Benchmarking P2C for HPC using NPB

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Abstract

We report some benchmarking results of the Peak-Two Cloud(P2C) for High-Performance Computing(HPC) using the NAS Parallel Benchmarks(NPB).

1 Introduction

In order to evaluate the performance of the P2C[1] for HPC, NPB[1] version 3.3.1 was run on a 16-node MPI cluster provisioned using vcluster[2]. vcluster provisions nodes with one core, 1GB RAM, and 20GB disk.

NPB consists of a set of programs that implements different computational approaches associated with Computational Fluid Dynamics(CFD). These programs represent the types of applications that are run in supercomputers and HPC clusters. In running the benchmark, classes A and B were used for each program. Different classes have different problem sizes and parameters which result to different measurements.

The programs were run using 1, 2, 4, 8, and 16 nodes. The completion times were recorded and plotted using gnuplot. Figure 2 shows the hosts where the VMs used in the cluster were instantiated. The state of the hypervisors are shown in Figure 1.

P2C uses the default FilterScheduler of OpenStack. Observe that the host cinterlabs-02 in Figure 1 is overprovisioned. It only has a total of four physical cores but five VCPUs are allocated. In Figure 2, the cluster nodes benchmark-slave-5,benchmark-slave-13, and benchmark-slave-14 are assigned to the host cinterlabs-02.

For related work, see [2].

Hypervisors

Hostname	Type	VCPUs (used)	VCPUs (total)	RAM (used)	RAM (total)	Storage (used)	Storage (total)	Instances
cinterlabs-01	QEMU	4	4	4GB	3.8GB	63GB	454GB	3
cinterlabs-04	QEMU	1	4	1.5GB	3.8GB	21GB	454GB	1
cinterlabs-05	QEMU	2	4	2.5GB	3.8GB	21GB	454GB	1
cinterlabs-02	QEMU	5	4	5GB	3.8GB	105GB	454GB	5
cinterlabs-03	QEMU	3	4	3.5GB	3.8GB	63GB	454GB	3
cinterlabs-06	QEMU	1	4	1GB	3.8GB	21GB	454GB	1
cinterlabs-07	QEMU	4	4	4GB	3.8GB	84GB	454GB	4
cinterlabs-08	QEMU	3	4	3.5GB	3.8GB	63GB	454GB	3
cinterlabs-09	QEMU	4	4	4GB	3.8GB	84GB	454GB	4
cinterlabs-11	QEMU	3	4	3.5GB	3.8GB	42GB	454GB	2
cinterlabs-10	QEMU	3	4	3.5GB	3.8GB	63GB	454GB	3
cinterlabs-12	QEMU	3	4	3.5GB	3.8GB	42GB	454GB	2

Figure 1: Hypervisor state after the 16-node cluster was created.

[1] https://www.nas.nasa.gov/publications/npb.html
[2] http://srg.ics.uplb.edu.ph/projects/peak-two-cloud/peak-two-cloud-resources/deployinganmpiclusterusingvcluster

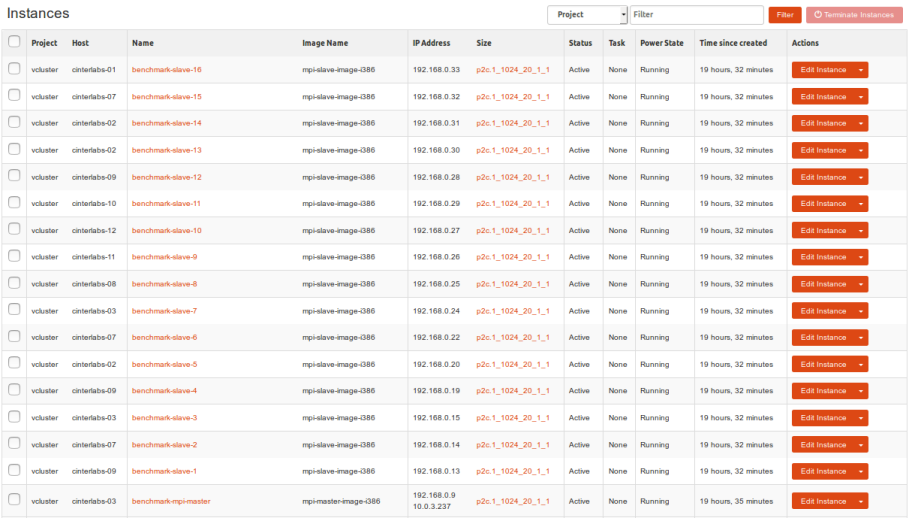

Figure 2: VM assignment for the nodes of the cluster.

2 Results

The following subsections show the completion time for each program in NPB tested using different number of nodes. Ideally, the completion time of the programs should decrease as the number of nodes is increased. However, the results show some fluctuations for some programs.

2.1 Conjugate Gradient

Performs irregular memory access and communication.

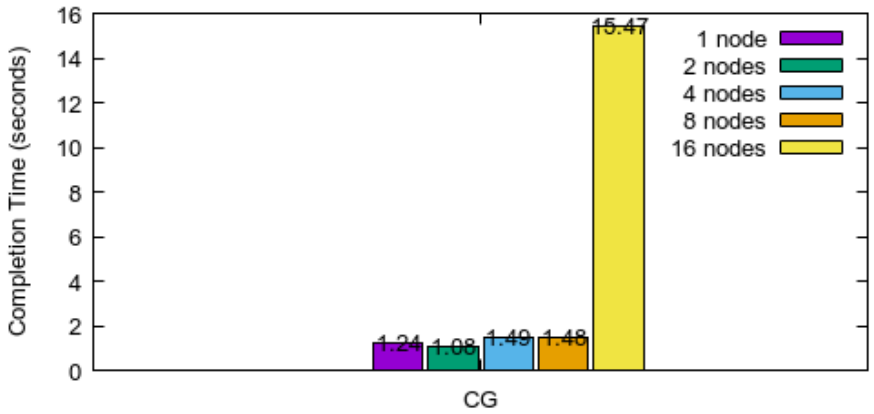

Figure 3: CG, Class A

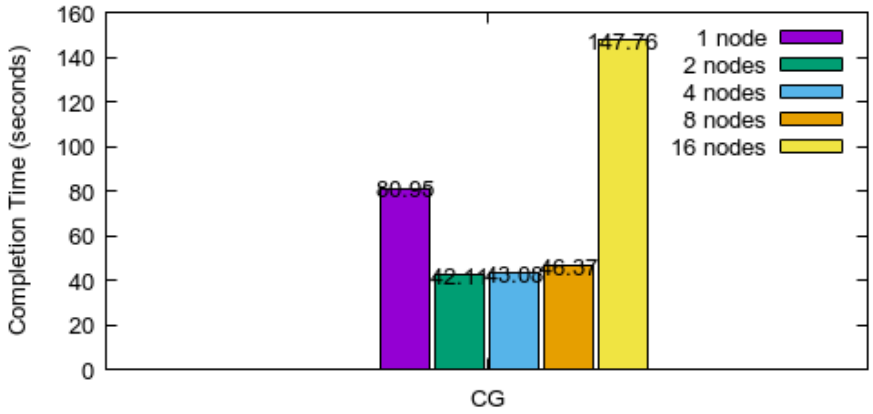

Figure 4: CG, Class B

2.2 Embarassingly Parallel

An application with very minimal communication and synchronization to complete a task.

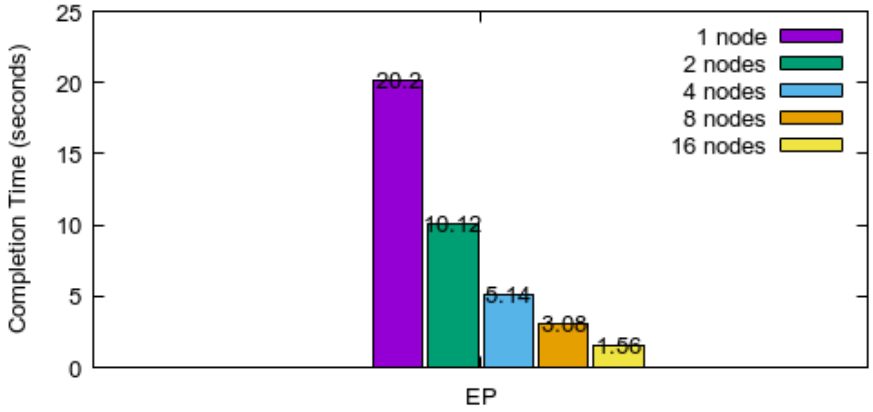

Figure 5: EP, Class A

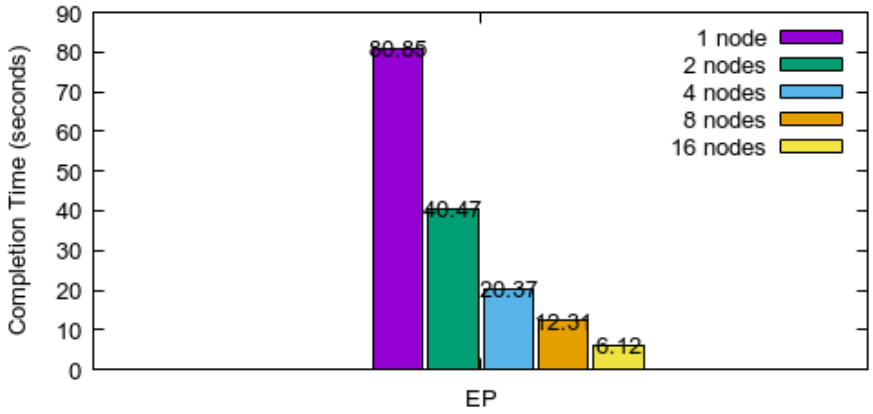

Figure 6: EP, Class B

2.3 Fourier Transform

Performs all-to-all communication.

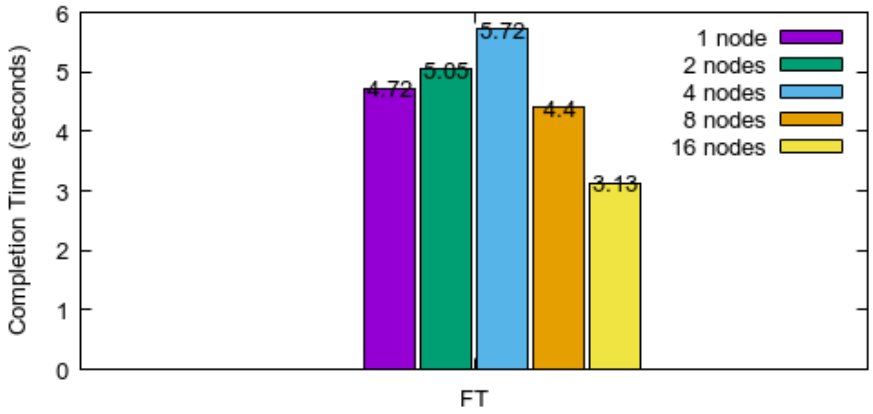

Figure 7: FT, Class A

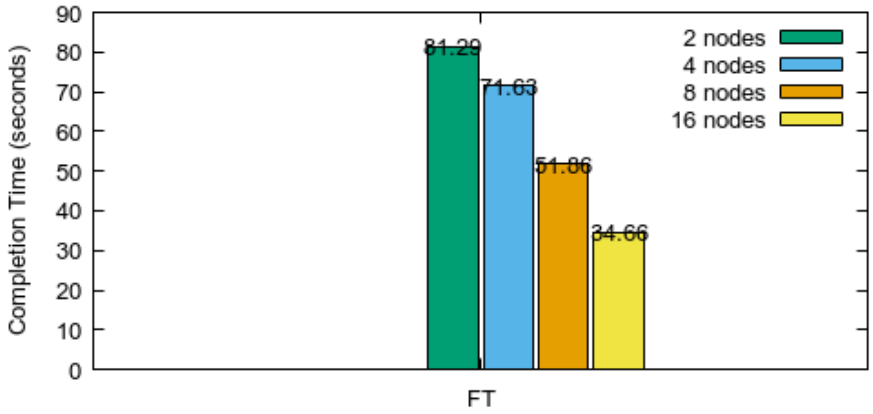

Figure 8: FT, Class B

2.4 Integer Sort

Performs random memory access.

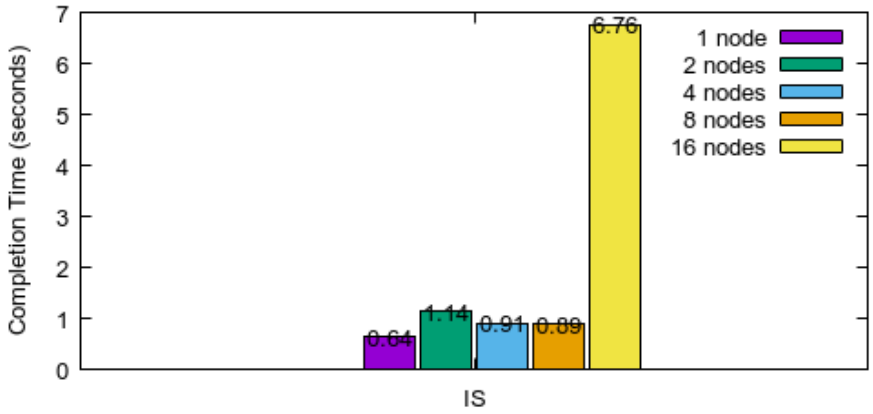

Figure 9: IS, Class A

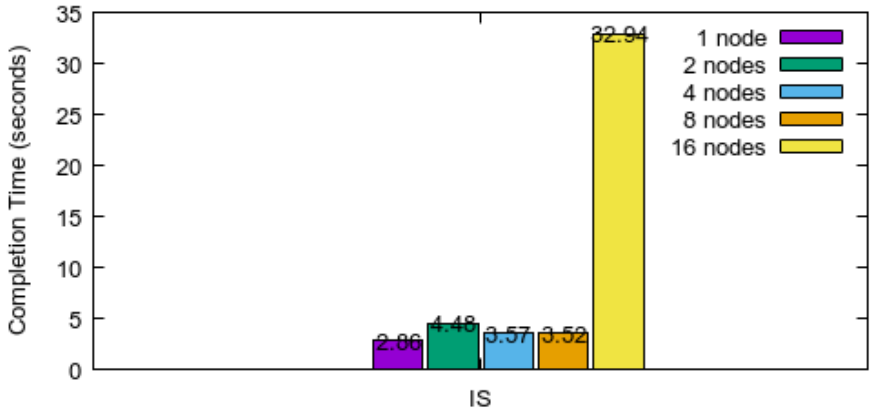

Figure 10: IS, Class B

2.5 Lower-Upper Gauss-Seidel Solver

A pseudo application that solves a system of linear equations.

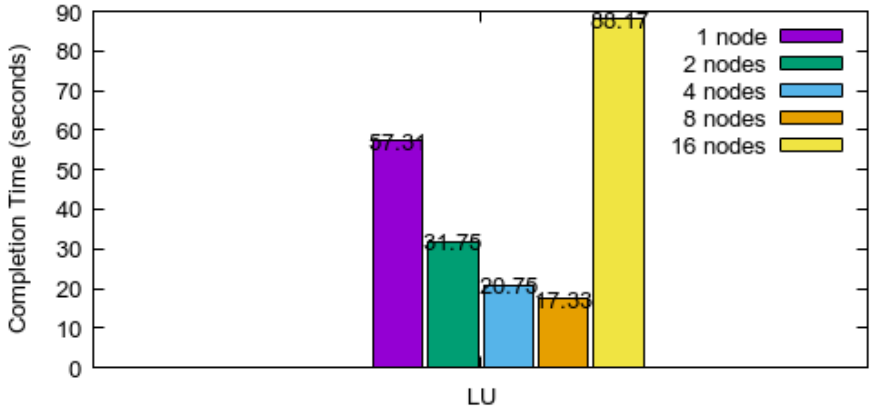

Figure 11: LU, Class A

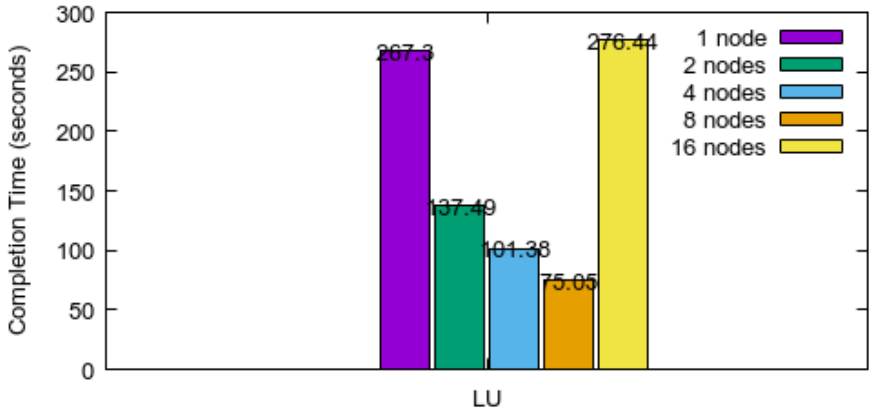

Figure 12: LU, Class B

2.6 Multi-Grid

Solves differential equations using long- and short-distance communication and is memory intensive.

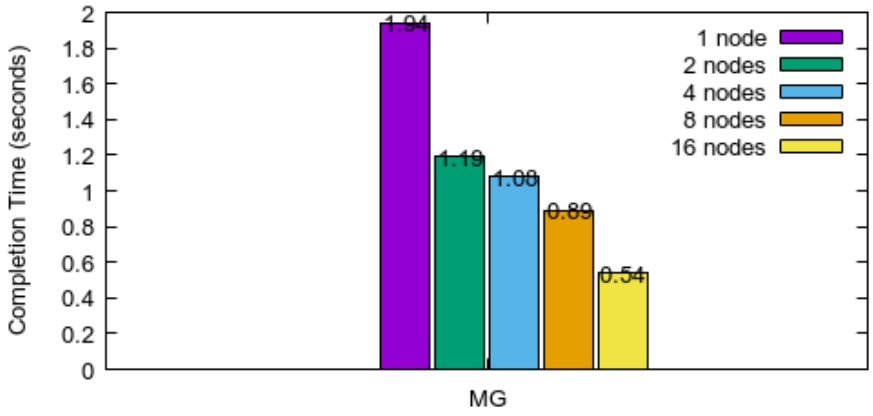

Figure 13: MG, Class A

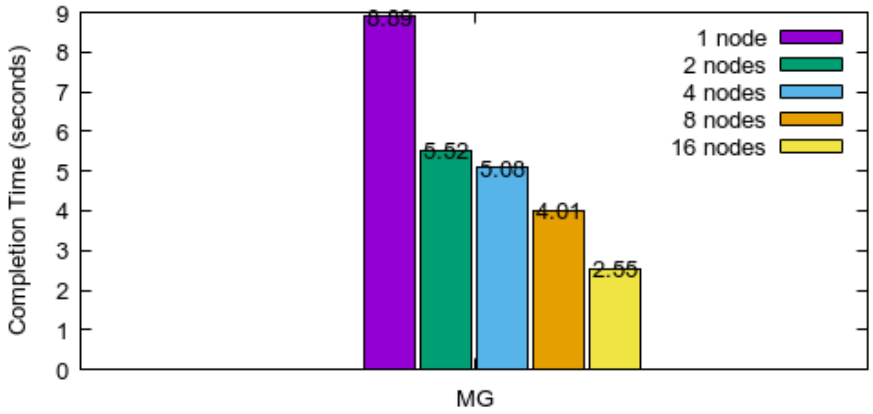

Figure 14: MG, Class B

References

[1] J. A. C. Hermocilla. P2c: Towards scientific computing on private clouds. In *Proceedings of the 12th National Conference on IT Education (NCITE 2014)*, pages 163–168. Philippine Society of Information Technology Educators, Oct. 2014.

[2] E. Walker. Benchmarking Amazon EC2 for high-performance scientific computing. *;Login*, 33(5), Oct. 2008.