High Performance Computing (HPC)

High Performance Computing refers to the practice of aggregating computing power in a way that delivers much higher performance than one could get out of a typical desktop computer or workstation to solve large problems in science, engineering, or business. HPC is critical for computational and data-intensive tasks in various fields, including quantum mechanics, weather forecasting, climate research, oil and gas exploration, and molecular modelling, to name a few.

Hardware Components

- Supercomputers or Computing Clusters: These are the most fundamental components in HPC. Supercomputers or clusters comprise numerous processors that work together to perform large scale computations. They allow organisations to solve complex computational problems.
- Parallel File Systems: Parallel file systems are a type of storage system that allows many clients to access data files simultaneously. These are necessary in an HPC environment where data from large computations needs to be accessed, stored, or retrieved rapidly.
- High-Speed Interconnects: These are crucial for facilitating communication between nodes in an HPC cluster. Interconnects like InfiniBand or high-speed Ethernet are used in HPC environments to reduce latency and increase bandwidth between the nodes.
- Cooling Systems: HPC systems generate a lot of heat and thus require robust cooling systems. Efficient cooling is crucial for optimal performance and longevity of the hardware.
- Power Supply: High Performance Computing requires a reliable and efficient power supply due to its high power consumption. High-capacity UPS systems are used to prevent power disruptions that could cause computation errors or hardware failure.

Software Components

- Operating Systems: HPC systems commonly use a variant of Linux due to its flexibility, cost-effectiveness, and robust community support. The operating system manages the hardware resources and provides services for executing the application software.
- Parallel Processing Software (Middleware): This software allows for the simultaneous use of multiple compute resources to solve a computational problem. MPI (Message Passing Interface) and OpenMP are commonly used for this purpose.
- Job Scheduler: In HPC environments, job schedulers or workload managers (like SLURM or PBS) are necessary to distribute workloads among the available compute resources effectively.
- Compilers: High-performance compilers are used to translate the high-level language code into machine language while optimising for the target HPC hardware architecture.
- Performance Libraries: Libraries like Intel's MKL or AMD's ACML are often used to optimise the performance of mathematical operations in HPC applications.

SAN and NAS in HPC

In an HPC environment, both Storage Area Network (SAN) and Network Attached Storage (NAS) can be used, depending on the specific needs of the workload. SAN can provide block-level storage for databases or file systems and is particularly suited to applications requiring high input/output operations per second (IOPS).

NAS, on the other hand, serves files over Ethernet and is relatively easier to manage, making it suitable for storing and sharing less frequently accessed data across a network.

Mass storage solutions can be used for long-term storage or archiving of data. They offer virtually unlimited storage space, high durability, and availability. In HPC, these could be useful for storing the large datasets that are not currently in use or for backing up computational data.