

## **Paper Review: *Deploying a High Throughput Computing Cluster***

Many research organizations are performing scientific supercomputing that might take months and sometimes years. The scientists and engineers are more interested in the amount of computations that can be accomplished in particular time length rather than the response time. The simulations that they are performing are not suitable to be done on distributed systems that provide High Performance Computing (HPC) because their applications are strongly linked to computing throughput. HPC provides large amounts of processing power to do extensive computational jobs over relatively short periods of time, while High Computing Throughput (HTC) provides large amounts of computing power over length periods of time. Since relatively large number of networked commodity computers is already available in most organizations, their capacities can be used to provide high computational capacity that can be brought to reduces the processing time. The throughput problem can be solved by such inexpensive solution that can be realizable only by an efficient resource management and a good cooperation.

Such high through computing system relies on the resources provided by machine owners, customers who use the resources to run their applications, and administrator who configure and maintain the system. These three parties will not participate on the system if they are not satisfied with the system that has to meet their needs. For example, resources owners will not donate resources if their rights are not respected or the policies they specify are not enforced. The customers will use the system only if the work involved in running their applications does not need a lot of effort. Finally, administrator will stop working on the system if the provided benefits are less than the amount of work that he does on the system. In addition, the distributive owned resources are usually associated with complexities that need to be carefully managed by the system to provide reliable, flexible, secure, and fault tolerant HTC environment.

In this paper, Basney et al. introduced some challenges that the software developer and system administrator have to overcome when deploying a HTC cluster. The authors provided the problems and suggested solutions based on their experience gained by development and administration of Condor HTC environment, which has been deployed at the Computer Sciences Department at the University of Wisconsin-Madison. They claimed that usability, flexibility, reliability, and maintainability are the primary factors for making an HTC environment successful. The heterogeneity of the workstations may be efficiently utilized by portability that allows HTC system to be deployed on workstations with different operating systems. The portability might be accomplished using Layered architecture with flexible network protocols. Also, the reliability might be achieved by using check-pointing technique that gives the ability to transparently continue executing the failed tasks from the point of failure on other machines without the need to re-execute them from scratch. Furthermore, the administrator may use logging technique to track and detect failures. The HTC system must provide trustworthy environment by using the appropriate security mechanisms to protect the resources against attacks and ensure that the policies cannot be violated.

The proposed paper brought good thoughts to overcome some challenges associated with deploying HTC system in order to efficiently exploit the wasted processing resources of the individual workstations and provide high throughput computing environment that can be used to perform jobs. However, since the paper was published in 1999, some of suggested solutions are not practicable today. Since that time many technologies have been emerged in field of resource sharing and distributed computations. Therefore, some aspects that were represented as big issue in the paper are not considerable today. Also, that some of the problems have been addressed using better solutions than the suggest solutions in the paper.

The focus of the paper was on the challenges associated with deploying and managing of the resources of HTC environment. It might be reasonable in time the paper was written. However, with appearing of cloud computing systems like amazon EC2 that provides “pay-as-you-go” services, you get the required capacity with relative low price comparing the costs needed to build your own cluster system. The organizations can pay per hour for renting unlimited number of virtual machines without restricting the individual’s computers owners and without buying new computers that need software and frequently maintenance, which require hiring new workers. Since the cost of renting one hour of 1000 virtual machines is the same cost of renting 1000 hours of one machine, the organizations can obtain high throughput computing capacity by renting any number of virtual machines for the needed hours. By this way, the organizations shift the responsibility of providing reliability into the cloud computing system

Also, the authors proposed check-points as a solution of failed processes problem. It is essentially a good technique because it avoids wasting of resources by stopping and resuming the execution of any task due to the fact that the resources are under the control of HTC system. Also, failed tasks do not need to be re-executed from scratch. However, the authors did not show where the check-points should be saved, which they can cause massive network traffic when they are replicated on different machines. Another aspect of wasting resources did not discussed is how to assign jobs to machines, which has impact on wasting resources if big jobs are assigned to low capacity machines. Load balancing of the work load in this case can play a big role to efficiently utilize the resources and reduce completion time of jobs.

Furthermore, the authors did not show how to detect strugglers and did not assume any deadline for the running processes. Since HTC system deals with processes that can be running for long period of time, it is important that system must track their progress to avoid the situations where time is wasted without any progress. Also, intermediate results must be checked and validated from time to time during the running of tasks because you do not wait long time to get wrong results due to not properly working computers.

Finally, the authors starts their paper by showing that the three entities using the system, which are the resource owner, customer, and administrator, will not use the system if the required effort outweigh the benefits. However, they did not mention the organization, which is the primary entity that should satisfied by retrieving more benefits by less effort. The reality says that using existing cloud computing system or purchase capacity per hours will provide desired goal with less costs.