

**Welcome To The 69<sup>th</sup>  
HPC User Forum  
Meeting  
April 16-18, 2018**



Welcome to T10000  
Welcome HPC User Forum

12:21 PM 4/18/2018

# Thank You To Our Sponsors!

- Monday Dinner - Dell EMC & Intel
- Tuesday Breakfast - D-Wave
- Tuesday AM Refreshments - Altair
- Tuesday Lunch - AMD
- Tuesday PM Refreshments - Cray
- Tuesday Dinner - HPE & Intel
- Wednesday Breakfast - Rigetti
- Wednesday AM Refreshments - OnScale
- Wednesday Lunch - Panasas
- Wednesday PM Refreshments - IBM

# Important Dates For Your Calendar

## HPC USER FORUM MEETINGS:

- April 16 to 18, Tucson, Arizona
- September 4 to 6, Dearborn, Michigan
- October 1 to 2, Stuttgart, Germany
- April 22 to 24, 2019, Santa Fe, New Mexico
- September 9 to 11, 2019, Chicago Illinois, Argonne National Laboratory

# Introduction: Logistics

**We have a very tight agenda (as usual)**

- Please help us keep on time!

**Review handouts**

- Note: We will post most of the presentations on the web site

**Dinner event**

# CHAIRMAN'S WELCOME

# HPC User Forum Mission

**To Improve The Health Of The  
High Performance Computing Industry  
Through Open Discussions, Information-  
sharing And Initiatives Involving  
HPC Users In Industry, Government And  
Academia  
Along With HPC Vendors  
And Other Interested Parties**



# The HPC User Forum: 69 Meetings Worldwide Since 2000

Amsterdam, Netherlands (SARA)

Annecy, France

Bangalore, India (Indian Institute of Technology)

Beijing, China (Chinese Academy of Sciences)

Bologna, Italy (CINECA)

Bristol, UK

Bruyères-le-Châtel, France (Teratec)

Canberra, Australia

Geneva, Switzerland (CERN)

Kobe, Japan (RIKEN)

Lausanne, Switzerland (EPFL)

London, UK (Imperial College)

Manchester, UK (Manchester University)

Melbourne, Australia

Munich, Germany (LRZ)

New Delhi, India (Indian Institute of Science)

Paris, France (GENCI)

Seoul, Korea (National Institute of Supercomputing & Networking)

Stuttgart, Germany (HLRS)

Warsaw, Poland (University of Warsaw)

Yokohama, Japan (Earth Simulator Center)

Zurich, Switzerland (ETH Zurich)

United States (many locations)

# Introduction

## HPC User Forum Steering Committee

**Paul Muzio**  
Chairman, Industry Expert

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NASA Ames  
Vice Chairman

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Executive Director,  
Hyperion Research

**Vijay Agarwala**  
Virginia Tech.

**Swamy Akasapu**  
General Motors

**Alex Akkerman**  
Ford Motor Company

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Industry Expert - Advanced  
Analytics/Dense  
Supercomputing

**Simon Burbidge**  
University of Bristol (UK)

**Jack Collins**  
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Vice President,  
Hyperion Research

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Oak Ridge National Laboratory

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NERSC/Lawrence  
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**Paul Buerger**  
Industry Expert

**Clayton Chandler**  
Credit Suisse Group AG

**Candace Culhane**  
Los Alamos National Labs

**Sharan Kalwani**  
Industry Specialist  
Consultant

**Chris Gathmann**

**Jysoo Lee**  
KAUST

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Argonne National Laboratory

**Michael Resch**  
HLRS, University of Stuttgart

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FUTURE  
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# HPC Market Update

Visit Our Website: [www.HyperionResearch.com](http://www.HyperionResearch.com)  
Twitter: HPC\_Hyperion@HPC\_Hyperion



## Hyperion Research Holdings, LLC:

- Owns 100% of the IDC HPC assets
- Tracking the HPC market since 1986
- Headquarters:  
365 Summit Ave., St. Paul, MN 55102



# The Hyperion Research Team

**Earl Joseph**

Research studies & strategic consulting

**Steve Conway**

Strategic consulting, HPC UF, Big Data, AI

**Bob Sorensen**

Strategic research, government studies, QC

**Alex Norton**

Special studies, new data analysis, surveys

**Mike Thorp**

Global sales management

**Kurt Gantrish**

Global sales management

**Mary Rolph**

Meetings and events planning

**Jean Sorensen**

Office manager

**Kirsten Chapman**

Data collection and surveys

**Nishi Katsuya**


Japan research and studies

**Jie Wu**

China studies and award program



# Hyperion Research HPC Activities

- Track all HPC servers sold each quarter
- 4 HPC User Forum meetings each year 
- Publish 85 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
- Developing a worldwide ROI measurement system
- **HPDA program (includes ML/DL/AI)**
- **HPC Cloud usage tracking**
- **Quarterly tracking of GPUs/accelerators**
- **Cyber Security**
- **Quantum Computing**



# Top Trends in HPC



**2017 was strong – Exceeded \$12 billion (US\$) in revenues!**

- 2018 is looking good

**The top systems has slowed for **over 4 years****

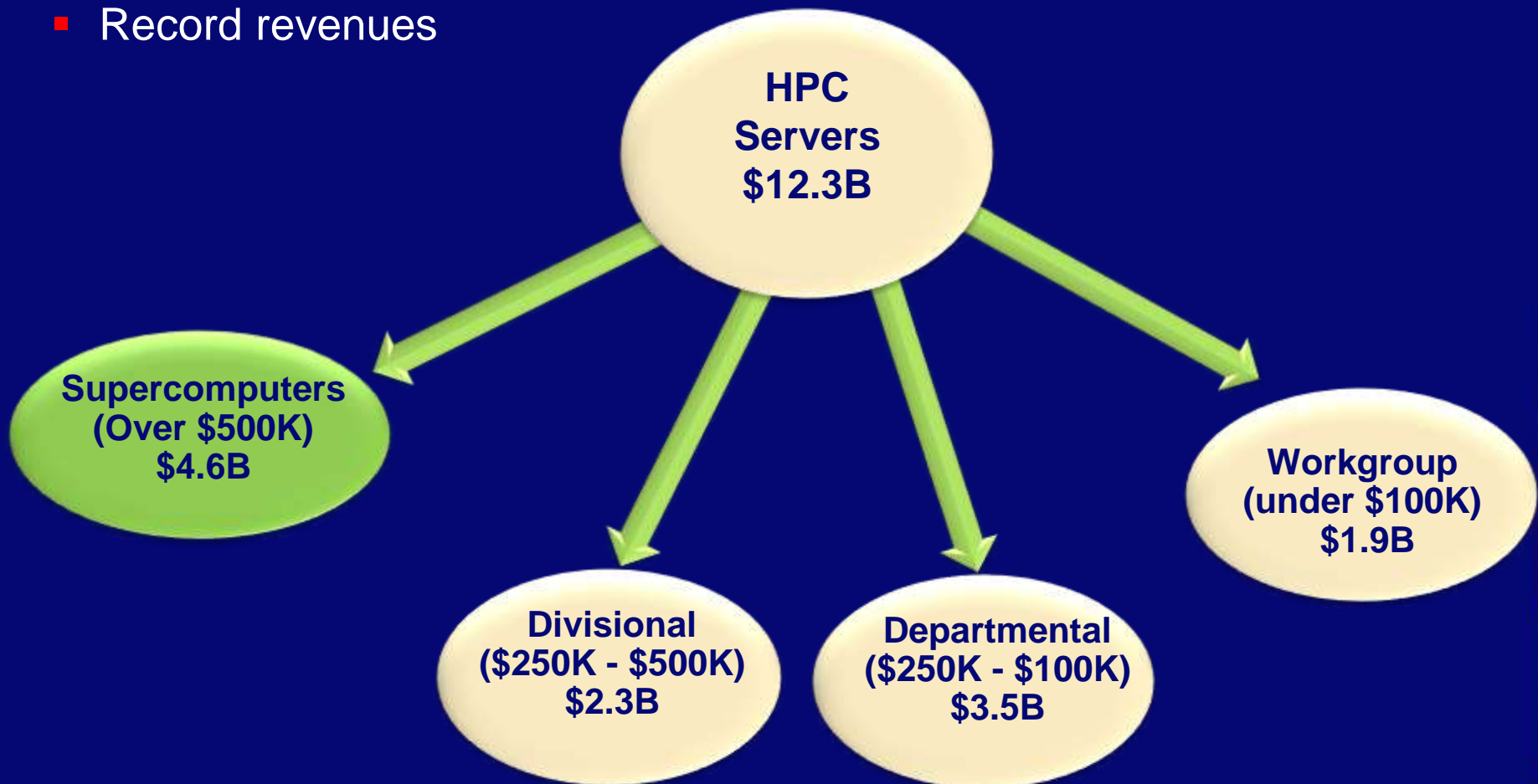
- But the profusion of Exascale announcements is generating a lot of buzz
- Governments are investing heavily in exascale systems

**Big data combined with HPC is creating new solutions**

- Adding many new users/buyers to the HPC space
- AL/ML/DL & HPDA are the hot new areas

# The Worldwide HPC Server Market: \$12.3 Billion in 2017

- Record revenues



# 2017 HPC Market By Vertical (\$ Millions)

	2017
<b>Bio-Sciences</b>	1,114,627
<b>CAE</b>	1,361,539
<b>Chemical Engineering</b>	184,203
<b>DCC &amp; Distribution</b>	698,000
<b>Economics/Financial</b>	667,791
<b>EDA / IT / ISV</b>	881,140
<b>Geosciences</b>	920,642
<b>Mechanical Design</b>	56,487
<b>Defense</b>	1,255,355
<b>Government Lab</b>	2,341,167
<b>University/Academic</b>	2,165,472
<b>Weather</b>	501,574
<b>Other</b>	114,300
<b>Total Revenue</b>	12,262,296
<b>Source: Hyperion 2018</b>	-

# HPC Market By Regions (\$K)

	2016	2017	2017
Data			%
HPC server N.A. Rev.	5,155,105	5,595,811	45.6%
HPC server EMEA Rev.	3,247,174	3,621,498	29.5%
HPC server Asia/Pac Rev.	2,284,973	2,171,111	17.7%
HPC server Japan Rev.	770,011	734,599	6.0%
HPC server ROW Rev.	137,365	139,278	1.1%
<b>Total</b>	<b>11,594,628</b>	<b>12,262,296</b>	
<i>Source: Hyperion Research</i>			

# HPC Market By Vendor Shares (\$K)

	2017
Mftr	
HPE/HP	4,194,470
Dell	2,330,134
Lenovo	869,895
IBM	575,130
Cray	250,195
Sugon (Dawning)	348,846
Fujitsu	227,802
NEC	171,344
Inspur	740,207
Bull Atos	133,422
Other	2,420,852
<b>Grand Total</b>	<b>12,262,296</b>

# New HPC Market Forecasts (\$ K)

	2017	2022	CAGR 17-22
<b>Supercomputer</b>	4,840,985	9,521,092	14.5%
<b>Divisional</b>	2,295,273	3,058,506	5.9%
<b>Departmental</b>	3,370,137	4,540,846	6.1%
<b>Workgroup</b>	1,755,901	2,436,173	6.8%
<b>Total</b>	12,262,296	19,556,617	9.8%
<b>Source: Hyperion 2018</b>	-	-	

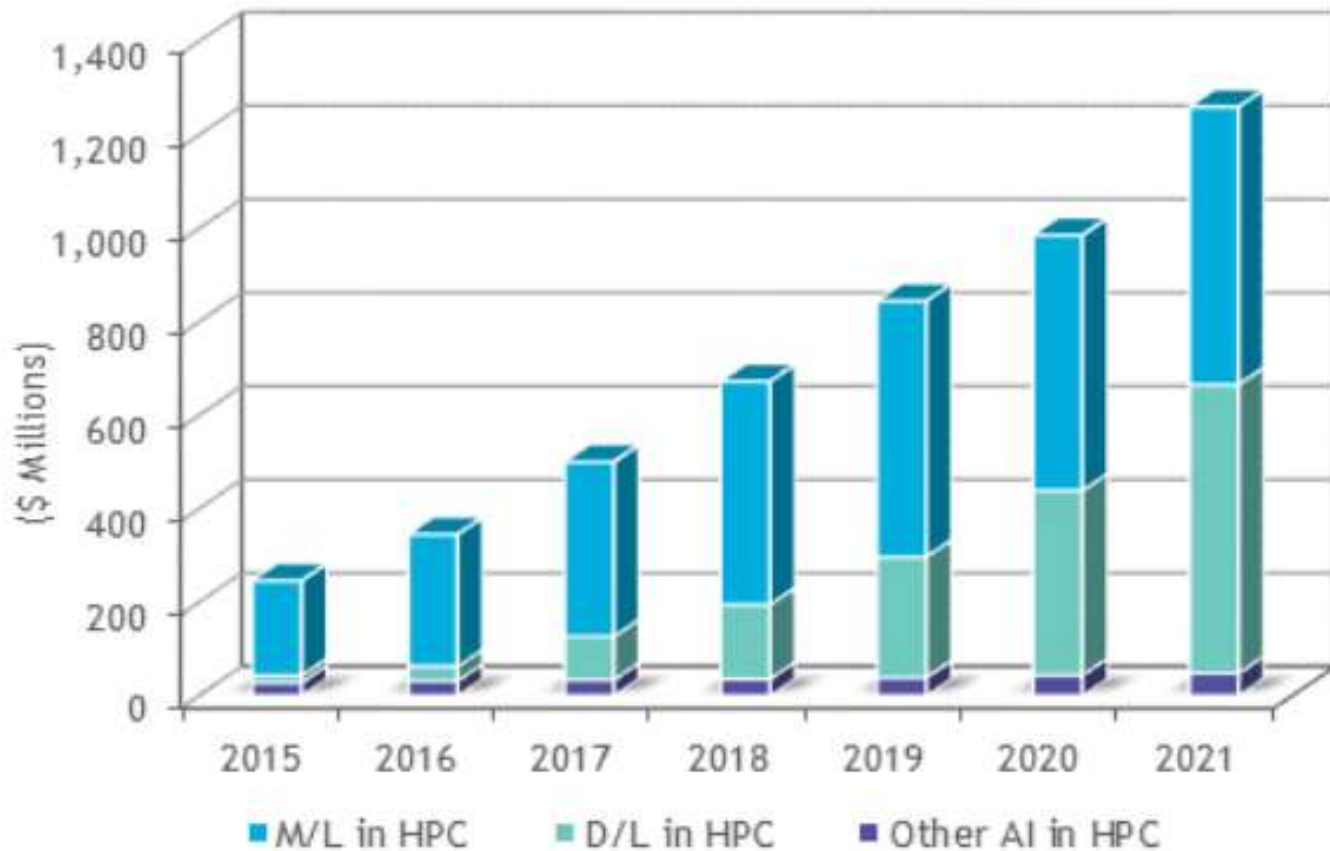
# New Forecast: The Broader HPC Market (\$ K)

<b>Revenues by the Broader HPC Market Areas</b>			
	2017	2022	CAGR 17-22
<b>Server</b>	12,262,296	19,556,617	9.8%
<b>Storage</b>	4,661,102	7,606,884	10.3%
<b>Middleware</b>	1,367,147	2,170,912	9.7%
<b>Applications</b>	3,961,491	6,277,996	9.6%
<b>Service</b>	2,022,090	2,798,378	6.7%
<b>Total Revenue</b>	24,274,126	38,410,788	9.6%
<b>Source: Hyperion 2018</b>			

# WW M/L, D/L, & AI Forecasts

FIGURE 2

## Worldwide M/L, D/L & AI HPC-Based Revenues



Source: Hyperion Research 2017

# UPDATE: THE ROI AND ROR FROM HPC

# Background: Project Overview

A study that describes how HPC investments are related to improved economic success and increased scientific innovation

The study includes large scale data collection to populate two unique models:

1. A macroeconomic model which depicts how HPC investments result in economic advancements in the form of ROI, GDP growth and jobs
2. Three Innovation Indexes that measure and compares innovation levels, based on the level of applying HPC computing resources towards scientific and technical advancement

# The Financial ROI Models Used

## The Financial ROI models:

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

## The ROI models show variances by:

- Industry & sector
- Country
- Organization size

# The Innovation Models Used (ROR)

Three innovations indexes are used to show the Return on Research (ROR):

1. Based on the importance of the innovation
2. How broadly the innovations impact different organizations
3. A combined score to create innovation “Class” levels

The innovations are also sorted by the primary area:

1. Better Products
2. Major Scientific Breakthrough
3. Cost Saving
4. Created New Approach
5. Discovered Something New
6. Helped Society
7. Helped Research Program

# What the Models Measure

## Currently:

- A single project or discovery, e.g.:
  - Design of a new tire
  - Discovery of a new scientific principle
  - Discovering a new material
  - Solving a specific problem

## In the future, we would like to add:

- The ability to measure the value of a whole supercomputer (in both financial and scientific terms)
- The ability to predict the value of a future supercomputer (in both financial and scientific terms)

# Financial ROI Results

Results continue to indicate very substantial returns for investments in HPC:

- \$463 dollars on average in revenue per dollar of HPC invested
- \$44 dollars on average of profits (or cost savings) per dollar of HPC

Q3: Industry	Sum of Total Jobs Added	Average of Revenue \$ per HPC \$	Average of Profit or Cost Saving \$ per HPC \$
Academic	14	\$9 M	\$44 M
Defense		\$75 M	\$5 M
Financial	602	\$834 M	\$61 M
Government	42	\$1,206 M	\$112 M
Insurance	5	\$71 M	
Life Sciences	48	\$160 M	\$41 M
Manufacturing	678	\$83 M	\$20 M
O&G	100	\$416 M	\$54 M
Retail	49	\$30 M	\$12 M
Telecomm	420	\$211 M	\$30 M
Transportation	377	\$1,804 M	\$16 M
<b>Grand Total</b>	<b>2,335</b>	<b>\$463 M</b>	<b>\$44 M</b>

# Findings: Job Creation

## Job creation by sector:

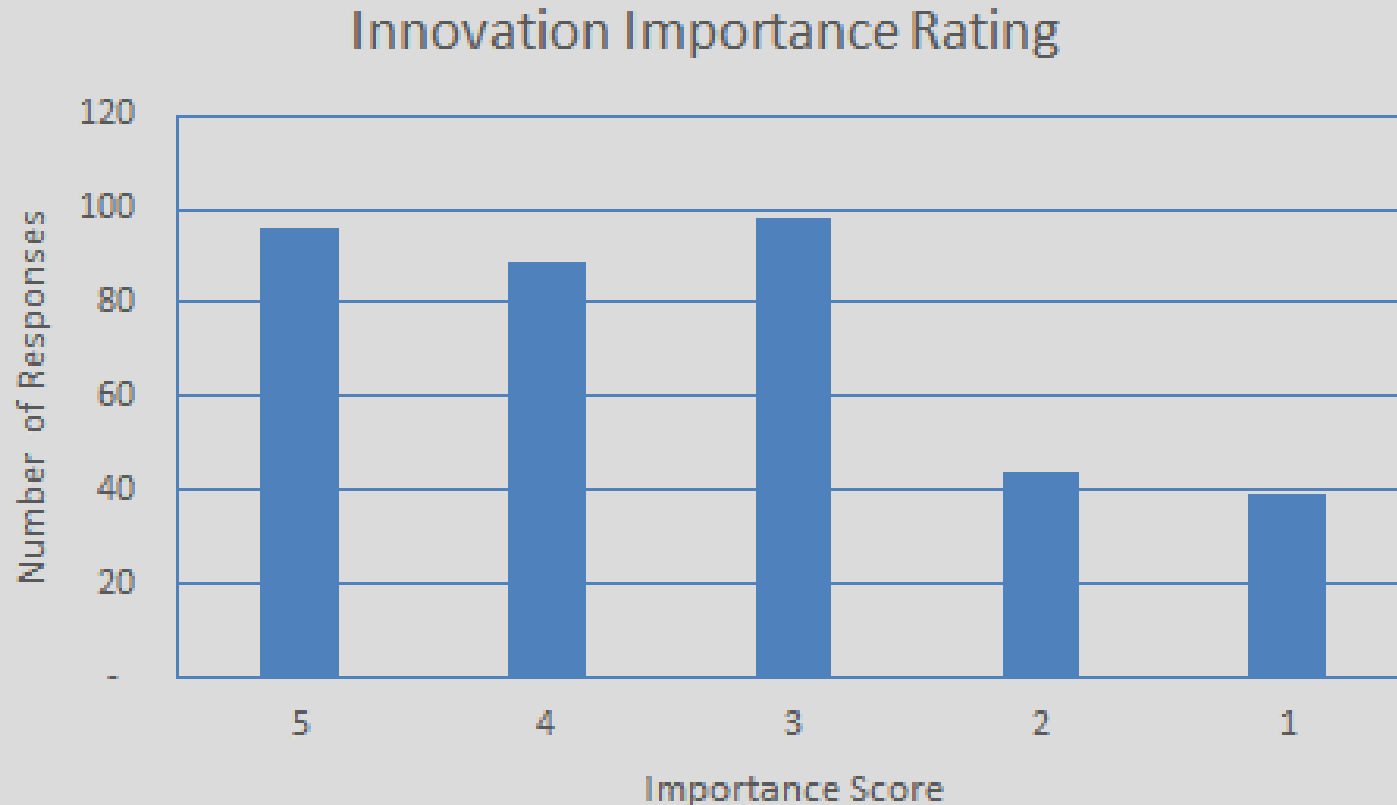
Sector	Sum of Total Jobs Added	Average of HPC \$K per New Employee
Academic	14	\$129 K
Government	42	\$588 K
Industry	2,279	\$270 K
<b>Grand Total</b>	<b>2,335</b>	<b>\$298 K</b>

# The Mix Of Innovation Types

- The study has 356 BASIC innovations and 307 APPLIED research innovations
- On average, each innovation required \$11 million in HPC
- Across these innovations, \$4.1 billion was spent on HPC

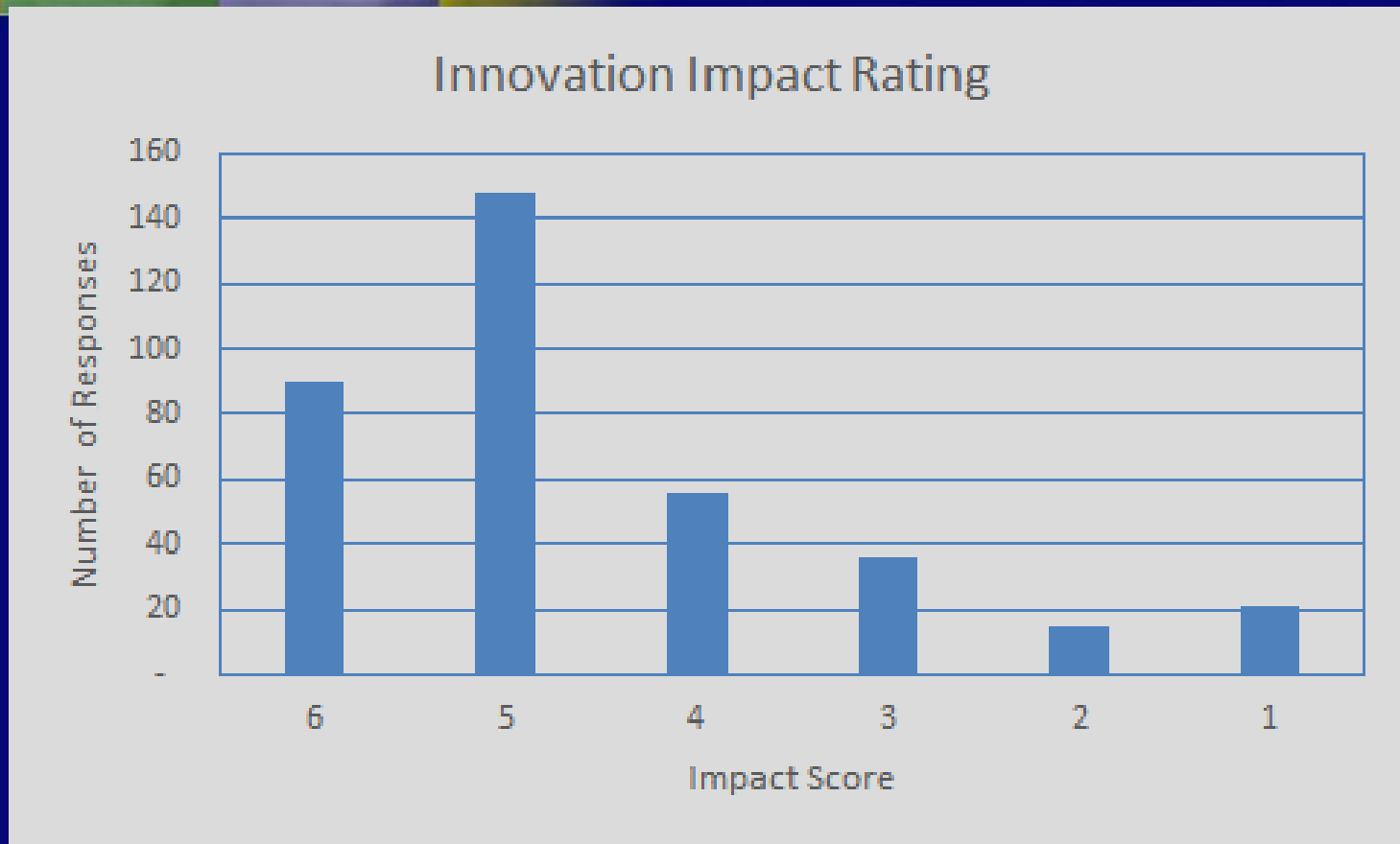
Q4: Primary Innovation / I	Count of Accomplishments	Average of HPC \$M per Innovation	Count of Q8: Basic	Count of Q8: Applied	Sum of Q11: Total HPC Investment
Better Products	164	\$5.4 M	31	122	\$484 M
Cost Savings	22	\$1.5 M	9	13	\$357 M
Created New Approach	282	\$1.4 M	191	91	\$337 M
Discovered Something New	51	\$2.9 M	33	17	\$96 M
Helped Society	49	\$6.0 M	23	25	\$202 M
Scientific Breakthrough	59	\$76.3 M	50	10	\$1,527 M
Support Research Programs	47	\$27.2 M	19	29	\$1,152 M
<b>Grand Total</b>	<b>674</b>	<b>\$10.8 M</b>	<b>356</b>	<b>307</b>	<b>\$4,156 M</b>

# INDEX #1: The Innovation IMPORTANCE Index



- 5. One of the top 2 to 3 innovations in the last decade
- 4. One of the top 5 innovations in the last decade
- 3. One of the top 10 innovations in the last decade
- 2. One of the top 25 innovations in the last decade
- 1. One of the top 50 innovations in the last decade

# INDEX #2: The Innovation IMPACT Index



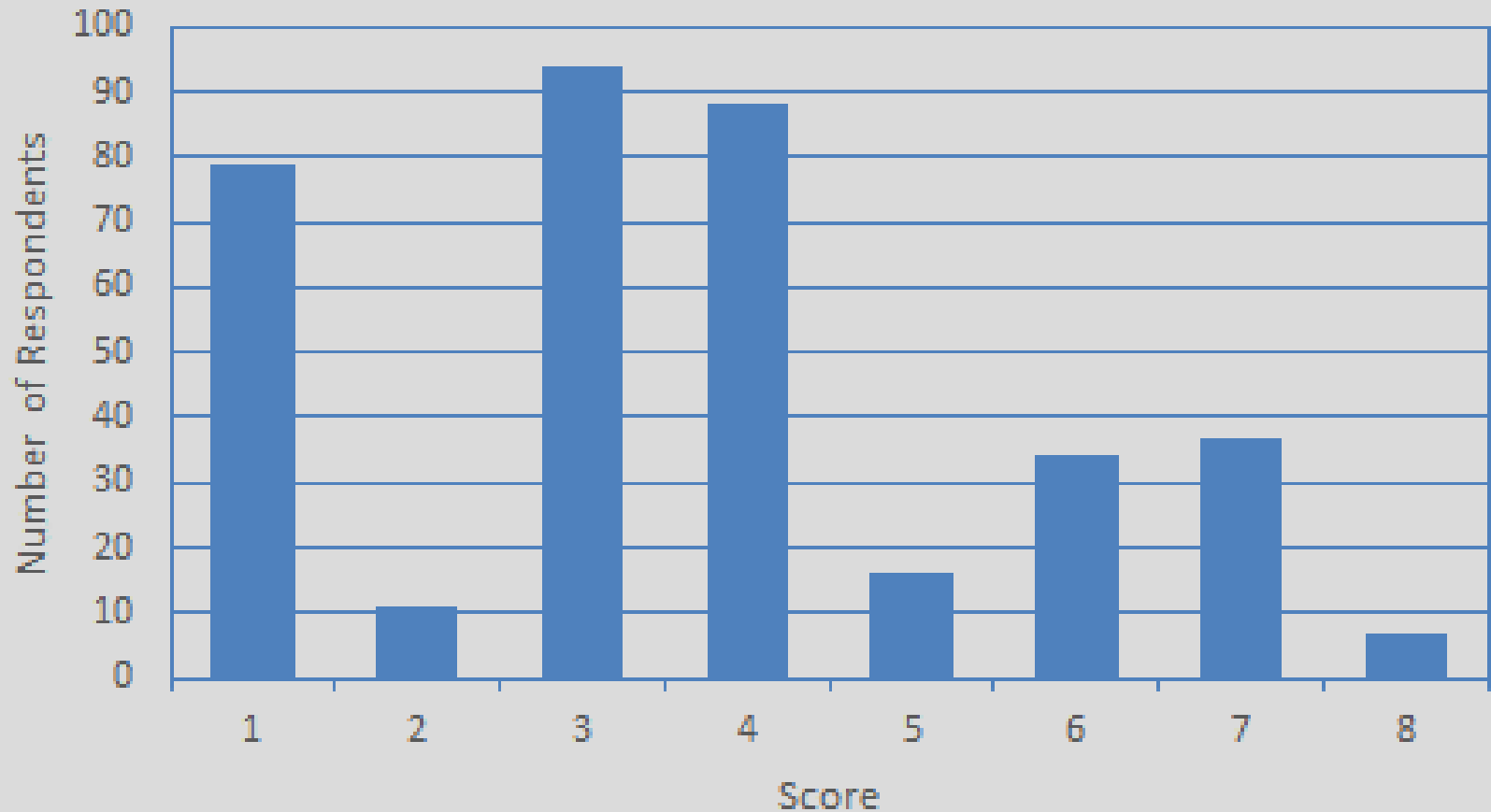
6. It is useful to over 50 organizations
5. An innovation that is useful to 10 to 49 organizations
4. An innovation that is useful to 6 to 10 organizations
3. An innovation useful to 2 to 5 organizations
2. An innovation only useful to 1 organization
1. An innovation that is recognized ONLY by experts in the field

# INDEX #3: Innovation “Class” Scale

- Class 1 innovations – One of the top 2-3 innovations in a field over the last ten years PLUS useful to over 10 organizations
- Class 2 innovations -- One of the top 5 innovations in a field over the last ten years PLUS useful to over 10 organizations
- Class 3 innovations – One of the top 5 innovations in a field over the last ten years PLUS useful to at least 5 organizations
- Class 4 innovations – One of the top 10 innovations in a field over the last ten years PLUS useful to at least 5 organizations
- Class 5 innovations – One of the top 25 innovations in a field over the last ten years PLUS useful to at over 10 organizations
- Class 6 innovations – One of the top 25 innovations in a field over the last ten years PLUS useful to at least 2 organizations
- Class 7 innovations – One of the top 50 innovations in a field over the last ten years PLUS useful to at least 2 organizations
- Class 8 innovations – The rest of the innovations in the study

# INDEX #3: The INNOVATION CLASS Index

## Innovation Class Ratings



# Example of Results Used In Reports/Studies: Blue Waters Assessment Report

FIGURE 4

Blue Water Innovations: Innovation Importance Levels

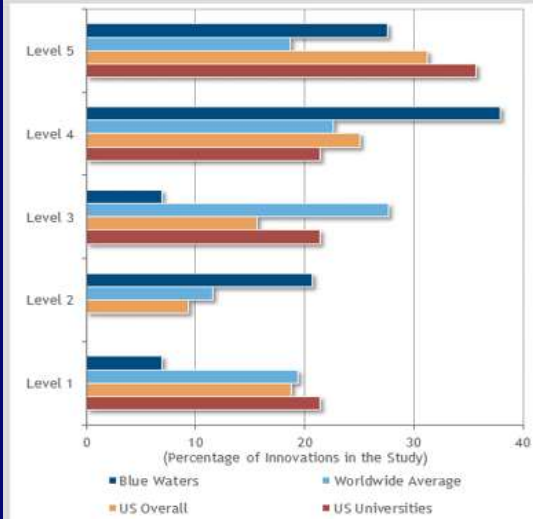


FIGURE 6

Blue Water Innovations: Innovation Number of Organizations Impacted

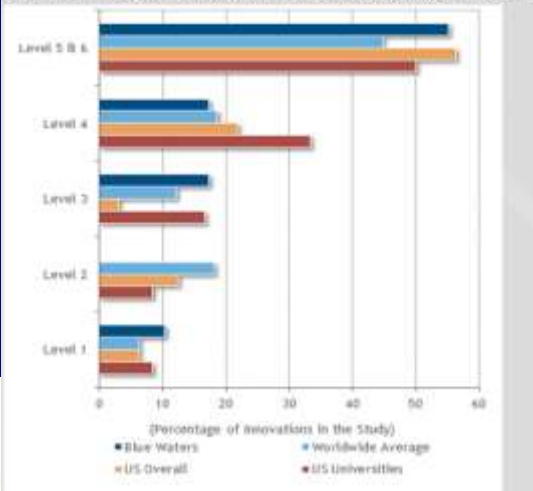
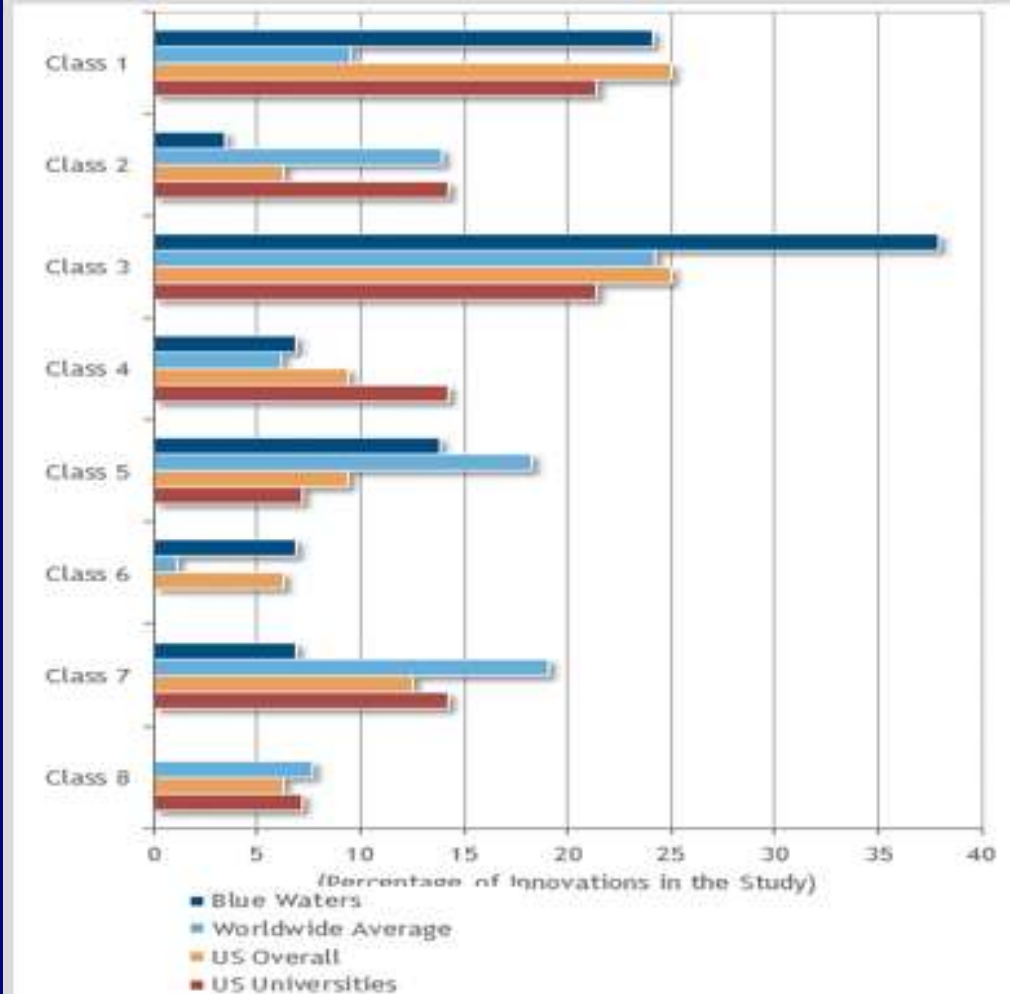


FIGURE 8

Blue Water Innovations: Innovation Class Level



# For A Copy Of The Study And Updates: www.hpcuserforum.com/ROI



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## Economic Models Linking HPC and ROI

### ROI Study: Latest Results

These are the latest results of the ROI study that measures how HPC investments are related to improved economic success and increased scientific innovation.

[Latest ROI Data](#)

[ROI Slide Deck](#)

### ROI Pilot Study Overview

These are the results of the 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 Full Report](#)

[The ROI Models](#)

[HPC Success Stories](#)

HPC User Forum thanks DOE for its insights, guidance and funding of this 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.*



# Questions?

Please email:

[ejoseph@hyperionres.com](mailto:ejoseph@hyperionres.com)

Or check out:

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# Agenda: Tuesday Morning

- 8:15am Meeting Welcome and Announcements: Paul Muzio, Rupak Biswas, Earl Joseph and Steve Conway**
- 8:25am HPC Market Update, Earl Joseph and Steve Conway:**
- **HPC Market Forecast Update**
- 8:45am Addressing Key Science Challenges with Adversarial Neural Networks, Wahid Bhimji, NERSC**
- 9:15am Session: HPC and the Environment. Chair: Paul Muzio, HPC User Forum Steering Committee**
- **HPC Use for Earthquake Research, Christine Goulet, Southern California Earthquake Center**
  - **Exploiting Exascale Platforms for Regional-Scale Earthquake Hazard and Risk Assessment, David McCallen, Lawrence Berkeley National Laboratory**
- 10:15am Break**
- 10:45am HPC and the Environment (continued)**
- **The Use of HPC to Model the California Wildfires, Ilkay Altintas, San Diego Supercomputer Center**
  - **Using ORNL Titan to Develop 50,000 Years of Flood Risk Scenarios for the National Flood Insurance Program, Dag Lohmann, KatRisk**
- 11:45am HPE Vendor Technology Update, Jimmy Daley**
- 12:00pm Networking Lunch**



**Please Return  
By 1:00PM**



# Agenda: Tuesday Afternoon

- 1:00pm** End User Site Update: University of Bristol, Simon Burbidge
- 1:25pm** HPC and Precision Medicine - A New Framework for Alzheimer's and Parkinson's, Joseph Lombardo, NSI at UNLV
- 1:50pm** HPC and the Environment (continued)
- Weather Prediction Using the K Computer and Himwari-B Satellite, Miyoshi Takemasa, RIKEN
  - The Galactos Project: Using HPC To Run One of Cosmology's Hardest Challenges, Deborah Bard, NERSC
- 2:40pm** Intel Technology Update
- 2:50pm** Improving Scientific Research with HPC, Chris Reidy
- 3:15pm** Networking Break
- 3:45pm** Session: Technical Updates on Processors (15-minute updates)
- AMD, Jay Owen
  - ARM, ARMv8, Srinath Vadlamani
  - IBM, Power 9 plus Open CAPI, Jeff Stuecheli
  - Intel, Mark Kachmarek
  - NVIDIA, Dale Southard
- 5:00pm** Networking Break
- 6:30pm** Special Dinner Event and Speaker: "The Threat of Asteroids and What We Are Doing About It", by Dr. Donovan Mathias, acting deputy chief of NASA's NAS Division

**Welcome To The  
Second Day Of The  
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# Agenda: Wednesday Morning

- 8:00am** Welcome: Paul Muzio, Rupak Biswas, Earl Joseph and Steve Conway  
AI, ML, DL Transparency Issues, Steve Conway
- 8:10am** HPC in Ontario, Canada: Chris Loken, Compute Ontario
- 8:35am** Session: Quantum Computing. Chair: Rupak Biswas
- John Martinis, Google
  - T.R. Govindan, NASA
  - Jim Held, Intel
- 10:00am** Networking Break
- 10:15am** Session: Quantum Computing (continued)
- Jay Gambetta, IBM
  - Steve Reinhardt, Dwave
- 11:15am** Innovative Technologies Panel: Short 4-minute presentations of HPC-enabled innovations
- Sumit Puri, Liquid Inc.
  - Ian Campbell, OnScale
  - Sid Mair, Penguin Computing
  - Curtis Anderson, Panasas
  - Cray
  - IBM
- 12:00pm** Dell EMC Technology Update
- 12:15pm** Networking Lunch



**Please Return  
By 1:15PM**



# Agenda: Wednesday Afternoon

- 1:00pm Understanding AI for HPC and HPC for AI: Lessons, Gaps and Challenges, Rangan Sukumar, Cray
- 1:15pm Session: Quantum Computing (continued)
- Matthias Troyer, Microsoft
  - Blake Johnson, Rigetti Computing
  - Carl Williams, NIST
  - Xiaobo Zhu, Division of Quantum Physics
- 3:15pm Networking Break
- 3:30pm **Panel Discussion: HPC and Quantum Computing.**  
**Moderator: Bob Sorensen**
- 4:45pm HPC Innovation Excellence Winner: HPC Simulations of the Impact of Drug-induced Arrhythmias in Living Hearts, Wolfgang Gentzsch, UberCloud
- 5:15pm Meeting Wrap-Up, Paul Muzio, Rupak Biswas, Earl Joseph and Steve Conway

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- September 4 to 6, Dearborn, Michigan
- October 1 to 2, Stuttgart, Germany
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