



# Cluster Computing : Architecture and Performance



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# Cluster Computing : Driving Factors

- HA-Clusters in Business Computing.
- Primary Goal : Availability through Redundancy.
- Emergence of low cost, high-performance Linux-x86 platforms, coupled with high bandwidth and low latency system interconnects -> horizontally scalable computing platform.
- <http://www.beowulf.org/>
- Clusters -> Grid -> Utility Computing (N1)

# Architecture = f(Application/s)

- Computing Platform Architecture = f(Customer Application Requirements, QOS)
- Computing Requirements of Applications.
- Vertically Scaling : Applications Category :: Large Databases, Dataware houses, Signal Processing, Nuclear simulation and Climate simulation.
- Horizontal Scaling : Applications Category :: Web Servers, Proxy Servers, Oil and Gas Applications, Bioinformatics.

# CTQs

- Over 60% of firms identified scalability or availability as a principal infrastructure concern.
- Over 18% savings projected with best practices in scalability and availability.
- Source : Hurwitz Group Study.
- CTQs => TCO, Scalability, Availability

## Cluster : Classical Definition

- *A parallel or distributed system that consists of a collection of interconnected whole computers that are utilized as a single, unified computing resource.*

# Cluster Architecture : Commerical Computing

- Multiple compute nodes interconnected by high-performance interconnects such as Sun Fire Link, Dolphin PCI-SCI with shared/non-shared storage amongst them. Every node has a copy of the operating system, a database instance or process and application software.
- Example : Oracle 9i RAC runing on a distributed cluster of nodes with Sun Cluster software for RSM (Remote Shared Memory).
- Node, Storage, Network redundancy for HA.

# Clusters in HPTC

- HPTC : Early Adopter of Cluster Computing Platform.
- Oil and Gas, Bioinformatics, MCAE.
- Price/performance conscientious segment of the market.
- Interconnects : Gbe, Myrinet, Infiniband.

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## Cluster Performance= $f(a,b,c,d)$

- Processor Clock Speed, Memory System performance.
- Compiler Performance
- OS performance
- Network and Storage Performance
- System Interconnect Performance (bandwidth and latency)



# CMT vs Clusters and Interconnects

- Ethernet [100 MB/s, 100-10  $\mu$ s][system call]
- Myrinet [0.4-4.8 GB/s, 10-1  $\mu$ s][lib call]
- Memory [9.6-57 GB/s, 1-0.1  $\mu$ s][load/store instruction]
- CMT (System on Chip) [100-1000s GB/s, 0.1-0.01  $\mu$ s]

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# Cluster Benchmark Performance

- HPL
- HPC-Challenge Benchmarks
- Applications : Eclipse, SeisSpace, Fluent
- Results and Discussion.