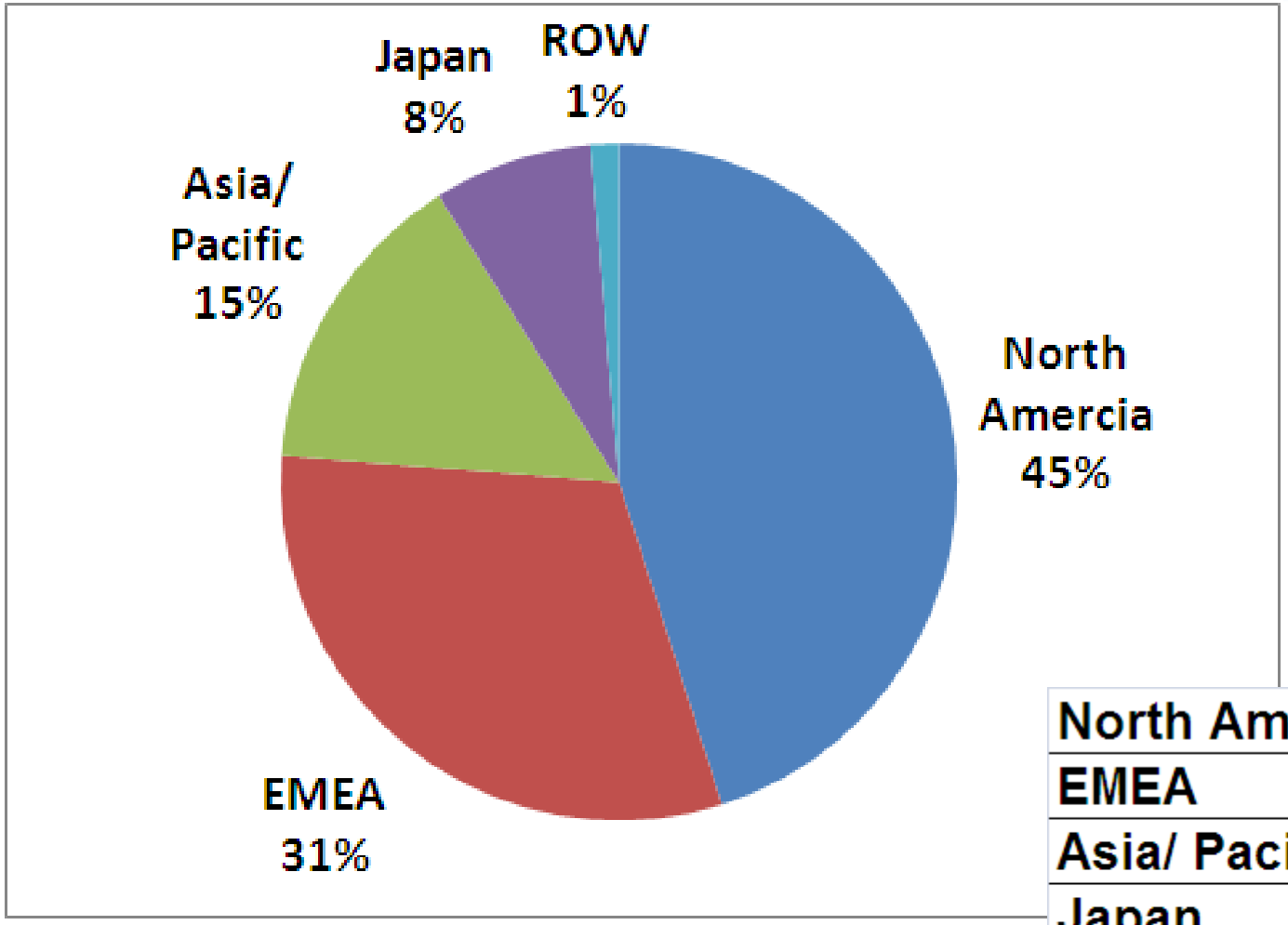


- **The French HPC market was less impacted by the recession, and has been flat for 5 years**



- **The French supercomputer segment is growing well**

By Region 2011



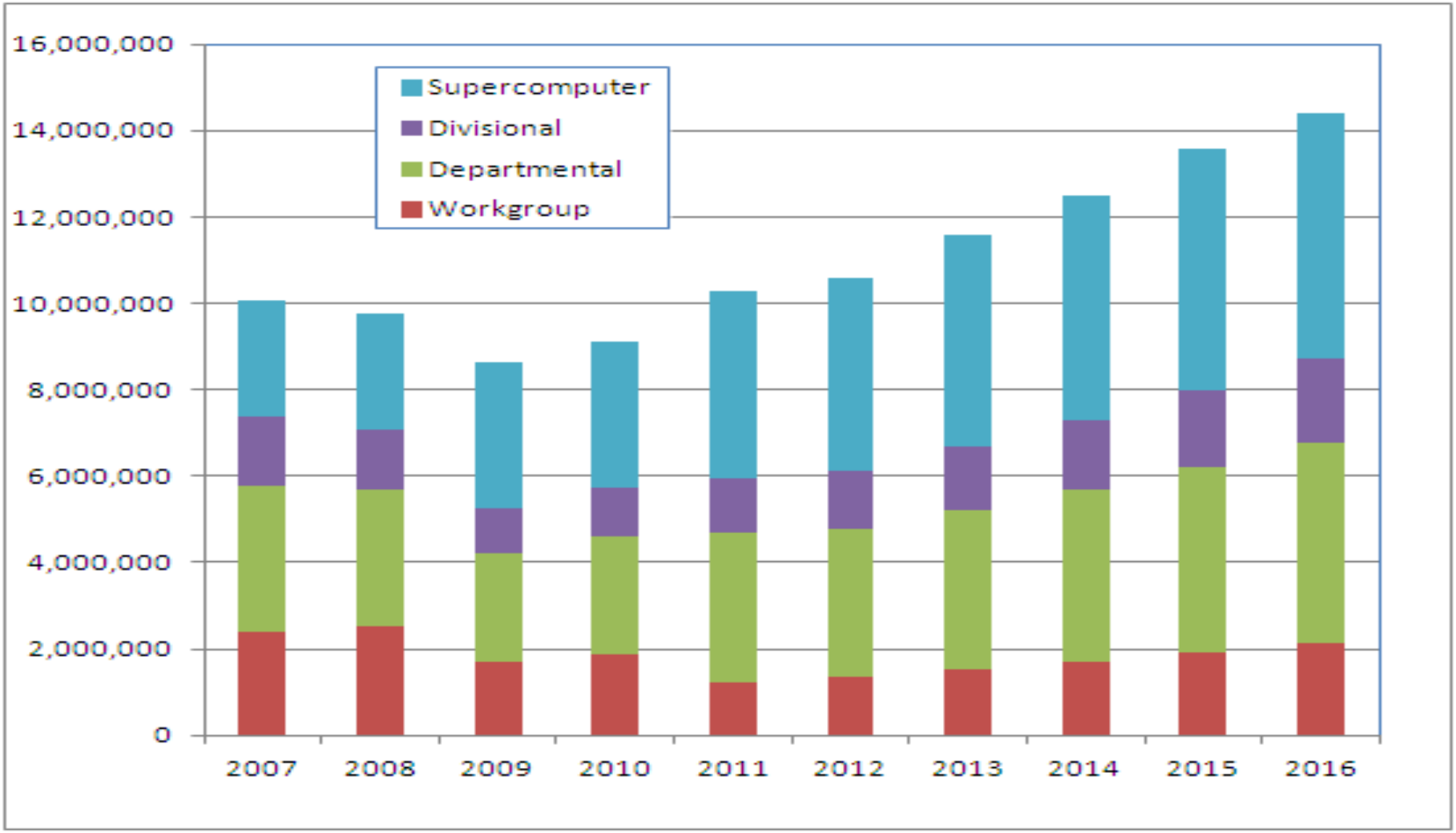
North Amercia	4,642,827
EMEA	3,210,905
Asia/ Pacific	1,525,464
Japan	783,154
ROW	137,708
Total	10,300,058

HPC Vendor Revenue Shares

Mftr	2010	2011	2010	2011
IBM	2,819,087	3,362,098	29.7%	32.6%
HP	3,017,555	3,307,427	31.8%	32.1%
Dell	1,462,995	1,493,289	15.4%	14.5%
Cray	273,225	155,620	2.9%	1.5%
SGI	258,959	225,741	2.7%	2.2%
Sun	178,227	75,630	1.9%	0.7%
Fujitsu	134,596	120,351	1.4%	1.2%
NEC	102,429	84,141	1.1%	0.8%
Appro	109,665	135,360	1.2%	1.3%
Hitachi	59,257	62,802	0.6%	0.6%
Dawning	63,469	102,923	0.7%	1.0%
Bull	106,112	327,536	1.1%	3.2%
Other	912,747	847,140	9.6%	8.2%
Grand Total	9,498,323	10,300,058	100.0%	100.0%

HPC Forecasts
And
Growth Areas

HPC Forecasts: By Competitive Segment



HPC Forecasts: By Verticals

IDC Analyze the Future

	2010	2011	2016	CAGR (11-16)
Bio-Sciences	$1,240,127	$1,251,665	$1,722,588	6.6%
CAE	$1,013,233	$1,095,398	$1,714,457	9.4%
Chemical Engineering	$193,759	$192,789	$251,392	5.5%
DCC & Distribution	$519,549	$569,026	$868,925	8.8%
Economics/Financial	$253,607	$279,294	$472,015	11.1%
EDA / IT / ISV	$594,187	$662,674	$1,009,535	8.8%
Geosciences	$579,355	$653,859	$906,900	6.8%
Mech Design and Drafting	$75,316	$63,102	$79,128	4.6%
Defense	$919,558	$1,004,632	$1,380,750	6.6%
Government Lab	$1,467,110	$2,078,029	$2,714,603	5.5%
University/Academic	$1,762,777	$1,900,883	$2,526,773	5.9%
Weather	$388,735	$453,999	$601,585	5.8%
Other	$108,912	$94,708	$137,736	7.8%
Total Revenue	$9,116,225	$10,300,058	$14,386,387	6.9%

Source IDC, April, 2012

The HPC Market Beyond The Servers

The Broader HPC Market

The Broader HPC Market Growth to 2016							
HPC Compute, Storage, Middleware, Application and Service Revenues, 2011 -- 2016 ($M							
	2011	2012	2013	2014	2015	2016	CAGR (11-16)
Server	10,300	11,031	11,910	12,778	13,839	14,621	7.3%
Storage	3,664	3,992	4,350	4,739	5,163	5,625	8.9%
Middleware	1,147	1,233	1,326	1,426	1,534	1,650	7.5%
Applications	3,370	3,618	3,884	4,169	4,475	4,804	7.3%
Service	1,801	1,924	2,056	2,197	2,348	2,509	6.9%
Total	20,282	21,799	23,526	25,310	27,359	29,209	7.6%
Source: IDC 2012							

The Future Of Supercomputing:

Exascale

Exascale Goals – A Leap Forward In Technology

IDC Analyze the Future

HPC System Characteristics

(The Road to Exascale)

	ASCI Red	Road Runner	K Computer	Sequoia	Exascale
Peak (Tflops)	1.3	1,700	11,280	20,133	1,200,000
Linpack (Tflops)	1	1,000	10,510	16,325	1,000,000
Total Cores	9,298	130,464	705,024	1,572,864	1,000,000,000
Processors	9,298	12,960 +6,912	88,128	98,304	1,000,000
Cores/Processor	1	9, 2	8	16	1,000
Power	0.85 MW	2.35 MW	9.89 MW	7.9 MW	~20 MW
Year	2000	2008	2011	2012	2020+

An Few Interesting HPC Examples

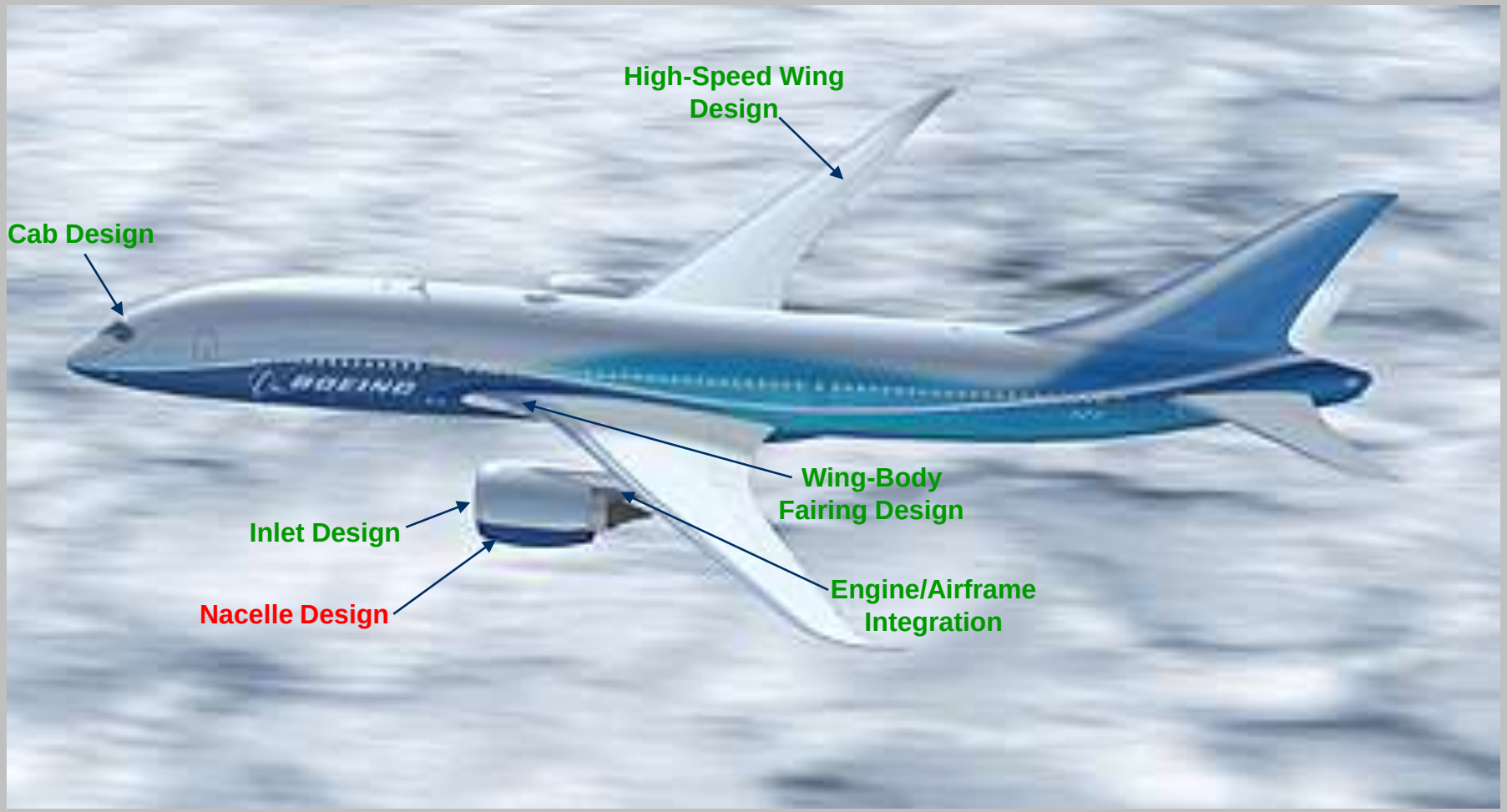
1979: CFD Contributions to the 767

IDC Analyze the Future

Much CFD penetration. Opportunities exist for higher accuracy and expanded complexity

Some CFD penetration. Opportunities exist for large increases in design process speed and application

CFD penetration opportunity



2005: CFD Contributions to the 787

IDC Analyze the Future

Much CFD penetration. Opportunities exist for higher accuracy and expanded complexity

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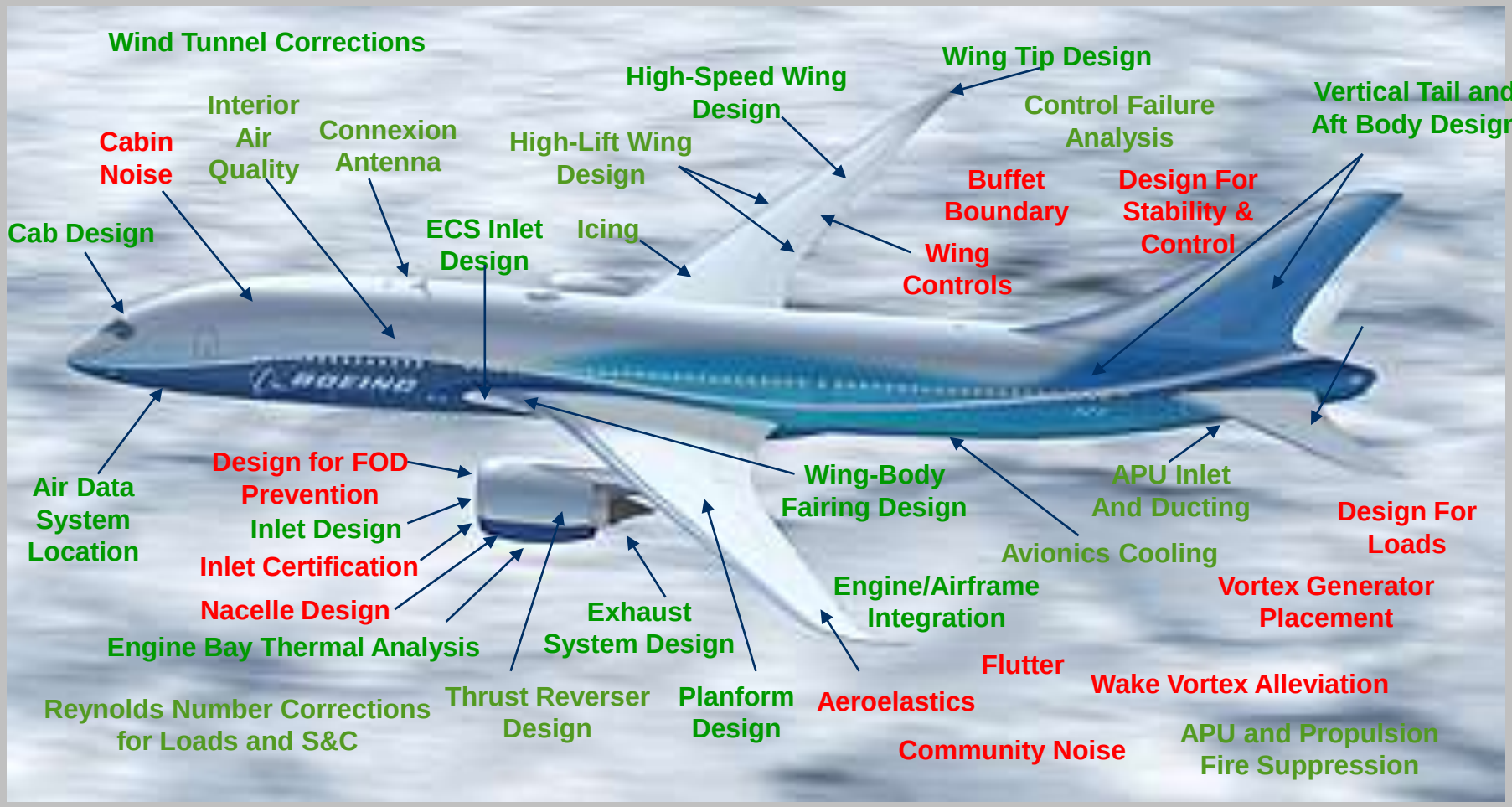
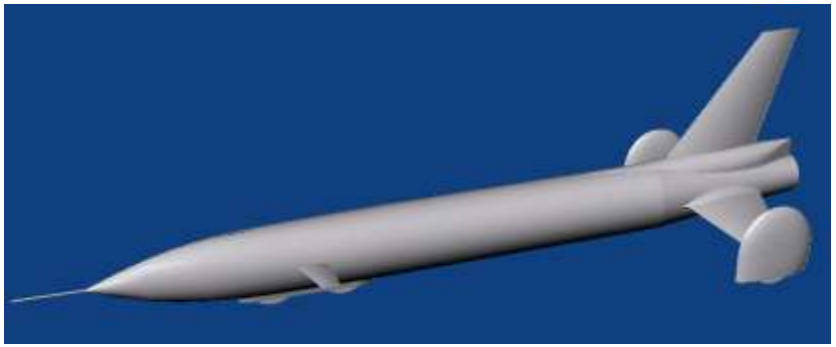
CFD penetration opportunity

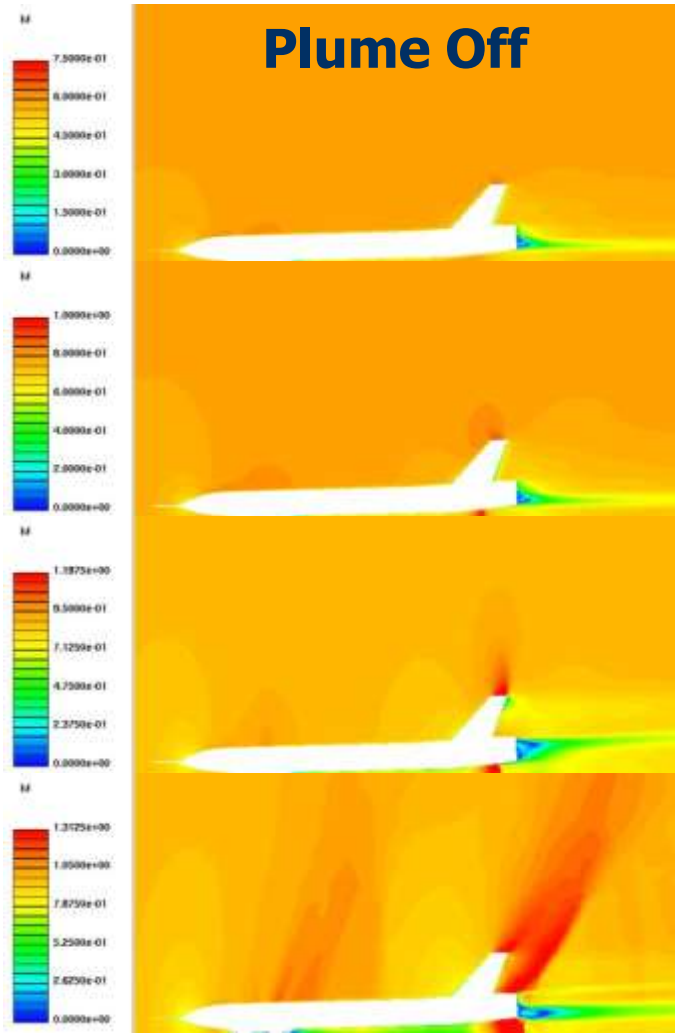


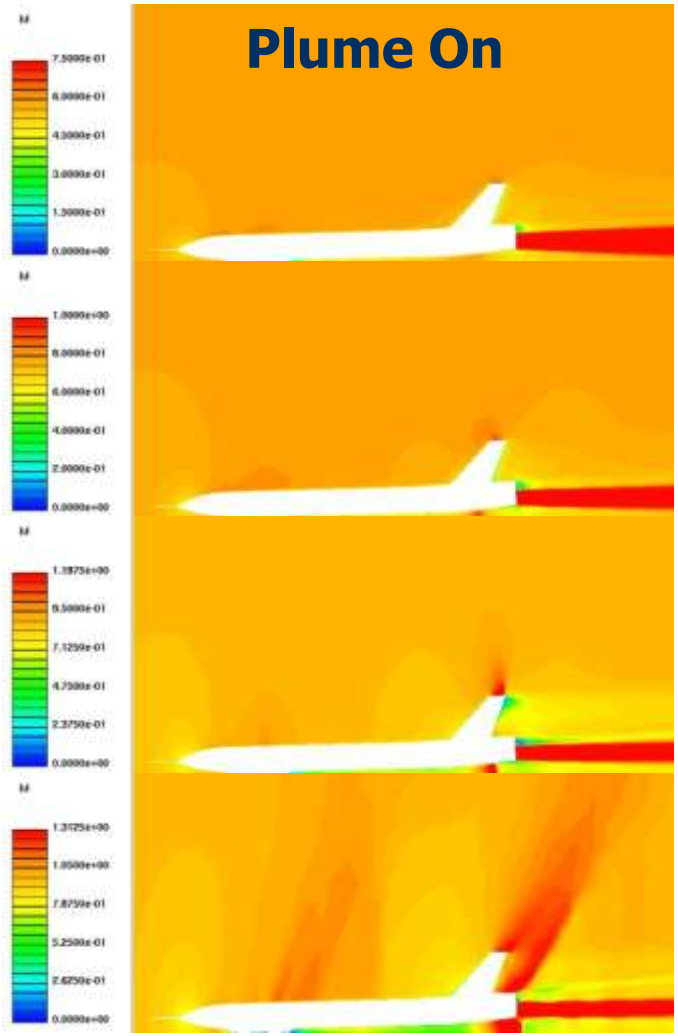
HPC User Example: CFD & The American Challenger Rocket Car

- **In 1979, Bill Fredrick's Budweiser rocket car — first land vehicle to break the speed of sound (739 mph)**
- **A new land speed racer is under development by Bill Fredrick:**
  - American challenger is a 47 ft long, **120,000 horsepower** car, powered by a hybrid rocket engine

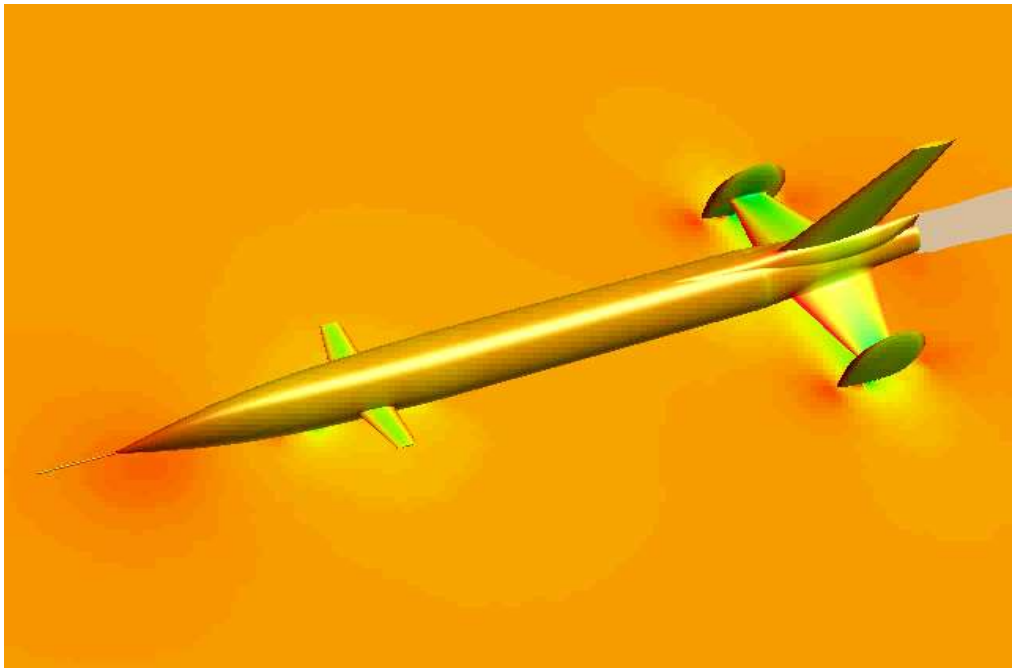


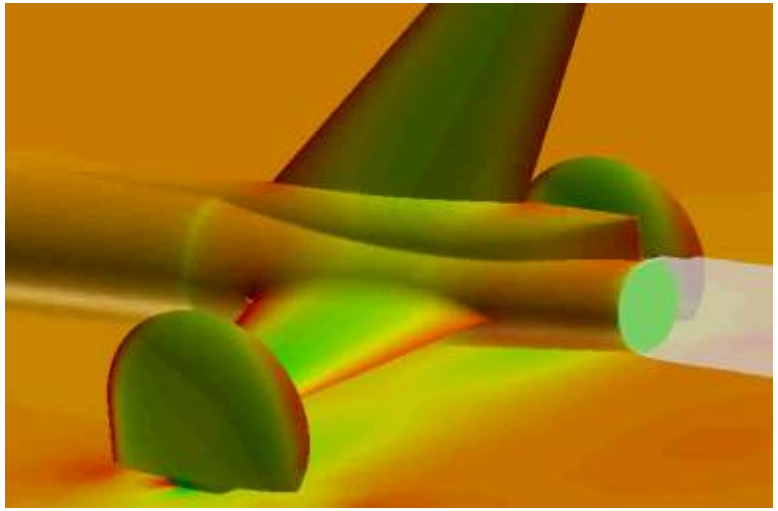
Results: Plume Off Can Cause Undesirable Behavior

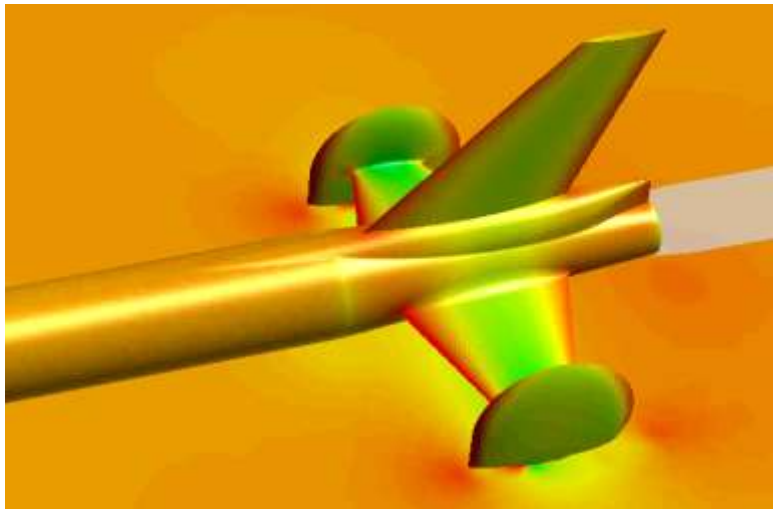




New Design – Revision K







Cases:

400mph – 500mph – 600mph – 680mph

690mph – 700mph – 710mph – 720mph

Summary: HPC is Required for a 120,000 Horsepower Supersonic Car Design

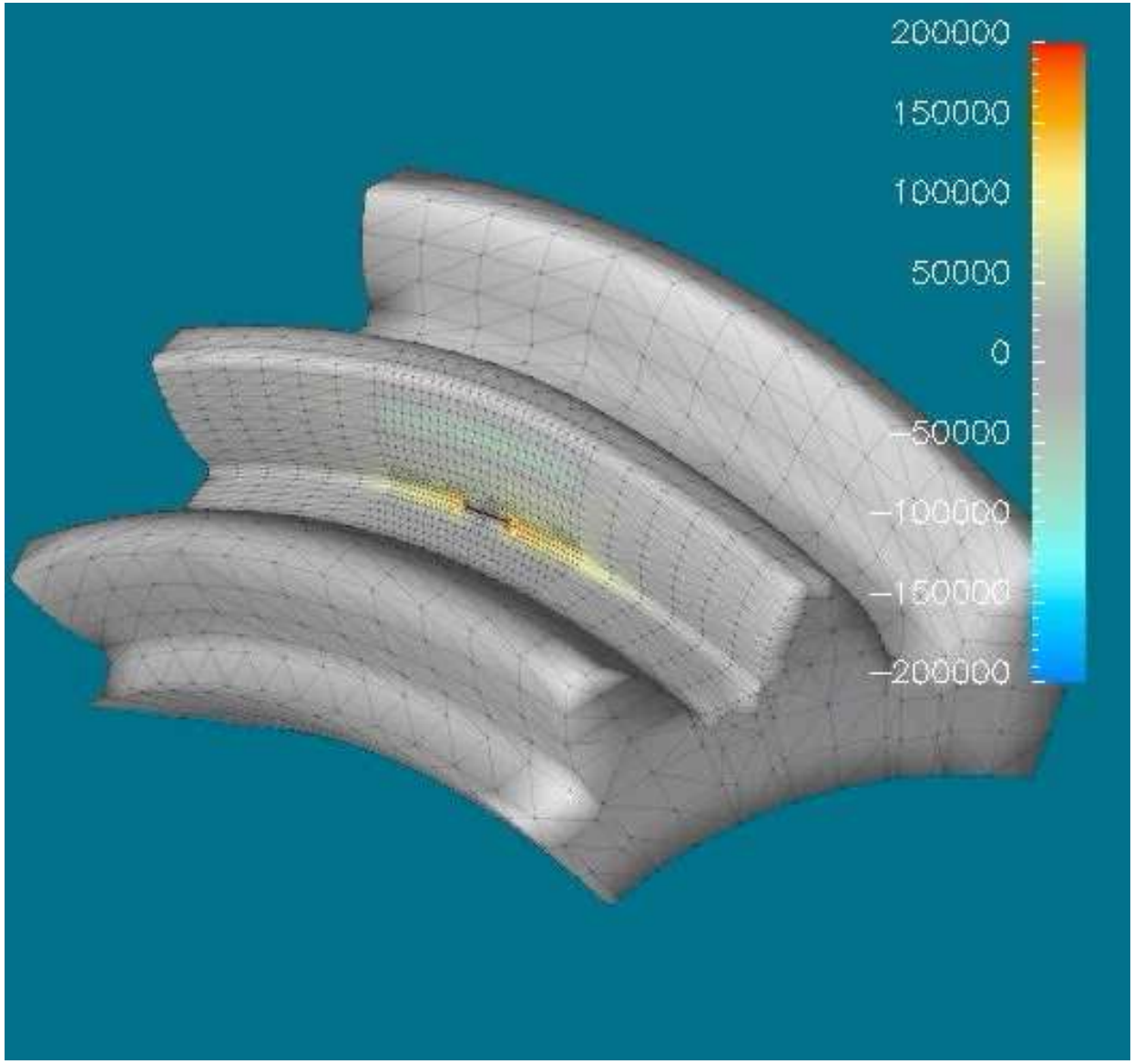
IDC
Analyze the Future

Flow analysis of rocket car is different than typical automotive application and different from typical aerospace application:

- **The CFD results indicated a range of potential problems arising as the vehicle gathers speed:**
  - Including the nose-up pitching moment at the low speed regime, which could cause the car to tumble as it accelerates to its final speed
- **The diamond-shaped strut design was found to induce pulsating flow separation bubbles in the range Mach 0.6 to 0.9, which lead to asymmetric shock oscillations**

"High Performance Computing can be used to help realize the dreams of adventurous individuals and organizations"

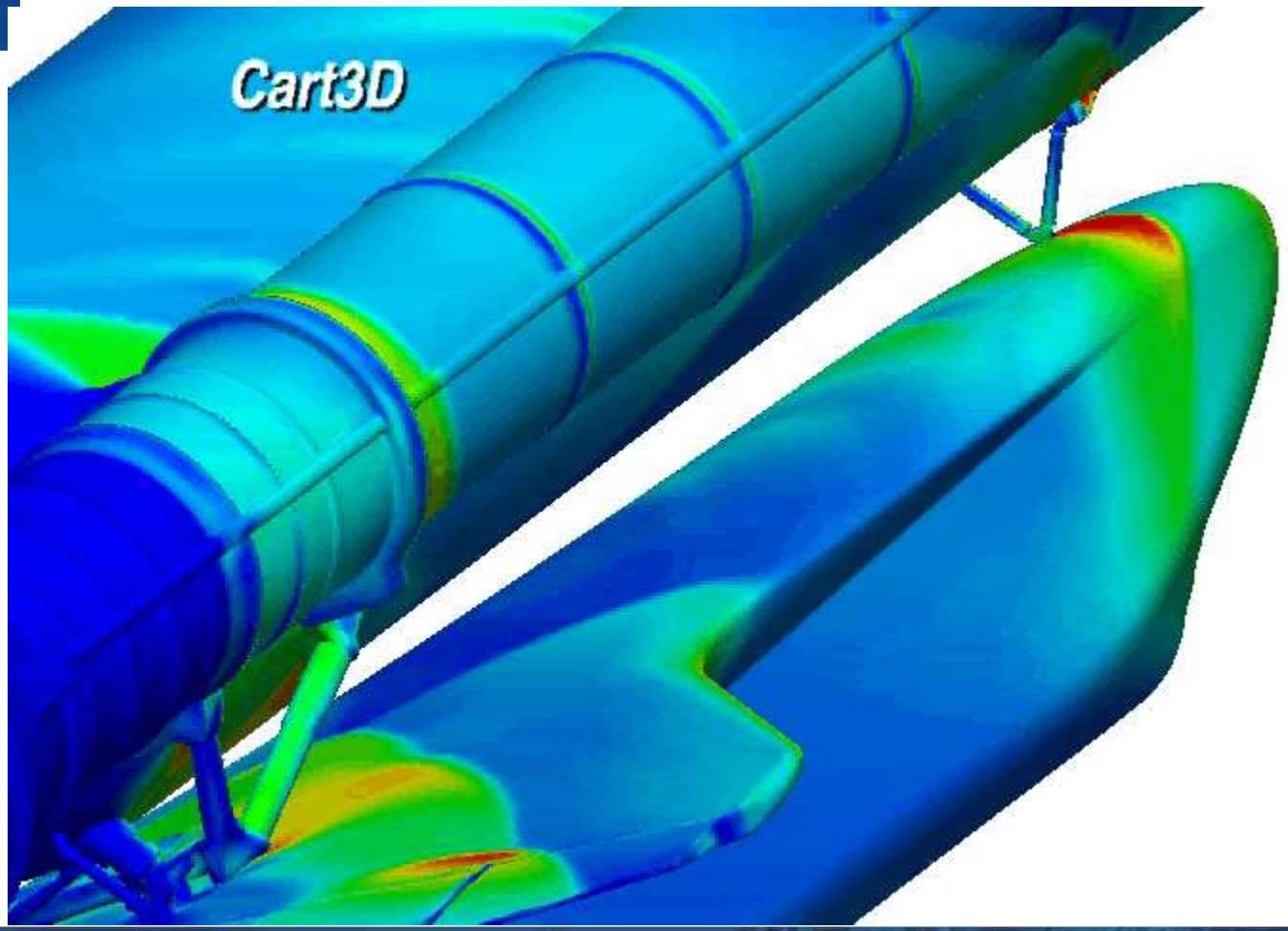
Interesting Uses Of HPC: Competition Is Requiring More Than Just A CAD Design



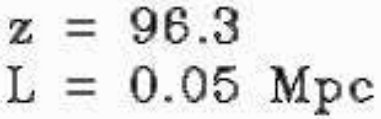
Interesting Uses Of HPC: The Evolution Of Designing Safer Cars

Interesting Uses Of HPC: Simulations Need To Match The Real World Results

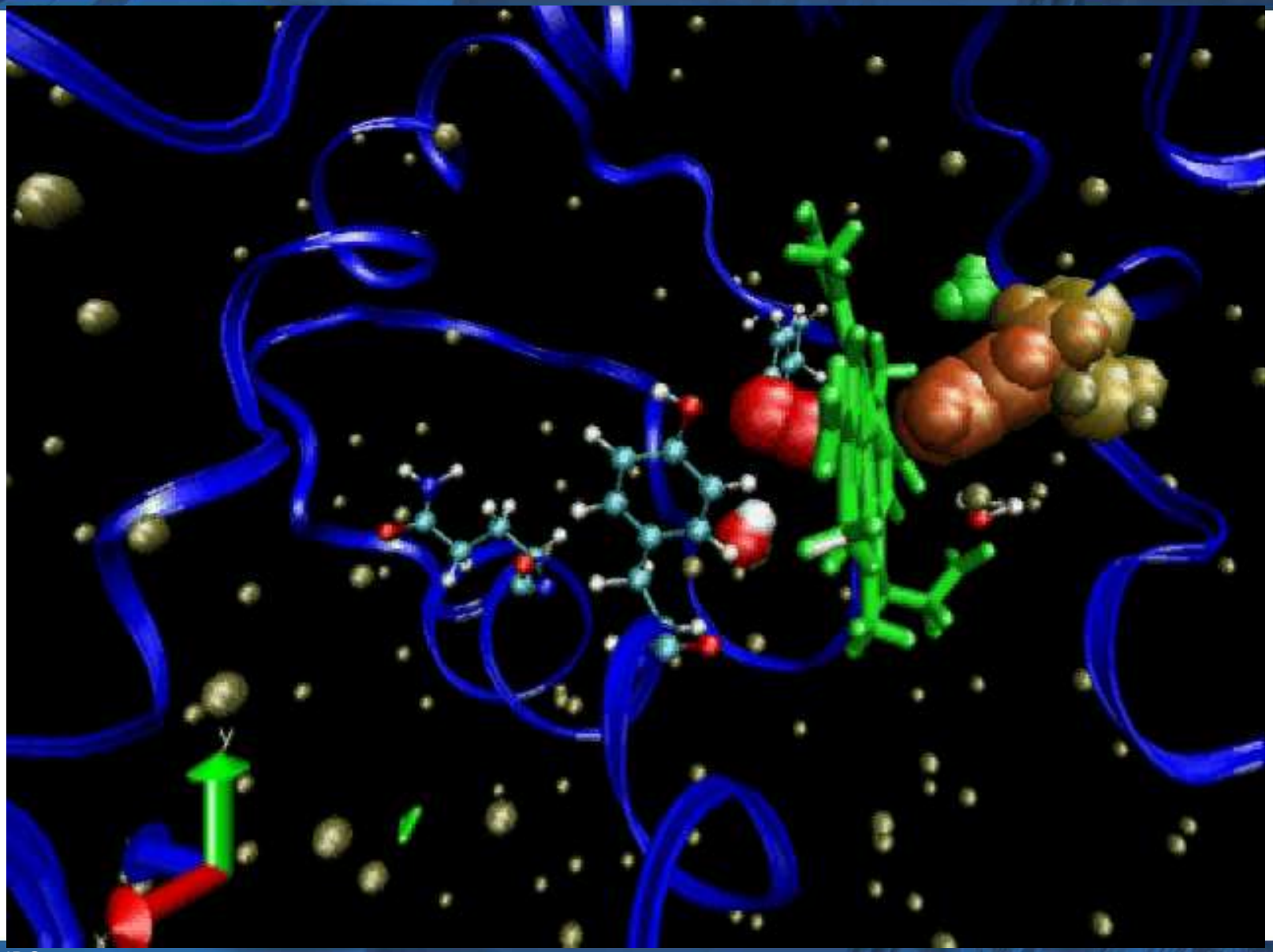
Interesting Uses Of HPC: Addressing Major Failures



Interesting Uses Of HPC: Evolution Of The Universe



Interesting Uses Of HPC: Molecules



A New Hot Topic:

Big Data

HPDA Market Drivers

More input data (ingestion):

- More powerful scientific instruments/sensor networks
- More transactions/higher scrutiny (fraud, terrorism)
- More stringent standards, regulations

More output data for integration/ analysis:

- More powerful computers
- More realism
- Faster solutions
- More iterations in available time

PayPal: Online Fraud Detection -- $700 Million Saved In Year 1



Detecting fraud in 'real time' as millions of transactions are processed between disparate systems at volume.

Finding suspicious patterns that we don't even know exist in related data sets.

Ability to create and deploy new fraud models into event flows quickly and with minimal effort.

Provide environment for fraud modeling, analytics, visualization, M/R, dimensioning and further processing.

GEICO: Real-Time Insurance Quotes

- **Problem: Need accurate automated phone quotes in 100ms**
- **Solution: Each weekend, use HPC cluster to pre-calculate quotes for every American adult and household (60 hours)**

Mayo Clinic: Outcomes-Based Medical Diagnosis and Treatment Planning

- **Enter the patient's history and symptomology**
- **While patient is still in the office, sift through 10 million archived patient records for relevant outcomes**
- **Provider considers the efficacies of various treatments for "similar" patients (but is not bound by the findings)**
- **Ergo, this functions as a powerful decision-support tool**
- **Benefits: better outcomes + rein in costly outlier practices**

MAYO CLINIC

MEDICA.

A New IDC Study:

Creating An Economic Model For HPC and ROI And for HPC and Innovation

Project Overview

A study that describes how increases in HPC investments can significantly improve the nation's economic success and increase its overall scientific innovation

The study includes creating two unique models:

1. A macroeconomic model which depicts the way HPC investments result in economic advancements in the form of ROI, growth and jobs
2. An "Innovation Index" that provides a means of measuring and comparing national innovation levels, based on the level of applying HPC computing resources towards scientific and technical advancement

Project Overview: Why It Is Key To DOE

IDC Analyze the Future

- DOE's core missions in the Office of Science and in NNSA are greatly dependent of the appropriate level of application of HPC computing resources -- to maintain a leadership position requires an in-depth understanding of what other countries are doing in HPC
- World scientific leadership and innovation are becoming more dependent on the use of HPC/supercomputers every year
- Economic leadership increasingly directly results from a nation's or an industry's or an enterprise's application of supercomputers in innovative and productive ways
- Other countries are putting into place plans to gain leadership in innovation and economic progress by more broadly applying HPC/supercomputing across many different industry and segments (like China, Russia, Europe and other Asian countries)

Project Overview: Why Is This Different Than "Normal" Economic Data

Almost all economic and census data is based on collecting large sets of data points without creating a predictive model

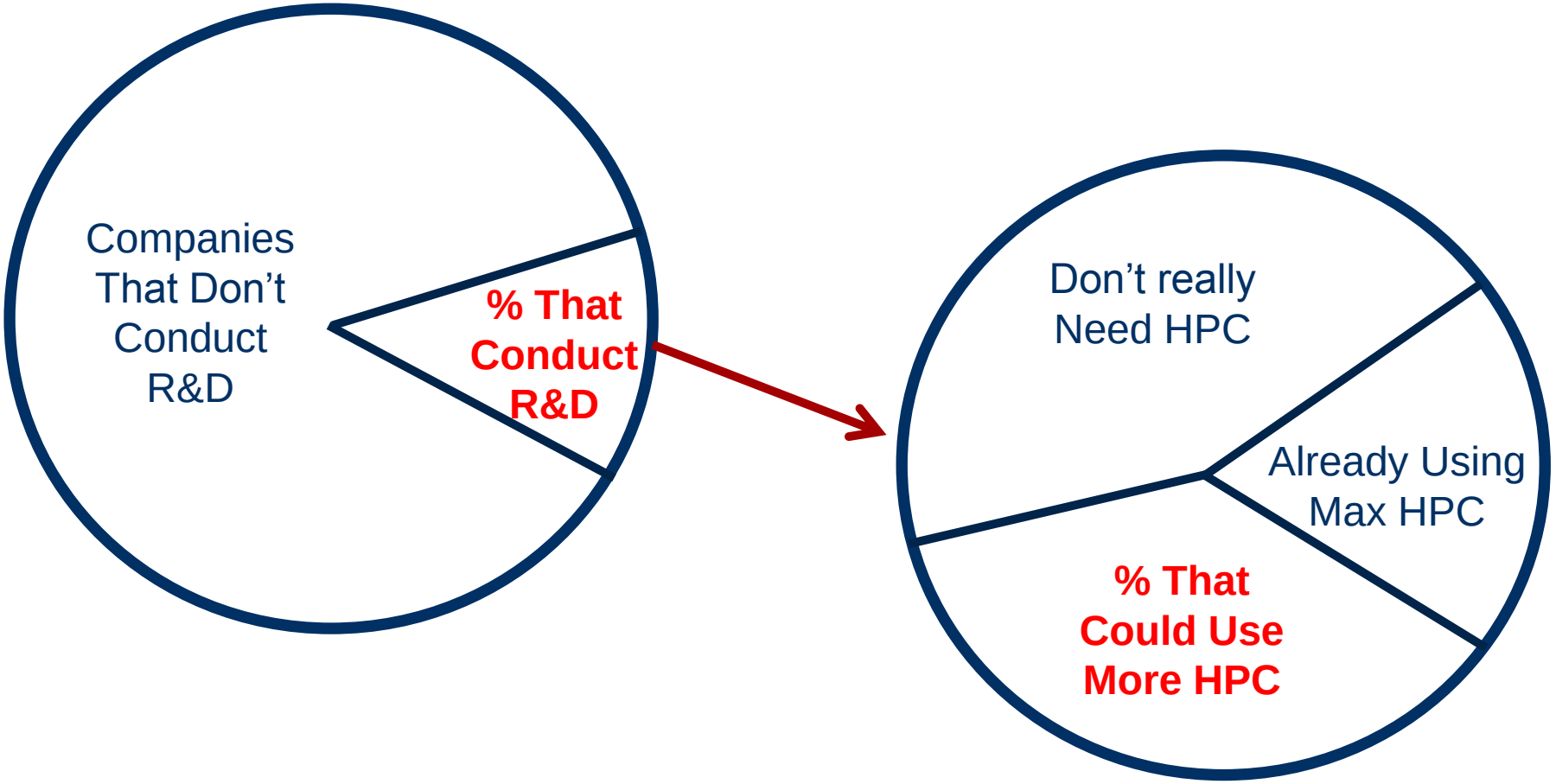
Two examples of the value of this proposal and how this proposal is unique:

1. **DEVELOPING THE CORRELATION:** In Egyptian archeology most of the early effort (and most of the current effort) has been focused on collecting raw data – finding the artifacts
   - It wasn't until Jean Champollin decoded hieroglyphics that it was possible to understand the meaning of collected raw data elements

2. **DEVELOPING A PREDICTIVE MODEL:** Technology has been improving at a high rate, but it took a predictive model to establish the actual rate of improvement within the computer industry:
   - Over 50 years ago (in 1965) Gorden Moore determined the rate of density improvement of a silicon chip to be 2x every 24 months, and this established a predictive model that lasted for over a half century

Research Overview – An Example of the Parameters Needed

For Each Industry Sector:
e.g. in Manufacturing



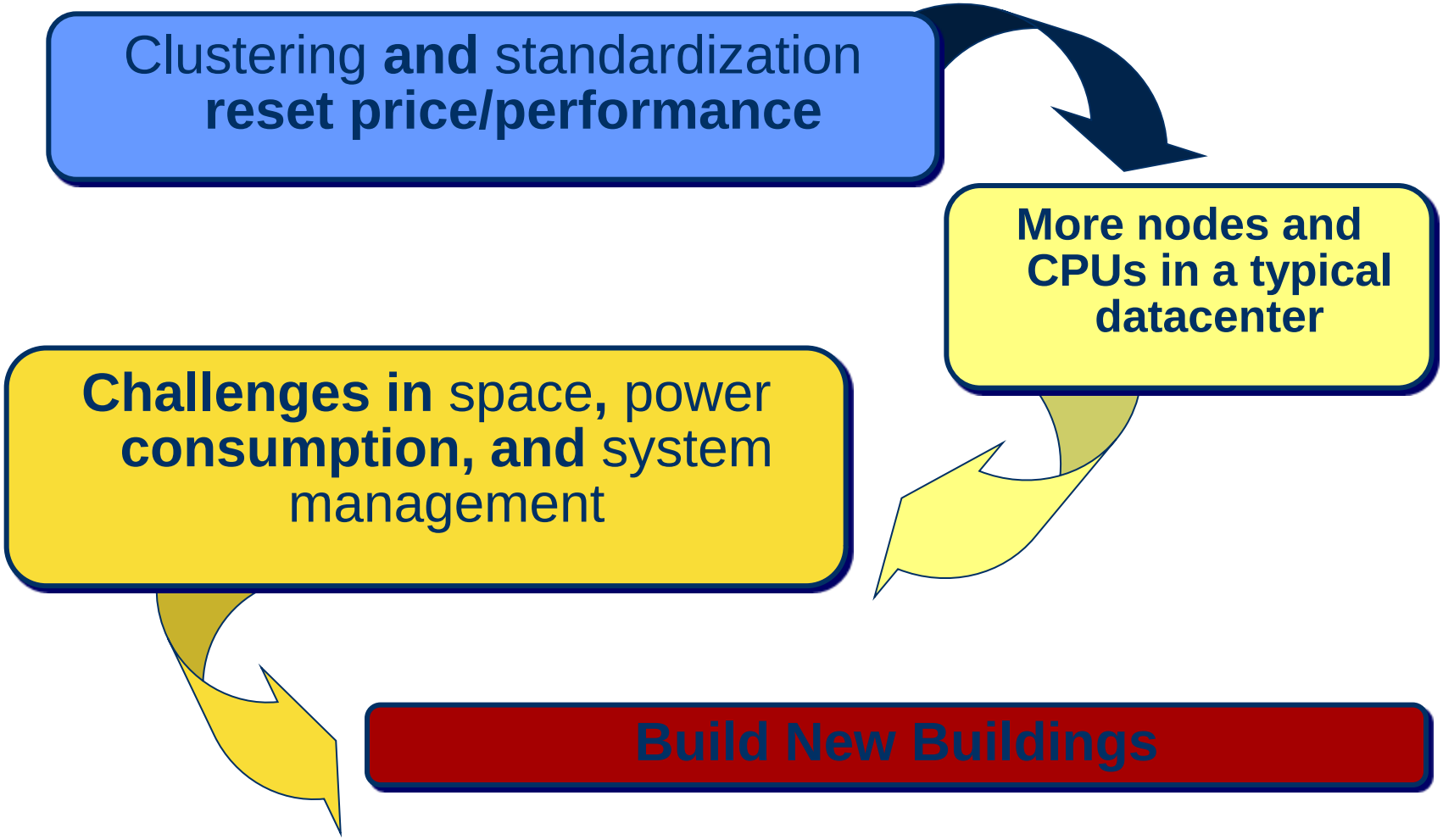
In Summary

Why HPC Is Projected To Grow

IDC Analyze the Future

1. **It has become a competitive weapon**
   - For companies, universities and governments
   - Global competitiveness is driving R&D and better product designs
   - Even small companies are using HPC to gain market share
2. **Governments view HPC leadership as critical**
   - For national pride, but more importantly for economic prosperity
   - It use to be 1 large supercomputer – now its multiple ones
3. **There are very critical HPC issues that need to be solved**
   - Global warming, alternative energy, safe NE, financial disaster modeling, healthcare, homeland security, …
   - And 3D movies and large scale games are fun
4. **At the same time, "live" science and "live" engineering costs have escalated**
   - And time-to-solution is months faster with simulations

Market Dynamics



But There are Still Major Customer Pain Points

Software is the #1 roadblock

- Better management software is needed
- Parallel software is lacking for most users
  - ➢ Many applications will need a major redesign

Clusters are still hard to use and manage

- System management & growing cluster complexity
- Power, cooling and floor space are major issues
- Third party software costs
- RAS is a growing issue
- Storage and data management are becoming new bottle necks
- Weak support for heterogeneous environment and accelerators

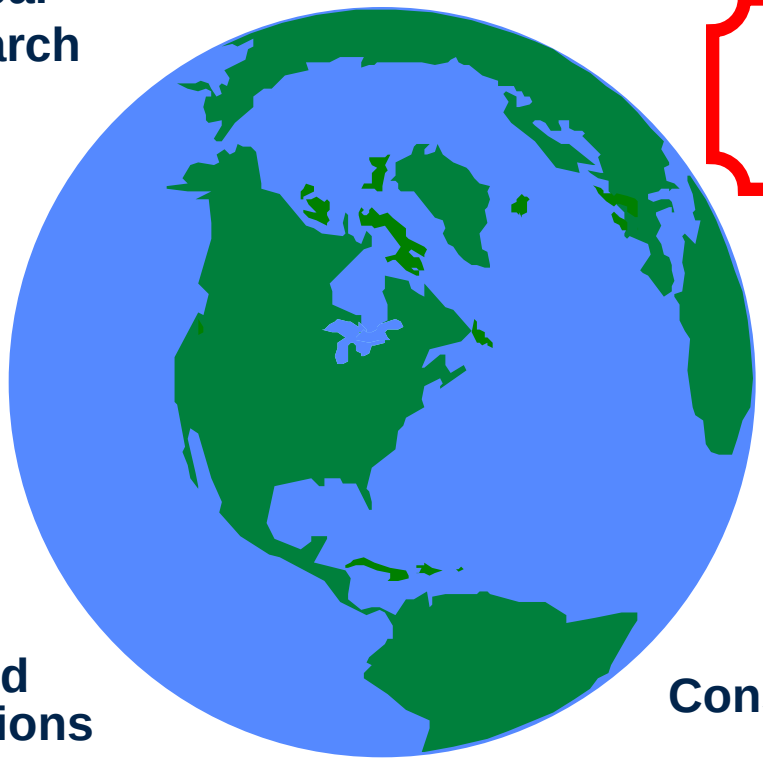
ROI is becoming a requirement, especially as system costs escalate

Questions?

Please email:
hpc@idc.com

Or check out:
www.hpcuserforum.com

IDC Research Areas



Enterprise Systems

Workstations

Global Research

Technical Computing

Services

Software

Internet

Channels

Verticals

Personal Systems

Networking and Telecommunications

Consumer and Small Business

Components and Peripherals

Growth In HPC Clusters