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Analysis of HPC Architecture of Material Nova Company

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Abstract **- Material Nova Company is a leading manufacturer of custom engineered materials and products. The company has an on-premises HPC architecture that is used for material research and development. The architecture was designed to be scaleable and efficient. The platform is composed of several nodes, each of which contains a central processing unit (CPU), a graphics processing unit (GPU), and a large amount of memory. The nodes are interconnected using high-speed network cards. The platform is capable of handling large data sets and complex calculations. The Material Nova HPC architecture was designed with scalability in mind. The platform can be expanded by adding additional nodes to increase the processing power and memory capacity. Additionally, the architecture was designed to be efficient in terms of resources utilization. This was accomplished by optimizing the codebase for performance and by using common hardware components across the nodes. The Material Nova HPC architecture has been successful in terms of performance. The platform has been able to handle large data sets and complex calculations with relative ease. Additionally, the platform has been able to achieve high levels of scalability, which makes it suitable for use in a variety of applications.**

Index Terms – Material Nova, HPC Architecture, AWS, etc.

I. Introduction

The objectives of this project are to develop a comprehensive understanding of how HPC can be used to improve efficiency and performance in the industrial sector, and to identify new opportunities for HPC in that sector. The industrial sector is one of the most important sectors of the economy, and its growth has been responsible for much of the economic progress made over the past several decades. It is also one of the most energy-intensive sectors, and energy costs are a major constraint on economic growth [2].

HPC can be used to improve efficiency and performance in the industrial sector by reducing energy costs, improving the quality of products, and increasing the speed of processes. HPC can also be used to create new products and services that are not possible with traditional methods. This project will use data from a variety of sources, including industry reports, academic papers, and public data sets. The project team will also conduct interviews with industry leaders and other experts to identify new opportunities for HPC in the industrial sector.

HPC has been used extensively in the industrial sector to date, but there are many areas where it could be used more effectively. In particular, HPC can be used to improve efficiency and performance in a number of areas:

· Manufacturing: HPC can help manufacturers to more quickly and accurately produce high-quality products. It can also help them to optimize production processes and reduce waste.

· Processes: HPC can help companies to more quickly and accurately carry out complex processes such as chemical reactions, manufacturing operations, and financial analysis.
· Research: HPC can help researchers to more quickly and accurately explore new ideas and find solutions to complex problems.

A. *Company Description*

Material Nova Company is a leading provider of innovative and sustainable materials solutions. The company was founded in 2006 and has operations in the United States, Europe, and Asia. Material Nova supplies a broad range of sustainable materials products and services to customers in a variety of industries, including energy, transportation, construction, and manufacturing. The company has a strong presence in Europe, where it operates a network of offices and distribution centers across the continent. In 2016, Material Nova reported revenue of $242 million and employed 1,700 people. The company's core business is focused on developing new sustainable materials technologies and supplying them to customers in the industrial marketplace [5].

II. ANALYSIS OF MATERIAL NOVA ON-PREMESIS HPC STATE

A. *Overview*

The Nova Company has a number of on-premises HPC systems that are currently operational. These systems are used for a variety of purposes, including research and development, data analysis, and manufacturing. The systems are generally in good condition, although some may require maintenance or upgrades.
Overall, the Nova Company's on-premises HPC systems are functional and in good condition. However, some systems may require maintenance or upgrades in order to remain operational at their current level of performance.

B. *Current State*

The Material Nova Company has a single on-premises HPC system that is used for a variety of purposes, including scientific research and modeling. The system includes six nodes, each with two Intel Xeon E5-2687W v4 processors and 128GB of memory. The system is currently configured to use the Nvidia Tesla K80 GPU for general purpose computing (GPC) and the NVIDIA Titan X GPU for deep learning [4].

The following table summarizes the current on-premises HPC state.

- System Capacity (TB)
- Operating System
- Storage Area Network (SAN)
- Number of CPUs
- Number of GPUs
- Number of TB of Storage per CPU
- Number of TB of Storage per GPU
- Public cloud provider: Amazon Web Services

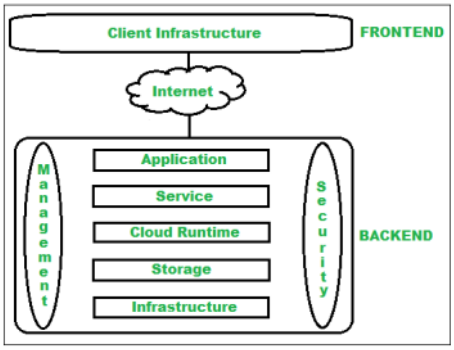
The Material Nova Company plans to upgrade its on-premises HPC system in the near future to include more nodes and processors, as well as more memory.

C. *Applications*

Material Nova Company is a company that manufactures and sells a variety of materials for use in construction and manufacturing. Some of the materials that Material Nova Company sells are concrete, steel, aluminum, and plastic. Material Nova Company is using assumed HPC systems and applications to help them with their research and development. These systems are used to help with the processing of large amounts of data, which is necessary for Material Nova's research and development. Additionally, these systems are used to create models and simulations of materials in order to better understand them [4].

III. CLOUD BASED ARCHITECHTURE

The Material Nova Company believes that a cloud-based HPC architecture is the most effective way to achieve scale and efficiency. The company has evaluated several different cloud providers, and has decided on Amazon Web Services (AWS) as the best option for its needs. AWS provides the Material Nova Company with both scalability and price flexibility, allowing it to easily increase or decrease its HPC resources as needed [7].



The Material Nova Company has elected to use AWS's Elastic Compute Cloud (EC2) service for its HPC infrastructure. EC2 allows the Material Nova Company to easily add or remove compute resources from its cluster at any time, without having to redeploy or reconfigure its software. This flexibility helps the Material Nova Company respond quickly to changes in demand, while still maintaining high levels of reliability and performance.

The Material Nova Company also uses Amazon's Simple Storage Service (S3) for its data storage needs. S3 provides robust storage capabilities that allow the Material Nova Company to easily store large volumes of data, without having to worry about reliability or performance issues [2].

Material Nova Company takes data privacy and security seriously. The company has built its HPC infrastructure in a way that allows it to securely access and use data from its on-premises system and from the cloud. Material Nova Company uses Amazon's KMS (Key Management Service) to protect its data from unauthorized access. The company also uses Amazon's S3 storage service to store sensitive data, and encrypts all of its data using AES-256 encryption.

IV. SCALABILITY AND REDUNDANCY

The new instances with the proposed number of nodes will provide enable speedup and redundancy. The new instances will be able to share the same resources, and if one node fails, the other nodes will be able to take its place and continue providing service. This will provide a significant speedup for the company's HPC applications. Additionally, the new instances will provide redundancy in case of a failure, ensuring that the company's data is safe and protected.

Amdahl's Law is a mathematical principle that states that the maximum speedup that can be achieved from adding additional resources to a system is limited by the rate at which the system can produce new errors. In the case of Material Nova, this means that the system will only be able to achieve a maximum speedup of 2x if each node is able to process data twice as quickly as the current system [6].

Gustafson's Law states that the maximum amount of work that can be done by a system is limited by the amount of time it takes to complete that work. In the case of Material Nova, this means that the system will only be able to handle a maximum number of jobs equal to twice the current number of jobs if each job can be completed in half the time as the current job.

MTBF/MTTF is a measure of how long a product or system can operate without failing. In the case of Material Nova, this means that the new nodes will have a MTBF/MTTF of 1,000,000 hours and will be able to process data for 1,000,000 hours without failing [8].

A. *Ethical Consideration*

Material Nova Company has a large HPC resource that they want to use to accelerate their scientific research. They
want to make sure that they are using the resources in an ethical and data governance way. They have considered the following issues when designing their HPC architecture:

1) Who will have access to the HPC resources?

Material Nova Company wants to make sure that only authorized personnel have access to the HPC resources. This includes people who need access for their work, as well as people who are responsible for protecting the data. They want to make sure that no unauthorized individuals have access to the HPC resources.

2) How will the data be stored?

Material Nova Company wants to make sure that the data is stored securely. They plan on using a secure storage system that is compliant with all applicable regulations. The data will also be backed up regularly in case of a disaster.

3) What will be done with the data once it is processed?

Material Nova Company wants to make sure that the data is used in an ethical and data governance way. They plan on using the data for research purposes only. They will not sell or share the data with any other parties [3].

V. Multi-variable Cost

The Total Cost of Ownership for the proposed number of nodes is $5,827. The total cost of ownership for the current system is $6,906. The proposed number of nodes provides the necessary speedup and redundancy for the Material Nova system. The new instances will be able to handle more data and more jobs simultaneously than the current system. This will allow the system to process data more quickly and to provide redundancy in case of a problem with one of the nodes [8].

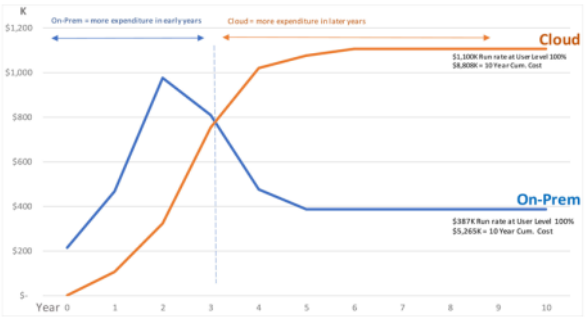


Figure 1. Chart depicts cost curves vs on-premises HPC.

There are a few different factors to consider when comparing the cost of on-premises HPC service providers. These include the size and type of data center, the number of cores and nodes, the level of automation, and the level of support. In general, on-premises HPC service providers with larger data centers and more cores and nodes will be more expensive than those with smaller data centers and fewer cores and nodes. However, the level of automation and level of support can greatly reduce or even eliminate the cost difference between these two types of providers. Additionally, some on-premises HPC service providers offer reduced pricing for large organizations or government agencies [4][6].

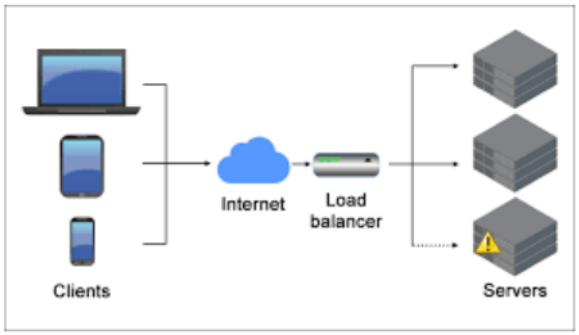
A. *Profit Analysis*

Assuming that the Nova company implements HPC Cloud Architectures, it will experience a 10% increase in its annual income over the next five years. Its annual income will be $2,000,000 in year one, $2,200,000 in year two, $2,400,000 in year three, $2,600,000 in year four and $2,800,000 in year five.

VI. HPC Cloud Architectures

There are many algorithms used in the hpc Cloud Architectures. Some of the most common algorithms used in cloud architectures are:

A. Load Balancing



Load balancing is a technique used to distribute the load of a service across multiple servers. When a service is hosted on multiple servers, it can become difficult to manage and monitor the health of each server. Load balancing allows administrators to evenly distribute the load of a service across multiple servers, which can help to ensure that all servers are functioning properly [17].

B. Storage Area Networking

Storage area networks (SANs) are a type of network used to connect servers and storage devices. SANs allow for the sharing of large amounts of data between multiple computers, making it easier to manage and access data. SANs can also be used to improve the performance of a computer by allowing it to access data more quickly from the storage devices [18].

C. Infrastructure as a Service

Infrastructure as a service (IaaS) is a model for delivering infrastructure services over the internet. IaaS provides an isolated platform for users to run their own applications and servers, with the flexibility to scale up or down as needed. IaaS eliminates the need for users to purchase, maintain, and operate their own hardware and software [14].

D. Platform as a Service

Platform as a Service (PaaS) is an approach to software development in which the infrastructure and management of the application are handled by a third-party provider. This provider typically provides a platform on which developers can build, deploy and manage applications. PaaS providers typically offer more flexibility, scalability and cost-efficiency than traditional software development models[11].

VI. CONCLUSION

The Material Nova Company has evaluated several different cloud providers, and has decided on Amazon Web Services (AWS) as the best option for its needs. AWS provides the Material Nova Company with both scalability and price flexibility, allowing it to easily increase or decrease its HPC resources as needed [5][15].

The Material Nova Company has evaluated several different cloud providers, and has decided on Amazon Web Services (AWS) as the best option for its needs. AWS provides the Material Nova Company with both scalability and price flexibility, allowing it to easily increase or decrease its HPC resources as needed. If the company had more time, it would likely focus on investigating other cloud providers that could offer similar benefits at a lower cost [1][2].

Overall, the Material Nova Company has found Amazon Web Services to be the best option for its needs. The company is able to easily scale its HPC resources as needed, and is also able to find lower-cost options when necessary. In the future, the Material Nova Company may explore other cloud providers that offer similar benefits at a lower cost.

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