Computer Clusters

Lecture-5

Parallel & Distributed Computing

Course Outlines

Course Name: Parallel and Distributed Computing
Credit Hours: 3(3-0)
Prerequisites: Data Communications and Computer Networks

Course Outlines:

Why use parallel and distributed systems? Why not use them? Speedup and Amdahl's Law, Hardware architectures: multiprocessors (shared memory), networks of workstations (distributed memory), clusters (latest variation). Software architectures: threads and shared memory, processes and message passing, distributed shared memory (DSM), distributed shared data (DSD). Possible research and project topics, Parallel Algorithms, Concurrency and synchronization, Data and work partitioning, Common parallelization strategies, Granularity, Load balancing, Examples: parallel search, parallel sorting, etc. Shared-Memory Programming: Threads, Pthreads, Locks and semaphores, Distributed-Memory Programming: Message Passing, MPI, PVM. Other Parallel Programming Systems, Distributed shared memory, Aurora: Scoped behaviour and abstract data types, Enterprise: Process templates. Research Topics.

Computer Clusters

- A computer cluster is a ***set of computers*** that ***work together*** so that they can be viewed as a ***single system***.
- Unlike ***grid computers*** (where each node set to perform a **different task/ application**), ***computer clusters*** have ***each node set to perform the same task***, ***controlled*** and ***scheduled*** by ***software***.

Computer Clusters cont…

Sun Microsystems Solaris computer cluster

Computer Clusters cont…

- The components of a cluster are usually connected to each other through ***fast local area networks***, with each **node** (computer used as a server) ***running its own instance of an operating system***.

Computer Clusters cont…

- In most circumstances, all of the nodes use the ***same hardware*** and the ***same operating system***, although in some setups (e.g. using ***Open Source Cluster Application Resources*** (OSCAR)), ***different operating systems*** can be used on each computer, or ***different hardware***.
- **OSCAR** is a Linux-based ***software installation*** for ***high-performance cluster computing***.

Computer Clusters cont…

- Clusters are usually deployed ***to improve performance*** and ***availability*** over that of a ***single computer***, while typically being much more ***cost-effective*** than single computers of **comparable speed** or **availability**.

Computer Clusters cont…

- Computer clusters emerged as a result of convergence of a number of computing trends including the availability of ***low-cost microprocessors***, ***high-speed networks***, and ***software*** for ***high-performance distributed computing***.

Computer Clusters cont…

- Prior to the advent of clusters, single unit ***fault tolerant*** ***mainframes*** with ***modular redundancy*** were employed; but the lower upfront cost of clusters, and increased speed of network fabric has favored the adoption of clusters.
- In contrast to ***high-reliability mainframes*** ***clusters are cheaper*** to **scale out**, but also have ***increased complexity*** in ***error handling***.

Computer Clusters cont…
Challenges

- One of the challenges in the use of a computer cluster is the ***cost of administrating*** it which can at times be ***as high as*** the ***cost of administrating N independent machines***, ***if the cluster has N nodes***.
- Some other challenges are discussed here:

Computer Clusters cont…
Challenges (Task scheduling)

- When a large multi-user cluster needs to access ***very large amounts of data***, task ***scheduling becomes a challenge***.
- In a ***heterogeneous CPU-GPU cluster*** with a ***complex application environment***, the performance of each job depends on the characteristics of the underlying cluster.

Computer Clusters cont…
Challenges (Task scheduling)

- Therefore, ***mapping tasks*** onto **CPU cores** and **GPU devices** provides significant challenges.

Computer Clusters cont…
Challenges (Node Failure Management)

- When a node in a cluster fails, strategies such as ***fencing*** may be employed to keep the ***rest of the system operational***.
- Fencing is the process of ***isolating a node*** or ***protecting shared resources*** when a node ***appears to be malfunctioning***.
- There are two classes of fencing methods; one ***disables a node itself***, and the other ***disallows access to resources such as shared disks***.

Computer Clusters cont… Implementation

- Linux supports various **cluster software**; for application clustering, there is **distcc**, and **MPICH**.
- **Linux Virtual Server**, ***Linux-HA*** - director-based clusters that allow incoming requests for services to be distributed across multiple cluster nodes.

Computer Clusters cont… Implementation

- MOSIX, LinuxPMI, Kerrighed, OpenSSI are **full-blown clusters** integrated into the kernel that provide for automatic process migration among ***homogeneous nodes***.
- OpenSSI, openMosix and Kerrighed are single-system image implementations.

Computer Clusters cont… Implementation

- Microsoft Windows computer cluster **Server 2003** based on the Windows Server platform provides pieces for High Performance Computing like the ***Job Scheduler***, ***MSMPI library*** and ***management tools***.