

Approaches to Manage Computational Cluster Resources

Gaiduchok V.
Ahmed N.
Rukovchuk V.
Ivanov P.
Kamande M.

GRID'2016

Agenda

Introduction

Tests

Approaches

Traditional approach

Virtualization and clouds

Proposed approach

Conclusions

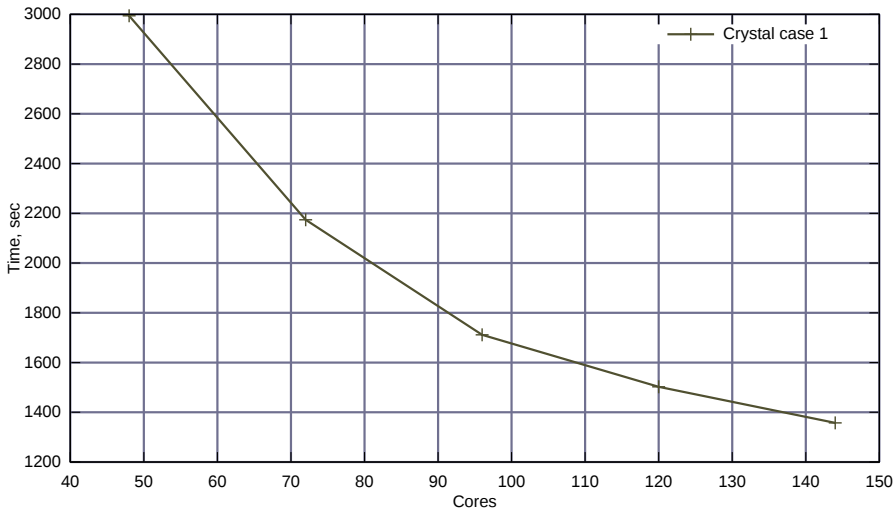
Introduction

- ▶ The cluster architecture is the most widely used one nowadays.
- ▶ There are many views on cluster management.
- ▶ The task of heterogeneous cluster management is very difficult today.
- ▶ Administrators should set resource sharing policies that will meet different requirements.
- ▶ Users want to compute their tasks fast while organizations want their resources to be utilized efficiently.

Introduction

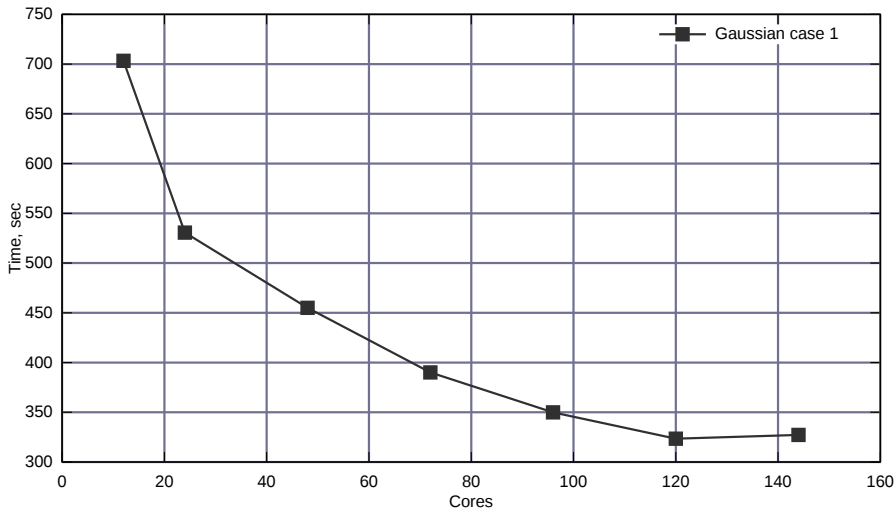
- ▶ Users run different applications with different scalability.
- ▶ An average application could use many libraries with different performance.
- ▶ Heterogeneous computing could impose new complexities.
- ▶ Traditional schedulers do not allow administrator to efficiently solve problems.
- ▶ User should estimate many parameters in order to achieve good performance and overall system utilization.

Tests



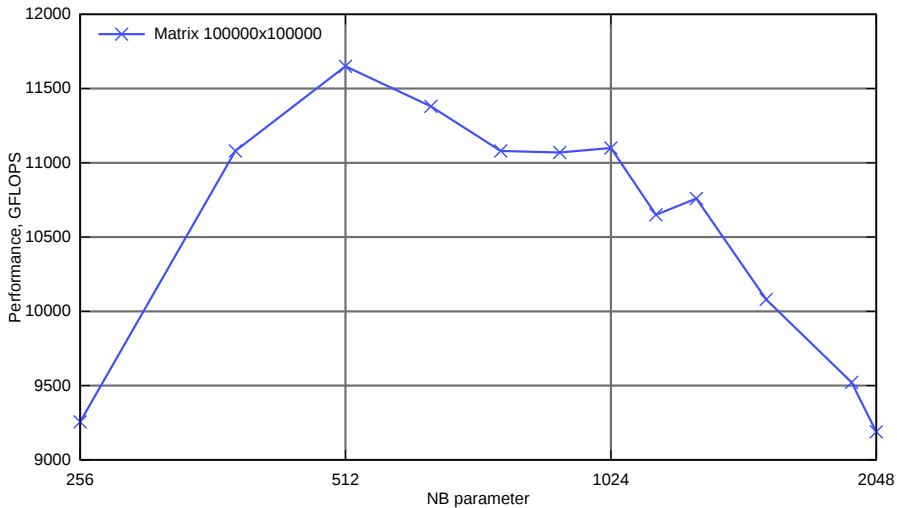
Application tests

Tests



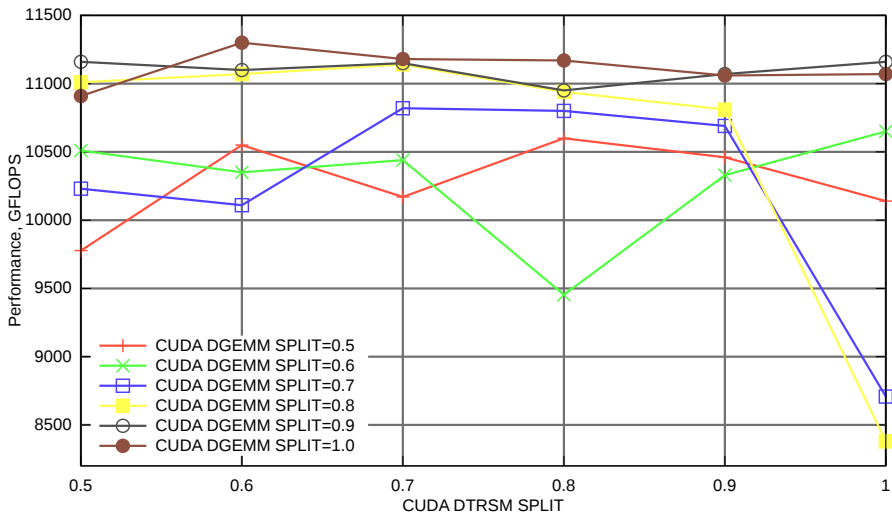
Application tests

Tests



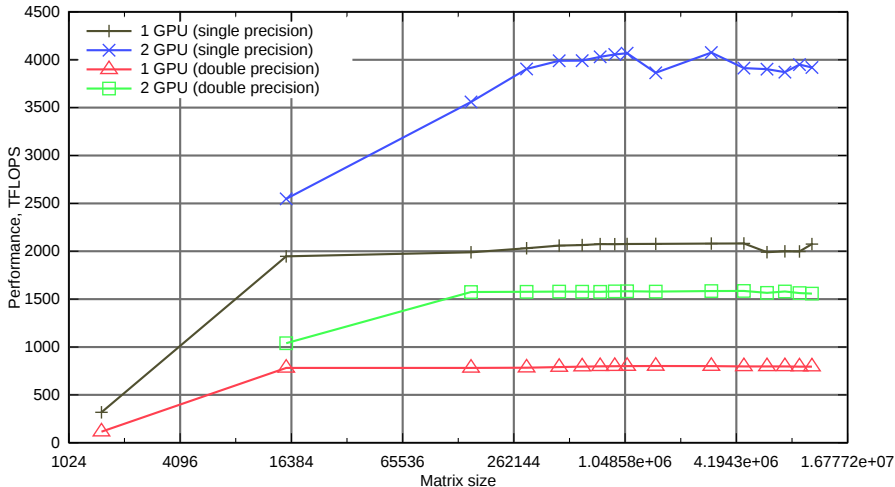
GPGPU LINPACK benchmark

Tests



GPGPU LINPACK benchmark

Tests

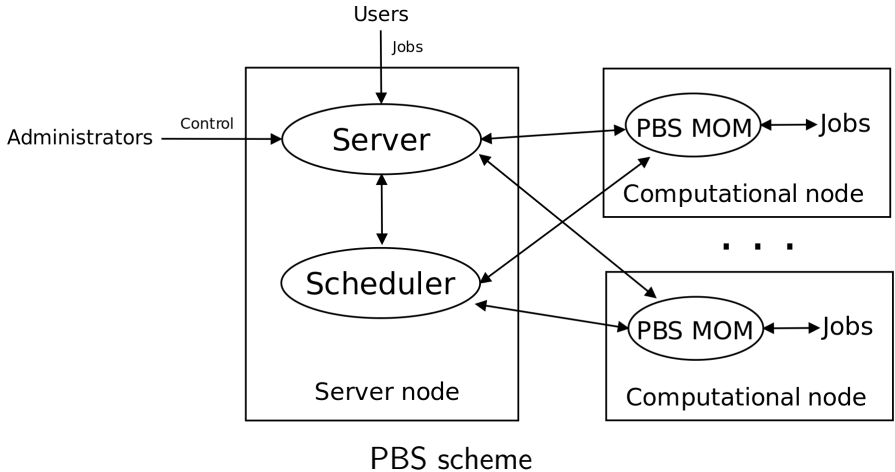


Nbody test

Approaches

- ▶ No management system. *Maintenance, system utilization, user convenience.*
- ▶ Classical management system. *System utilization, user convenience*
- ▶ Single system image. *Fault tolerance.*
- ▶ Virtualization with manual VM creation. *Overheads, maintenance.*
- ▶ Cloud. *Overheads.*
- ▶ Special APIs (integration with scheduler). *Application rewriting.*
- ▶ Other approaches.

Traditional approach



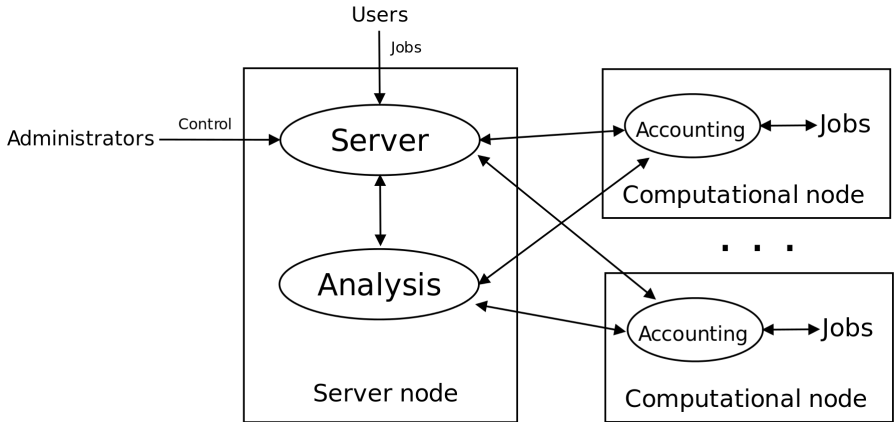
Traditional approach

- ▶ Implements the classical scheme (Portable Batch system).
- ▶ Several implementations (TORQUE, PBS Professional, etc).
- ▶ Dynamic resource reallocation is usually not possible.
- ▶ Resource reservation can be changed only by user or administrator.
- ▶ Scarce accounting information.

Virtualization and clouds

- ▶ Virtual machines could be used for convenient access to cluster resources.
- ▶ Organization could create private clouds.
- ▶ Virtual machines could be used to compute tasks, but it could introduce some overheads.
- ▶ Moreover, one will not be able (usually) to distinguish the task itself.
- ▶ Virtual machines could be created when necessary, e.g. for security reasons.

Proposed approach



New approach based on PBS scheme

Proposed approach

- ▶ Dynamic resource reallocation.
- ▶ Profiling, detailed accounting and monitoring.
- ▶ Flexible resource reservation.
- ▶ Predictions module.
- ▶ User rating.
- ▶ Native API.
- ▶ Modules can be used within existing PBS.
- ▶ Small overheads.
- ▶ Especially beneficial in case of underload or overload.

Proposed approach

- ▶ The described system is designed for applications that use traditional APIs.
- ▶ Effective solution is a new API.
- ▶ Such API implies tight cooperation with the scheduler.
- ▶ Dynamic resource reallocation could solve the resource utilization problem.
- ▶ API implies step by step resource allocation up to allowable maximum with detailed monitoring.
- ▶ A special algorithm is used in order to orchestrate the nodes of the cluster for efficient network communication.

Conclusions

- ▶ Resource management for scientific computations sometimes can be challenging.
- ▶ Dynamic resource reallocation could lead to effective resource utilization.
- ▶ Scheduling of applications can be done using the described approach.
- ▶ Virtual machines could be created when necessary.
- ▶ Transition to the new API can take time, but it could be considered as a way to improve utilization of a heterogeneous complex.

Questions

Thank you!