IDC SC13
Breakfast Briefing
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IDC Has >1,000 Analysts In 52 Countries
IDC’s HPC Team

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IDC HPC research studies, HPC User Forum and strategic consulting

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Strategic consulting, HPC User Forum, market trends, Big Data

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HPC QView, technology trends, Big Data, innovation awards program

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HPC market analysis, data analysis and workstations

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Government account support and special projects

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IDC Government Insights

Charlie Hayes
Government HPC issues, DOE and special studies

Mary Rolph
HPC User Forum conference planning and logistics
About IDC: 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
Presentation Topics

- General economic trends
- HPC market results and forecasts
  - Early results from 30,000 micro HPC surveys
- New IDC Pulse panel
- High Performance Data Analysis (HPDA) update
- New ROI report and model
- Multiclient study highlights
- HPC User Forum update
- Innovation award winners
General Economic Trends

Worldwide IT Spending (% growth, total IT spending)

Source: IDC Worldwide Black Book, Q3 2013
General Economic Trends

Worldwide IT Spending Growth

Source: IDC Worldwide Black Book Q3 2013; growth in constant currency
General Economic Trends

Regional IT Growth (%)
General Economic Trends

BRIC GDP Growth (% Real)

Forecasts for 2014 now look optimistic, in light of recent downgrades by IMF, World Bank and others.

- China
- Brazil
- India
- Russia
HPC Market Update and Trends
Top Trends in HPC

The global economy in HPC is growing again:

- 2011: grew 8.4% to reach $10.3 billion
- 2012: HPC revenue exceeded $11B
- From our micro-surveys → 1Q13 -- The lower half of the market is growing well again

Ongoing 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/Exascale Race is at full speed

Big Data and accelerators are hot new technologies

HPC Cloud computing is growing slowly, steadily
2014 Hot Topics in HPC: IDC HPC Research Areas

Potentially Disruptive Trends and Technologies

- Growing need to demonstrate/quantify ROI and innovation
- Rise in industrial partnership programs
- Proliferation of High Performance Data Analysis (Big Data using HPC)
- New processors, co-processors and accelerators
- New memory & I/O solutions (flash/SSDs, in-memory processing, etc.)
- New software solutions
- Government programs to help bring to market new capabilities

Special HPC Research Areas & Reports:

- Updating of IDC HPC competitive segments
- End-user based MCS reports: clusters, processors, accelerators, storage, interconnects, system software, and applications
- Emerging markets including China, Russia, Korea, Latin America, etc.
- Pioneering research on ROI from investments in HPC
- SMB and SMS research
- The HPC Innovation Award program
- The evolution of clouds in HPC
- Scaling of software – issues and solutions
- Worldwide exascale initiatives
Research Overview – Parameters Being Collected to Tie to Broader Economic Reports

For each sector we need 4 basic ratios

- % That Conduct R&D
- % Already Using Max HPC
- % That Could Use More HPC
- % That Don’t Really Need HPC

Note: IDC has conducted over 30,000 light phone calls for this data. We will likely require 5x to 10x more surveys.
## HPC WW Market Trends ($K): By Competitive Segments

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supercomputers</strong></td>
<td>3,475,577</td>
<td>4,370,194</td>
<td>5,654,960</td>
<td>1,725,756</td>
<td>29.4%</td>
</tr>
<tr>
<td><strong>Divisional</strong></td>
<td>1,268,735</td>
<td>1,236,684</td>
<td>1,216,187</td>
<td>702,067</td>
<td>-1.7%</td>
</tr>
<tr>
<td><strong>Departmental</strong></td>
<td>3,342,747</td>
<td>3,467,271</td>
<td>2,979,230</td>
<td>1,853,790</td>
<td>-14.1%</td>
</tr>
<tr>
<td><strong>Workgroup</strong></td>
<td>1,411,264</td>
<td>1,225,910</td>
<td>1,247,366</td>
<td>809,349</td>
<td>1.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>9,498,323</td>
<td>10,300,058</td>
<td>11,097,743</td>
<td>5,090,962</td>
<td>7.7%</td>
</tr>
</tbody>
</table>
## HPC WW Market Trends: By System Units Sold

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supercomputers</td>
<td>2,560</td>
<td>2,908</td>
<td>2,400</td>
<td>748</td>
<td>-17.5%</td>
</tr>
<tr>
<td>Divisional</td>
<td>3,914</td>
<td>3,724</td>
<td>3,663</td>
<td>2,189</td>
<td>-1.6%</td>
</tr>
<tr>
<td>Departmental</td>
<td>20,382</td>
<td>20,625</td>
<td>16,981</td>
<td>11,048</td>
<td>-17.7%</td>
</tr>
<tr>
<td>Workgroup</td>
<td>92,988</td>
<td>84,294</td>
<td>81,104</td>
<td>50,963</td>
<td>-3.8%</td>
</tr>
<tr>
<td>Total</td>
<td>119,844</td>
<td>111,551</td>
<td>104,148</td>
<td>64,947</td>
<td>-6.6%</td>
</tr>
</tbody>
</table>
# HPC WW Market Trends ($K): By OEM

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>1H2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM</td>
<td>3,362,098</td>
<td>3,551,723</td>
<td>1,563,771</td>
</tr>
<tr>
<td>HP</td>
<td>3,307,427</td>
<td>3,419,554</td>
<td>1,573,560</td>
</tr>
<tr>
<td>Dell</td>
<td>1,493,289</td>
<td>1,493,172</td>
<td>737,733</td>
</tr>
<tr>
<td>Cray</td>
<td>155,620</td>
<td>353,800</td>
<td>122,220</td>
</tr>
<tr>
<td>SGI</td>
<td>225,741</td>
<td>274,693</td>
<td>216,743</td>
</tr>
<tr>
<td>Fujitsu</td>
<td>120,351</td>
<td>686,657</td>
<td>65,139</td>
</tr>
<tr>
<td>NEC</td>
<td>84,141</td>
<td>64,112</td>
<td>37,106</td>
</tr>
<tr>
<td>Appro</td>
<td>135,360</td>
<td>111,648</td>
<td>-</td>
</tr>
<tr>
<td>Dawning</td>
<td>102,923</td>
<td>115,359</td>
<td>74,906</td>
</tr>
<tr>
<td>Bull</td>
<td>327,536</td>
<td>60,494</td>
<td>40,049</td>
</tr>
<tr>
<td>Other</td>
<td>847,140</td>
<td>966,531</td>
<td>659,736</td>
</tr>
<tr>
<td>Total</td>
<td>10,300,058</td>
<td>11,097,743</td>
<td>5,090,962</td>
</tr>
</tbody>
</table>
### Table 45

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP (1)</th>
<th>Average Supercomputer Sales Over Last Five Years (2)</th>
<th>Supercomputers As A Percentage Of GDP</th>
<th>Average 5 year HPC Spending</th>
<th>HPC As A Percentage Of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>14,270,000</td>
<td>1,276,057</td>
<td>0.0089%</td>
<td>4,464,817</td>
<td>0.0313%</td>
</tr>
<tr>
<td>Japan</td>
<td>5,049,000</td>
<td>278,385</td>
<td>0.0055%</td>
<td>651,126</td>
<td>0.0129%</td>
</tr>
<tr>
<td>China</td>
<td>4,758,000</td>
<td>67,836</td>
<td>0.0014%</td>
<td>278,480</td>
<td>0.0059%</td>
</tr>
<tr>
<td>Germany</td>
<td>3,235,000</td>
<td>203,245</td>
<td>0.0063%</td>
<td>761,309</td>
<td>0.0235%</td>
</tr>
<tr>
<td>France</td>
<td>2,635,000</td>
<td>142,209</td>
<td>0.0054%</td>
<td>517,170</td>
<td>0.0196%</td>
</tr>
<tr>
<td>U.K.</td>
<td>2,198,000</td>
<td>129,384</td>
<td>0.0059%</td>
<td>478,353</td>
<td>0.0218%</td>
</tr>
<tr>
<td>Italy</td>
<td>2,090,000</td>
<td>76,751</td>
<td>0.0037%</td>
<td>338,661</td>
<td>0.0162%</td>
</tr>
<tr>
<td>Spain</td>
<td>1,466,000</td>
<td>37,690</td>
<td>0.0026%</td>
<td>138,984</td>
<td>0.0085%</td>
</tr>
<tr>
<td>Russia</td>
<td>1,255,000</td>
<td>30,371</td>
<td>0.0024%</td>
<td>75,720</td>
<td>0.0060%</td>
</tr>
<tr>
<td>India</td>
<td>1,243,000</td>
<td>19,627</td>
<td>0.0016%</td>
<td>74,780</td>
<td>0.0060%</td>
</tr>
<tr>
<td>Australia</td>
<td>920,000</td>
<td>55,411</td>
<td>0.0060%</td>
<td>239,900</td>
<td>0.0260%</td>
</tr>
<tr>
<td>Korea</td>
<td>800,300</td>
<td>59,305</td>
<td>0.0074%</td>
<td>284,705</td>
<td>0.0356%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>484,100</td>
<td>24,144</td>
<td>0.0050%</td>
<td>94,481</td>
<td>0.0195%</td>
</tr>
<tr>
<td>Sweden</td>
<td>397,700</td>
<td>21,314</td>
<td>0.0054%</td>
<td>75,043</td>
<td>0.0189%</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>208,800</td>
<td>15,491</td>
<td>0.0074%</td>
<td>67,547</td>
<td>0.0324%</td>
</tr>
</tbody>
</table>
China Supercomputer Growth

- The China HPC market wasn’t impacted by the recession, and is well under way to reach $1 billion.

- The China supercomputer segment grew the most heavily since 2007.
HPC Forecasts: By Competitive Segment

- Supercomputer
- Divisional
- Departmental
- Workgroup

Yearly Forecasts:
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017

Graph showing the forecasted growth of HPC by segment from 2008 to 2017.
## HPC Forecasts ($K): By Verticals/Application Areas

<table>
<thead>
<tr>
<th>Vertical/Category</th>
<th>2012</th>
<th>Est. 2013</th>
<th>2017</th>
<th>CAGR (12-17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-Sciences</td>
<td>$1,199,980</td>
<td>$1,267,745</td>
<td>$1,839,750</td>
<td>8.9%</td>
</tr>
<tr>
<td>CAE</td>
<td>$1,164,471</td>
<td>$1,220,781</td>
<td>$1,832,921</td>
<td>9.5%</td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>$182,006</td>
<td>$189,902</td>
<td>$262,116</td>
<td>7.6%</td>
</tr>
<tr>
<td>DCC &amp; Distribution</td>
<td>$585,696</td>
<td>$621,945</td>
<td>$910,431</td>
<td>9.2%</td>
</tr>
<tr>
<td>Economics/Financial</td>
<td>$316,397</td>
<td>$339,485</td>
<td>$499,871</td>
<td>9.6%</td>
</tr>
<tr>
<td>EDA / IT / ISV</td>
<td>$624,696</td>
<td>$687,245</td>
<td>$1,028,523</td>
<td>10.5%</td>
</tr>
<tr>
<td>Geosciences and Geo-engineering</td>
<td>$707,869</td>
<td>$706,911</td>
<td>$958,673</td>
<td>6.3%</td>
</tr>
<tr>
<td>Mechanical Design and Drafting</td>
<td>$55,531</td>
<td>$61,482</td>
<td>$86,430</td>
<td>9.3%</td>
</tr>
<tr>
<td>Defense</td>
<td>$1,129,225</td>
<td>$1,104,015</td>
<td>$1,511,223</td>
<td>6.0%</td>
</tr>
<tr>
<td>Government Lab</td>
<td>$2,396,806</td>
<td>$2,279,607</td>
<td>$2,990,083</td>
<td>4.5%</td>
</tr>
<tr>
<td>University/Academic</td>
<td>$2,058,774</td>
<td>$2,029,805</td>
<td>$2,737,149</td>
<td>5.9%</td>
</tr>
<tr>
<td>Weather</td>
<td>$486,467</td>
<td>$476,181</td>
<td>$642,012</td>
<td>5.7%</td>
</tr>
<tr>
<td>Other</td>
<td>$189,823</td>
<td>$151,927</td>
<td>$141,563</td>
<td>-5.7%</td>
</tr>
<tr>
<td><strong>Total Revenue</strong></td>
<td><strong>$11,097,742</strong></td>
<td><strong>$11,137,031</strong></td>
<td><strong>$15,440,744</strong></td>
<td><strong>6.8%</strong></td>
</tr>
</tbody>
</table>
## The HPC Market Beyond The Servers: The Broader HPC Market

### Worldwide HPC Compute, Storage, Middleware, Application and Service Revenues ($M)

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2017</th>
<th>CAGR (12-17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>10,300</td>
<td>11,098</td>
<td>15,441</td>
<td>6.8%</td>
</tr>
<tr>
<td>Storage</td>
<td>3,664</td>
<td>4,059</td>
<td>6,008</td>
<td>8.2%</td>
</tr>
<tr>
<td>Middleware</td>
<td>1,147</td>
<td>1,254</td>
<td>1,568</td>
<td>4.6%</td>
</tr>
<tr>
<td>Applications</td>
<td>3,370</td>
<td>3,621</td>
<td>4,837</td>
<td>6.0%</td>
</tr>
<tr>
<td>Service</td>
<td>1,801</td>
<td>1,877</td>
<td>2,368</td>
<td>4.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>20,282</td>
<td>21,909</td>
<td>30,223</td>
<td>6.6%</td>
</tr>
</tbody>
</table>
IDC WORLDWIDE HPC END-USER MULTI-CLIENT STUDY (2013)

Six Topical Reports:
- Industries/applications/workloads report
- System software and middleware report
- Storage and interconnect report
- Processors/co-processors/accelerators
- High performance data analysis
- Cloud computing
Surveys were conducted from January to May 2013

The sample represents 905 installed HPC systems across 139 sites around the world

<table>
<thead>
<tr>
<th>Sector/Industry</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>7.9%</td>
</tr>
<tr>
<td>Education/Academia</td>
<td>41.7%</td>
</tr>
<tr>
<td>a. Energy, petroleum, oil and gas</td>
<td>2.9%</td>
</tr>
<tr>
<td>b. Chemical</td>
<td>0.7%</td>
</tr>
<tr>
<td>c. Pharmaceutical, life sciences, healthcare</td>
<td>2.2%</td>
</tr>
<tr>
<td>d. Financial or economic modeling and BI</td>
<td>20.1%</td>
</tr>
<tr>
<td>e. Manufacturing</td>
<td>10.8%</td>
</tr>
<tr>
<td>f. IT, electronics and telecommunications</td>
<td>4.3%</td>
</tr>
<tr>
<td>g. Transportation and logistics</td>
<td>2.9%</td>
</tr>
<tr>
<td>h. Entertainment</td>
<td>2.2%</td>
</tr>
<tr>
<td>i. Other</td>
<td>4.3%</td>
</tr>
</tbody>
</table>
2013 MCS Report Highlights: Industries/Applications/Workloads

Scaling remains a major issue:

- 13.3% of the codes are running on 1 core
- 64.4% of the codes are running on 1 node or less
- Only 5.2% of codes run on >1,000 cores
- Only 0.9% of codes run on >10,000 cores

IDC forecasts that HPC software applications spending will reach $4.8 billion in 2017
Key Challenges:

- Increasing system sizes
- Increasing system complexity
- New environments (e.g., cloud)
- Shortage of skilled personnel

IDC forecasts that HPC system software spending will reach $1.5 billion in 2017
Storage is the fastest-growing HPC segment
- Ethernet variants lead
- InfiniBand is a strong second

IDC forecasts that storage & interconnect spending will reach $6.0 billion in 2017
- This equals the value of the HPC server market in 2000
Coproprocessor/accelerator use is growing fast

- 2011: 28.2% of sites and 1.0% of processor parts
- 2013: 76.9% of sites and 3.4% of processor parts
- Still used more often for experimentation than production

CPUs from the embedded world are arriving (Atom, ARM)

Indigenous processor initiatives in Asia
2013 MCS Report Highlights: High Performance Data Analysis (HPDA)

HPDA is becoming pervasive
- 67% of surveyed sites run HPDA workloads
- On average, HPDA workloads consume 30% of compute cycles

IDC forecasts robust HPDA growth
- HPDA server revenue will grow from $748.8M in 2012 to $1.4B in 2017
- HPDA storage revenue will approach $1B in 2017
HPC Cloud Computing Is Growing Steadily

- From 13.8% of sites in 2011 to 23.5% in 2013
- Private and public cloud computing about equally represented
New HPC & HPDA Technical Computing Pulse Panel
A new IDC capability (available now)

- Rapid answers to urgent questions about the HPC, HPDA markets: new trends, new technologies, emerging markets
- Rifle-shot probes: 3-6 weeks, vs. several months for full-out studies
- IDC developed this capability for key clients
- Many successful Pulses carried out over past 6 months

Methodology: the Pulse panel

- Highly qualified, representative panel of 500+ HPC/HPDA technical experts, funders, buyers, and end-users already in the program
- To develop and qualify the panel, IDC has contacted 30,000 scientists and engineers around the world. Will grow to 100,000.
- Primarily web-based
Example: HPDA Pulse (Highlights)

Pulse conducted Sept/Oct 2013

- Only panelist organizations that use HPDA (Big Data on HPC)
- 62.2% have access to supercomputer-class systems (>500,000)
  - Respondents also included many SMEs
- 45.9% consider HPDA jobs “very critical” to their missions
- 46.6% have near-real time HPDA requirements (few seconds to few minutes)
  - 19.2% real time to a few seconds
  - 27.4% within a few minutes
HPDA Update
High Performance Data Analysis

- Needs HPC resources
- Intelligent questions / smart algorithms
- Often near-real time

- The 4 V’s: volume, variety, velocity, value
- Partitionable & non-partitionable problems
- Regular and irregular data patterns

- Search & pattern discovery
- Simulation & analytics
- Also iterative methods
- Established HPC users + new commercial users
HPC Adoption Timeline (Examples)

- Ford
- Morgan Stanley
- P&G
- Schrödinger, Inc.
- Walmart
- GEICO
- CMS
- PayPal
- Visa
- Mastercard
- JPMorgan Chase
- United States Postal Service
- Boeing
- Toyota
- DreamWorks Animation
- BP
- Samsung
- Merck
- Panasonic
- Mayo Clinic
- Airbus
- PING
- Emcien

1960
1970
1980
1990
2000
2012
HPDA User Talks: HPC User Forums, UK, Germany, France, China, U.S.

HPC in Evolutionary Biology, Andrew Meade, University of Reading
HPC in Pharmaceutical Research: From Virtual Screening to All-Atom Simulations of Biomolecules, Jan Kriegl, Boehringer-Ingelheim
European Exascale Software Initiative, Jean-Yves Berthou, Electricite de France
Real-time Rendering in the Automotive Industry, Cornelia Denk, RTT-Munich
Data Analysis and Visualization for the DoD HPCMP, Paul Adams, ERDC
Why HPCs Hate Biologists, and What We're Doing About It, Titus Brown, Michigan State University
Scalable Data Mining and Archiving in the Era of the Square Kilometre Array, the Square Kilometre Array Telescope Project, Chris Mattmann, NASA/JPL
Big Data and Analytics in HPC: Leveraging HPC and Enterprise Architectures for Large Scale Inline Transactional Analytics in Fraud Detection at PayPal, Arno Kolster, PayPal, an eBay Company
Big Data and Analytics Vendor Panel: How Vendors See Big Data Impacting the Markets and Their Products/Services, Panel Moderator: Chirag Dekate, IDC
Data Analysis and Visualization of Very Large Data, David Pugmire, ORNL
The Impact of HPC and Data-Centric Computing in Cancer Research, Jack Collins, National Cancer Institute
Urban Analytics: Big Cities and Big Data, Paul Muzio, City University of New York
Stampede: Intel MIC And Data-Intensive Computing, Jay Boisseau, Texas Advanced Computing Center
Big Data Approaches at Convey, John Leidel
Cray Technical Perspective On Data-Intensive Computing, Amar Shan
Data-intensive Computing Research At PNNL, John Feo, Pacific Northwest National Laboratory
Trends in High Performance Analytics, David Pope, SAS
Processing Large Volumes of Experimental Data, Shane Canon, LBNL
SGI Technical Perspective On Data-Intensive Computing, Eng Lim Goh, SGI
Big Data and PLFS: A Checkpoint File System For Parallel Applications, John Bent, EMC
HPC Data-intensive Computing Technologies, Scott Campbell, Platform/IBM
The CEA-GENCI-Intel-UVSQ Exascale Computing Research Centre, Marie-Christine Sawley, Intel
IDC HPDA Server Forecast

- Fast growth from a small starting point: $1.2B by 2016)
- HPDA ecosystem >$2B in 2016

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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WW HPC Server Sales</td>
<td>8,637</td>
<td>9,498</td>
<td>10,300</td>
<td>11,098</td>
<td>11,397</td>
<td>12,371</td>
<td>13,485</td>
<td>14,621</td>
<td>7.3%</td>
</tr>
<tr>
<td>WW HPDA Server Sales</td>
<td>535</td>
<td>603</td>
<td>673</td>
<td>744</td>
<td>786</td>
<td>881</td>
<td>1,109</td>
<td>1,253</td>
<td>13.3%</td>
</tr>
<tr>
<td>HPDA Portion</td>
<td>6.2%</td>
<td>6.3%</td>
<td>6.5%</td>
<td>6.7%</td>
<td>6.9%</td>
<td>7.1%</td>
<td>8.2%</td>
<td>8.6%</td>
<td>5.6%</td>
</tr>
</tbody>
</table>

Source: IDC 2013
Storage is the fastest-growing HPC market (8.4% CAGR, 2011-16) and HPDA storage will grow even faster (18.1% CAGR).

**TABLE 2**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC storage</td>
<td>3,023.0</td>
<td>3,325.9</td>
<td>3,761.5</td>
<td>4,194.0</td>
<td>4,349.8</td>
<td>4,739.1</td>
<td>5,163.2</td>
<td>5,625.3</td>
<td>8.4</td>
</tr>
<tr>
<td>Share as total HPC server revenue (%)</td>
<td>35.0</td>
<td>35.0</td>
<td>36.5</td>
<td>37.8</td>
<td>38.2</td>
<td>38.3</td>
<td>38.3</td>
<td>38.5</td>
<td>1.0</td>
</tr>
<tr>
<td>HPDA storage</td>
<td>262.2</td>
<td>301.5</td>
<td>343.0</td>
<td>387.0</td>
<td>432.2</td>
<td>519.9</td>
<td>676.5</td>
<td>789.5</td>
<td>18.1</td>
</tr>
<tr>
<td>Big Data attach rate (%)</td>
<td>49.0</td>
<td>50.0</td>
<td>51.0</td>
<td>52.0</td>
<td>55.0</td>
<td>59.0</td>
<td>61.0</td>
<td>63.0</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Source: IDC, 2013
67% of the sites perform HPDA work (data-intensive simulation and/or advanced analytics).

On average, HPDA consumes 30% of compute cycles.

Major pain points worth 10-15% premium pricing:
- Higher-performance interconnects between nodes
- Higher-performance external I/O and storage
Big Science: Big Data Challenges Are Growing…

Some “Big Data” Grand Challenges

- How do we handle 700 TB/sec of data coming off the wire when we actually have to keep it around?
  - Required by the Square Kilometre Array

- Joe scientist says I’ve got an IDL or Matlab algorithm that I will not change and I need to run it on 10 years of data from the Colorado River Basin and store and disseminate the output products
  - Required by the Western Snow Hydrology project

- How do we compare petabytes of climate model output data in a variety of formats (HDF, NetCDF, Grib, etc.) with petabytes of remote sensing data to improve climate models for the next IPCC assessment?
  - Required by the 5th IPCC assessment and the Earth System Grid and NASA

- How do we catalog all of NASA’s current planetary science data?
  - Required by the NASA Planetary Data System

Anomaly Detection / Remediation via Pattern Discovery

- Fraud/errors
- Identity resolution
- Anti-terrorism, anti-crime
- Cyber security
Total Revenue Protection Program

- **Processing Requirements**
  - **Rate**
    - 4 billion mail scans per day peak (74,000 per second)
  - **Geographic Scope**
    - Incoming mail from 275 Processing and Distribution Centers
    - Outgoing mail to 33,000 postal operated facilities
  - **Objective**
    - To find, track and reject mail pieces due to:
      - Duplicate postage
      - Short Pay
      - Ineligible Discounts
Why Real Time Fraud Detection?

Save time... print your postage online.
Print exact postage for letters and packages using just your PC and printer.

Print Postage Stamps
- Print any denomination
- Use for letters or packages
- Never run out of stamps again

Stamps.com... Your own personal Post Office open 24 hours a day.
Developed in conjunction with the United States Postal Service, Stamps.com is a revolutionary software-based service that allows you to calculate and print official USFS postage right from your PC.
NO ADDITIONAL HARDWARE REQUIRED. Stamps.com even keeps track of all your postal spending using your client codes, and can even recommend optimal delivery methods, formats and more. Plus, Stamps.com gives you postage discounts you can't even get at the Post Office or with a postage meter.
**TRP Results using MCDB & TimesTen**

**Pre-MCDB**
1. 509 row inserts per second (RIPS)
2. Direct path load option a partial solution (2000 RIPS)
3. 275 Million Transactions per 15 hour processing window created backlog during peak processing windows
4. Revenue Protection performed as a batch data warehouse process, run 3 – 12 hours after Mailpiece scan

**With MCDB Deployed**
1. 190,222 RIPS (3 Threads)
2. 1,091,018 RIPS (18 Threads)
3. Processed 4 B Transactions in less than 6 hours
4. Revenue Protection is performed in real-time upon first scan

**MCDB = memory-centric database**
Life Sciences / Materials Science

• Drug discovery
• Genome mapping/comparison
• Health care management
• Personal / outcomes-based medicine
• Materials science
Schrödinger: Cloud-based Lead Discovery for Drug Design

<table>
<thead>
<tr>
<th>Metric from March, 2012</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute Hours of Work</td>
<td>109,927 hours</td>
</tr>
<tr>
<td>Compute Years of Work</td>
<td>12.55 years</td>
</tr>
<tr>
<td>Total # Cores/Servers</td>
<td>51132 cores, 6742 servers</td>
</tr>
<tr>
<td>Infrastructure Value</td>
<td>~ $20,000,000 (£12,500,000)</td>
</tr>
<tr>
<td>AWS Regions</td>
<td>All (7: us-east, us-west1, us-west2, eu-west, sa-east, ap-northeast, ap-southeast)</td>
</tr>
</tbody>
</table>

**Using CycleCloud & AWS:**
Impossible run in 3 hours for $4,828/hr
Today’s pricing < $1,000/hr (£625/hr)
Genome Sequencing/Analysis

**Shotgun genomics**
- Collect samples
- Extract DNA
- Feed into sequencer
- Computationally analyze
- A lab can generate ~100 Gbp in ~1 week for $10k (£6.3K)

**Real-World Use Cases**
- Real-time pathogen analysis
- Cancer genome analysis => diagnosis & treatment
- Drug resistance in HIV
- Gene expression analysis in agricultural animals
- Microbial community change in response to agriculture or global climate change
- Gene discovery & genome sequencing in non-model organisms

Courtesy Titus Brown, Michigan State University
Outcomes-Based Medical Diagnosis and Treatment Planning

- Enter the patient’s history and symptomology.

- While patient is still in the office, sift through millions of 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
Iterative Methods (Cumulative Data)

• Parametric modeling (product design)
• Stochastic modeling (financial)
• Ensemble modeling (weather/climate)
Summary: HPDA Market Opportunity

- **HPDA: simulation + newer high-performance analytics**
  - IDC predicts fast growth from a small starting point

- **HPC and high-end commercial analytics are converging.**
  - Algorithmic complexity is the common denominator

- **Economically important use cases are emerging**
  - Which ones will become attractive markets?

- **No single HPC solution is best for all problems.**
  - Clusters with MR/Hadoop will handle most but not all work (e.g., graph analysis)
A New IDC Study:
Creating Economic Models For HPC and ROI
And for HPC And Innovation
The authors thank DOE for its insights and guidance on and funding of this grant-based research project.

This study is based upon work funded by the U.S. Department of Energy Office of Science, Office of Advanced Scientific Computing Research, and the National Nuclear Security Administration, under award number DE-SC0008540.

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• Senior technical project manager: John Daly, 508-935-4643, jdaly@idc.com
A pilot study that describes how HPC investments are related to improved economic success and increased scientific innovation

The study included creating two unique models:

1. A macroeconomic model which depicts how HPC investments result in economic advancements in the form of ROI, growth and jobs

2. An "Innovation Index" that measures and compares innovation levels, based on the level of applying HPC computing resources towards scientific and technical advancement
The Financial ROI Models That Were Developed

The Financial ROI models include:

1. ROI based on revenues/GDP generated, divided by HPC investment
2. ROI based on profits generated, divided by HPC investment
3. ROI based on jobs created (and the HPC investment required per job created)

The ROI models were tested for variances by:

- Industry sector
- Country
- Organization size
The Innovation Models That Were Developed

The Innovation models are of two main types:

1. Basic Research / Major Innovations
2. Applied Research / Incremental Innovations

These are captured as:
- Innovations in government & academia
- Innovations in industry

The Innovation models can be sorted for variances by:
- Industry sector
- Country
- Organization size
- Government, Industry and Academia
The Innovation Index Scale

10 = One of the top 2 to 3 innovations in the last decade
9 = One of the top 5 innovations in the last decade
8 = One of the top 10 innovations in the last decade
7 = One of the top 25 innovations in the last decade
6 = One of the top 50 innovations in the last decade
5 = It had a major impact and is useful to many organizations
4 = A minor innovation that is useful to many organizations
3 = A minor innovation or only useful to 2-3 organizations
2 = A minor innovation or only useful to 1 organization
1 = An innovation that is recognized ONLY by experts in the field
Sample demographics:

- A total of 208 case study examples of ROI and innovations were collected as part of the study:
  - 67 financial ROI examples
  - 141 innovation examples

- In addition, a large number of micro-surveys were conducted to learn key ratios in order to eventually apply the results to large economic data sets.
  - Over 30,000 scientists and engineers were contacted, with over 1,500 completing the micro-survey.
1. IDC is able to collect the required data across a broad set of organizations with enough detail to create the two economic models and the innovation index.

2. Early results indicate very substantial returns for investments in HPC:

   - $356 dollars on average in revenue per dollar of HPC invested.
   - $38 dollars on average of profits (or cost savings) per dollar of HPC invested.
Key Findings: The Financial ROI Model – By Sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Count</th>
<th>Sum of Employee Growth</th>
<th>Years Before 1st Return</th>
<th>Average of Revenue $ per HPC $</th>
<th>Average of Profit $ per HPC $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic</td>
<td>12</td>
<td></td>
<td>2</td>
<td>1.8</td>
<td>37.4</td>
</tr>
<tr>
<td>Government</td>
<td>4</td>
<td></td>
<td>10</td>
<td>1.4</td>
<td>9.2</td>
</tr>
<tr>
<td>Industry</td>
<td>51</td>
<td></td>
<td>1,157</td>
<td>1.9</td>
<td>462.4</td>
</tr>
<tr>
<td>Grand Total</td>
<td>67</td>
<td>1,169</td>
<td>1.9</td>
<td>356.5</td>
<td>38.7</td>
</tr>
</tbody>
</table>
## Key Findings:
The Financial ROI Model – By Country

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
<th>Sum of Employee Growth</th>
<th>Average Years Before 1st Return</th>
<th>Average of Revenue $ per HPC $</th>
<th>Average of Profit $ per HPC $</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>3</td>
<td>30</td>
<td>1.3</td>
<td>8.7</td>
<td>5.4</td>
</tr>
<tr>
<td>France</td>
<td>4</td>
<td>896</td>
<td>5.1</td>
<td>621.7</td>
<td>125.0</td>
</tr>
<tr>
<td>UK</td>
<td>31</td>
<td>243</td>
<td>1.6</td>
<td>366.5</td>
<td>26.7</td>
</tr>
<tr>
<td>US</td>
<td>27</td>
<td>243</td>
<td>1.6</td>
<td>373.3</td>
<td>49.8</td>
</tr>
<tr>
<td>Italy</td>
<td>2</td>
<td>243</td>
<td>1.0</td>
<td>10.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Grand Total</td>
<td>67</td>
<td>1,169</td>
<td>1.9</td>
<td>356.5</td>
<td>38.7</td>
</tr>
</tbody>
</table>
Pilot Study Results: Innovation
Key Findings: The Innovation Areas For The 141 Innovation Data Examples

<table>
<thead>
<tr>
<th>Primary Innovation / ROI Area</th>
<th>Count</th>
<th>Sum of Total HPC Investment</th>
<th>Average Years Before 1st Return</th>
<th>Average of HPC $M per Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better Products</td>
<td>54</td>
<td>$114 M</td>
<td>1.9</td>
<td>$4.2 M</td>
</tr>
<tr>
<td>Created New Approach</td>
<td>40</td>
<td>$15 M</td>
<td>1.2</td>
<td>$0.4 M</td>
</tr>
<tr>
<td>Discovered Something New</td>
<td>20</td>
<td>$46 M</td>
<td>1.8</td>
<td>$2.7 M</td>
</tr>
<tr>
<td>Helped Society</td>
<td>11</td>
<td>$66 M</td>
<td>1.0</td>
<td>$6.0 M</td>
</tr>
<tr>
<td>Cost Saving</td>
<td>6</td>
<td>$180 M</td>
<td>1.3</td>
<td>$2.1 M</td>
</tr>
<tr>
<td>Major Breakthrough</td>
<td>5</td>
<td>$3 M</td>
<td>3.2</td>
<td>$1.1 M</td>
</tr>
<tr>
<td>Helped Research Program</td>
<td>5</td>
<td>$71 M</td>
<td>1.5</td>
<td>$14.3 M</td>
</tr>
<tr>
<td>Grand Total</td>
<td>141</td>
<td>$497 M</td>
<td>1.6</td>
<td>$3.1 M</td>
</tr>
</tbody>
</table>
5. The average HPC investment per innovation was $3.1 million.

- Overall $497 million in HPC investments were made to generate the 141 innovations in the pilot study.
- With many at under $1 million per innovation.
Key Findings: 
The New Innovation Index Scores

The average innovation rating = 5.0

• 4.4 for the 67 basic research/major innovations
• 5.5 for the 74 applied research/incremental innovations

10 = One of the top 2 to 3 innovations in the last decade
9 = One of the top 5 innovations in the last decade
8 = One of the top 10 innovations in the last decade
7 = One of the top 25 innovations in the last decade
6 = One of the top 50 innovations in the last decade
5 = It had a major impact and is useful to many organizations
4 = A minor innovation that is useful to many organizations
3 = A minor innovation or only useful to 2 - 3 organizations
2 = A minor innovation or only useful to 1 organization
1 = An innovation that is recognized ONLY by experts in the field
Key Findings: The New Innovation Index Scores – For All 141 Innovations

**FIGURE 12**

HPC Innovation Index Scale Results: All Respondents

- Number of Innovations
- Innovation Index Scale

N = 141
Source: IDC 2013
### Key Findings: The Innovation Index By Country

<table>
<thead>
<tr>
<th>Country</th>
<th>Count of Basic</th>
<th>Count of Applied</th>
<th>Average Innovation Level</th>
<th>Average of HPC $M per Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>3.0</td>
<td>10.0</td>
<td>6.8</td>
<td>12.0</td>
</tr>
<tr>
<td>France</td>
<td></td>
<td></td>
<td>8.5</td>
<td>17.1</td>
</tr>
<tr>
<td>India</td>
<td>1.0</td>
<td>4.0</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>43.0</td>
<td>7.0</td>
<td>3.5</td>
<td>1.1</td>
</tr>
<tr>
<td>US</td>
<td>20.0</td>
<td>48.0</td>
<td>5.6</td>
<td>2.4</td>
</tr>
<tr>
<td>Italy</td>
<td></td>
<td>5.0</td>
<td>4.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Grand Total</td>
<td>67.0</td>
<td>74.0</td>
<td>5.0</td>
<td>3.1</td>
</tr>
</tbody>
</table>
Note that an additional outcome of this research is an expansive list of HPC success stories

- These can be used to help explain the importance of HPC to funding bodies, key decision makers and the broader public
- IDC is writing up a number of them for broader dissemination

Download the report and models at:
www.hpcuserforum.com/ROI
HPC User Forum Update
HPC User Forum Steering Committee

Newest Members:

- Swamy Akapasu, General Motors
- Sharan Kalwani, Fermi Lab
- Keith Gray, BP
- Jysoo Lee, NISN (Korea)
- Suzy Tichenor, ORNL
Recent Meetings

50th HPC User Forum: Boston (Sept. 2013)

51st HPC User Forum: Seoul (October 2013)
2014 HPC User Forum Meetings

April 5-7, 2014
Santa Fe, NM

- Industrial outreach programs
- ROI from HPC investments
- Storage innovation
- x86 processor alternatives
- High performance data analysis
- Computing for national security
- Global exascale initiatives
- IDC market update and forecast

September 15-15, 2014: Seattle, WA

International Meetings Will Be Announced Soon
SC13
HPC Innovation Award Winners
We Are Collecting A Large Set Of HPC ROI Examples

We invite users to submit their examples at: www.hpcuserforum.com/innovationaward/
IDC is launching a new program to recognize noteworthy achievements made by users using High Performance Computing (HPC) technologies.

**Program Goals**
- Showcase success stories involving HPC in science and industry
- Help other users better understand the benefits of adopting HPC and justify HPC investments, especially for SMBs
- Demonstrate the value of HPC to funding bodies
- Expand public support for increased HPC investments
- If you have one or more HPC success stories you would like to see recognized through our program, we encourage you to complete and submit this application form. Please submit a separate form for each success story that you want considered.

**Program Objectives**

While there are multiple benchmarks to measure the performance of technical computers, there currently isn’t an adequate methodology to evaluate the economic and scientific value HPC systems contribute. The HPC Innovation Excellence Award Program is designed to help close that gap.

**The main objectives of the program are as follows:**
- Recognize users and their vendors for major HPC-supported achievements in industry, government and academia.
- Build a large portfolio of quantified ROI success stories.
Sponsors – Thanks!

Gold Sponsor

Silver Sponsors

Bronze Sponsors

![Intel](image1)

Platform Computing

![SGI](image2)

Altair

Adaptive Computing

![ANSYS](image3)

![AFPR](image4)
HPC Award Program Goals

#1 Help to expand the use of HPC by showing real ROI examples:

1. Expand the “Missing Middle” – SMBs, SMSs, etc. by providing examples of what can be done with HPC
2. Show mainstream and leading edge HPC success stories

#2 Create a large database of success stories across many industries/verticals/disciplines

- To help justify investments and show non-users ideas on how to adopt HPC in their environment
- Creating many examples for funding bodies and politicians to use and better understand the value of HPC → to help grow public interest in expanding HPC investments
- For OEMs to demonstrate success stories using their products
Users are required to submit the value achieved with their HPC system, using 3 broad categories, following a very specific set of guidelines:

a) Dollar value of the HPC usage
   - e.g., made $$$ in new revenues, saved $$$ in costs, made $$$ in profits, etc.

b) Scientific or engineering accomplishment
   - e.g. discovered how xyz really works, develop a new drug that does xyz, etc.

c) Value to society as a whole
   - e.g. ended nuclear testing, made something safer, provided protection against xyz, etc.

... and the investment in HPC that was required
The ranking of the accomplishments are done by only HPC USERS, following very specific rules.

A three step process is proposed:

1. First the submission has to be complete with a clear “value” shown
   • A number of the submissions were good, but needed a little more information – we have invited them to apply for the fall award

2. Secondly, an assessment is made to see that it is a realistic assessment of the value/returns
   • By the HPC User Forum Steering Committee

3. Then in cases where the value isn’t clear, or a deeper technical depth is required -- the final evaluation is by experts in the specific area/discipline
### The Winners At SC13

<table>
<thead>
<tr>
<th>Site</th>
<th>Lead</th>
<th>Area</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imperial College London &amp; NAG</td>
<td>NAG Hector CSE Team</td>
<td>Innovation</td>
<td>U.K</td>
</tr>
<tr>
<td>Spectrasis Inc, Denver, USA, &amp; CADMOS, Univ. of Lausanne, Switzerland</td>
<td>Igor Podladtchikov &amp; Yury Podladchikov</td>
<td>Both</td>
<td>U.S./ Switzerland</td>
</tr>
<tr>
<td>HydrOcean / ECN</td>
<td>David Le Touzé</td>
<td>Innovation</td>
<td>France</td>
</tr>
<tr>
<td>The Procter and Gamble Company</td>
<td>Kelly L. Anderson</td>
<td>Innovation</td>
<td>U.S.</td>
</tr>
<tr>
<td>Southern California Earthquake Center</td>
<td>SCEC Community Modeling Environment</td>
<td>Innovation</td>
<td>U.S.</td>
</tr>
<tr>
<td>GE Global Research</td>
<td>Aero Acoustics team</td>
<td>Innovation</td>
<td>U.S.</td>
</tr>
</tbody>
</table>
## The Winners At SC13

<table>
<thead>
<tr>
<th>Site</th>
<th>Lead</th>
<th>Area</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queen Mary University of London and, NAG</td>
<td>NAG Hector CSE Team</td>
<td>Innovation</td>
<td>U.K</td>
</tr>
<tr>
<td>EDISON Project - KISTI/NISN</td>
<td>Dr. Kumwon Cho</td>
<td>Both</td>
<td>S.Korea</td>
</tr>
<tr>
<td>Facebook</td>
<td>Avery Ching</td>
<td>Innovation</td>
<td>U.S.</td>
</tr>
<tr>
<td>Ford Werke GMBH</td>
<td>Dr. Burkhard Hupertz, Alex Akkerman</td>
<td>Innovation</td>
<td>Germany</td>
</tr>
<tr>
<td>Intelligent Light</td>
<td>Dr. Earl P.N. Duque</td>
<td>Innovation</td>
<td>U.S.</td>
</tr>
<tr>
<td>Oak Ridge National Lab</td>
<td></td>
<td>Innovation</td>
<td>U.S.</td>
</tr>
<tr>
<td>Princeton University</td>
<td>Dr. William Tang</td>
<td>Innovation</td>
<td>U.S.</td>
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<td>GE Global Research</td>
<td>Dr. Masako Yamada</td>
<td>Innovation</td>
<td>U.S.</td>
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The Trophy For Winners

The Innovation Excellence Award

For the Outstanding Application of HPC

Global • 2011

Presented to:

For the Outstanding Application of HPC for Business and Scientific Achievements

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We invite users to submit their ROI / achievement examples at:

www.hpcuserforum.com/innovationaward/
In Summary
CUSTOMER NEEDS AND STRATEGIES
The Cold War arms race is becoming an economic race.

HPC is a proven accelerator of economic competitiveness.

High-end supercomputers can cost $200-500 million.

ROI can be a scientific advance or corporate profit, new jobs.

More large HPC centers have industry outreach programs.

IDC’s HPC ROI pilot study for DOE quantified 208 examples.
Buyer Insights: The Exascale Race Is Off and Running

The Outcome Could Shift Global HPC Leadership Positions

- Some original goals (e.g., 20MW) will be pushed back beyond 2020.
- The U.S. effort has been slow to ramp up.
- Software will be at least as important as hardware.
- Will the extreme high end split off from mainstream HPC?
Architectures Will Need to Shift Away from Extreme

- Static searches will give way to dynamic pattern discovery
- 67% of surveyed HPC sites are running big data workloads
- HPDA includes data-intensive simulation & advanced analytics
- Most HPDA work will happen on clusters, but not everything
- Data movement is a big challenge
- Storage vendors will benefit
Essential Guidance: General

- Existing major challenges will remain inadequately addressed:
  - Weak application performance improvements
  - Highly parallel programming
  - System imbalance (the "memory wall")
  - Power and space usage
  - Software licensing costs
  - Ease-of-use – dealing with the growing system complexity

- HPC server growth will continue to outpace enterprise server growth through 2016
  - The HPC community will need to present strong ROI cases to compete for pressured government budgets
New challenges affecting HPC data centers -- the increase in CPUs, heterogeneous processing, server units and data is creating significant IT challenges in:

- Managing HPC system complexity
- Balancing user needs & peak/Linpack performance expectations
- Managing data volumes and types
- Specifying and managing storage
- Planning for power/cooling and space
- **Application scaling and hardware utilization**
- Making optimal use of new processor and system designs
- Finding the appropriate role for private/public cloud computing
In Conclusion: Why HPC Is Projected To Keep Growing

1. The low half of the market is finally back to a recovery mode
2. It has become a competitive weapon
3. Governments view HPC leadership as critical
   - For national pride, but more importantly for economic prosperity
   - It used to be 1 large supercomputer – now it is multiple ones
4. 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
5. The combination of big data and HPC is creating many new opportunities
6. At the same time, “live” science and “live” engineering costs have escalated
   - And time-to-solution is months faster with simulations
Questions?

Please email: hpc@idc.com

Or check out: www.hpcuserforum.com