Hewlett Packard Enterprise (HPE) emerged from 2015 as the clear revenue leader in the expanding worldwide market for high-performance computing (HPC) servers, with a 35.9% share of this $11.4 billion market and an even higher 41.1% share of the $3.3 billion supercomputers segment for HPC server systems selling for $500,000+. HPE had the largest share of systems on the November 2015, June 2016, and November 2016 Top500 lists. The company captured the leadership position with a strategy combining a long-term corporate commitment to HPC, adequate scale to address all segments of the market, a strong embrace of open standards, expanded HPC hardware and software ecosystem innovation (due to HP Labs), and strong and deepening expertise in HPC-reliant domains. Now HPE has upped the ante. First, the company has expanded its comprehensive portfolio of purpose-built platforms and related solutions aimed squarely at the rapid convergence of Big Compute, Big Data, and the Internet of Things (IoT) — including industry-specific requirements. Initial turnkey solutions are aimed at the economically important financial services, oil and gas (energy), healthcare, life sciences, and manufacturing sectors. Second, HPE’s acquisition of SGI substantially strengthens the combined company’s abilities to develop highly scalable, production-grade hardware and software and to pursue ultrahigh-end procurements (including pre-exascale and exascale), as well as the most challenging high-performance data analysis (HPDA) opportunities. This paper examines HPE’s rise to HPC market leadership against the background of escalating user requirements that present new opportunities and challenges for vendors.

HPC/HPDA Market Dynamics: Rapid Growth and Change

The global market for HPC server systems has been one of the fastest-growing IT markets. HPC server revenue more than doubled, from $4.8 billion to $11.4 billion, from 2001 to 2015 and is en route to an IDC-predicted value of $15.3 billion in 2019 (a CAGR of 7.7% versus a CAGR of 2.2% for the worldwide server market as a whole). When software, storage, and service are added to the mix, the 2019 HPC forecast effectively doubles.

During the past 15 years, clusters and other server systems based on x86-architecture processors have been primarily responsible for propelling the rapid growth of the global HPC server market. In the 2009–2015 period, the number of x86 processors sold annually into the HPC market doubled from 1.7 million to 3.4 million. In 2015, x86-based systems accounted for 97.2% of worldwide HPC server revenue.

- Historically, HPC market growth has been driven by expanding use at established sites, targeting higher performance and density. This has been heavily augmented by successive waves of new users, each presenting vendors with new requirements and challenges.
- The new edition of A Strategy for American Innovation, made public on October 21, 2015, named HPC as one of the top investment priorities for growing the U.S. economy. A key role for HPC cited in A Strategy for American Innovation is to address “the rise of extremely large data sets and attendant computational challenges.”
**Big Compute**

HPC began in the 1960s as a niche market for government- and university-based researchers, primarily for compute-intensive, floating point modeling and simulation (M&S) of physical and quasi-physical phenomena. But in less than a decade, HPC M&S began penetrating tier 1 commercial firms as a game changer for accelerating product development and competitiveness. In a pioneering IDC study for the Washington, D.C.–based Council on Competitiveness, 97% of companies that had adopted HPC said they could no longer compete or survive without it.

The arrival of standards-based, commercial-grade clusters in 2001–2002 made HPC M&S affordable for many small and medium-sized enterprises (SMEs) and start-ups. In 2015, 113,000 HPC systems were sold at prices below $100,000.

The spread of HPC into private sector firms of all sizes has brought with it a need for vendors to begin developing industry-specific, and even workload-specific, solutions. Today, the ability to create solutions purpose built for economically important HPC domains and use cases is becoming crucial for large-scale vendors that want to address all segments of the HPC market.

**Big Data**

Historically, the HPC market has included Big Data workloads of two main types. First, some M&S jobs have been data intensive (i.e., they have involved much more data processing than computation). Second, a few HPC domains — notably the intelligence community and the financial services industry (FSI) — have long relied heavily on integer-based analytics (as opposed to floating point–based M&S). The back offices ("quants") of large investment banks began using HPC in the late 1980s, especially for pricing exotic instruments, portfolio optimization, and firmwide risk management (high frequency trading was recently added to this mix). Today, a growing number of HPC sites have both M&S and analytics workloads.

Much newer is the trend for large commercial firms to move up to HPC to tackle mission-critical analytics challenges that are too complex and time critical for the firms' enterprise server technology to handle alone. In these cases, HPC servers typically are inserted directly into the live data pipeline. The drivers here are competitive forces and the opportunity to save money (PayPal has saved over $700 million by migrating to HPC).

In 2012, IDC launched the High-Performance Data Analysis (HPDA) service, which tracks both historical data-intensive computing and newer advanced analytics in the commercial sector. Economically important use cases include fraud and anomaly detection, business intelligence, affinity marketing, and personalized ("precision") medicine. Arguably, no IT market has seen a more powerful Big Data explosion than the HPC/HPDA market. An important consequence of this explosion is the need for users to adopt advanced data analytics methods (e.g., Hadoop, Spark). Even more important is the need to elevate storage capacities and capabilities, such as by adding object storage and software-defined storage, to enable effective scaling.
Internet of Things

HPC will almost certainly perform two key functions in the nascent IoT market.

- HPC systems will provide dense nodes needed for local, exceedingly data-intensive, real-time use cases such as managing urban traffic with a mix of human-driven, driverless, and semi-driverless vehicles. Urban traffic management is already an important HPC application around the world, and major automakers are using HPC heavily to develop tomorrow's driverless vehicles, along with the IoT real-time infrastructure that will be needed to support their use.

- HPC will be needed for functional and wellness management of large portions of the global IoT network, such as national-level IoT networks (China’s national IoT plan already calls for HPC management). HPC will also be needed for IoT data tracking and aggregation, especially in network-edge environments.

Technical and Other Challenges

Today, HPC system developers and users face an array of interrelated challenges:

- Developing software capable of efficiently exploiting HPC hardware systems
- Burgeoning system sizes and complexity
- Heterogeneity (CPUs, accelerators)
- New environments (e.g., public clouds)
- Reliability/resiliency requirements
- A mix of compute- and data-intensive workloads
- Energy efficiency
- An influx of small and medium-sized businesses (SMBs) and other commercial users that want "ease of everything"
- The movement from synchronous applications to asynchronous workflows
- A serious shortage of qualified job applicants, especially programmers, system administrators, and others able to bridge the gap between HPC and domain science/engineering/analytics

Together, these challenges represent a daunting agenda for future system development.

Considering HPE

As noted previously, HPE exited 2015 as the clear revenue leader in the expanding worldwide market for all HPC servers, with a 35.9% share of this $11.4 billion market (see Figure 1). In 2015, HPE also captured an even larger 41.1% share of the $3.3 billion supercomputers segment for HPC server systems selling for $500,000+.
FIGURE 1

2015 Worldwide HPC Server Revenue by Vendor

[Histogram diagram showing revenue by vendor, with HPE/SGI leading, followed by Dell, Lenovo, Cray, IBM, Sugon, NEC, Fujitsu, Bull Atos, and Other.]

Source: IDC, 2017

HPE has been ramping up efforts to tackle HPC system and storage challenges head-on. For example, HPE is addressing the Big Compute-Big Data convergence with an expanding lineup of server and storage offerings for the related HPC, deep/machine learning, and IoT markets. The offerings include tailored solutions for financial services, oil and gas, life sciences, and manufacturing.

Concerted R&D Initiatives for HPC

HPE leverages the company’s overall R&D on behalf of the HPC market and also invests substantial R&D funding specifically for HPC. Metagoals are to democratize HPC and make it easier to access, use, and maintain.

Domain Expertise and Centers of Excellence

A prerequisite for these purpose-built solutions is HPE’s deep, expanding domain expertise. The company has been investing in industry consortiums and collaborating with leading academic institutions and other vendors to develop benchmarks and best practices at the intersection of HPC and Big Data.

- HPE and Intel jointly created three HPC centers of excellence (CoEs): one in Grenoble, France; one in Houston, Texas; and one in Bangalore, India. The companies have staffed the centers with deep engineering expertise, vertical industry knowledge, and expertise in performance optimization and code modernization. The centers focus on benchmarking and proof-of-concept work.
HPE and Intel created another CoE at Teratec in Bruyères-le-Châtel, France. Teratec is "a European pole of competence in high-performance digital simulation" and brings together over 80 companies, laboratories and research centers, universities, and engineering schools. The CoE's roles are to showcase new technologies, conduct proof of concepts and performance benchmarks, and develop educational white papers and reference architectures for HPC and Big Data analytics solutions.

HPE is actively engaged in the National Strategic Computing Initiative (NSCI) and is helping provide exascale computing capabilities to the United States to shape the future of the country’s technology direction. To date, HPE has participated in NSCI activities including a congressional panel sponsored by ITIF, OSTP workshops, and meetings with NSCI stakeholders.

**Expanding Product Portfolio for Big Compute, Big Data, and IoT**

HPE's new HPC solutions feature innovations in systems design, workload optimization, density optimization, open source software, and visualization (including software-defined visualization). Together, the innovations aim to accelerate time to value in machine learning/deep learning, energy exploration, mechanical design, financial trading and regulatory compliance, genomic sequencing, and other major HPC domains.

HPE's HPC solutions are designed to be customer centric and technology agnostic. The limited scope of this paper does not permit fuller descriptions, but a mere list of the product portfolio should give some feel for the breadth and depth of HPE's product set, which consists of hardware and software platforms, horizontal solutions, and more. The product portfolio includes the following offerings:

- HPE Apollo 6500 deep learning platform, which has 2U server nodes that can hold up to 8 NVIDIA GPU cards
- HPE Apollo 4520 System high-density, high-scalability, high-resiliency storage server, which can be outfitted with Intel Enterprise Edition for Lustre* software or open source Lustre
- HPE Trade and Match Server, optimized for superior high-frequency financial trading performance
- HPE Risk Compliant Archive for regulatory compliance management in financial services
- HPE Quantitative Finance Library to enhance application software performance by enabling customers to more easily introduce multiple levels of parallelism into their applications
- HPE Next Generation Sequencing solution to enable faster genome assembly and sequencing while decreasing genome sequencing costs
- HPE Moonshot Trader Workstation, designed to maximize trader experience and productivity while lowering total cost of ownership (TCO)
- Apollo 2000 System, highly scalable for HPC workloads, such as ANSYS for CAE, or traditional IT workloads
- Apollo 6000 System, designed for HPC workloads at rack scale
- The new HPE Edgeline IoT Systems, resulting from an HPE-Intel partnership to help deliver proven, open solutions for the IoT market (The HPE Edgeline IoT Systems 10 and 20, as well as the HPE Edgeline 1000 and 4000 systems, sit at the network edge and are designed to enable customers to securely aggregate and analyze data in real time and control devices and things.)
HPE Apollo 8000, a warm water–cooled supercomputer that delivers over 250 peak teraflops per square foot while targeting high efficiency and minimal energy consumption.

The HPE Big Data portfolio, which includes the purpose-built HPE Apollo 4510 System that is tailored for object storage at petabyte scale; HPE Apollo 4530 and 4200 Systems, aimed at Hadoop analytics and other Big Data analytics; and HPE Integrity Superdome X System, designed for workloads benefiting from in-memory computing and real-time analytics.

In addition to these purpose-built platforms, HPE has a comprehensive portfolio of general-purpose compute platforms in the company's HPE ProLiant racks and towers and HPE BladeSystem series. HPE's comprehensive software portfolio includes HPE's Core HPC Software Stack, Insight CMU, Cluster Test, and HPE OneView.

HPE's overall market leadership is fueled by close collaboration and deep relationships with the company's technology partners. The HPE portfolio builds on industry-leading technologies from partners including (but not limited to) AMD, Intel, Mellanox, NVIDIA, Seagate, independent software vendors, and the open source community.

The SGI Acquisition

On November 1, 2016, HPE announced that it had completed the acquisition of supercomputing company SGI. IDC sees the most important benefits of integrating SGI's personnel and technology into the combined company as follows:

- **An enhanced ability to pursue ultrahigh-end, leadership-class supercomputer procurements**, including bids for exascale prototypes and full exascale systems. As noted earlier, before the acquisition HPE was already the leader in the market for supercomputers sold for $500,000 and above. The SGI employees who are now part of HPE are experienced at designing hardware-software systems that compete at the bleeding-edge performance levels that typify leadership-class supercomputers. Prior to the acquisition, HPE was already selling rebranded SGI UV 300 server systems. Following the acquisition, the combined company is migrating technologies from the high-end UV 300 supercomputer to HPE's Superdome product line.

- **Strong capability in HPDA.** SGI's in-memory technology systems captured accounts for commercial advanced analytics, including PayPal and the U.S. Postal Service, where no other vendor could pass the customers' daunting benchmark tests. The combined company will aim to exploit these capabilities as HPE targets the global HPDA market, including organizations that use SAP HANA.

- **More U.S. government opportunities.** SGI's strong experience with U.S. government agencies and accounts, especially through SGI Federal, should help bring the combined company into more of those opportunities.

- **Global services capabilities.** SGI contributes experience providing global technical support services to high-end supercomputing customers in the public and private sectors. This should enhance HPE's strong existing service organization.
Opportunities and Challenges

Opportunities

- Exploit IDC's forecast market growth, HPE's market leader position, and the escalating convergence of Big Compute, Big Data, and IoT. Being the OEM revenue leader in a robust and growing market presents opportunities for further growth, especially as HPC competencies increasingly drive the convergence of advanced computation and advanced analytics and are becoming indispensable for large commercial firms and the nascent IoT market. The SGI acquisition should be especially valuable for pursuing these new HPC market opportunities.

- Maintain HPE's exceptional customer loyalty. IDC studies have shown that with regard to customer loyalty, most HPC vendors' ratings are bunched closely together, but HPE rises above the crowd to form a class of its own. HPE has an opportunity to bank on this valuable asset as the company works to expand its HPC market leadership.

- Successfully integrate SGI personnel and technologies into the company. Not all acquisitions succeed, but indications so far are that HPE is serious about extracting maximum value from the SGI acquisition. HPE has an opportunity to gain value by ensuring that the acquisition goes well.

- Promote HPE's R&D innovation for HPC more assertively. In IDC's opinion, HPE has been overly modest about its R&D investments and innovations benefiting the HPC community. The company has an opportunity to tell this story more assertively in order to receive proper recognition for these contributions.

Challenges

- Ensure that HPE's senior management publicly and consistently expresses the company's long-term commitment to the HPC market. HPE's senior management has taken important steps to demonstrate this commitment, such as creating a dedicated HPC-, Big Data-, and IoT-focused business unit with a strong leadership team; forging an HPC alliance with Intel; engaging deeply in NSCI; and funding several new, long-term R&D initiatives and go-to-market programs.

- Extend HPE's HPC customer base beyond the current large, loyal contingent.

- Grasp and exploit the dynamics of the convergence of Big Compute, Big Data, and IoT.

Conclusion

HPE is now the clear revenue leader in the fast-growing worldwide market for HPC servers, valued at $11.4 billion in 2015, and in the $3.3 billion supercomputers segment of the market. The company’s winning strategy started with a long-term commitment to the HPC market, both in its own right and as an effective lever for opening up major new opportunities for Big Compute, Big Data, and IoT, all of which face crucial challenges that need to be addressed by the global HPC community. HPE's product portfolio is comprehensive enough to cover the vast majority of HPC user/buyer requirements — and the newly announced products move that collection substantially forward. HPE has also been growing its domain-specific solutions for economically important vertical segments, along with the domain expertise that enables peer-to-peer sales and support. HPE has been ramping up R&D for its HPC strategy, from new technology initiatives to centers of excellence where promising new technologies and ideas can be evaluated and benchmarked. The addition of SGI has strong potential to accelerate HPE's strategy while jump-starting HPE's entry into promising new HPC market segments. IDC predicts that by 2019, the global market for HPC servers will reach $15.3 billion and the whole HPC market — servers, storage, software, and service — will be worth about double that amount. We believe that HPE's existing leadership status, combined with the company's long-term
commitment and strategy for this market, positions the company well to exploit our forecast growth for the interrelated HPC Big Compute, Big Data, and IoT markets. For HPE, as for any major vendor, it will be challenging to anticipate and respond effectively to the increasingly complex dynamics of the HPC market, but the company so far has shown an impressive ability to do so.

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