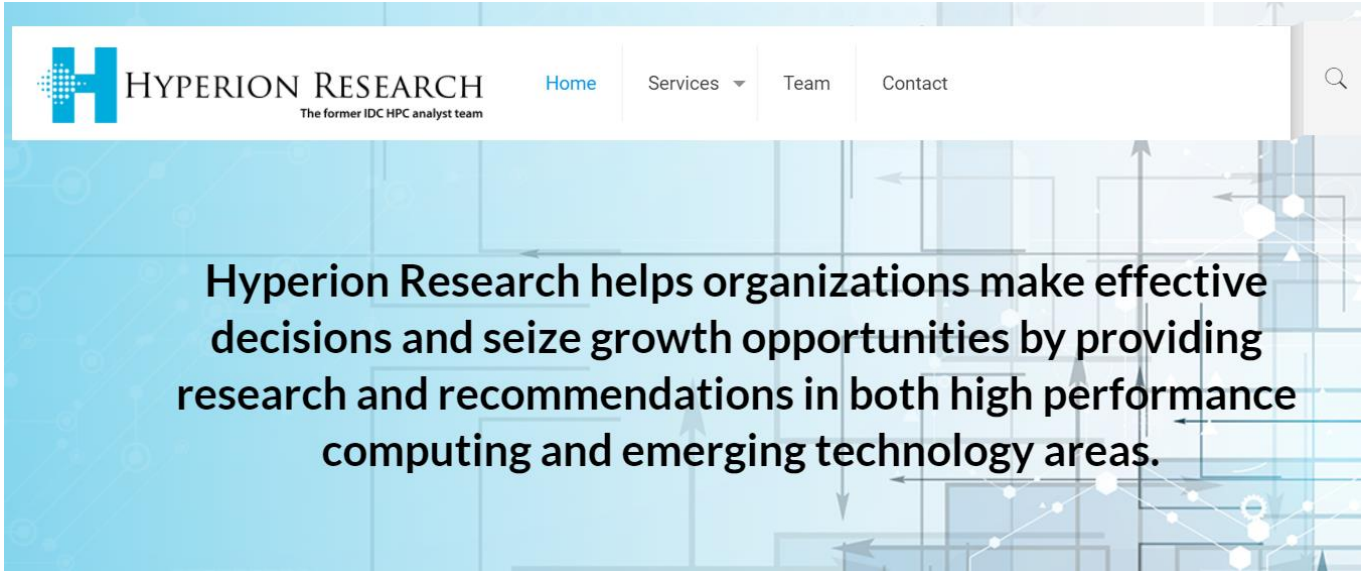
HYPERION RESEARCH

Hyperion Research HPC Market Update

March, 2018

Alex Norton, Earl Joseph,
Steve Conway, and Bob Sorensen

Check Out Our Website: www.HyperionResearch.com



Hyperion Research Holdings, LLC

- **We are the previous IDC HPC team**
  - We were separated from IDC prior to IDC being sold
- **Single owner -- with no investors**
  - DUNS Number: 080598994
  - Employer Identification Number: 81-5061463
- **We own 100% of the IDC HPC assets**
  - Tracking the HPC market since 1986
  - IDC is barred from doing HPC work for 3 years
- **Headquarters:**
  - 365 Summit Ave., St. Paul, MN 55102
  - 612-812-5798
  - www.HyperionResearch.com

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

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

What We Do

We help IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy. Specifically, we offer:

Technical Computing subscription service

HPC QView quarterly Worldwide server sales data

High Performance Data Analysis subscription service

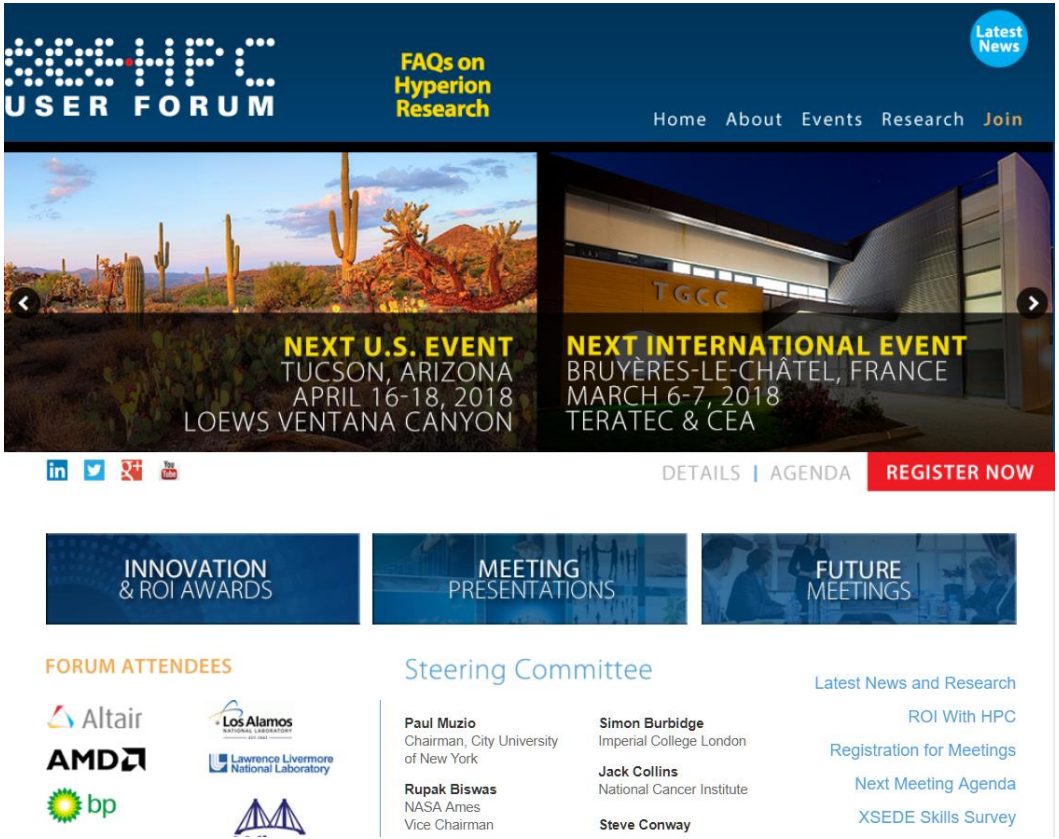
Pathfinders subscription service

HPC User Forums

Custom Studies

The HPC User Forum:

www.hpcuserforum.com



68 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)

HPC Market Update

Top Trends in HPC

2016 was strong – Exceeded $11.2 billion (US$) in revenues!

- 2017 is looking ok, but is slowing down some

The top systems have slowed for over 4 years

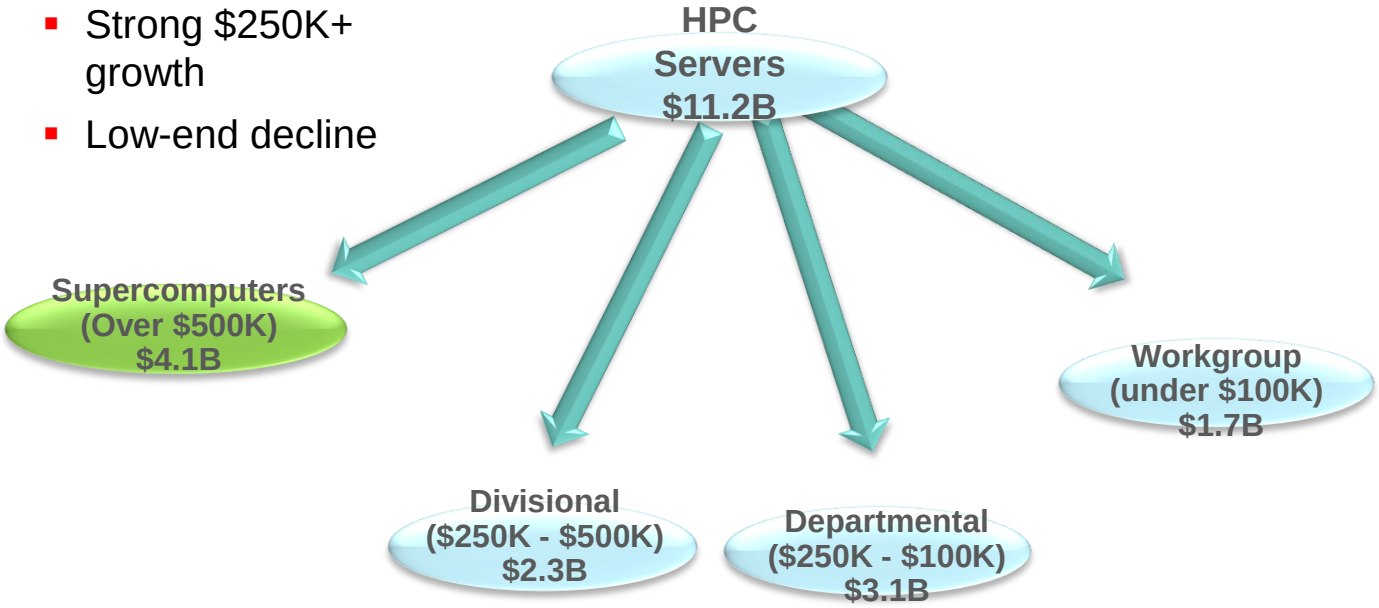
- But the profusion of Exascale announcements is generating a lot of buzz
- Governments are investing heavily in exascale systems

Big data combined with HPC is creating new solutions

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

The Worldwide HPC Server Market: $11.2 Billion in 2016

- Record revenues
- Strong $250K+ growth
- Low-end decline



1H-2017 HPC Market By Segments ($K)

HPC Server Revenues					
Competitive Segment	**Q117**	**Q217**	**1H2017**		**1H17/ 1H16**
Supercomputer	948,900	1,062,626	2,011,526		17.3%
Divisional	477,178	518,868	996,046		-14.1%
Departmental	681,172	730,732	1,411,904		-7.3%
Workgroup	329,933	363,125	693,058		-22.9%
Total	2,437,183	2,675,351	5,112,534		-3.5%

1H-2017 HPC Market By Shares ($K)

Mftr	Q1-2017	Q2-2017	Q2 Market Share
HPE/HP	896,027	984,974	36.8%
Dell	488,628	547,582	20.5%
Lenovo	190,521	209,995	7.8%
IBM	97,125	131,682	4.9%
Sugon (Dawning)	71,796	76,369	2.9%
Cray	21,100	47,000	1.8%
NEC	38,572	32,182	1.2%
Fujitsu	42,692	25,801	1.0%
Bull Atos	26,938	19,862	0.7%
Other	563,784	599,905	22.4%
Grand Total	**2,437,183**	**2,675,351**	**100.0%**

2016 HPC Market By Vertical ($ Millions)

2016 Market Results	
Bio-Sciences	1,049
CAE	1,251
Chemical Engineering	183
DCC & Distribution	692
Economics/Financial	624
EDA / IT / ISV	823
Geosciences	844
Mechanical Design	57
Defense	1,125
Government Lab	2,059
University/Academic	1,934
Weather	490
Other	70
Total Revenue	11,200

Source: Hyperion 2017

1H-2017 HPC Market By Processor Type

WW Processor Package Volume						
	2016				2017	
CPU Type	**Q116**	**Q216**	**Q316**	**Q416**	**Q117**	**Q217**
RISC	21,852	22,725	21,765	19,789	16,264	18,826
x86-64	783,921	827,036	864,815	895,454	799,794	805,708
Custom		40,960				
Total	**805,773**	**890,721**	**886,580**	**915,243**	**816,058**	**824,534**

1H-2017 HPC Market By Coprocessor Type

Data	Q117	Q217
Sum of Nvidia Board Count	25,455	33,553
Sum of Intel Phi Board Count	4,086	4,204
Sum of Other Acce/CoProc Board Count	1,324	1,338
Total	30,865	39,095

1H-2017 HPC Market By Regions ($K)

	2017	
Data	**Q1-2017**	**Q2-2017**
North America	1,163,472	1,298,153
EMEA	648,976	730,000
Asia/Pacific	449,927	484,618
Japan	146,194	131,404
Rest-of-World	28,615	31,175
Total	**2,437,183**	**2,675,351**

HPC Market Forecasts ($ Millions)

	2016	2021
Supercomputer	4,091	5,356
Divisional	2,273	2,902
Departmental	3,147	4,274
Workgroup	1,689	2,287
Total	11,200	14,819

Source: Hyperion 2017

Forecast: The Broader HPC Market
($ Millions)

	2016	2021	CAGR 16-21
Server	11,200	14,819	5.8%
Storage	4,316	6,269	7.8%
Middleware	1,277	1,786	6.9%
Applications	3,739	5,071	6.3%
Service	1,907	2,309	3.9%
Total Revenue	22,439	30,253	6.2%

Source: Hyperion 2017

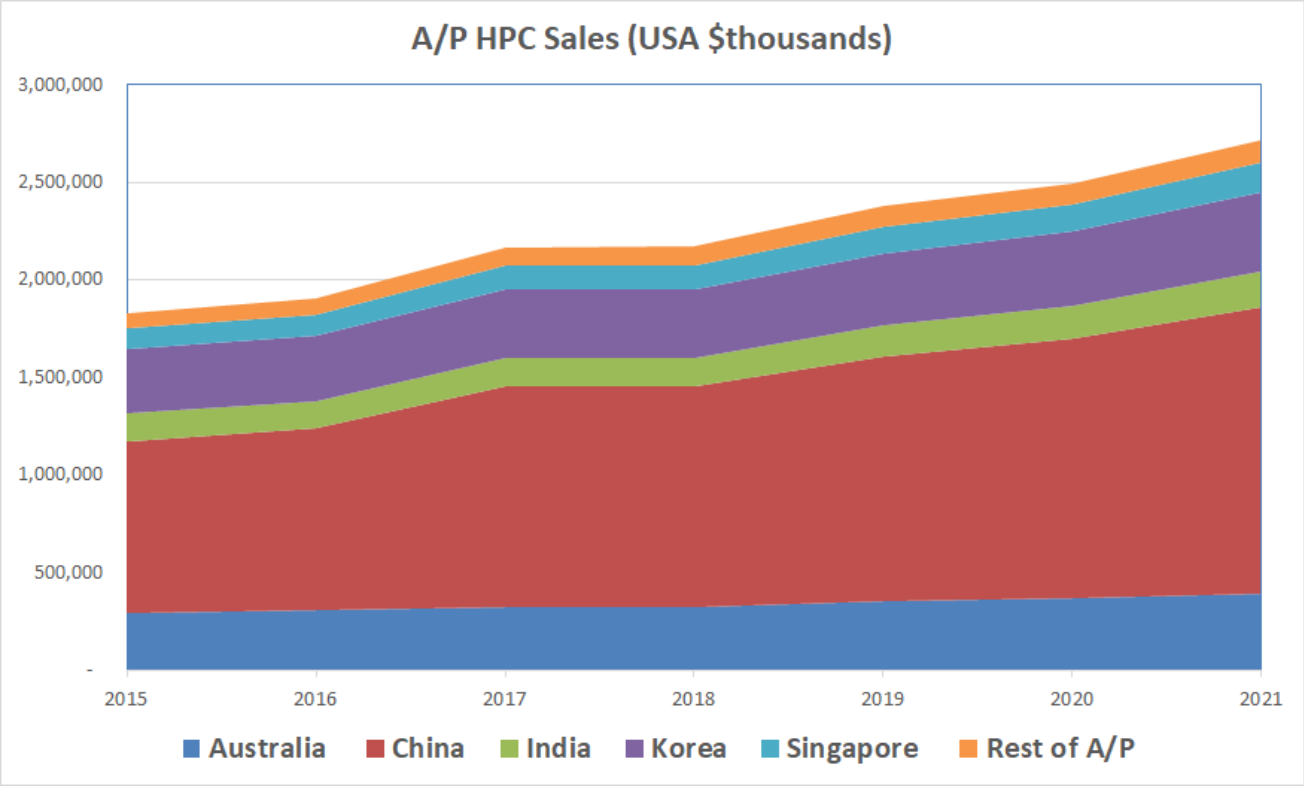
Major Trend

HPC in the Cloud

- **64% of HPC sites run some jobs in public clouds**
  - Up from 13% in 2011
- **But only 7-8% of all their jobs (average)**
  - Not much changed since 2011
  - Public clouds are cost-effective for some jobs, but up to 10x more expensive for others
  - Key concerns: security, data loss
- **Private and hybrid cloud use is growing faster**
- **Big public clouds are going heterogeneous**
  - AWS with Ryft FPGAs, Google with NVIDIA GPGPUs

The HPC Market In Asia

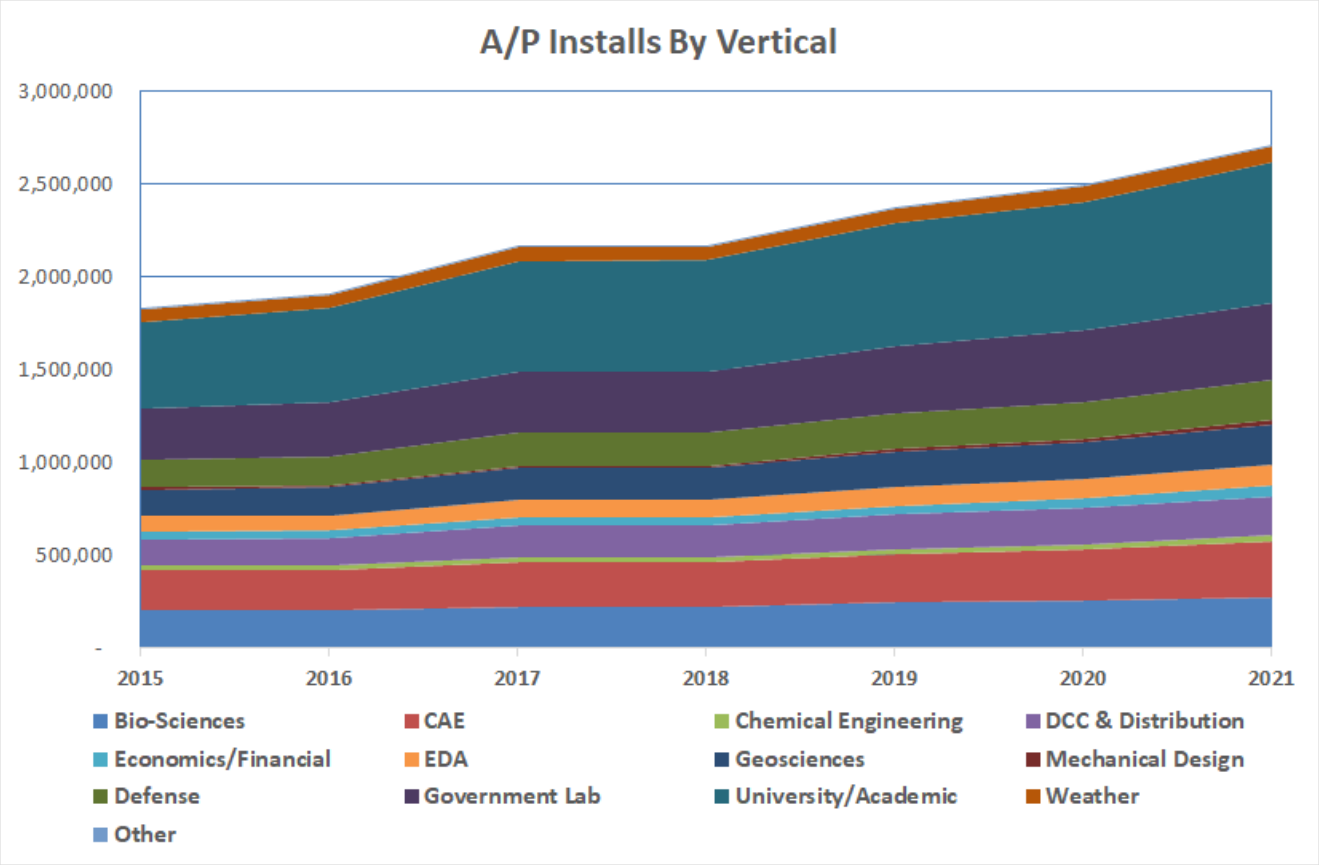
Asia/Pacific w/o Japan Servers Installed By Country
(USA $thousands)



Asia/Pacific w/o Japan Servers Installed By Country
(USA $thousands)

Asia/Pacific HPC Revenues By Country								
	2015	2016	2017	2018	2019	2020	2021	CAGR 16-21
Australia	296,827	305,876	324,742	325,776	353,186	367,313	395,691	5.3%
China	876,461	937,056	1,127,835	1,130,426	1,251,484	1,328,719	1,460,859	9.3%
India	145,418	138,430	149,655	147,600	161,636	169,799	184,765	5.9%
Korea	324,595	331,112	347,026	347,156	372,563	383,552	409,011	4.3%
Singapore	106,593	109,843	123,640	123,674	134,080	139,443	150,216	6.5%
Rest of A/P	82,778	85,302	96,016	95,091	103,092	107,216	115,499	6.2%
Asia/Pacific Total	1,832,673	1,907,619	2,168,914	2,169,723	2,376,042	2,496,042	2,716,042	7.3%
Source: Hyperion 2017	-	-	-	-	-	-	-	

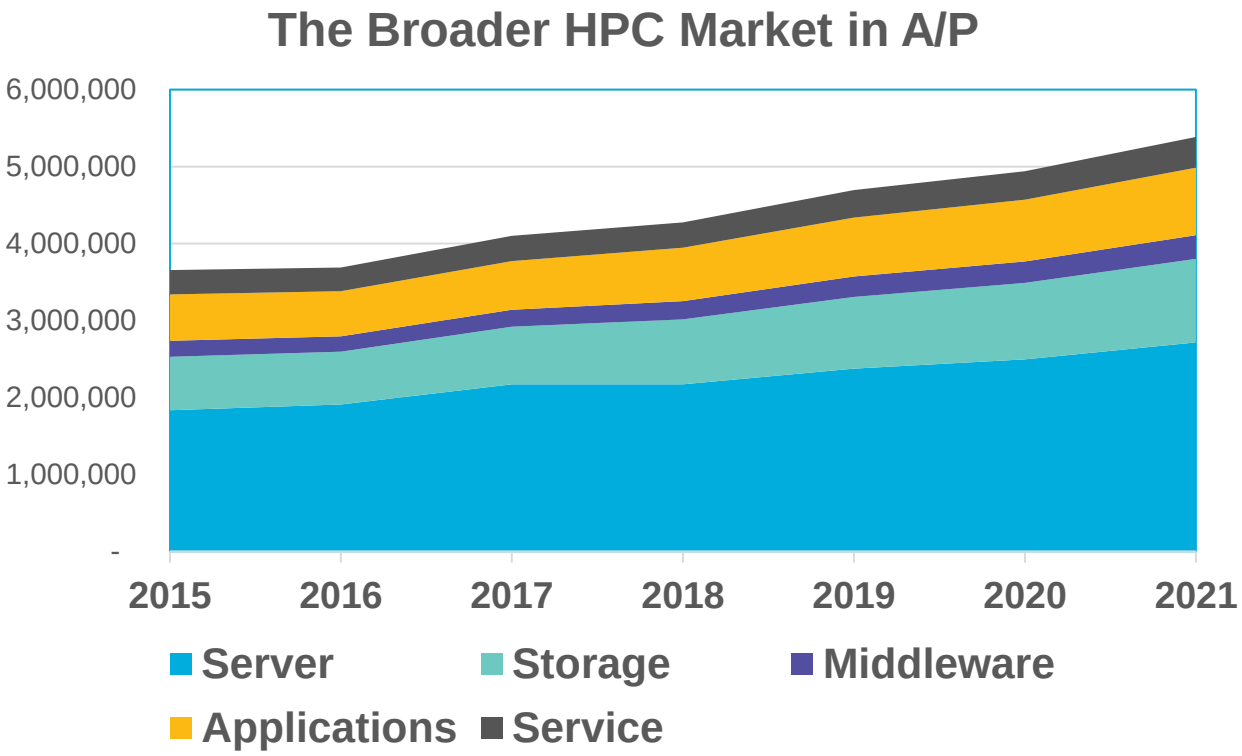
Asia/Pacific by Verticals/ Applications



Asia/Pacific by Verticals/ Applications

HPC Industry/Application Segments for Asia/Pacific								
	2015	2016	2017	2018	2019	2020	2021	CAGR 16-21
Bio-Sciences	203,442	205,654	221,017	220,913	241,007	252,237	273,462	5.9%
CAE	214,091	215,550	240,546	240,515	262,881	275,636	299,371	6.8%
Chemical Engineering	26,067	23,702	25,310	25,308	27,659	29,000	31,495	5.9%
DCC & Distribution	139,572	146,578	169,371	169,414	185,502	194,848	211,998	7.7%
Economics/Financial	39,598	39,831	44,422	44,424	48,547	50,894	55,267	6.8%
EDA	87,214	83,847	95,045	95,100	104,236	109,596	119,358	7.3%
Geosciences	138,408	146,705	169,841	169,937	186,565	196,472	214,307	7.9%
Mechanical Design	15,403	15,136	15,838	15,844	17,365	18,257	19,883	5.6%
Defense	149,455	152,785	174,555	174,614	191,051	200,527	218,017	7.4%
Government Lab	275,219	290,688	330,801	331,091	363,130	382,044	416,333	7.4%
University/Academic	467,984	514,384	599,202	599,612	657,427	691,454	753,281	7.9%
Weather	63,501	64,479	73,525	73,521	80,401	84,347	91,658	7.3%
Other	12,718	8,279	9,441	9,432	10,271	10,730	11,612	7.0%
Asia/Pacific Total	1,832,673	1,907,619	2,168,914	2,169,723	2,376,042	2,496,042	2,716,042	7.3%
Source: Hyperion 2017	-	-	-	-	-	-	-	

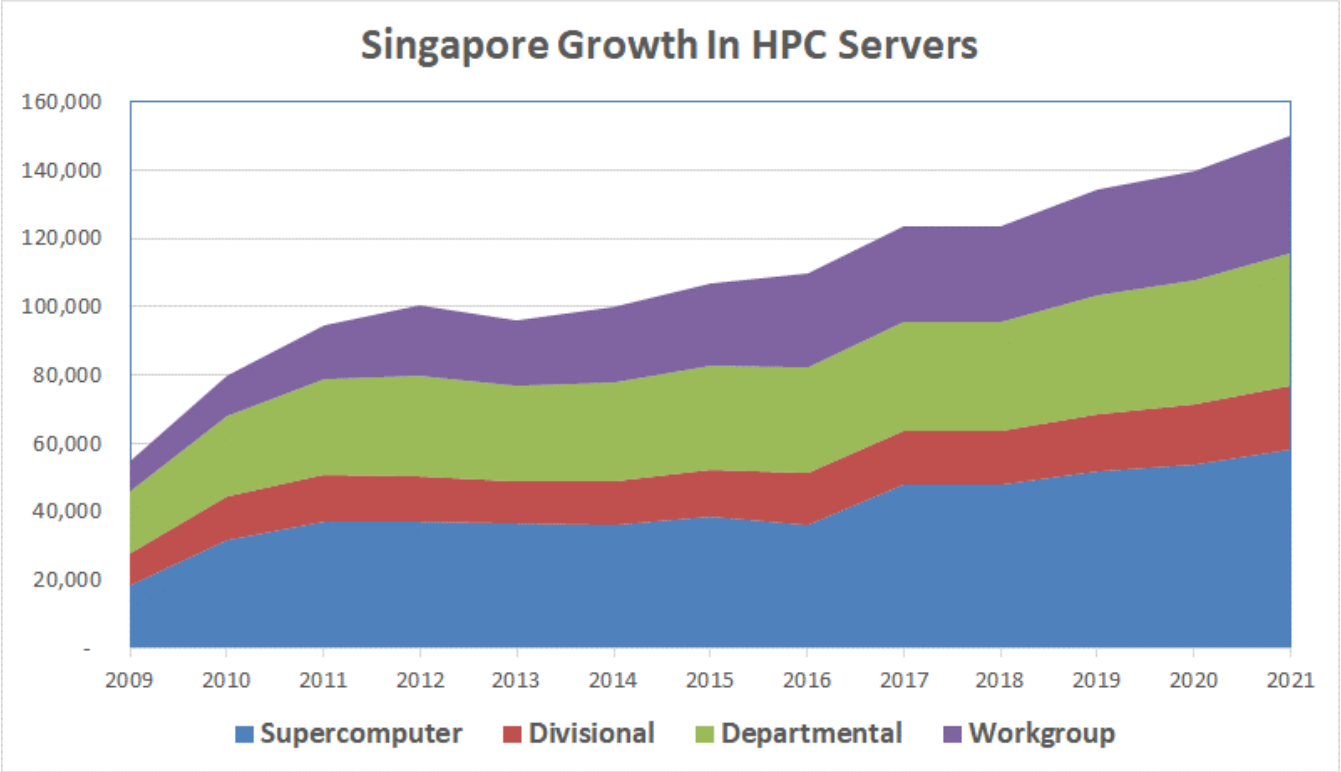
Asia/Pacific w/o Japan By Broader Market Categories



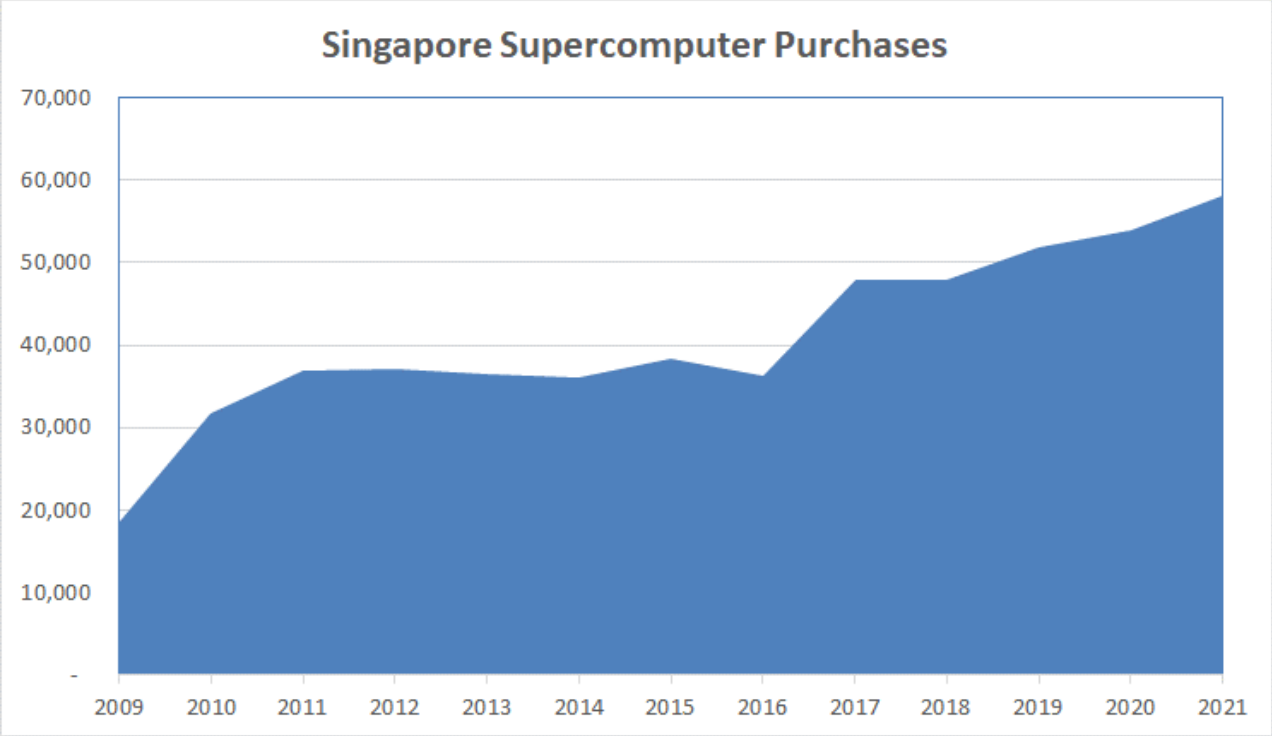
Asia/Pacific w/o Japan By Broader Market Categories

Revenues by the Broader HPC Market Areas								
	2015	2016	2017	2018	2019	2020	2021	CAGR 16-21
Server	1,832,673	1,907,619	2,168,914	2,169,723	2,376,042	2,496,042	2,716,042	7.3%
Storage	696,124	687,093	751,143	845,482	931,331	991,420	1,084,235	9.6%
Middleware	206,800	201,476	219,234	238,811	266,132	279,573	307,458	8.8%
Applications	603,394	586,820	631,983	694,668	762,748	803,979	880,274	8.4%
Service	316,543	306,443	330,650	327,435	357,573	370,640	397,876	5.4%
Total Revenue	3,655,534	3,689,450	4,101,924	4,276,121	4,693,826	4,941,653	5,385,884	7.9%
Source: Hyperion 2017								

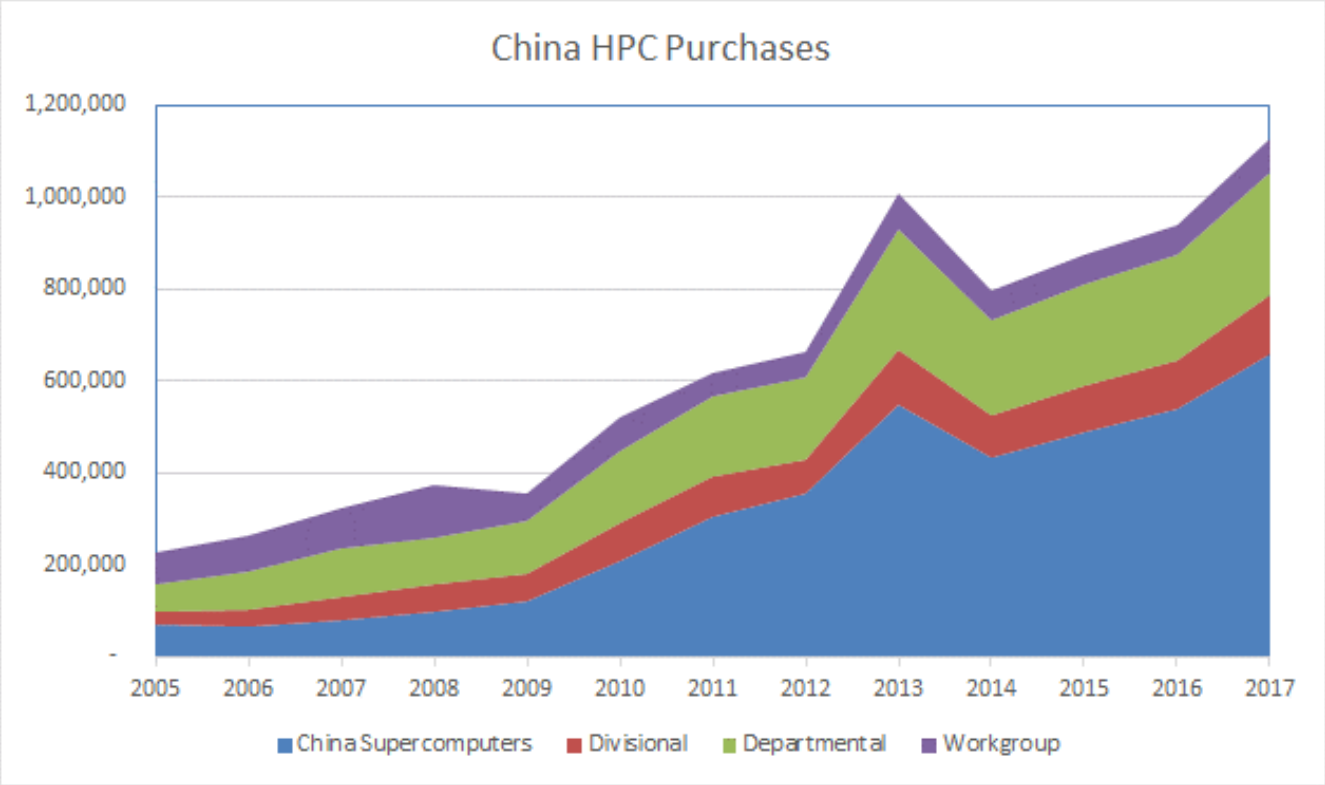
Singapore Growth In Acquiring HPC Servers



Singapore Growth In Acquiring Supercomputers



China Historic HPC Purchases



Hyperion Research Exascale Projections

Projected Exascale Dates and Suppliers

U.S.

- Sustained* ES: 2022-2023
- Peak ES: 2021
- Vendors: U.S.
- Processors: U.S. (some ARM?)
- Initiatives: NSCI/ECP
- Cost: $300-$600M per system, plus heavy R&D investments

EU

- Peak ES: 2023-2024
- Pre ES: 2021-2022
- Vendors: U.S., Europe
- Processors: Likely ARM
- Initiatives: EuroHPC
- Cost: $150-$250M per system, plus very heavy R&D investments

China

- Sustained ES*: 2021-2022
- Peak ES: 2020
- Vendors: Chinese (multiple sites)
- Processors: Chinese (plus U.S.?)
- 13th 5-Year Plan
- Cost: $350-$500M per system, plus heavy R&D

Japan

- Sustained ES*: 2022
- Peak ES: Likely as a AI/ML/DL system
- Vendors: Japanese
- Processors: Japanese
- Cost: $800M-$1B, this includes both 1 system and the R&D costs, will also do many smaller size systems

**** 1 exaflops on a 64-bit real application***

Projected Exascale Investment Levels
(In Addition to System Purchases)

U.S.

- $1 to $2 billion a year in R&D
- Investments by both governments & vendors
- Plans are to purchases multiple exascale systems each year

EU

- About 5 billion euros in total
- Investments in multiple exascale and pre-exascale systems, and in new processor developments
- Investments mostly by country governments with a little from the EU

China

- Over $1billion a year in R&D
- Investments by both governments & vendors
- Plans are to purchases multiple exascale systems each year
- Already investing in 3 pre-exascale systems starting in late 2018

Japan

- Planned investment of over $1billion* (over 5 years) for both the R&D and purchase of 1 exascale system
- To be followed by a number of smaller systems ~$100M to $150M each
- Creating a new processor and a new software environment

** Note that this includes both the system and R&D*

HPDA-AI Update

New HPC Segments from HPDA Buyers

1. **Fraud and anomaly detection.** This "horizontal" workload segment centers around identifying harmful or potentially harmful patterns and causes using graph analysis, semantic analysis, or other high performance analytics techniques. The patterns may point to fraud, which is the deceptive exploitation or annotation of data for wrongful or illegal personal gain, or they may point to cyber security crime or insider threats, significant errors, or other anomalies that may deserve further investigation.
2. **Marketing.** This segment covers the use of HPDA to promote products or services, typically using complex algorithms to discern potential customers' demographics, buying preferences and habits.
3. **Business intelligence.** The workload segment uses HPDA to identify opportunities to advance the market position and competitiveness of businesses, by better understanding themselves, their competitors, and the evolving dynamics of the markets they participate in.
4. **Other Commercial HPDA.** This catchall segment includes all commercial HPDA workloads other than the three just described. Over time, Hyperion expects some of these workloads to become significant enough to split out of this "other" category and command their own segments. An example of such a high-potential workload is the use of HPDA to manage large IT infrastructures, ranging from on premise data centers to public clouds and Internet-of-Things (IoT) infrastructures.

Forecasts: HPDA, AI

Table 25

Worldwide HPC-Based AI Revenues vs Total HPDA Revenues (Millions)

	2015	2016	2017	2018	2019	2020	2021	CAGR 16-21
Total WW HPDA Server Revenues	$1,455	$1,845	$2,333	$2,830	$3,224	$3,488	$4,040	17.0%
Total HPC-Based AI (DL, ML, and Other)	$246	$346	$501	$673	$845	$986	$1,260	29.5%

Table 26

Worldwide M/L, D/L & AI HPC-Based Revenues ($ Millions)

	2015	2016	2017	2018	2019	2020	2021	CAGR 16-21
M/L in HPC	$203	$282	$373	$478	$548	$546	$594	16.0%
D/L in HPC	$15	$31	$93	$159	$258	$395	$618	81.5%
Other AI In HPC	$28	$32	$34	$36	$39	$44	$48	8.4%
Total	$246	$346	$501	$673	$845	$986	$1,260	29.5%

Worldwide Demand Study (Late 2017): Who Is Doing HPDA Work?

Table 13

Percentage of System Running Big Data Jobs, By Sector

Of all the workloads on your systems, what percentage of your total system utilization is devoted to Big Data analytics (MapReduce/Hadoop, graph analytics, semantic analysis, etc.)?				
In 2017:	Percentage of System in Government	Percentage of System in Academia	Percentage of System in Industry	Overall
Currently used for Big Data analytics - Percent	24.6%	12.8%	30.3%	26.3%
Expected 6 to 18 months from now - Percent	33.1%	22.9%	39.2%	34.9%
In 2015:				
Currently used for Big Data analytics - Percent	18.2%	8.4%	32.6%	22.7%
Expected 6 to 18 months from now - Percent	19.8%	15.6%	33.4%	26.1%
N = 87				

Source: Hyperion Research, 2017

Worldwide Demand Study (Late 2017): Top HPDA Application Areas

Table 14

Top HPDA Applications in 2017

Q. What application categories do your top 3 data-intensive analytics applications fall under?

	Number of Responses	Percentage of Responses
App #1 - Graph Analysis	28	26.2%
App #1 - Semantic Analysis	19	17.8%
App #1 - Knowledge Discovery	49	45.8%
App #1 - Other	11	10.3%
N = 87		

Source: Hyperion Research, 2017

Worldwide Demand Study (Late 2017): Middleware

Table 16

Middleware to Support HPDA Workloads

What types of middleware system software are you using for managing your data intensive workloads (e.g., Hadoop, HPCC, etc.)?		
Type Software Used	Number of Responses	Percentage of Respondents
Hadoop	47	54.0%
SPARC	29	33.3%
HPCC	23	26.4%
IBM IIS/Watson/WebSphere/ MQSeries/InfoSphere/DataStage	6	6.9%

Worldwide Demand Study (Late 2017): Use of Clouds for HPDA Applications

	% Total HPDA Workload on External Clouds - TODAY	% Total HPDA Workload on External Clouds – In 6-18 Mos.
	Percentage of Respondents	Percentage of Respondents
0%	58.9%	45.3%
1-9%	11.6%	9.3%
10-24%	14.7%	22.1%
25-50%	6.3%	9.3%
> 50%	8.4%	14.0%
N = 95		

Hyperion Research
ROI Research

Download The Results At:
www.hpcuserforum.com/ROI

Grant References

- **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-SC0012576.

- **DOE Program Managers:**
  - Christine Chalk, 301-903-5152, christine.chalk@science.doe.gov, and Barbara J. Helland, 301-903-3127, barbara.helland@science.doe.gov, U.S. Department of Energy Office of Science, Germantown Building, 1000 Independence Avenue, S.W. Washington, D.C., 20585-1290, and Doug Wade in National Nuclear security Administration (NNSA).

- **Administrator/Contracting Officer:**
  - Warren Riley, 630-252-2485, warren.riley@ch.doe.gov, U.S. Department of Energy Office of Acquisition and Assistance, 9800 South Cass Avenue, Argonne, Illinois, 60439

- **Hyperion Reporting:**
  - Principal investigator: Earl C. Joseph, Ph.D., 612-812-5798, ejoseph@hyperionresearch.com

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, growth and jobs
2. Two Innovation Indexes that measures 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 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

HPC ROI

Latest Findings: ROI from HPC is Very High

Results <u>indicate high ROI returns</u> resulting from investments in HPC

On average, from the latest data:

- **<u>$551 dollars on average in revenue</u>** per dollar of HPC invested.
- **<u>$52 dollars on average of profits</u>** (or cost savings) per dollar of HPC invested.

<u>Extreme Example:</u>

- In Oil/Gas
- Maximizing oil reservoir production
- Profit ROI = $3.75 billion

<u>Extreme Example:</u>

- In Finance
- HPC driven underwriting of insurance quotes
- Revenue ROI = $11.6billion

Study Results: Innovation

Findings: Mix Of Innovation Types (For ALL 329 PROJECTS)

Q4: Primary Innovation / ROI Area	Count of Q4: Primary Innovation / ROI Area	Average of HPC $M per Innovation
Better Products	118	$6.1 M
Cost Saving	11	$1.9 M
Created New Approach	127	$1.1 M
Discovered Something New	29	$3.6 M
Helped Research Program	11	$8.7 M
Helped Society	25	$5.1 M
Major Breakthrough	8	$1.0 M
Grand Total	**329**	**$3.7 M**

Findings: Mix Of Innovation Types (For 114 FINANCIAL ROI PROJECTS)

Q4: Primary Innovation / ROI Ar	Count of Q4: Primary Innovation / ROI Area	Average of HPC $M per Innovation
Better Products	50	$12.2 M
Cost Saving	3	$1.8 M
Created New Approach	43	$3.0 M
Discovered Something New	8	
Helped Research Program	2	$2.0 M
Helped Society	7	$0.2 M
Major Breakthrough	1	
Grand Total	**114**	**$7.7 M**

Findings: Mix Of Innovation Types (For 215 INNOVATION PROJECTS)

Q4: Primary Innovation / ROI Area	Count of Q4: Primary Innovation / ROI Area	Average of HPC $M per Innovation
Better Products	68	$3.8 M
Cost Saving	8	$1.9 M
Created New Approach	84	$0.9 M
Discovered Something New	21	$3.6 M
Helped Research Program	9	$9.6 M
Helped Society	18	$5.7 M
Major Breakthrough	7	$1.0 M
Grand Total	**215**	**$3.0 M**

Innovation Models Used

Two innovations indexes are used:

1. **Based on the <u>importance</u> of the innovation**
2. **How broadly the innovations <u>impact</u> different organizations**

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

The Two Innovation Index Scales

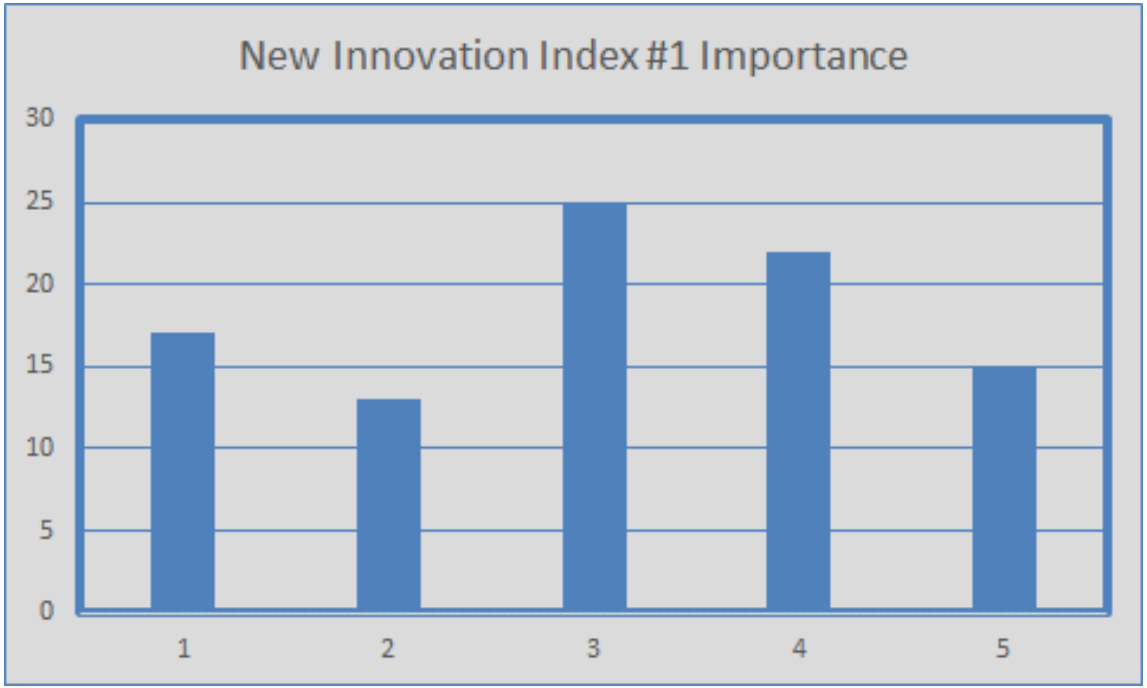
The <u>IMPORTANCE</u> of this innovation compared to all other innovations in this field over the last ten years

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

The <u>IMPACT</u> of this innovation to multiple organizations

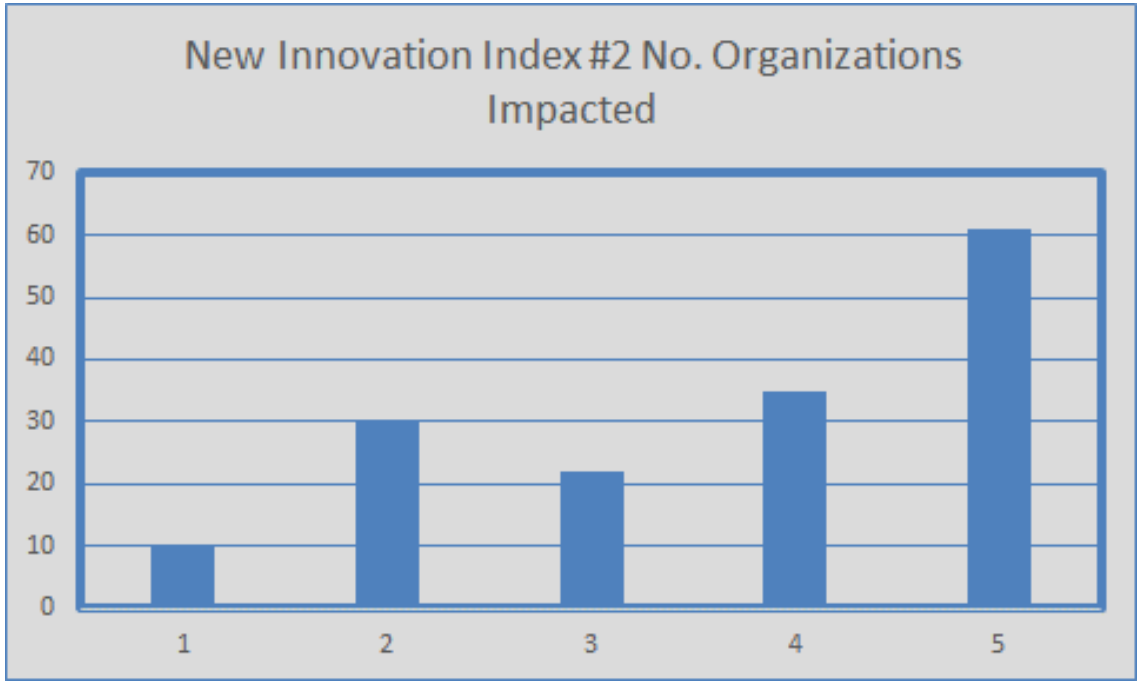
5. An innovation that is useful to over 10 organizations
4. An innovation that is useful to 6 to 10 organizations
3. An innovation useful to 2 to 5 organizations
2. An innovation only useful to 1 organization
1. An innovation that is recognized ONLY by experts in the field

New Findings: 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

New Findings: The Innovation IMPACT Index



5. An innovation that is useful to over 10 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

In Summary

Conclusions

- **HPC is still expected to be a growth market**
  - Growing recognition of HPC's strategic value
  - HPDA, including ML/DL, cognitive and AI
  - HPC in the Cloud will lift the sector writ large
- **Vendor share positions shifted greatly in 2015 & 2016 & 2017 and continue to shift**
  - E.g., HPE acquisition of SGI
- **The HPDA, AI, ML & DL markets will expand opportunities for vendors**

Important Dates For Your Calendar

- **2018 HPC USER FORUM MEETINGS:**
  - March 6 & 7, CEA & Teratec, France
  - April 16-18, Tucson, Arizona
  - September 4-6, Dearborn, Michigan
  - October 1-2, Stuttgart, Germany

QUESTIONS?

anorton@hyperionres.com

ejoseph@hyperionres.com

sconway@hyperionres.com

bsorensen@hyperionres.com

jeansorensen@hyperionres.com

mthorp@hyperionres.com

kgantrish@hyperionres.com