

FROST & SULLIVAN

BEST PRACTICES

AWARDS

FROST & SULLIVAN

2020 BEST PRACTICES AWARD



PAVILION

**2020 NORTH AMERICAN HYPERPARALLEL
FLASH ARRAY FOR DATA STORAGE
TECHNOLOGY INNOVATION AWARD**

Contents

| | |
|--------------------------------------------------------------------------------------------------------------|-----------|
| <i>Background and Company Performance</i> | <i>3</i> |
| <i>Industry Challenges.....</i> | <i>3</i> |
| <i>Technology Attributes and Future Business Value.....</i> | <i>3</i> |
| <i>Conclusion</i> | <i>7</i> |
| <i>Significance of Technology Innovation.....</i> | <i>8</i> |
| <i>Understanding Technology Innovation.....</i> | <i>8</i> |
| <i>Key Benchmarking Criteria</i> | <i>9</i> |
| <i>Technology Attributes</i> | <i>9</i> |
| <i>Future Business Value.....</i> | <i>9</i> |
| <i>Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices.....</i> | <i>10</i> |
| <i>The Intersection between 360-Degree Research and Best Practices Awards.....</i> | <i>11</i> |
| <i>Research Methodology</i> | <i>11</i> |
| <i>About Frost & Sullivan</i> | <i>11</i> |

Background and Company Performance

Industry Challenges

Flash storage has been in the market for many years and is considered the most adaptable type of storage system. Most enterprises are adopting either virtualized or centralized data centers or cloud systems for storing data; however, by adopting advanced flash storage platforms, a company's performance and capacity requirements are met effectively at a low cost. For data storage, companies require devices that consume low power, and flash storage platforms, such as adaptive flash, hybrid flash, and all-flash array (AFA) storage, can provide such advanced storage systems.

In a shared storage database architecture, however, a simple architecture, high-performance, and high-density storage devices are needed. Traditional flash storage systems integrated with the nonvolatile memory express (NVMe) drive in both AFA and direct attached storage (DAS) are unable to meet these demands because of their dual storage controller architecture, which affects the scalability, performance, and density of the flash storage device.

Companies in this space need to develop AFA storage with a software-defined and composable architecture to address industry-critical applications that provide solutions for artificial intelligence (AI), machine learning (ML), and Big Data analytics applications.

Technology Attributes and Future Business Value

California-based Pavilion Data Systems Inc has developed a NVMe over Fabrics (NVMe-oF) storage platform called Hyperparallel Flash Array for parallel applications, thus enabling an end-to-end solution, from the host to the media. In addition, the company has developed the OpenChoice Storage™ licensing model that allows customers to integrate their solid-state drives (SSDs) with Hyperparallel Flash Array, resulting in the upgradation of the SSDs.

Industry Impact and Product Impact

Pavilion Data Systems' NVMe-oF storage platform is an ultra-modular 4U chassis array, which is 100% compliant with several standards, such as NVMe-oF/transport control protocol (TCP) and remote direct memory access (RDMA), and provides seamless, independent performance and capacity expansion. The NVMe-oF technology leverages peripheral component interconnect express (PCIe) for linking, computing, and storing data, similar to the traditional DAS array. This storage design architecture is defined as rack-scale flash, with NVMe providing end-to-end fabric connectivity for shared storage, and is designed to use both present and future memory-class media.

Unlike conventional storage arrays that have two flash storage controllers that manage only 6 NVMe drives, Pavilion Data Systems' Hyperparallel Flash Array storage platform can support up to 72 NVMe SSDs, while performing data management using thin provisioning and snapshots and clones that provide true performance without unnecessary proprietary drivers or the software burdening the host. Hyperparallel Flash Array has a performance of 120 gigabytes per second (GB/s) for read applications and 90 GB/s for write throughput,

with a latency of 40 microseconds using redundant array of independent disks (RAID)-6 protection, whereas traditional rack-scale server systems deliver 800,000 read input/output operations per second (IOPS) with a 100-microsecond latency time period. Moreover, the Hyperparallel Flash Array storage platform provides fast SWARM recovery for RAID rebuilding and consistency groups for snapshots. With the enhanced SWARM Recovery feature, a single SSD can be restored at the rate of less than 5 minutes per terabyte, compared to the traditional storage array that typically consumes 25 minutes per terabyte. The company's storage platform allows users to repurpose storage media to move from a consumable to a reusable asset. Moreover, this solution has no single point of failure because of its true redundant controllers, dual parity RAID, which allow customers to gain the profits of shared resources.

Pavilion Data Systems strategically collaborates with other industry participants, such as Tier I software firms and suppliers of computer networking products (e.g., VMware, Dell, IBM, and MongoDB), to develop solutions for specific application workloads, such as AI, ML, and deep learning. For example, in 2016, Pavilion Data Systems collaborated with Mellanox Technologies to leverage Mellanox ConnectX network interface cards (NICs) to deliver the excellent performance of end-to-end smart interconnect solutions for data center servers and storage systems. In addition, this partnership focuses on the development of integrated networking solutions that accelerate NVMe-oF. Pavilion Data Systems' Hyperparallel Flash Array storage platform has achieved world-record performance against all other publicly disclosed systems, including DAS SSD storage systems and Intel Optane drives, in four Securities Technology Analysis Center (STAC)-M3 analytical benchmarks.

Frost & Sullivan research indicates that compared to competing solutions, Pavilion Data Systems' storage platform excels at generating extremely high-performance, high-density storage but with the economic and operational benefits of shared storage, thus enabling the technology to compete against and displace traditional DAS arrays in several areas, such as data centers.

Scalability

Pavilion Data Systems' Hyperparallel Flash Array storage platform, based on NVMe-oF, enhances the company's core competency by achieving a high-performance, high-density, and low-latency storage platform, thus enabling opportunities for a wide range of applications. For example, the company's storage platform can scale up to 20 storage controllers to support up to 1 petabyte of capacity in a 4U footprint. Pavilion Data Systems' OpenChoice Storage business model provides the company with this flexibility to scale applications for its customers. Moreover, to offer a scalable technology, Pavilion Data Systems has developed a patented configurable storage system architecture and processes that customers can integrate into different network fabrics to address more applications with increased performance and functionality.

With Internet of Things (IoT) connected devices fostering the global storage market, Frost & Sullivan finds significant value in Pavilion Data Systems' NVMe-oF technology, which is

well suited to address future IoT needs by analyzing, processing, and achieving the maximum performance density in storing petabytes of data cost effectively.

Customer Acquisition

Pavilion Data Systems' Hyperparallel Flash Array storage platform and OpenChoice Storage model have received positive feedback from market participants and from the company's large client base in the webscale, financial services, scale-out government research, and media and entertainment sectors. For example, the Central Bureau of Statistics (CBS) in the Netherlands is utilizing Pavilion Data Systems' VMware consolidation over several traditional all-flash arrays because of its high performance and footprint manageability. Therefore, Pavilion Data Systems has a strong competitive edge in the market, where demand is focused on high performance, high fault tolerance, and high performance density at a reasonable cost.

Since its establishment in 2014, Pavilion Data Systems has raised \$58 million in funding from investors, including Kleiner Perkins, Korea Investment Partners, DAG Ventures, Artiman Ventures, SK Telecom, Taiwania Capital, RPS Ventures, and Tyche Partners. The company has been using this funding to continue accelerating its development of its Hyperparallel Flash Array storage platform based on NVMe-oF, thereby entering into new markets and expanding the team to support customer demand. The technical superiority of the Hyperparallel Flash Array and OpenChoice Storage business model has enabled Pavilion Data Systems to acquire customers that intend to integrate the technology into their platforms. For example, customers can purchase their own SSDs to use on the platform, thus driving Pavilion Data Systems' continued customer acquisition.

Since 2018, the company has been shipping products through channel partners and has further increased its customer base by aggressively marketing its Hyperparallel Flash Array storage platform and reaching out to targeted segments, such as research facilities and retail banking. By segmenting its customer base, Pavilion Data Systems can acquire new customers by actively engaging with potential customers and by participating in various technical events and workshops (e.g., VMworld Barcelona and Flash Memory Summit) to showcase its products worldwide.

Frost & Sullivan research indicates that as a key value proposition, Pavilion Data Systems' technology development, with high performance, high density, and reduced costs, is a major factor in attracting more customers. Moreover, Pavilion Data Systems is planning to increase its customer base in the near term by partnering with undisclosed Tier I and Tier II customers.

Technology Licensing

Pavilion Data Systems, a technology-driven company, utilizes a business-to-business (B2B) licensing model as one of its key monetization strategies. The company has demonstrated its long-term commitment to the storage domain by filing 20+ patents worldwide related to flash storage server architecture, minimized data read latency for SSDs, and the remote access of SSDs. To support its technology licensing revenues, Pavilion Data Systems developed a disruptive business model called OpenChoice Storage

that allows customers to restore and upgrade their storage media-on-demand cost effectively, based on their application needs, budgets, and technology availability. Unlike traditional storage vendors that license their software based on storage system capacity, Pavilion Data Systems' OpenChoice Storage model provides the license to customers for storage controllers, support, and maintenance.

Frost & Sullivan recognizes Pavilion Data Systems ability to craft a powerful strategy of licensing its formidable intellectual property (IP) portfolio and business model, enabling linear scaling and higher performance density storage that overcome the limitations in other storage solutions, such as NVMe compatibility issues in flash storage arrays.

Human Capital

Pavilion Data Systems' highly efficient resources and strong IP are key factors that have contributed to its development of the industry-leading, ultra-fast, and rack-scale NVMe-oF storage platform. To date, the company has about 95 employees in its California, Europe, and India offices who offer high technical expertise in storage system architecture, network switch design, dense micro-server architecture, and SSD storage technology, thus serving global customer requirements.

Pavilion Data Systems nurtures a diverse work culture that promotes technological innovation. Employees credit the company for providing them with the flexibility to execute their duties, thus ensuring a fast turnaround time on proposed ideas and offering customized solutions by receiving continuous feedback and strongly engaging with clients. Consequently, the company maintains a high employee retention rate, with several employees in the 5+ years-of-service bracket. The skills of its technologists have enabled the company to file key patents related to its unique non-volatile memory express networking and storage methods. By focusing on advancing innovation in its NVMe-oF storage platform through its IP portfolio, team of engineers, and experienced leadership and by establishing a culture of innovation and creativity, Pavilion Data Systems has gained a strong competitive advantage in the industry.

Conclusion

Pavilion Data Systems' Hyperparallel Flash Array storage platform, powered by NVMe-oF technology, has the potential to overcome the shortcomings of existing traditional AFA and DAS platforms for simple, high-performance, and high-density storage and is positioned to become a significant standard for rack-scale NVMe-oF storage systems in the future.

High performance in storage platforms and the ability to reduce operational problems are critical needs for massively parallel applications, such as AI, ML, and deep learning, that demand more advanced storage platforms than flash arrays. This need is driving the adoption of the company's NVMe-oF storage platform. Furthermore, Pavilion Data Systems' technology can be integrated into existing facilities to enhance and streamline applications in a wide range of industries, including webscale, financial services, scale-out government research, and media and entertainment.

For its strong overall performance and ability to enhance the performance of flash storage, Pavilion Data Systems is recognized with Frost & Sullivan's 2020 Technology Innovation Award for its Hyperparallel Flash Array in the North American data storage industry.

Significance of Technology Innovation

Ultimately, growth in any organization depends on finding new ways to excite the market and maintaining a long-term commitment to innovation. At its core, technology innovation, or any other type of innovation, can only be sustained with leadership in 3 key areas: understanding demand, nurturing the brand, and differentiating from the competition.



Understanding Technology Innovation

Technology innovation begins with a spark of creativity that is systematically pursued, developed, and commercialized. That spark can result from a successful partnership, a productive in-house innovation group, or a bright-minded individual. Regardless of the source, the success of any new technology is ultimately determined by its innovativeness and its impact on the business as a whole.

Key Benchmarking Criteria

For the Technology Innovation Award, Frost & Sullivan analysts independently evaluated two key factors—Technology Attributes and Future Business Value—according to the criteria identified below.

Technology Attributes

Criterion 1: Industry Impact

Requirement: Technology enables the pursuit of groundbreaking ideas, contributing to the betterment of the entire industry.

Criterion 2: Product Impact

Requirement: Specific technology helps enhance features and functionalities of the entire product line for the company.

Criterion 3: Scalability

Requirement: Technology is scalable, enabling new generations of products over time, with increasing levels of quality and functionality.

Criterion 4: Visionary Innovation

Requirement: Specific new technology represents true innovation based on a deep understanding of future needs and applications.

Criterion 5: Application Diversity

Requirement: New technology serves multiple products, multiple applications, and multiple user environments.

Future Business Value

Criterion 1: Financial Performance

Requirement: Potential is high for strong financial performance in terms of revenue, operating margins, and other relevant financial metrics.

Criterion 2: Customer Acquisition

Requirement: Specific technology enables acquisition of new customers, even as it enhances value to current customers.

Criterion 3: Technology Licensing

Requirement: New technology displays great potential to be licensed across many verticals and applications, thereby driving incremental revenue streams.

Criterion 4: Brand Loyalty

Requirement: New technology enhances the company's brand, creating and/or nurturing brand loyalty.

Criterion 5: Human Capital

Requirement: Customer impact is enhanced through the leverage of specific technology, translating into positive impact on employee morale and retention.

Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

Frost & Sullivan analysts follow a 10-step process to evaluate award candidates and assess their fit with select best practices criteria. The reputation and integrity of the awards are based on close adherence to this process.

| STEP | OBJECTIVE | KEY ACTIVITIES | OUTPUT |
|---------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| 1 Monitor, target, and screen | Identify award recipient candidates from around the world | <ul style="list-style-type: none"> • Conduct in-depth industry research • Identify emerging industries • Scan multiple regions | Pipeline of candidates that potentially meet all best practices criteria |
| 2 Perform 360-degree research | Perform comprehensive, 360-degree research on all candidates in the pipeline | <ul style="list-style-type: none"> • Interview thought leaders and industry practitioners • Assess candidates' fit with best practices criteria • Rank all candidates | Matrix positioning of all candidates' performance relative to one another |
| 3 Invite thought leadership in best practices | Perform in-depth examination of all candidates | <ul style="list-style-type: none"> • Confirm best practices criteria • Examine eligibility of all candidates • Identify any information gaps | Detailed profiles of all ranked candidates |
| 4 Initiate research director review | Conduct an unbiased evaluation of all candidate profiles | <ul style="list-style-type: none"> • Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles | Final prioritization of all eligible candidates and companion best practices positioning paper |
| 5 Assemble panel of industry experts | Present findings to an expert panel of industry thought leaders | <ul style="list-style-type: none"> • Share findings • Strengthen cases for candidate eligibility • Prioritize candidates | Refined list of prioritized award candidates |
| 6 Conduct global industry review | Build consensus on award candidates' eligibility | <ul style="list-style-type: none"> • Hold global team meeting to review all candidates • Pressure-test fit with criteria • Confirm inclusion of all eligible candidates | Final list of eligible award candidates, representing success stories worldwide |
| 7 Perform quality check | Develop official award consideration materials | <ul style="list-style-type: none"> • Perform final performance benchmarking activities • Write nominations • Perform quality review | High-quality, accurate, and creative presentation of nominees' successes |
| 8 Reconnect with panel of industry experts | Finalize the selection of the best practices award recipient | <ul style="list-style-type: none"> • Review analysis with panel • Build consensus • Select recipient | Decision on which company performs best against all best practices criteria |
| 9 Communicate recognition | Inform award recipient of recognition | <ul style="list-style-type: none"> • Present award to the CEO • Inspire the organization for continued success • Celebrate the recipient's performance | Announcement of award and plan for how recipient can use the award to enhance the brand |
| 10 Take strategic action | Upon licensing, company is able to share award news with stakeholders and customers | <ul style="list-style-type: none"> • Coordinate media outreach • Design a marketing plan • Assess award's role in strategic planning | Widespread awareness of recipient's award status among investors, media personnel, and employees |

The Intersection between 360-Degree Research and Best Practices Awards

Research Methodology

Frost & Sullivan's 360-degree research methodology represents the analytical rigor of the research process. It offers a 360-degree view of industry challenges, trends, and issues by integrating all 7 of Frost & Sullivan's research methodologies. Too often companies make important growth decisions based on a narrow understanding of their environment, resulting in errors of both omission and commission. Successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. The integration of these research disciplines into the 360-degree research methodology provides an evaluation platform for benchmarking industry participants and for identifying those performing at best-in-class levels.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS



About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, helps clients accelerate growth and achieve best-in-class positions in growth, innovation, and leadership. The company's Growth Partnership Service provides the CEO and the CEO's growth team with disciplined research and best-practices models to drive the generation, evaluation, and implementation of powerful growth strategies. Frost & Sullivan leverages nearly 60 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on 6 continents. To join Frost & Sullivan's Growth Partnership, visit <http://www.frost.com>.