Addison Snell, *addison@Intersect360.com*

Intersect360
RESEARCH

Cost Models for HPC and Supercomputing

Actionable Market Intelligence for High Performance Computing

January 2013

Intersect360 Research

- HPC industry research reports: market sizing, forecasting, and technology trend analysis
- Quarterly surveys of worldwide end users since 2007
- Feature articles in partner publications
- Custom research, consulting, special studies
- Weekly podcast with HPCwire
- “Analyst Crossfire” at HPC conferences
- HPC500 user organization

Technical vs. Enterprise Computing

Technical Computing

- Top-line missions:
  - Find the oil
  - Design the minivan
  - Cure the disease
- Driven by price/ performance
- Fast adoption of new technologies, algorithms, and approaches

Enterprise Computing

- Keeps business running
  - Communicate/collaborate
  - Market and sell the product
  - Accounting, HR, finance, …
- Driven by RAS: reliability, availability, serviceability
- Slow adoption of new technologies, algorithms, and approaches

Where We Find Technical Computing

High Performance Technical Computing (HPTC)

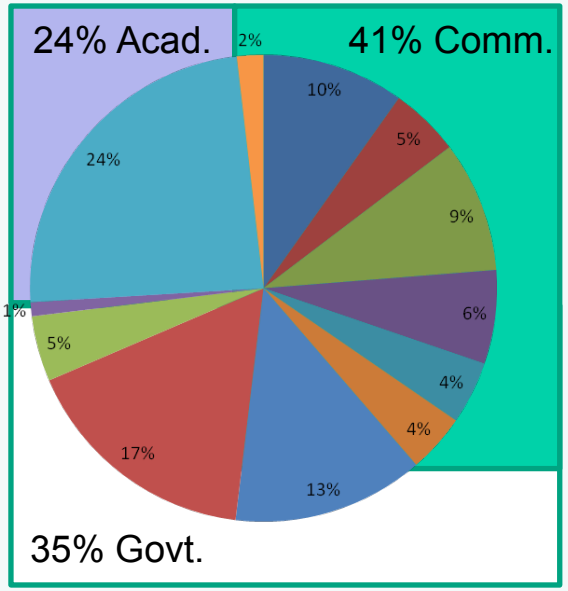
- Applications in science and engineering
- Top markets: academia, government labs, defense, manufacturing, bio/life science, oil/gas exploration

High Performance Business Computing (HPBC)

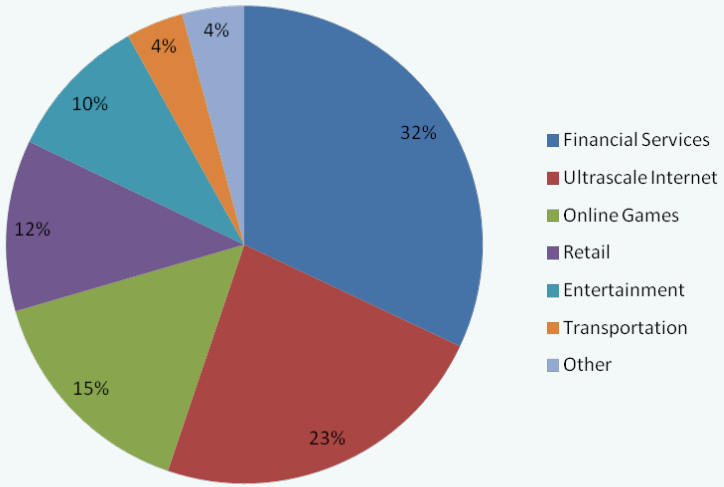
- Applications include trading, pricing, risk management, logistics, fraud detection, online games, analytics, …
- Top markets: financial services, ultrascale internet, online games, retail, entertainment

HPTC and HPBC Vertical Markets

HPTC Total Market (2011 rev., 68%) by Vertical



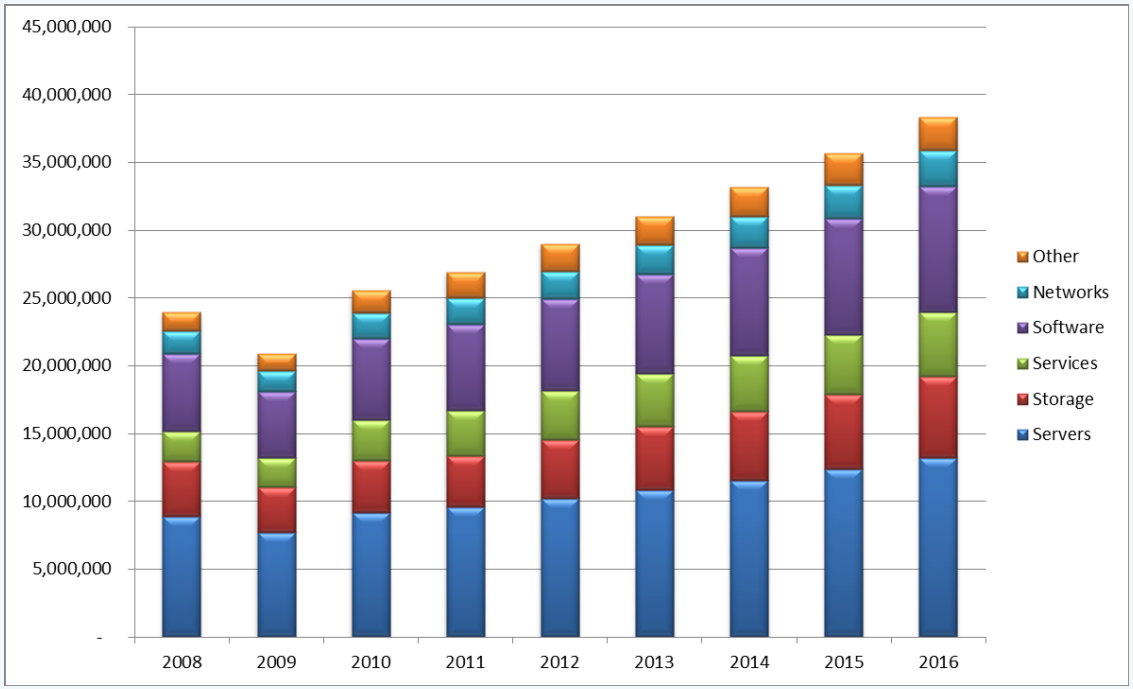
HPBC Total Market (2011 rev., 32%) by Vertical



- Financial services has overtaken manufacturing as largest commercial vertical
- HPBC is >95% commercial (exceptions: Fannie Mae, Federal Reserve Bank, …)
- Worldwide, private sector is growing faster than public sector

Intersect360 RESEARCH

Growth in High Performance Computing



- $27B worldwide in 2011, growing to $38B in 2016
- Servers are the largest individual component, about $10B in 2012
- Storage is fastest-growing component

Intersect360 RESEARCH

HPC User Budget Map Survey

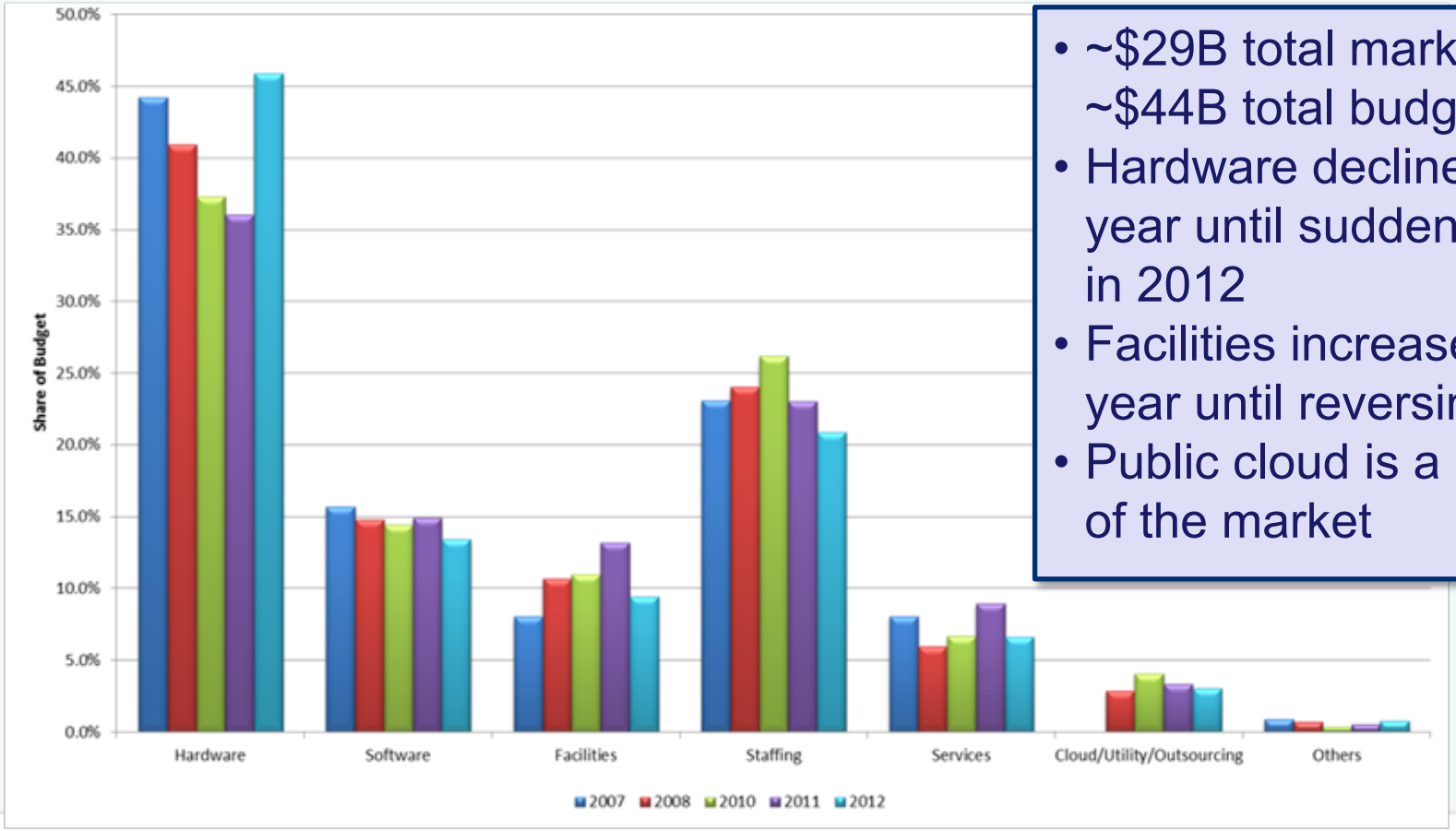
- Users describe their HPC budgets
  - Size and projected growth of budget (in ranges)
  - Breakdown by category: hardware, software, staffing, facilities, services, cloud/utility, other
  - Breakdown within category – e.g., Software: operating systems, middleware, developer tools, storage software, application software, transfer costs, …
- Respondents may or may not be in “acquisition years”; therefore budget distribution is a good model basis for total cost of ownership calculation

HPC User Budget Map Survey

The seven top-level spending categories were defined as follows:

- *Hardware purchases and upgrades*, including servers, storage, networks, clients, and other.
- *Software purchases and upgrades*, including O/S and systems software, middleware, applications, tools/libraries/compilers, in-house developed, and other.
- *Facilities spending*, including building/floor space, power consumption, cooling, and other.
- *Staffing*, including system managers, maintenance personnel, systems programmers, application programmers, user services consultants, and others.
- *Services purchases*, including maintenance and repair, external training, programming, and other.
- *Cloud/Utility/Outsource:* Purchases of computational capacity/capability through an external utility-based service, including raw cycles, applications support, and other.
- *Other:* Anything not covered above

HPC Budget Distribution by Year



- ~$29B total market implies ~$44B total budget
- Hardware declined every year until sudden rebound in 2012
- Facilities increased every year until reversing in 2012
- Public cloud is a small part of the market

Intersect360 RESEARCH

A Digression on HPC and Public Clouds

- Cost Models

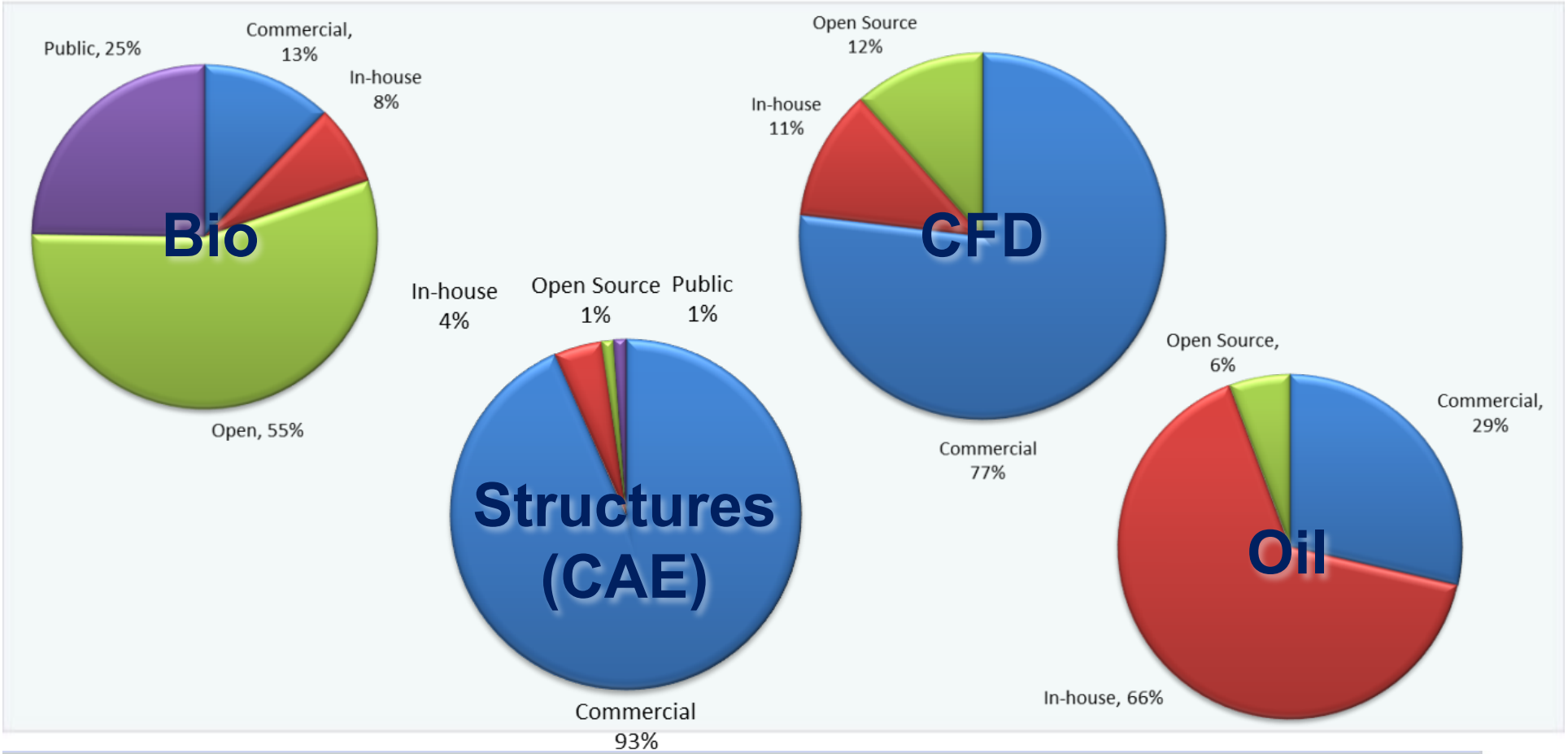
- Barriers

Hardware Increases in All Sectors

Hardware by Sector	2007	2008	2010	2011	2012	All Years
Academic	45%	41%	39%	39%	47%	42%
Commercial	44%	41%	36%	32%	44%	38%
Government	38%	44%	37%	33%	46%	40%

- Hardware increases across all segments indicate a market change, not likely to be sampling error
- Public sector markets spend a higher proportion of budgets on hardware than commercial markets
- Academic markets spend much less on software than commercial markets in general; commercial markets vary significantly depending on their usage of licensed software

Different Software Approaches



Hardware Distribution

Category	2007	2008	2010	2011	2012	All Years
Server	65%	50%	48%	45%	50%	49%
Storage	19%	27%	27%	24%	25%	26%
Network	10%	13%	13%	14%	12%	13%
Client	6%	10%	11%	15%	12%	12%
Other	0%	1%	1%	2%	1%	1%

- Half of hardware spending goes to the compute system
- Half of the rest (one-fourth) is storage (on average)
- Remainder split between networks, clients

Facilities Distribution

Category	2007	2008	2010	2011	2012	All Years
Building/floor space	23%	32%	37%	27%	22%	29%
Power Consumption	37%	40%	37%	44%	50%	43%
Cooling	40%	28%	26%	29%	28%	28%
Other	1%	4%	8%	3%	6%	5%

Building / floor space is often a “step function.” It doesn’t cost much (or anything) as long as I have it. Once I have to knock down a wall, or designate new lab space, or build a new building, it can cost a lot.

Supercomputing Budgets

Budgets over $10M/year	
Hardware	37.5%
Software	10.7%
Facilities	17.3%
Staffing	25.7%
Services	7.9%
Cloud/Utility	0.4%
Others	0.5%

Budgets over $5M/year	
Hardware	40.1%
Software	10.6%
Facilities	13.7%
Staffing	25.2%
Services	8.3%
Cloud/Utility	1.7%
Others	0.3%

All Budget Sizes	
Hardware	41.3%
Software	14.1%
Facilities	11.2%
Staffing	21.9%
Services	7.7%
Cloud/Utility	3.1%
Others	0.7%

- Supercomputing sites spend less on hardware, software, cloud
- Supercomputing sites spend more on facilities, staffing

These spending trends make intuitive sense. We can use the > $10M budget data as a proxy for petascale spending distributions.

Planning to Buy a 100M€ Computer?

- Be prepared to also spend (over multiple years):
  - 50M€ on storage
  - 50M€ on other hardware
  - 57M€ on software
  - 46M€ on power consumption
  - 26M€ on cooling
  - 20M€ on a building
  - 137M€ on people
  - 47M€ on other stuff (services, other utilities, etc.)
- Total cost of ownership: 533M€

All costs vary by site and by installation. These are averages for modeling TCO of a supercomputer. Your mileage may vary.

Future-Looking Trends (tomorrow a.m.)

- Multi-core, and its implications for:
  - Memory usage
  - Power consumption
  - System utilization
- Accelerators (e.g. GPU computing)
  - Programming models
  - System efficiency
- Big Data
- Adoption of HPC

Intersect360 RESEARCH

Actionable Market Intelligence for High Productivity Computing