Benchmarking Scientific Parallel Computation in the Cloud

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Abstract

The scalability and ease of implementation in cloud computing drives the transition from traditional computing to cloud based solutions. Benchmarking scientific parallel computation in the cloud is the goal of this project.

Benchmarking was performed using Amazon Elastic Compute Cloud (EC2) on a c3.2xlarge instance. The benchmarks are tailored to computations common in scientific workloads and applications, developed by the NASA Advanced Supercomputing Division (NAS) at the Ames Research Center. The NAS Parallel Benchmarks (NPB) are codes available to the public that aid in characterizing typical workloads of supercomputers. Nine applications were selected from NPB class B: Block Tri-diagonal solver (BT), Conjugate Gradient (CG), Embarrassingly Parallel (EP), discrete 3D Fast Fourier Transform (FT), Integer Sort (IS), Lower-Upper Gauss-Seidel solver (LU), MultiGrid (MG), Scalar Penta-diagonal solver (SP), and Unstructured Adaptive (UA).

The results of the study are plotted using the execution time and the number of parallel processors. Speedup of computation is explored based on Amdahl's law, where speedup is defined as the execution time of a program ran on a single processor divided by the execution time of the same program executed in parallel across *n* processors. The resulting speedup graphs are generally logarithmic in shape, with the exception of EP.

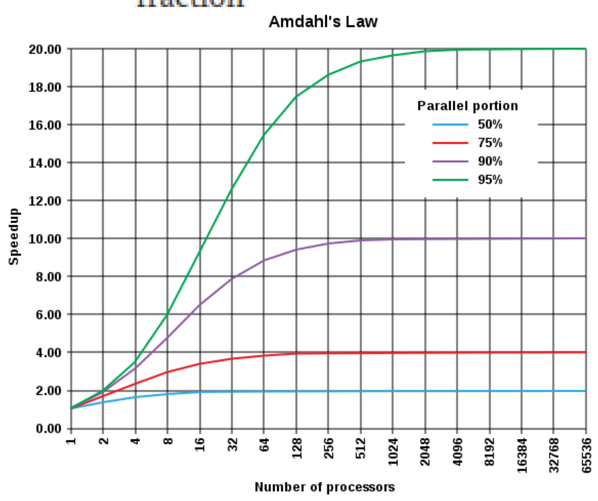
Amdahl's Law

$$S = \frac{1}{(1-F) + F / S_{\text{fraction}}}.$$

S = Speedup

F = percentage of the parallel portion of the program

$S_{fraction}$ = number of processors



Hardware

Instance	c3.2xlarge
Processor	Xeon E5-2680 v2 @ 2.80GHz
vCPU	8
Memory (GB)	15
Storage (GB)	2 x 80 (SSD)

Amazon EC2

Benchmarks

Acronym	Benchmark
BT	Block Tri-diagonal solver
CG	Conjugate Gradient
EP	Embarrassingly Parallel
FT	discrete 3D Fast Fourier Transform
IS	Integer Sort
LU	Lower-Upper Gauss-Seidel solver
MG	MultiGrid
SP	Scalar Penta-diagonal solver
UA	Unstructured Adaptive

Results