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Application Note

EMPOWERING HIGH PERFORMANCE COMPUTING (HPC) RESEARCH APPLICATIONS WITH FUTURE-ENABLED INFRASTRUCTURE

Single-row, Micro-Module, High density enclosure designed for HPC/AI applications

AP-SS/135

Introduction

Modern science and education have progressed rapidly bearing fruit from leap frogging of technological advancements. Over time, HPC systems have gained a lot of significance in the field of Educational & Scientific research, Life sciences, Automotive manufacturing and Oil & Gas which demand enormous computing capabilities at varied application platforms.

However, to cope with this high demand in research labs, these HPC systems have to be pre-configured and executed with the right infrastructures to perform efficiently and effectively. As a result, HPC systems are relatively unique and pose quite a challenge in the deployment stage.

High-performance Computing (HPC) solves the problem of large-scale scientific computing and massive concurrent data processing by increasing the speed of computation through parallel computing.

Today's HPC is no longer limited to traditional 'high-performance' fields such as Scientific Research, Military, Petroleum and Petrochemical, but is also rapidly popularized in Life Science, Finance, Healthcare, Artificial Intelligence, Data Analysis and other industries. There is a broad demand for HPC application in various sectors and industries.

In order to perform such a huge computing task across hundreds and thousands of nodes, HPC applications need the strong hand from the supporting infrastructure, such as Power systems, cooling and other distribution pieces, along with a superlative high density enclosure which can integrate all these functions in a way that it can reliably unburden organizations from maintaining the non-specialized areas and allow them to focus more on research applications. This paper focuses on defining this innovative supporting infrastructure for HPC applications.

Technology Trends

For decades, specialized computing resources were necessary to help researchers and scientists to extract insights from massive data sets. The requirement of large budget for infrastructure has restricted the application of HPC in the domain of top-tier research universities, global banks and the energy industry. However, in the last few years HPC has become more accessible to growing number of new segments and industry sectors with parallel computing on a large number of servers proving to be more efficient than specialized systems which is very exciting. Some of the major HPC trends are:

From Data collection to Data Insights

Due to the rise of the internet, Wi-Fi and mobile devices; the challenge of collecting massive data sets got minimized. As a result, the researchers and scientists now have the opportunity to spend more time refining the data and extracting insights from it with the help of High performance computing.

The Big Data on HPC has become an indispensable scientific tool for universities and research institutions to analyze huge data clusters and deriving key values lie in it.

Recently, as the ecosystem surrounding AI is getting mature enough, massive data sets are now being used to train machine learning models, while computing capacity has increased to train larger and more complex models faster. Now-a-days, AI finds its application across many fields like healthcare, robotics and automation to influence the major life criticality.

Artificial Intelligence goes mainstream

Rise in GPU computing

When it comes to high performance computing, it's all about the Graphics Processing Unit (GPU). Originally built for high resolution gaming, GPUs are now being used to perform data intensive work ranging from machine learning to self-driving cars. GPUs have proven to be superior chips for processing HPC workloads due to their singular focus on data computations. The self-driving cars require huge computing all the time during the ride for constant safety.

HPC Deployment: Key Concerns

Constant transformation in Information technologies has been rapidly changing HPC configuration; therefore, organizations who have a designated IT infrastructure, that can house top notch technologies, often gain a competitive advantage by leveraging the latest technology.

The main challenge for research establishments is the proper placement of high-density systems, specified by the right power and cooling solutions to deal with it. When the HPC system is put into organization's main computer room, it will potentially have a negative impact on the other IT systems in the data center by creating hot-spots or disrupting airflow. This is because the traditional business critical IT systems do not have the same characteristics as the HPC.

Due to lack of investment knowledge or ineptness in providing appropriate power and cooling solutions, the server environment is often over engineered or under-specified which leads to multiple data centers or computer rooms in the same environment. Eventually, the IT infrastructure costs more and become not fit for the purpose.

In addition as systems in the IT infrastructure continue to scale in size due to the adoption of many enterprise applications, the power consumption will become a major concern for future generation supercomputers. Current systems consume more than a Megawatt per Peta-flop. Achieving exascale levels of computation - a 100x improvement in performance from today - will be significantly constrained if power requirements were to scale similarly. The optimization of power and energy at all levels, from application to system software and to hardware at both processor and system scales, is required.

Additionally, some of the more challenges-in-brief are:

- How to meet the diversity of application scenario requirements (load, redundancy level, scalability, footprint)
- How to improve efficiency in energy usage and reduce energy consumption
- How to achieve rapid project delivery and deployment to reduce project management and implementation complexity
- How to reduce the negative impact of HPC on the environment (Noise, heat dissipation, vibration)
- How to achieve high reliability (not only at the device level, but also at system-level in unmanned environments)

Critical Business Needs

The aim and role is to create an environment where a high-standard IT infrastructure as per the required specification without any constraints can be deployed.

Operating efficiency and effective use of capacity is also impacted by resilience. In a typical or conventional data center, solutions are designed by providing concurrent maintainability or even fault tolerance with fully redundant M&E options. However, all type of HPC systems do not require the same level of resilience. In that case, it is important to right size the supporting infrastructure and not to over-engineer the HPC solutions.

Due to the high density of load in HPC, the racks and servers eject high heat and require an optimal cooling solution. For this, the exact operational load in racks is required to be calculated. In addition, the maximum air leaving temperature from servers is to be figured out to find out delta T which will actually help in designing the best thermal solution for your HPC with available mechanisms like row cooling, containment, etc.

Moreover, when it is to upgrade the IT infrastructure, the proper space allocation and its optimal use remains on the top of mind in an organization.

To remain competitive in the marketplace, truly excellent research requires both connectivity and processing power along with the below capabilities.

- Robust ICT infrastructure for research
- Extremely high computing power, capable of crunching complex datasets
- Superb connectivity for streamlined collaboration across the world

A conventional data center is only supported to business functions run on a day-to-day basis. HPC is designed to take on huge calculations that can take many hours, days or even months. Besides enormous processing power, there has to be a very low failure rate, given the amount of time and work that's at stake.

Solutions Analysis

In a business organization, when it is required to upgrade the existing IT setup or to develop a new IT system as per the requirement of organizational growth, the prime concern remains the space, to be allocated for the server room or data center. Moreover, if it is the requirement of HPC then obviously a definite and dedicated area need to be designated.

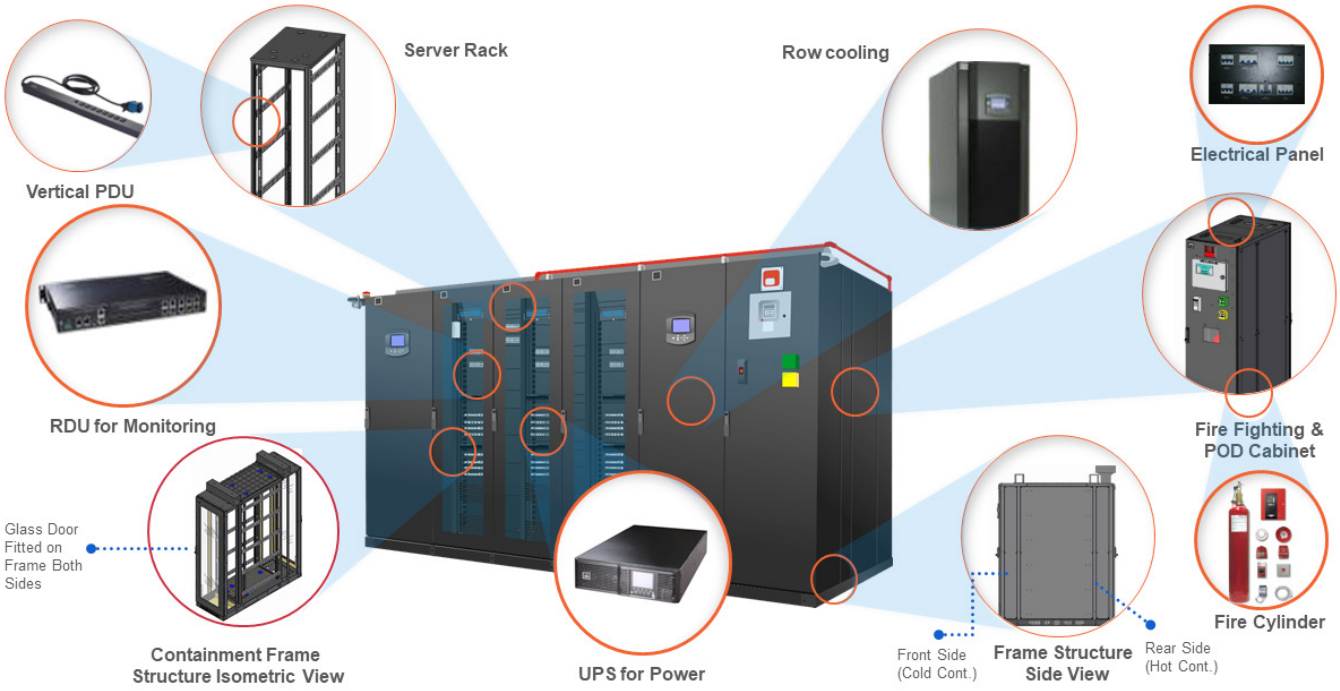
Due to the high processing of enormous data, billions of calculations in each second; HPC servers exhibit huge heat. So, to keep the system efficient, an optimized thermal management solution has to be integrated with the infrastructure.

To cater such demands in today's digital transformation to HPC; Vertiv, led by decades of research and expertise in supporting the IT industry have resulted in the development of phenomenal products that are each a master-class in its own.

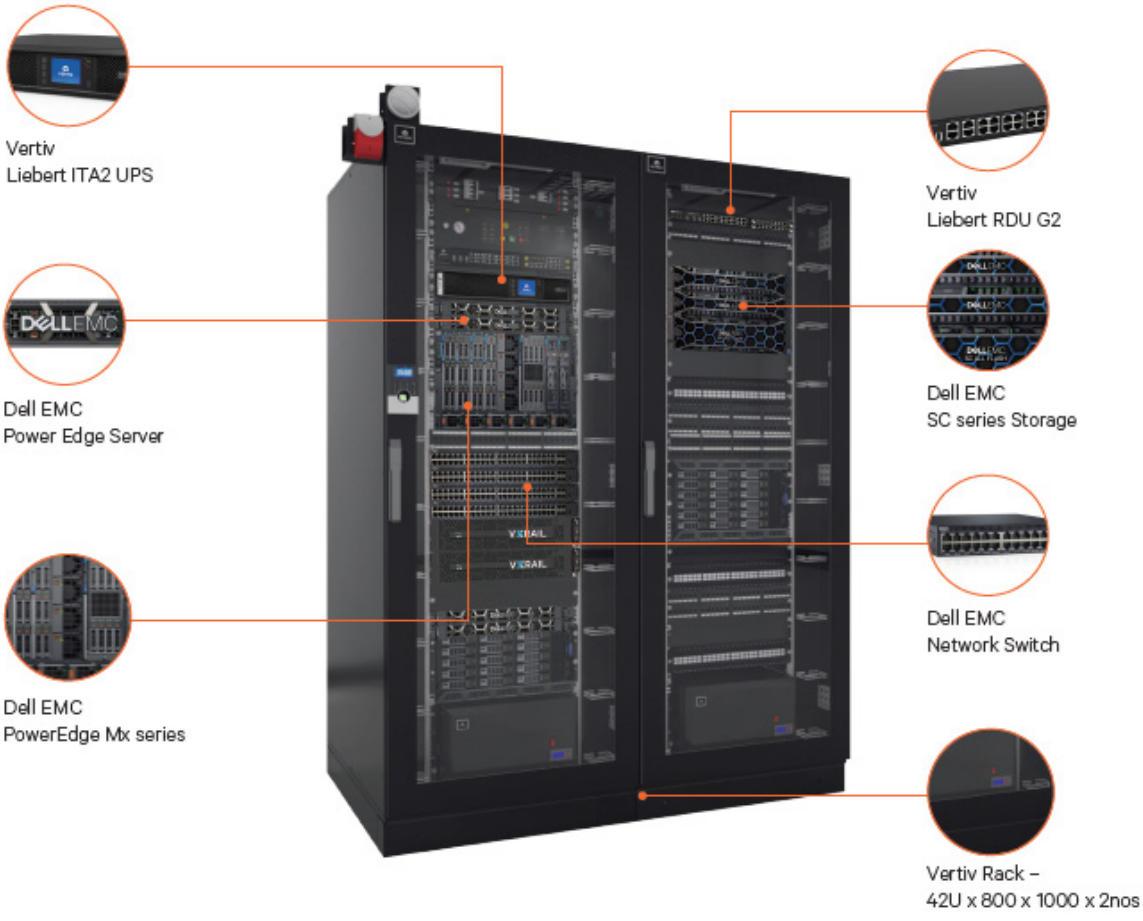
The SmartSolutions™ is a pre-engineered, factory fabricated solution that combines the best of Vertiv's offerings in the IT infrastructure under one roof.

- Dedicated Server Racks
- Built-in cooling systems with redundancy in operation
- UPS systems that ensure 100% uptime
- Highly advanced Monitoring & control systems
- Effective power management & distribution
- Cable management
- Access controls to the entire system
- Fire suppression system

SmartRow™



SmartCabinet™



Business Case

Background

The customer is a premier defense research and development laboratory in India. The Research Centre is a global front-runner in developing avionics and navigation systems for missiles.

The lab is responsible for Research and Development of Missile Systems, and advanced Avionics. This model high-technology research center tests and evaluates “missile components, modules, assemblies, major sub-assemblies, and completely integrated missiles.”

To take the research into next level, it intends to equip its HPC system with high-end IT infrastructure thereby contributing the Republic of India.

Challenges

Being a research lab, the racks in the server room exhibit high density. So, the primary challenge was to provide optimal thermal management solution.

Not being a large data center site, power failure is common, therefore the next challenge is to provide continuous quality power to the entire solution.

Critical Needs

- The prime focus is to implement a suitable cooling solution to counter the high return temperature (> 40 °C) from the high density racks (13 kW per rack load).
- To fit a reliable & quality power source with the system so that availability of power would remain constant.
- Unique solution supported by a single OEM who supply and service all the products in scope.

Solution Approach

The solution includes:

- SmartRow™ with both side containment and 3 racks set up, houses all the critical components
- Chilled Water In-row Cooling of 40 kW (N+N) with separate UPS backup for Cooling
- 40 kW Rack mount UPS (N+N) with automatic shutdown and 3 Ph Rack IPDUs
- IoT enabled Monitoring: RDU with the integration of UPS, IPDUs & CRV single window
- Fire Detection, Biometric Access control, water leak detection, and CCTV etc

Outcome

Vertiv team upgraded the existing IT infrastructure of a research laboratory of national importance with SmarSolution™ along with other critical accessories. The main concerns of the customer in cooling & power have been addressed with the most reliable and efficient technology.

Chilled Water Cooling along with In-row cooling addresses the concern of thermal management optimally. Separate UPS for In-row ensures extended cooling even in case of power failure and graceful shutdown of UPS ensures no losses of critical data, research study and test results.

Summary

Developments in the research labs of many organizations have led to the adoption of high technologies in this new digitized era. Therefore, the problems of analyzing huge data that is exponentially increasing, is accomplished by the innovative IT transformation with the faster network connectivity.

Vertiv's futuristic approach has helped many of the research labs deal with these problems by providing the best supportive infrastructures. With this SmartSolutions™ portfolio which is rugged and superlative compact structure, designed specifically for HPC, provides research establishments expand their capabilities to innovate and in most cases provides a great opportunity to improve on current designs and efficiency. Significantly, this solution reduces the deployment time from weeks to days and more importantly unburdens the customer from non-core areas.

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AP-SS/135