**Understanding the Cost Computing in the cloud**

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In this project, we are going to compare own created private cloud instances with public (Amazon EC2) cloud instances.

A public cloud consists of a service or set of services that are purchased by a business or organization and delivered via the Internet by a third-party provider.

A private cloud is essentially an extension of an enterprise's traditional datacenter that is optimized to provide storage capacity and processor power for a variety of functions.

Here, we have to find cost break down of private cloud and compare it with public (Amazon EC2) cloud. In this project, we did some experiment on different instances and found that private clouds are best to scale for larger data scale, while public clouds are best for small amount of data.

**Public Cloud Instances GFLOPS(Amazon EC2)**

In first bullet, we assumed 1 EC2 instance is 4.4 GFLOPs and accordingly we have to derive graph for GFLOPs versus Cost per hour for different instances of amazon EC2.

This is how we had calculated GFLOPs.

GFLOPs = ECU\*4.4

And then we have cost per hour for each instance. So to find the value for 1 GFLOPs, we divided cost per hour to GFLOPs.

Table 1 depicts the value of cost per hour as given and GFLOPs are being calculated for each EC2 instances.

**Table 1 Comparison between Amazon EC2 instances**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Instance Type | vCPU | Memory (GiB) | Storage  (GB) | ECU | GFLOPS | Cost per hour ($) |
| t2.small | 1 | 2 | EBS | 1 | 4.4 | 0.026 |
| m3.large | 2 | 7.5 | 1X32 SSD | 6.5 | 28.6 | 0.14 |
| c3.8xlarge | 32 | 60 | 2X320 SSD | 108 | 475.2 | 1.68 |
| g2.2xlarge | 8 | 15 | 60 SSD | 26 | 114.4 | 0.65 |
| r3.4xlrge | 16 | 122 | 1x320 SSD | 52 | 228.8 | 1.4 |
| i2.8xlarge | 32 | 244 | 8X800 SSD | 104 | 457.6 | 6.82 |
| hs1.8xlarge | 16 | 117 | 24X2048 | 35 | 154 | 4.6 |

**Private Instances Requirements:**

1. t2.small:

|  |  |  |
| --- | --- | --- |
| **Device** | **Details** | **Cost** |
| Chases | 700 W- 2U Rackmount Server Case with Power Supply | $565 |
| CPU | Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5GHz ,10 cores | $1534 |
| Memory | Kingston 48GB (3 x 16GB) DDR3 | $590 |
| HDD | 300 GB SSD | $393 |
| Motherboard | Motherboard LGA 2011 Intel C604 DDR3 1600 | $351 |
| System Admin | 120k \* 5 | $600000 |
| System Power | 700W | $4967 |
| Cooling Power | 115W | $816 |
| Rack | 25 u rack | $275 |
| Network Switch | 24LC-S Managed Switch | $436 |
| Total Cost (5years) | 100 GFLOPS | $ 609927 |
| Unit Cost | Per Instance/hour | $13.92527201 |

1. m3.large :

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| **Device** | **Details** | **Cost** |
| Chases | 700 W- 2U Rackmount Server Case with Power Supply | $565 |
| CPU | Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5GHz , 10 cores | $1534 |
| Memory | Kingston 24GB (3 x 8GB) DDR3 | $354 |
| HDD | 100 GB SATA | $190 |
| Motherboard | Motherboard LGA 2011 Intel C604 DDR3 1600 | $351 |
| System Admin | 120k \* 5 | $600000 |
| System Power | 700W | $4967 |
| Cooling Power | 115W | $816 |
| Rack | 25 u rack | $275 |
| Network Switch | 24LC-S Managed Switch | $436 |
| Total Cost (5years) | 100 GFLOPS | $ 609488 |
| Unit Cost | Per Instance/hour | $13.91524918 |

1. c3.8xlarge :

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| **Device** | **Details** | **Cost** |
| Chases | 700 W- 2U Rackmount Server Case with Power Supply | $565 |
| CPU | Intel Xeon E5- 2695 v3 14-Core Processor 2.3 GHz | $2340 |
| Memory | Crucial 64GB (2 x 32GB) 240-Pin DDR3 | $1084 |
| HDD | 320GB\*2 SSD | $2500 |
| Motherboard | Server Motherboard LGA 2011 R3 | $270 |
| System Admin | 120k \* 5 | $600000 |
| System Power | 700W | $4967 |
| Cooling Power | 135W | $957.906 |
| Rack | 25 u rack | $275 |
| Network Switch | 24LC-S Managed Switch | $436 |
| Total Cost (5years) | 515.2 GFLOPS | $ 613394.82 |
| Unit Cost | Per Instance/hour | $14.00444808 |

1. g2.2xlarge :

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| **Device** | **Details** | **Cost** |
| Chases | 700 W- 2U Rackmount Server Case with Power Supply | $565 |
| CPU | Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5GHz , 10 cores | $1534 |
| GPU | NVIDIA Quadro K5000 4GB | $1700 |
| Memory | Crucial 96GB (3 x 32GB) 240-Pin DDR3 | $5100 |
| HDD | 600GB\*2 SSD | $2500 |
| Motherboard | Motherboard LGA 2011 Intel C604 DDR3 1600 | $351 |
| System Admin | 120k \* 5 | $600000 |
| System Power | 822W | $5832 |
| Cooling Power | 115W | $816 |
| Rack | 25 u rack | $275 |
| Network Switch | 24LC-S Managed Switch | $436 |
| Total Cost (5years) | 2200 GFLOPS | $ 617669.5772 |
| Unit Cost | Per Instance/hour | $14.10204514 |

1. r3.4xlarge :

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| **Device** | **Details** | **Cost** |
| Chases | 700 W- 2U Rackmount Server Case with Power Supply | $565 |
| CPU | Intel Xeon E5- 2695 v3 14-Core Processor 2.3 GHz | $2340 |
| Memory | Crucial 128GB (4 x 32GB) DDR3 | $4600 |
| HDD | 320GB\*2 SSD | $2500 |
| Motherboard | Server Motherboard LGA 2011 R3 | $270 |
| System Admin | 120k \* 5 | $600000 |
| System Power | 700W | $4967 |
| Cooling Power | 135W | $957.906 |
| Rack | 25 u rack | $275 |
| Network Switch | 24LC-S Managed Switch | $436 |
| Total Cost (5years) | 515.2 GFLOPS | $ 616910.826 |
| Unit Cost | Per Instance/hour | $14.08472205 |

6. i2.8xlarge :

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| **Device** | **Details** | **Cost** |
| Chases | 700 W- 2U Rackmount Server Case with Power Supply | $565 |
| CPU | Intel Xeon E5- 2695 v3 14-Core Processor 2.3 GHz | $2340 |
| Memory | Crucial 128GB (4 x 32GB) DDR3 | $4600 |
| HDD | 800GB\*8 SSD | $6424 |
| Motherboard | Server Motherboard LGA 2011 R3 | $270 |
| System Admin | 120k \* 5 | $600000 |
| System Power | 700W | $4967 |
| Cooling Power | 135W | $957.906 |
| Rack | 25 u rack | $275 |
| Network Switch | 24LC-S Managed Switch | $436 |
| Total Cost (5years) | 515.2 GFLOPS | $ 620834.826 |
| Unit Cost | Per Instance/hour | $14.1743111 |

7. hs1.8xlarge :

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| **Device** | **Details** | **Cost** |
| Chases | 700 W- 2U Rackmount Server Case with Power Supply | $565 |
| CPU | Intel Xeon E5- 2695 v3 14-Core Processor 2.3 GHz | $2340 |
| Memory | Crucial 128GB (4 x 32GB) DDR3 | $6900 |
| HDD | 2048GB\*24 HDD | $3120 |
| Motherboard | Server Motherboard LGA 2011 R3 | $270 |
| System Admin | 120k \* 5 | $600000 |
| System Power | 700W | $4967 |
| Cooling Power | 135W | $957.906 |
| Rack | 25 u rack | $275 |
| Network Switch | 24LC-S Managed Switch | $436 |
| Total Cost (5years) | 515.2 GFLOPS | $ 619830.826 |
| Unit Cost | Per Instance/hour | $14.15138872 |

**Plot #1 :**

The graph shows the cost (in $) per instance per hour for 7 Amazon EC2 instance types vs. 7 private cloud equivalent instance types from 1GFlop to 1PFlop.

*Plot1-A : Cost Comparison between Private Cloud and Public Cloud Instances(Cost per instance/hour)*

As per above plot, we can see that for higher computing power(GFLOPS) private cloud has low cost then public cloud which have constant cost.

As per hardware selected for private cloud instances up to 100GFLOPS every instances have nearer to same cost because of scaling in number of instances.

After some specific number of GFLOPS every private instance’s cost become lower then it’s equivalent public cloud instance. Now when computing power becomes >100TFLOPS cost for private instances become constant at some specific value.

Another graph for cost comparison between private instances and public cloud instances in cost per GFLOPS per hour.

*Plot1-B : Cost Comparison between Private Cloud and Public Cloud Instances(Cost per GFLOPS/hour)*

**Plot #2** :

The graph shows the utilization of private cloud from 1 GFLOPs to 1 PFLOPs.

*Plot2 : Utilization of Private Cloud Instances (%)*

As per above plot, we can define that for the private cloud cost utilization remains infinite up to when it cross cost of equivalent public cloud instance. At the point of meeting utilization becomes 100% . After whenever private instance’s cost become lower it’s utilization % also become less. Whenever it goes for higher computing power >100TFLOPS utilization becomes constant at some specific value.

Reference for Hardware :

[1] <http://www.superbiiz.com/>

[2] http://www.newegg.com/