Computing Clusters

Atefeh Maleki
atefeh.maleki7@etu.univ-lorraine.fr
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Overview

History

Components

Architecture

Type of clustering

Advantages and disadvantages

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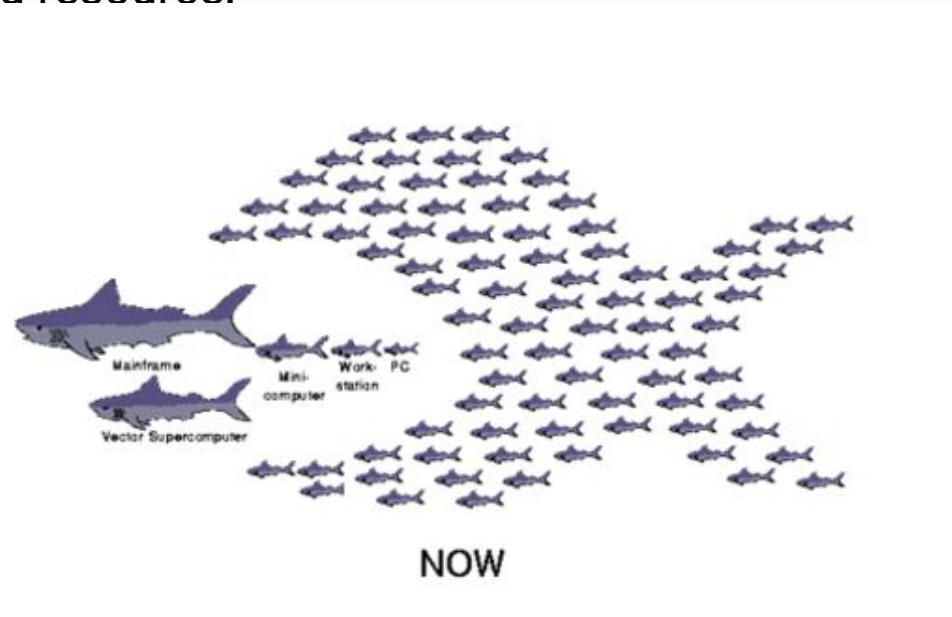
References

History

- The first inspiration for cluster computing was developed by IBM as an alternative of linking large mainframes to provide a more cost effective form of commercial parallelism
- High-performance microprocessors, high-speed networks, and standard tools for high performance distributed computing - VAXcluster released by DEC
- Microsoft, sun microsystems offered clustering packages
- Linux is the most widely used operating system for cluster computing

Cluster computing

A cluster is a type of parallel or distributed computer system, which consists of a collection of interconnected stand-alone computers working together as a single integrated computing resource.

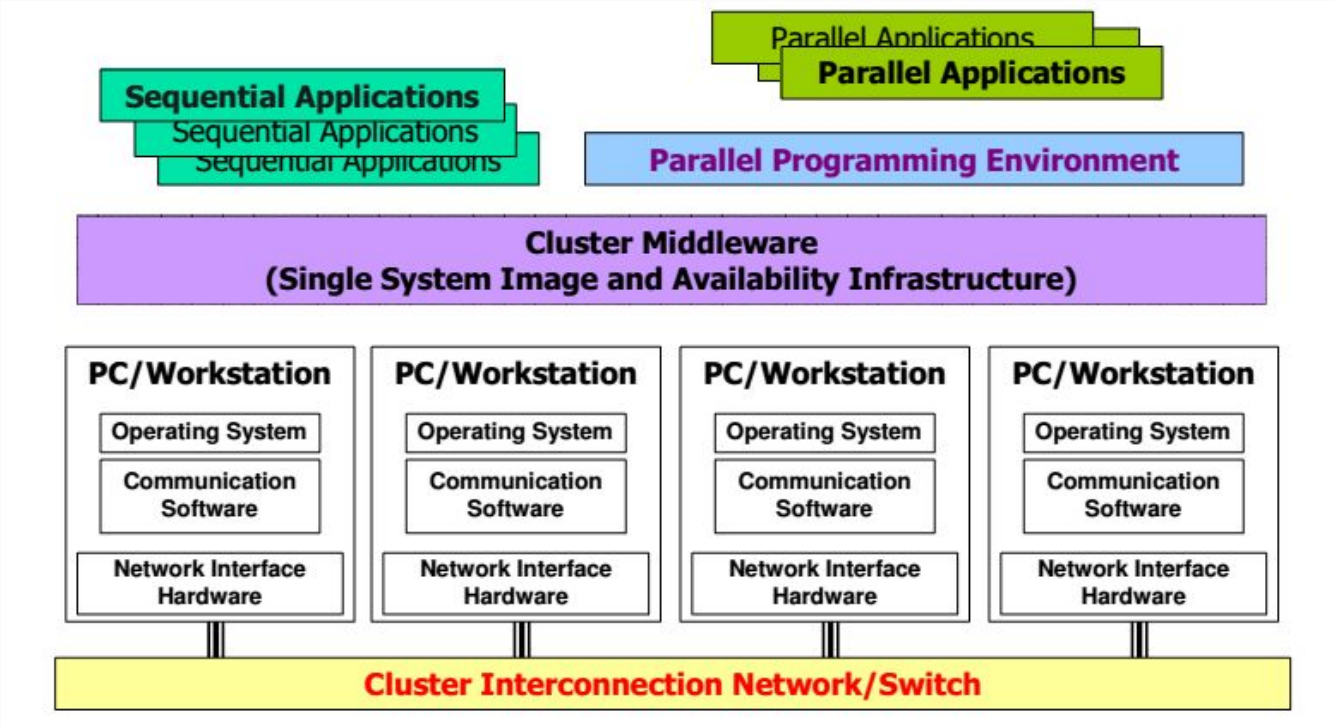


Cluster components

The key components of a cluster :

- Multiple standalone computers (PCs, Workstations, or SMPs),
- Operating systems,
- High-performance interconnects,
- Middleware,
- Parallel programming environments,
- Applications.

Architecture



Single System Image (SSI)

- A single view of the distributed systems
- Hides the complexities of the underlying distributed and heterogeneous nature of clusters
- Transparency of resource management, scalable performance, and system availability

SSI in different levels of abstraction

- **Hardware** Memory Channel- Distributed Shared Memory (DSM)
- **OS** MOSIX - Solaris MC- UnixWare
- **Middleware** Condor- Loadleveler -Load Share Facility (LSF)- Open Portable BatchSystem (OpenPBS)- Sun Grid Engine (SGE)- Libra
- **Application** PARMON- Linux Virtual Server -Problem Solving Environments
- **Programming** Linda- JavaSpaces-Message Queues-Parameter Sweep-Parallel Virtual Machine (PVM)-JavaGroups-Message Passing Interface (MPI)

Types of cluster computing

Storage

It allows the servers to read and write to a single shared file system simultaneously. A storage cluster eliminates the need for redundant copies of application data and simplifies backup and recovery.

High availability

Avoid single points of failure and by switching from one cluster node to another.

Load balancing

It helps to balance the request load by matching nodes according to the load requirements. In case of failure, the load balancing redirects the request to the other cluster nodes. FTP and web servers

High performance

For performing simultaneous calculations and providing parallel computing.

Advantages

- Clustering servers is completely a scalable solution. You can add resources to the cluster afterwards.
- If a server in the cluster needs any maintenance, you can do it by stopping it while handing the load over to other servers.
- It is reliable and easy to configure so the high availability is guaranteed.

Challenges

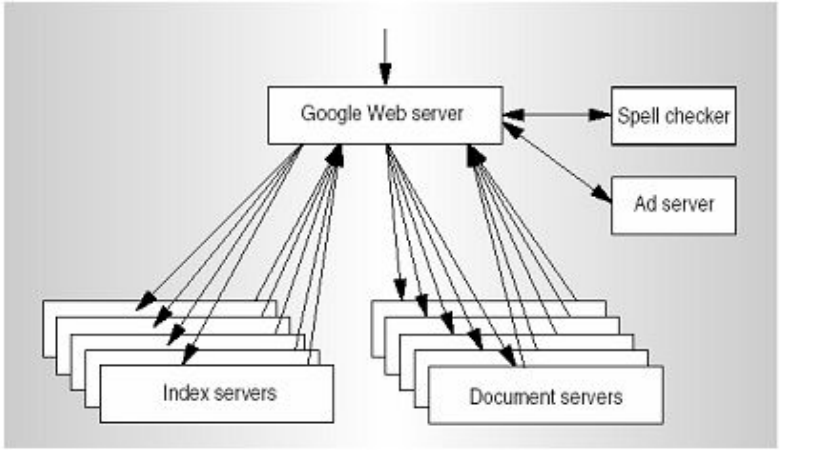
- Size scalability (physical and application)
- Single-system-image
- Security and encryption
- Enhanced availability

Computing Clusters Application

Petroleum Reservoir Simulation	Demands intensive computations in order to simulate geological and physical models
Protein Explorer	Molecular dynamics simulations
Earthquake Simulation	To model and forecast strong ground motion during earthquakes
Image Rendering	uses a swapping mechanism to manage datasets that are too large to load into the available texture memory, resulting in low performance and interactivity.

Google Search Engine

- Google uses cluster computing to meet the huge quantity of worldwide search requests with the peak of thousands of queries per second.
- The services for Google are also replicated across multiple machines by performing parallel execution of individual search requests.
- A hardware-based load balancer in the cluster distributes the requests evenly.
- The Google Web Servers machine receives the request, coordinates the query execution and sends the search result back to the user's browser.



TOP500 supercomputers JUNE 2015

RANK	SITE	SYSTEM	CORES	RMAX (TFLOP/S)	RPEAK (TFLOP/S)	POWER (KW)
1	National Super Computer Center in Guangzhou China	**Tianhe-2 (MilkyWay-2)** - TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P NUDT	3,120,000	33,862.7	54,902.4	17,808
2	DOE/SC/Oak Ridge National Laboratory United States	**Titan** - Cray XK7 , Opteron 6274 16C 2.200GHz, Cray Gemini interconnect, NVIDIA K20x Cray Inc.	560,640	17,590.0	27,112.5	8,209
3	DOE/NNSA/LLNL United States	**Sequoia** - BlueGene/Q, Power BQC 16C 1.60 GHz, Custom IBM	1,572,864	17,173.2	20,132.7	7,890
4	RIKEN Advanced Institute for Computational Science (AICS) Japan	K computer, SPARC64 VIIIfx 2.0GHz, Tofu interconnect Fujitsu	705,024	10,510.0	11,280.4	12,660
5	DOE/SC/Argonne National Laboratory United States	**Mira** - BlueGene/Q, Power BQC 16C 1.60GHz, Custom IBM	786,432	8,586.6	10,066.3	3,945

Conclusion

- Comparatively cheap and efficient, alternative to large server/mainframe computer solutions
- Scalable by adding devices as resources

References

"Cloud Computing Vs. Distributed Computing". *DeZyre*. N.p., 2015.

Yeo, Chee Shin et al. "Cluster Computing: High-Performance, High-Availability, And High-Throughput Processing On A Network Of Computers". *Handbook of Nature-Inspired and Innovative Computing* 521-551.

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Thank you !