HYPERION RESEARCH TECHNOLOGY SPOTLIGHT

Linux and Open Source Are Driving HPC into New High-Growth Markets

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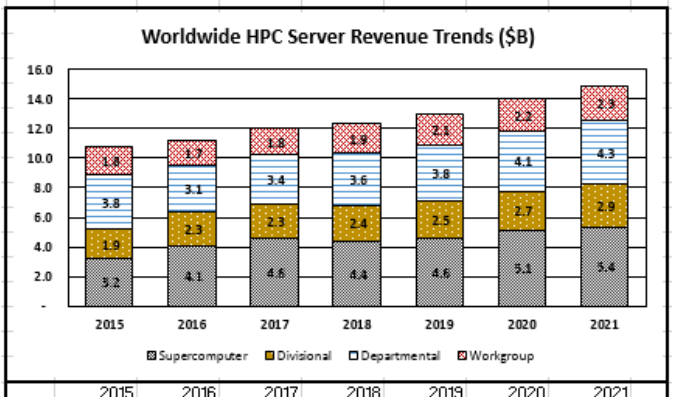
Sponsored by SUSE

The Linux operating system dominates high performance computing (HPC) and has played an important role in making HPC one of the fastest-growing IT markets. The fastest component of the market's projected growth is high performance data analysis (HPDA), where burgeoning new markets for HPC and Linux include machine learning and deep learning, cognitive computing, and artificial intelligence–and new use cases range from self-driving vehicles to smart cities, precision medicine, and the Internet of Things (IoT). In addition, Linux pioneered the open source software movement that is now rapidly advancing into all parts of the HPC software ecosystem. This paper reviews the new growth opportunities for HPC, using Linux and open source software pioneer SUSE to illustrate how a vendor is positioning itself to benefit from this forecast growth.

Rapid Growth of the Worldwide HPC Market

Since 2001, HPC has been one of the world's fastest-growing IT markets. Between 2001 and 2016, worldwide revenue for HPC server systems more than doubled from $4.8 billion to $11.2 billion, en route to an IDC-predicted value of $14.8 billion in 2021. When software, storage, and service are added to the mix, the 2021 HPC forecast approaches $30 billion. About $5.1 billion of the $30 billion total will come from HPDA server and storage sales, including new commercial market segments for fraud and anomaly detection, business intelligence, affinity marketing, and precision medicine.



	2015	2016	2017	2018	2019	2020	2021
Total	10.7	11.2	12.0	12.3	13.0	14.0	14.8

Source: Hyperion Research, 2017

Importance of the Operating System For HPC Market Growth

The market for HPC systems has expanded over time by adapting to the requirements of successive waves of new users – in large part through advances in software. As HPC has extended from government and university researchers into private sector markets, each new wave of users has expected HPC system vendors to do more for them, by providing software to make these systems easier to deploy and use.

These challenges fall heavily on the HPC operating system, which has evolved substantially over time and is evolving even more rapidly today. Prominent challenges confronting HPC operating systems today include scaling to larger system sizes, enabling enough reliability and resiliency to finish long-running jobs, and handling more heterogeneous data and a larger variety of workload types.

LINUX GROWTH IN THE HPC-HPDA MARKET

Linux was introduced in 1991 and first appeared on the semi-annual list of the world's top 500 supercomputers ("Top500 list") in June 2001, with a share of just 8.9% of the computers–compared with an 88.5% share for UNIX variants.

Fast forward to the November 2016 Top500 list and the fortunes are more than reversed. UNIX still appears, with a miniscule share of 0.4%, while the remaining 99.6% share belongs to Linux. The Linux success story doesn't end there. HPC server systems, with Linux on board, have been moving rapidly into emerging markets for HPDA. As noted earlier, IDC forecasts that the HPDA portion of the worldwide HPC market will exceed $5 billion in 2021, or about one-sixth of the value of the whole HPC market in that year.

BENEFITS OF THE OPEN SOURCE MODEL

The software development model pioneered by Linux is rapidly spreading to all parts of the HPC/HPDA software ecosystem, especially system software and software tools. In this model, software development is driven primarily by the open source community and vendors offer supported distributions with additional capabilities for customers that require and are willing to pay for them. As the Linux initiative demonstrates, this type of community-based, vendor-catalyzed model has major advantages for enabling software to keep pace with requirements for HPC and storage hardware systems. The Linux model has demonstrated the compelling benefits of the collaborative, open software ecosystem approach for HPC vendors and users alike:

- First and foremost, as noted previously, this model helps ensure that the software keeps pace with burgeoning user requirements – thereby making the HPC system a more productive, higher-returning investment. This model delivers more new capabilities to users and delivers them sooner.
- Programmers and other developers gain faster access to new capabilities, including features that can relieve them of explicit, labor-intensive work.
- Vendors can select the best open source components for baseline functions while focusing more of their R&D budgets and efforts on development targeted at providing competitive differentiation. In other words, open source software can act as an offset to vendors' R&D expenses.
- Last but not least, the open versions seed the community with potential new users of the paid versions who may want additional support or enhanced stability for production computing environments. A portion of users who become accustomed to employing the free version will want the paid version later. (For example, think of students who are later employed by HPC sites needing vendor-supported software.)

TODAY'S HIGH-GROWTH MARKETS

The worldwide server and storage markets for HPDA (big data needing the power of HPC) have been growing at a compound annual growth rate (CAGR) above 20%, about three times faster than the historical HPC market. The four HPDA use cases defined below are already large enough to constitute

new HPC commercial market segments. Business intelligence is the fastest-growing of the four segments today, and precision medicine promises to become the most economically important HPDA segment over time (health care spending in the U.S. alone is expected to reach $4.8 trillion in 2021).

These existing HPDA use cases, along with the emerging use cases discussed in the next section, will exploit a mix of emerging methodologies: graph and semantic analysis, machine and deep learning, cognitive computing, and early artificial intelligence (AI). The forefront of research using these methodologies has already moved to HPC.

- **Precision Medicine:** a medical model based on customizing healthcare, with medical decisions, practices, and products tailored to the individual patient, or to patients with very similar constitutions and symptomologies, rather than today's standardized procedures applicable to all patients. HPC is helping to lead the way toward precision medicine, especially by acting as a decision-support tool for physicians and other providers, with the help of fast, HPC-enabled DNA sequencing.
- **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 cybersecurity crime or insider threats, significant errors, or other anomalies that may deserve further investigation.
- **Affinity 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.
- **Business Intelligence:** This 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. Solutions such as SAP HANA and in-memory computing are important for this use case.

TOMORROW'S HIGH-GROWTH MARKETS

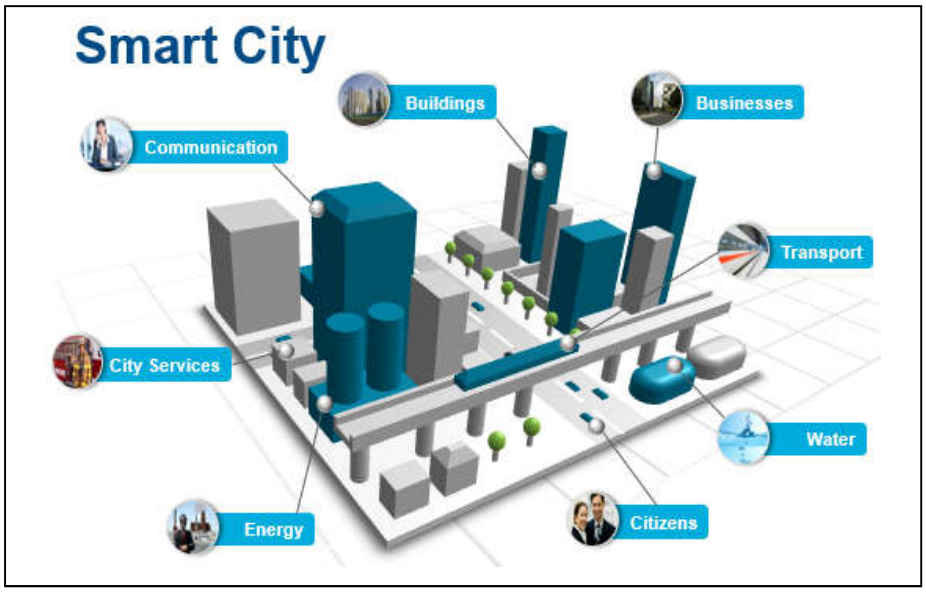
In addition to the four new commercial market segments just described, two major new use cases for HPC resources are emerging. Each of these use cases is a logical extension of tasks HPC systems have been handling for years, because only HPC systems have the fast communication rates and capacious memories needed to support these complex, time-critical tasks.

Smart Vehicles, Power Grids, and Cities

- **Smart vehicles**. HPC is already used to help design every major car and truck in the world, and HPC has been used since the 1990s to manage vehicle traffic in large cities. It should therefore not be surprising that carmakers are relying heavily on HPC systems to help them design tomorrow's self-driving vehicles and—even more challenging—the four-dimensional environments they will operate in, with fast-changing mixtures of conventional and smart vehicles. Multiple major automakers have privately briefed Hyperion Research analysts on their HPC-enabled plans for smart vehicles.
- **Smart Power Grids.** This is another important use case that in recent years has been pushed up into the HPC competency space by requirements for large memories and lightning-fast communication rates. Capturing, analyzing, and reporting power usage for millions of businesses and residences is a challenge ready-made for supercomputers. In addition, it takes faster-than-human communication to poll thousands of sensors to prevent a local power failure from cascading into a regional or national outage.
- **Smart Cities**. Start with smart vehicles and smart power grids as discussed above, add smart buildings, and you can begin to imagine how important HPC systems will be for managing the

smart cities of the future. That task will require processing vast amounts of data in fractions of a second, something beyond the abilities of typical enterprise server systems.

Smart City HPC Applications



Internet of Things (IoT)

HPC and its data-intensive incarnation, HPDA, have already begun to play key roles in the nascent IoT market.

- **IoT Local Dense Nodes.** HPC systems will provide the dense nodes needed for local, exceedingly data- and communications-intensive, real-time IoT applications. These include aforementioned smart city tasks such as traffic and power management, but dense nodes will dot the landscape far beyond urban areas–essentially anyplace where big computing and big data converge today, or will do so in the future.
- **IoT Network Management.** HPC will be needed for functional and wellness management of constituent areas of the global IoT, such as regional and national IoT networks. For example, China's IoT plan, which extends out to the year 2030, is based on an HPC operating system and exploitation of the ultrafast communication rates that properly configured HPC systems provide.
- **IoT Edge Computing.** This is a different application of HPC in local dense nodes. In the most serious applications of IoT edge computing, it will make sense to process mountains of data coming from sensor networks locally, rather than send all that data across large distances.

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SUSE: A Linux and Open Source Technical Leader Ramps Up Market Growth

SUSE is a highly regarded, successful Linux and open source pioneer. Founded in 1992, the year after Linux was announced, the company quickly gained a strong reputation as a technology innovator, contributing important new developments to the open source Linux community and to support SUSE's growing base of customers who want special added capabilities in a vendor-supported Linux distribution.

From its headquarters in Germany (Nuremberg), SUSE has expanded its presence in the global Linux market. For a time, global expansion was slowed by a series of ownership changes that didn't provide SUSE with adequate resources and attention to pursue this goal aggressively. The situation changed for the better when SUSE was acquired by Micro Focus International in November 2014. Today, SUSE reports that it's growing in Europe, the Americas, the Asia-Pacific region, and Africa, with revenue up nearly 20% per annum in the past two years. That's about three times the growth rate (CAGR) of the worldwide HPC market.

SUSE Products

The company's Linux and other open source products extend across physical, virtual, and cloud environments. In the latter category, SUSE is increasingly popular on Amazon Web Services and is the only commercial Linux HPC operating system supported on Microsoft's Azure public cloud.

SLES. The company's growth in the global HPC market centers around SUSE Enterprise Linux Server (SLES) and its strengths for HPC users. Chief among these are the following:

- Support for x86, ARM and Power architectures, including leadership in enabling 64-bit ARM processors for HPC/HPDA workloads
- Strong support for open-source HPC tools, including a new "HPC Module" to accelerate the introduction of new innovations
- Common code base across all HPC/HPDA hardware architectures
- Native POSIX thread library
- Advanced multi-pathing and I/O capabilities
- Kernel features designed to support maximum performance
- Simplified product structure for easier ordering
- Companion products such as SUSE OpenStack Cloud and software-defined SUSE Enterprise Storage whose features are becoming increasingly important for HPC and HPDA workloads
- Market leader for enablement of 64-bit ARM processors targeted for HPC/HPDA workloads

SUSE OpenStack Cloud. This product is based on OpenStack, the most popular solution for private clouds today. SUSE's implementation provides access to automated pools of high-performance infrastructure-as-a-service (IaaS) resources that are managed from users' data centers. SUSE OpenStack integrates with Ceph-based SUSE Enterprise Storage to provide software-defined storage capabilities. Key features of SUSE OpenStack Cloud include:

- Streamlined installation
- Tight integration with other SUSE products
- High reliability and production readiness
- Support for SLES 12 Service Pack 2

SUSE Partnerships

SUSE's growth strategy leverages a strong, growing network of partnerships that covers established HPC markets and new HPC directions such as cloud computing and big data analytics. Among the company's key partners are Amazon Web Services, Cisco, Dell, Fujitsu, Hitachi, HP Enterprise-SGI, IBM, Intel, Lenovo, Microsoft, SAP, and VMware.

The partnerships extend beyond these stellar names. For example, the Cray Linux Environment that drives some of the world's most powerful supercomputers is Cray's customized version of the SLES operating system. SUSE also has a successful partnership with Bright Computing, known in the HPC sector for combining ease-of-learning with strong functionality.

SUSE is also an active member of the OpenHPC community, which has shown strong momentum for its mission to revolutionize HPC software development through collaborations between vendors and the open source community.

SUSE Markets

Although SLES for HPC drives some of the world's most powerful public-sector supercomputers, SUSE is especially strong in commercial environments that buy midrange HPC systems and place an especially high value on ease-of-use, along with strong service and support capabilities. HPC vertical segments where SUSE has special strength include:

- Automotive
- Oil and gas
- Financial services
- Advanced commercial analytics

Opportunities and Challenges

This section describes opportunities and challenges Hyperion Research sees for SUSE.

Opportunities

- **Expand SLES Market Share**. SUSE has been on a roll recently, capturing Top500 accounts and other prestigious business and expanding its share of the global HPC/HPDA market for paid Linux distributions to an estimated 20%. The company is well positioned to capture more of the remaining 80% of the market.

- **Exploit Private Cloud Growth.** Hyperion Research recent studies show that the market for private HPC/HPDA clouds is growing substantially faster its public cloud counterpart. SUSE's OpenStack implementation is aimed squarely at this private cloud market and has an opportunity to match or even outpace the growth rate of the market itself, which Hyperion Research estimates at 15-20% a year.

- **Push into HPDA High Growth Markets.** The strong industrial-commercial experience built into SUSE's product portfolio positions the company well to move assertively into data-intensive (HPDA) high growth markets as described above. (Commercial-grade software products will also be needed on the public-sector side of the nascent markets for smart cities and IoT.) SLES and subsequent SUSE offerings have evolved historically in a way that has already equipped them with many of the capabilities that will be needed in the new high growth markets, such as the ability to handle both big compute and big data, heterogeneous architectures and environments (e.g., on premise and cloud), and reliability/resiliency at extreme scale, to name just a few.

Challenges

- **Keep Pace with Evolving Requirements.** The HPC/HPDA market has entered a period of accelerated change. During a time like this, it's especially challenging for vendors to address customers' existing and anticipated needs. Historically, SUSE has demonstrated an impressive ability to adapt to changing requirements, but SUSE and other software vendors will need to exercise strong focus and flexibility through the next 5-10 years.

- Control Growth. It may be tempting for companies with strong product portfolios and substantial addressable markets to pursue every opportunity that arises, but supporting the resultant mix of one-off accounts is usually unprofitable and defocuses the business. SUSE to date has shown no tendency to abandon its focus, but SUSE and other HPC/HPDA software vendors will need to remain vigilant about this.

Conclusion

Linux and open source pioneer SUSE for some years was known as a technology leader that focused almost exclusively on the European HPC market. The company's early attempts to become a global player were stymied by a succession of owners that didn't give SUSE enough attention and resources for this expansion. That changed for the better with Micro Focus' November 2014 acquisition of SUSE. During the past two years, the company's revenues have grown at a nearly 20% per annum rate and SUSE is finding success across the globe. The company's leading-edge Linux and other open source capabilities, centering on SLES and SUSE OpenStack, position the company well to exploit the robust growth Hyperion Research predicts for the HPC and HPDA markets through 2021 and beyond, as HPC growth carries Linux into new markets and as the open source movement accelerates. Hyperion sees SUSE's growth potential as especially strong in new high growth markets employing data-intensive methods such as graph and semantic analysis, machine and deep learning, cognitive computing and early AI, as well as applications related to smart cities and the IoT. SUSE will do best, in our opinion, by continuing its focus on markets with repetitive opportunities and SUSE's proven ability to adapt to the rapidly changing requirements that characterize the HPC/HPDA market.

About Hyperion Research

Hyperion Research is the new name for the former IDC high performance computing (HPC) analyst team. As Hyperion Research, the team continues all the worldwide activities that have made it the world's most respected HPC industry analyst group for more than 25 years, including HPC and HPDA market sizing and tracking, subscription services, custom studies and papers, and operating the HPC User Forum. For more information, see www.hpcuserforum.com.