CS 553: Cloud Computing
Understanding the Cost of Computing in the Cloud

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Abstract—The main purpose of this project is to grasp the importance of economic concerns regarding cloud computing. Since cloud computing becomes widespread within the industry of computer science, the management of prices has become a huge topic of cloud computing these years. We are to study the incentives of setting up a public rather than a private cloud.

Instance Type	vCPU	Memory (GiB)	Storage (GB)	Networking Performance	Physical Processor	Clock Speed (GHz)	Price
m4.10xlarge	40	160	EBS Only	10Gbps	Intel Xeon E5-2676 v3	2.4	$2.394
m3.large	2	7.5	1 x 32 SSD	Moderate (500Mbps)	Intel Xeon E5-2670 v2	2.5	$0.133
m3.2xlarge	8	30	2 x 80 SSD	High (1Gbps)	Intel Xeon E5-2670 v2	2.5	$0.532
c3.8xlarge	32	60	2 x 320 SSD	10Gbps	Intel Xeon E5-2680 v2	2.8	$1.680
g2.2xlarge	8	15	1 x 60 SSD	High (1Gbps)	Intel Xeon E5-2670	2.6	$0.650
r3.4xlarge	16	122	1 x 320 SSD	High (1Gbps)	Intel Xeon E5-2670 v2	2.5	$1.33
i2.8xlarge	32	244	8 x 800 SSD	10Gbps	Intel Xeon E5-2670 v2	2.5	$6.82
d2.8xlarge	36	244	24 x 2,000	10Gbps	Intel Xeon E5-2676 v3	2.4	$5.52

The above table describes about the ec2 instances of AWS. We use the concept of EC2 compute units to denote the compute capacity in Gflops of each instance. Each VCPU of the instance is a hyper thread of the Intel Xeon processor. We consider seven instances prm4.10xlarge, prm3.large, prm3.2xlarge, prc3.8xlarge, prg2.2xlarge, prr3.4xlarge, pri2.8xlarge and prd2.8xlarge which are compared to the amazon ec2 instances m4.10xlarge, m3.large, m3.2xlarge, c3.8xlarge, g2.2xlarge, r3.4xlarge, i2.8xlarge, and d2.8xlarge. We build a private cloud for all the amazon instances and compare the cost of each instance per hour. To build a private cloud the factors we consider are Processor, Storage, Memory, Network Adapter, Network Switch, System Admin, Cooling Power, Chassis, Rack, UPS, Motherboard. We consider building a private cloud from the scratch. While building the private cloud we check the compatibility of the hardware with the other factors. The total mentioned in the table is the cost of the instance amortized for 5 years. All the considered processors support hyper threading and while considering GFlops we also multiply the number of hyper threads which is 2 to the number of cores * instructions per cycle * processor speed.

Private Instances:

1. prm4.10xlarge

Device	Details	Cost
Processor Cost	2 Intel Xeon E5-2676 v3 12 Core 2.4GHz	$3,600
Storage	Western Digital Caviar Blue 640 GB Bulk/OEM Hard Drive 3.5 Inch, 16 MB Cache, 7200 RPM SATA II WD6400AAKS	$133.89
Memory	8*20 GB DDR4	$8000.00
Network Adapter	Intel Ethernet Server Adapter I350-T2 1gbps	$129.99
Network Switch	18 ports Linksys	$306.87
Cooling Power	399.42	$2,921.60
Chassis	2U SC823TQ-653LPB 650W	$370.27
Rack	42u Rack	$70.00
UPS	APC Smart-UPS SMC1500-2U 900w 6 outlets	$464.98
Motherboard	SUPERMICRO X9SRL-F ATX Server Motherboard LGA 2011 DDR3	$270.99
Adapter	ICY DOCK EZConvert MB882SP-1S-2B 2.5" to 3.5" SATA 6Gbps SSD	$37.73
Total		$16,306

GFLOPS	Instance Required		Hardware Cost	Cost of Electricity	Cost of Cooling	Administration Cos	Total Cost	Cost/hr	Cost/hr/gflop
1	1		$16,306	657.05	219.01	250000	$267,182.06	$7.68	$7.6776
10	1		$16,306	657.05	219.01	250000	$267,182.06	$7.68	$0.7678
100	3		$48,918.00	1971.15	657.03	250000	$301,546.18	$8.67	$0.0867
1000	27		$440,262.00	17740.35	5913.27	250000	$713,915.62	$20.51	$0.0205
10000	261		$4,255,866.00	171490.05	57161.61	250000	$4,734,517.66	$136.05	$0.0136
100000	2605		$42,477,130.00	1711615.25	570521.05	5000000	$49,759,266.30	$1,429.86	$0.0143
1000000	26042		$424,640,852.00	17110896.1	5703458.42	5000000	$452,455,206.52	$13,001.59	$0.0130

This instance is specific for general purpose computing. The prm4.10xlarge has a 24 core processor which can be shared between 24 instances implies we dedicate 1 core to each instance. The memory, storage, chassis, rack, motherboard are also considered to fit 24 instances. The adapter is considered because the tray size is 3.5 but the SSD is only 2.5 so, we put the SSD in the adapter and put this in the rack. We calculate the Gflops of this private instance it is 2*2.4*12*4*2=460.8, so each instance has a compute capacity of 38.4 Gflops.

2. prm3.large

Device	Details	Cost
Processor Cost	Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache	$1,559.99
Storage	(TS32GMSA370) mSATA 32GB SATA III MLC Internal (SSD)	$38.99
Memory	Kingston 8GB 240-Pin DDR3	$31.99
Network Adapter	Intel Ethernet Server Adapter I350-T2 1gbps	$129.99
Network Switch	18 ports Infiniband	$306.87
Cooling Power	399.42	$2,921.60
Chassis	2U SC823TQ-653LPB 650W	$370.27
Rack	42u Rack	$70.00
UPS	APC Smart-UPS SMC1500-2U 900w 6 outlets	$464.98
Motherboard	SUPERMICRO X9SRL-F ATX Server Motherboard LGA 2011 DDR3	$270.99
Adapter	ICY DOCK EZConvert MB882SP-1S-2B 2.5" to 3.5" SATA 6Gbps SSD	$37.73
Total		$6,203.40

GFLOPS	Instance Required		Hardware Cost	Cost of Electricity	Cost of Cooling	Administration Cost	Total Cost	Cost/hr	Cost($)/hr/gflop
1	1		$6,203.40	709.65	236.55	250000	$257,149.60	$7.39	7.3894
10	1		$6,203.40	709.65	236.55	250000	$257,149.60	$7.39	0.7389
100	5		$31,017.00	3548.25	1182.75	250000	$285,748.00	$8.21	0.0821
1000	50		$310,170.00	35482.5	11827.5	250000	$607,480.00	$17.46	0.0175
10000	500		$3,101,700.00	354825	118275	250000	$3,824,800.00	$109.91	0.0110
100000	5000		$31,017,000.00	3548250	1182750	5000000	$40,748,000.00	$1,170.92	0.0117
1000000	50000		$310,170,000.00	35482500	11827500	15000000	$372,480,000.00	$10,703.45	0.0107

This instance is specific for general purpose computing. The prm3.large has an 8 core processor which can be shared between 8 instances implies we dedicate 1 core to each instance. The memory, storage, chassis, rack, motherboard are also considered to fit 8 instances. . The adapter is considered because the tray size is 3.5 but the SSD is only 2.5 so, we put the SSD in the adapter and put this in the rack. We calculate the Gflops of this private instance it is 2*2.5*8*4=160, so each instance has a compute capacity of 20 Gflops.

3. prm3.2xlarge

Device	Details	Cost
Processor Cost	Intel Xeon E5-2670 v2 10 Core 2.5GHz	$1,675.99
Storage	Intel DC S3500 Series 2.5" 160GB SATA III MLC Internal SSD	$159.99
Memory	Kingston 32GB 240-Pin DDR3	$281.37
Network Adapter	Intel Ethernet Server Adapter I350-T2 1gbps	$129.99
Network Switch	Cisco SG200-18 Switch 16 10/100/1000 Ports, Gigabit Ethernet	$273.00
Cooling Power	464.22	$3,402.10
Chassis	SuperChasis 825TQ-600WB 2U	$349.99
Rack	42u Rack	$70.00
Motherboard	ASRock EP2C602-2T/D16 SSI EEB Server Motherboard Dual LGA 2011 DDR3 1600/1333/1066	$499.99
UPS	APC Smart-UPS SMC1500-2U 900w 6 outlets	$529.99
Adapter	ICY DOCK EZConvert MB882SP-1S-2B 2.5" to 3.5" SATA 6Gbps SSD	$24.99
Total		$7,397.40

GFLOPS	Instance Required		Hardware Cost	Cost of Electricity	Cost of Cooling	Administration Cos	Total Cost	Cost/hr	Cost/hr/gflop
1	1		$7,397.40	7021.9	2340.63	500000	$516,759.93	$14.85	$14.8494
10	1		$7,397.40	7021.9	2340.63	500000	$516,759.93	$14.85	$1.4849
100	1		$7,397.40	7021.9	2340.63	500000	$516,759.93	$14.85	$0.1485
1000	3		$22,192.20	21065.7	7021.89	500000	$550,279.79	$15.81	$0.0158
10000	25		$184,935.00	175547.5	58515.75	500000	$918,998.25	$26.41	$0.0026
100000	250		$1,849,350.00	1755475	585157.5	500000	$4,689,982.50	$134.77	$0.0013
1000000	2500		$18,493,500.00	17554750	5851575	1500000	$43,399,825.00	$1,247.12	$0.0012

This instance is compute optimized with high performing processors. The prm3.2xlarge has a 10 core processor. Each instance is allocated 10 cores. So we take 10core processor and for memory we take 32GB DDR3 RAM's. When we calculate the Gflops of this private instance it is 2*2.5*10*4*2=400, so each instance has a compute capacity of 400 Gflops.

4. prc3.8xlarge:

Device	Details	Cost
Processor Cost	2 Intel Xeon E5-2680 v2 Ivy Bridge-EP 2.8 GHz	$3,539.99
Storage	Western Digital Caviar Blue 640 GB Bulk/OEM Hard Drive 3.5 Inch, 16 MB Cache, 7200 RPM SATA II WD6400AAKS	$133.89
Memory	8*8 GB DDR3	$329.99
Network Adapter	Intel E10G42BT X520-T2 10Gigabit Ethernet Card 10Gbps	$503.38
Network Switch	Cisco SG200-18 Switch 16 10/100/1000 Ports, Gigabit Ethernet	$273.00
Cooling Power	464.22	$3,402.10
Chassis	SuperChasis 825TQ-600WB 2U	$349.99
Rack	42u Rack	$70.00
Motherboard	ASRock EP2C602-2T/D16 SSI EEB Server Motherboard Dual LGA 2011 DDR3 1600/1333/1066	$499.99
UPS	APC Smart-UPS SMC1500-2U 900w 6 outlets	$529.99
Adapter	ICY DOCK EZConvert MB882SP-1S-2B 2.5" to 3.5" SATA 6Gbps SSD	$24.99
Total		$9,657.31

GFLOPS	Instance Required		Hardware Cost	Cost of Electricity	Cost of Cooling	Administration Cos	Total Cost	Cost/hr	Cost/hr/gflop
1	1		$9,657.31	9083.6	2895.23	500000	$521,636.14	$14.99	$14.9895
10	1		$9,657.31	9083.6	2895.23	500000	$521,636.14	$14.99	$1.4990
100	1		$9,657.31	9083.6	2895.23	500000	$521,636.14	$14.99	$0.1499
1000	3		$28,971.93	27250.8	8685.69	500000	$564,908.42	$16.23	$0.0162
10000	23		$222,118.13	208922.8	66590.29	500000	$997,631.22	$28.67	$0.0029
100000	224		$2,163,237.44	2034726.4	648531.52	500000	$5,346,495.36	$153.63	$0.0015
1000000	2233		$21,564,773.23	20283678.8	6465048.59	2500000	$50,813,500.62	$1,460.16	$0.0015

This instance is compute optimized with high performing processors. The prc3.8xlarge has a 20 core processor. Each instance is allocated 20 cores. So we take two 10 core processors and for memory we take eight 8GB DDR3 RAM's. When we calculate the Gflops of this private instance it is 2*2.8*10*4*2=448, so each instance has a compute capacity of 448 Gflops.

5. prg2.2xlarge:

Device	Details	Cost
Processor Cost	Intel Xeon E5-2670 8 Core 2.6GHz	$1,349.95
Storage	64GB SATA III 6Gb/s SSD	$109.99
Memory	8*2 GB DDR3	$69.99
Network Adapter	Intel E10G42BT X520-T2 10Gigabit Ethernet Card 10Gbps	$503.38
Network Switch	Cisco SG200-18 Switch 16 10/100/1000 Ports, Gigabit Ethernet	$273.00
Cooling Power	576.72	$4,218.48
Chassis	2U SC823TQ-653LPB 650W	$360.41
Rack	42u Rack	$70.00
UPS	APC Smart-UPS SMC1500-2U 900w 6 outlets	$529.99
Adapter	ICY DOCK EZConvert MB882SP-1S-2B 2.5" to 3.5" SATA 6Gbps SSD	$24.99
Motherboard	ASUS Z9PE-D16 SSI EEB Server Motherboard Dual LGA 2011 DDR3 1600	$499.99
GPU	NVIDIA TESLA K20 3.52 Tflops Workstation Video Card - OEM	$2,899.99
Total		$8,010.17

GFLOPS	Instance Required		Hardware Cost	Cost of Electricity	Cost of Cooling	Administration Cos	Total Cost	Cost/hr	Cost/hr/gflop
1	1		$8,010.17	2190.25	730.1	500000	$510,930.52	$14.68	$14.6819
10	1		$8,010.17	2190.25	730.1	500000	$510,930.52	$14.68	$1.4682
100	1		$8,010.17	2190.25	730.1	500000	$510,930.52	$14.68	$0.1468
1000	1		$8,010.17	2190.25	730.1	500000	$510,930.52	$14.68	$0.0147
10000	3		$24,030.51	6570.75	2190.3	500000	$532,791.56	$15.31	$0.0015
100000	28		$224,284.76	61327	20442.8	500000	$806,054.56	$23.16	$0.0002
1000000	272		$2,178,766.24	595748	198587.2	3500000	$6,473,101.44	$186.01	$0.0002

This instance is intended for GPU computations with high performance NVIDIA TESLA K20 with Tflops. The prg2.2xlarge has an 8 core processor and the number of cores for the gpu processor is 2496 cores. For compute capacity we consider the gflops of both cpu and gpu. Cpu single precision performance = 166.4 GFLOPS, Gpu single precision performance = 3520 GFLOPS. TOTAL GFLOPS= 3686.4

6. prr3.4xlarge:

Device	Details	Cost
Processor Cost	Intel Xeon E5-2670 v2 10 Core 2.5GHz	$1,675.99
Storage	320GB SSD	$94.89
Memory	128GB DDR3	$1,059.00
Network Adapter	QLogic QLE3242-CU-CK 10Gbps PCI Express Gen2 x8 Dual Ethernet	$489.89
Network Switch	Cisco SG200-18 Switch 16 10/100/1000 Ports, Gigabit Ethernet	$273.00
Cooling Power	416.22	$3,042.87
Chassis	SC 514-R400c 1U	$463.21
Rack	42u Rack	$70.00
Motherboard	ASUS rampage IV black edition LGA 2011 ETAX	$374.99
UPS	APC Smart-UPS SMC1500-2U 900w 6 outlets	$489.99
Adapter	ICY DOCK EZConvert MB882SP-1S-2B 2.5" to 3.5" SATA 6Gbps SSD	$46.99
Total		$8,080.82

GFLOPS	Instance Required		Hardware Cost	Cost of Electricity	Cost of Cooling	Administration Cos	Total Cost	Cost/hr	Cost/hr/gflop
1	1		$8,080.82	1463.1	487.7	500000	$510,031.62	$14.66	$14.6561
10	1		$8,080.82	1463.1	487.7	500000	$510,031.62	$14.66	$1.4656
100	1		$8,080.82	1463.1	487.7	500000	$510,031.62	$14.66	$0.1466
1000	5		$40,404.10	7315.5	2438.5	500000	$550,158.10	$15.81	$0.0158
10000	50		$404,041.00	73155	24385	500000	$1,001,581.00	$28.78	$0.0029
100000	500		$4,040,410.00	731550	243850	500000	$5,515,810.00	$158.50	$0.0016
1000000	5000		$40,404,100.00	7315500	2438500	2500000	$52,658,100.00	$1,513.16	$0.0015

This instance is intended for memory intensive applications. The prr3.4xlarge has a 10 core processor. Each instance is allocated 10 cores. The RAM is 128 GB DDR3. When we calculate the Gflops of this private instance it is 2*2.5*10*4=200, so each instance has a compute capacity of 200 Gflops.

7. pri2.8xlarge:

Device	Details	Cost
Processor Cost	IBM 2.5GHz 16 MB L2 Cache 20MB L3 Cache Socket G34 115W Server Processor 00AM123[16-core] (3P)	$4,762.65
Storage	8 Intel SSD DC S3500 Series SSDSC2BB800G401 2.5" 800GB SATA III MLC Internal Solid State Drive (SSD)	$6,039.92
Memory	8*(4*8) GB DDR3 quad channel ram	$1,359.92
Network Adapter	Intel E10G42BT X520-T2 10Gigabit Ethernet Card 10Gbps PCI Express x8 2 x RJ45	$503.38
Network Switch	Cisco SG200-18 Switch 16 10/100/1000 Ports, Gigabit Ethernet	$273.00
Cooling Power	560.22	$1,639.11
Chassis	Supermicro CSE-826BAC4-R920WB 2U 920W Chassis	$1,199.99
Rack	42u Rack	$70.00
Motherboard	EP2C602-2T/D16 ASRock Dual LGA2011 Intel C602 DDR3 SATA3	$922.65
Ups	APC Smart-UPS SMC1500-2U 900w 6 outlets	$489.99
Adapter	ICY DOCK EZConvert MB882SP-1S-2B 2.5" to 3.5" SATA 6Gbps SSD	$46.99
Total		$17,307.60

GFLOPS	Instance Required		Hardware Cost	Cost of Electricity	Cost of Cooling	Administration Cos	Total Cost	Cost/hr	Cost/hr/gflop
1	1		$17,307.60	2549.45	849.82	500000	$520,706.87	$14.96	$14.9628
10	1		$17,307.60	2549.45	849.82	500000	$520,706.87	$14.96	$1.4963
100	1		$17,307.60	2549.45	849.82	500000	$520,706.87	$14.96	$0.1496
1000	4		$69,230.40	10197.8	3399.28	500000	$582,827.48	$16.75	$0.0167
10000	32		$553,843.20	81582.4	27194.24	500000	$1,162,619.84	$33.41	$0.0033
100000	313		$5,417,278.80	797977.85	265993.66	500000	$6,981,250.31	$200.61	$0.0020
1000000	3125		$54,086,250.00	7967031.25	2655687.5	1500000	$66,208,968.75	$1,902.56	$0.0019

This instance is storage optimized with high FLOPS that is used for random IO operations. The pri2.8xlarge has a 16 core processor. Each instance is allocated 16 cores. So we take eight 32 GB DDR3 RAM's. The storage is 6TB. When we calculate the Gflops of this private instance it is 2*2.5*16*4=320, so each instance has a compute capacity of 320 Gflops.

8. prd2.8xlarge:

Device	Details	Cost
Processor Cost	3 Intel Xeon E5-2676 v3 12 Core 2.4GHz	$5,400.00
Storage	Seagate Constellation CS ST2000NC001 2TB 64MB Cache SATA 6.0Gb/s 3.5" Enterprise Internal Hard Drive Bare Drive	$3,167.76
Memory	8*(4*8) GB DDR3 quad channel ram	$1,359.92
Network Adapter	Intel E10G42BT X520-T2 10Gigabit Ethernet Card 10Gbps PCI Express x8 2 x RJ45	$503.38
Network Switch	Cisco SG200-18 Switch 16 10/100/1000 Ports, Gigabit Ethernet 1U	$273.00
Cooling Power	497	$3,635.00
Chassis	Supermicro CSE-826BAC4-R920WB 2U 920W Chassis	$1,199.99
Rack	42u Rack	$70.00
Motherboard	EP2C602-2T/D16 ASRock Dual LGA2011 Intel C602 DDR3 SATA3	$922.65
ups	APC Smart-UPS SMC1500-2U 900w 6 outlets	$489.99
Adapter	ICY DOCK EZConvert MB882SP-1S-2B 2.5" to 3.5" SATA	$46.99
Total		$17,068.68

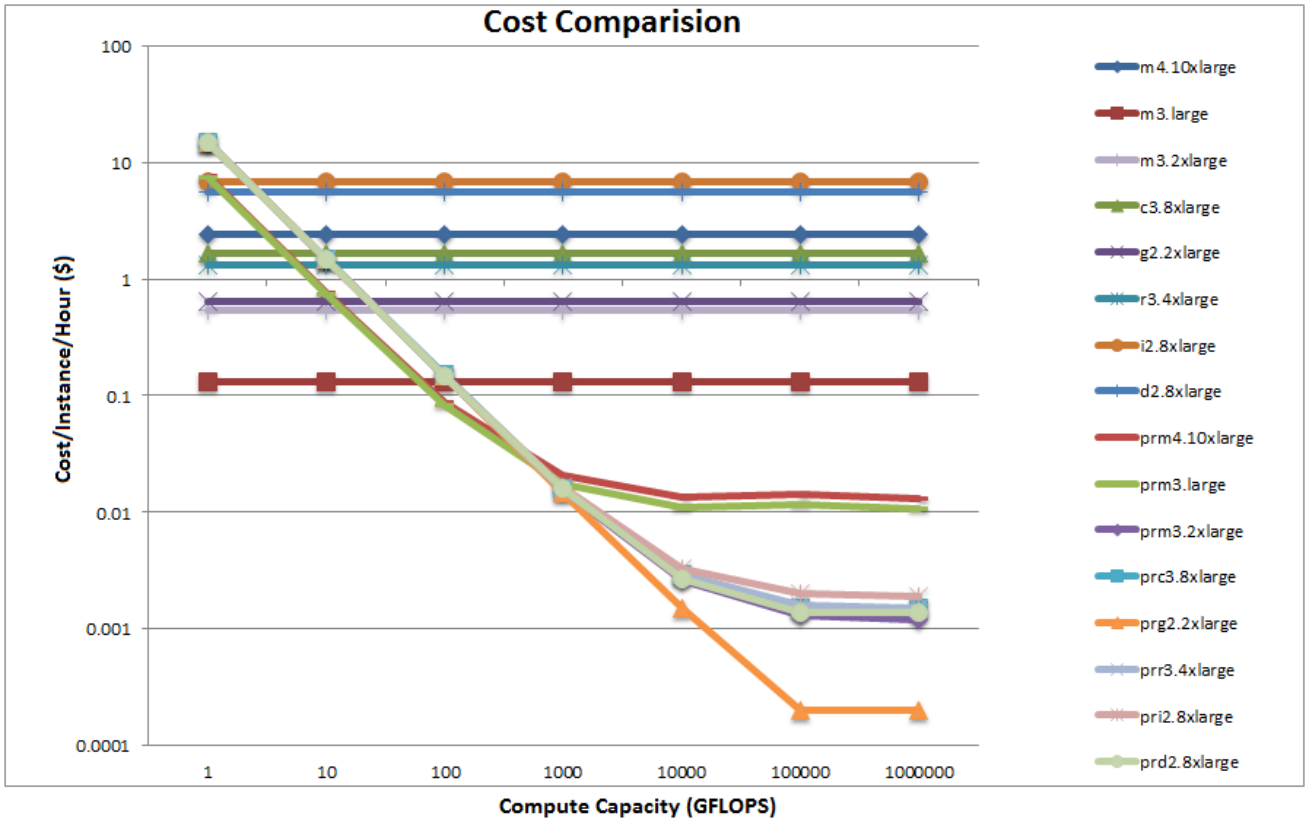
GFLOPS	Instance Required		Hardware Cost	Cost of Electricity	Cost of Cooling	Administration Cos	Total Cost	Cost/hr	Cost/hr/gflop
1	1		$17,068.68	2637.05	879.02	500000	$520,584.75	$14.96	$14.9593
10	1		$17,068.68	2637.05	879.02	500000	$520,584.75	$14.96	$1.4959
100	1		$17,068.68	2637.05	879.02	500000	$520,584.75	$14.96	$0.1496
1000	3		$51,206.04	7911.15	2637.06	500000	$561,754.25	$16.14	$0.0161
10000	22		$375,510.96	58015.1	19338.44	500000	$952,864.50	$27.38	$0.0027
100000	218		$3,720,972.24	574876.9	191626.36	500000	$4,987,475.50	$143.32	$0.0014
1000000	2171		$37,056,104.28	5725035.55	1908352.42	3500000	$48,189,492.25	$1,384.76	$0.0014

This instance is storage optimized with high storage density. The storage is 24*2 TB. The pri2.8xlarge has a 12 core processor. Each instance is allocated 36 cores. So we take three 12core processors and for memory we take eight 32 GB DDR3 RAM's. When we calculate the Gflops of this private instance it is 2*2.4*8*4*3=460.8, so each instance has a compute capacity of 460.8 Gflops.

Cost Comparison of Public Cloud(AMAZON) vs. Private Cloud:

Plot 1:

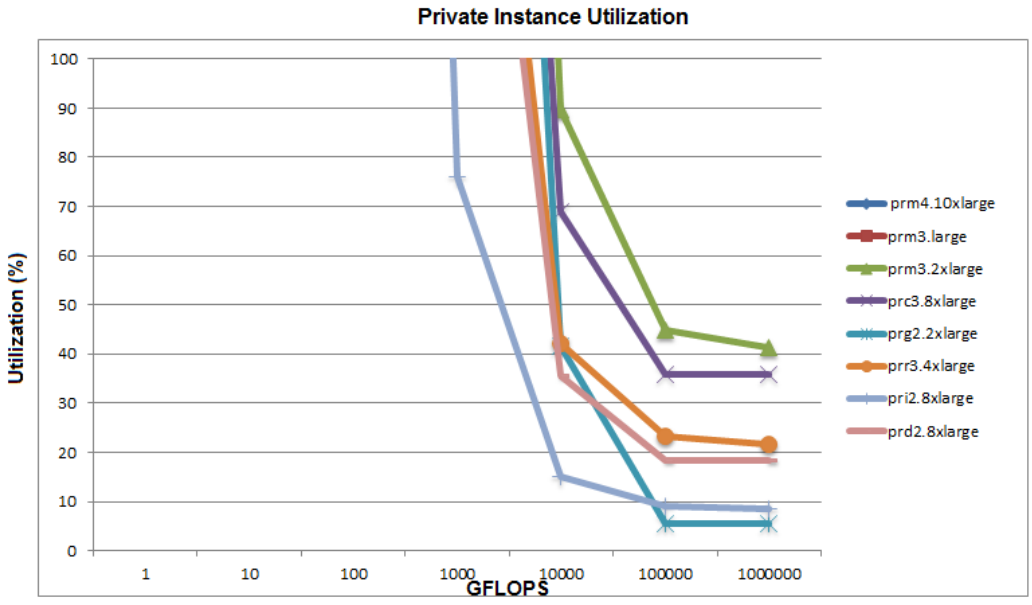
	1	10	100	1000	10000	100000	1000000
m4.10xlarge	2.394	2.394	2.394	2.394	2.394	2.394	2.394
m3.large	0.133	0.133	0.133	0.133	0.133	0.133	0.133
m3.2xlarge	0.532	0.532	0.532	0.532	0.532	0.532	0.532
c3.8xlarge	1.680	1.680	1.680	1.680	1.680	1.680	1.680
g2.2xlarge	0.650	0.650	0.650	0.650	0.650	0.650	0.650
r3.4xlarge	1.330	1.330	1.330	1.330	1.330	1.330	1.330
i2.8xlarge	6.820	6.820	6.820	6.820	6.820	6.820	6.820
d2.8xlarge	5.520	5.520	5.520	5.520	5.520	5.520	5.520
prm4.10xlarge	7.6776	0.7678	0.0867	0.0205	0.0136	0.0143	0.0130
prm3.large	7.3894	0.7389	0.0821	0.0175	0.0110	0.0117	0.0107
prm3.2xlarge	14.8494	1.4849	0.1485	0.0158	0.0026	0.0013	0.0012
prc3.8xlarge	14.9895	1.4990	0.1499	0.0162	0.0029	0.0015	0.0015
prg2.2xlarge	14.6819	1.4682	0.1468	0.0147	0.0015	0.0002	0.0002
prr3.4xlarge	14.6561	1.4656	0.1466	0.0158	0.0029	0.0016	0.0015
pri2.8xlarge	14.9628	1.4963	0.1496	0.0167	0.0033	0.0020	0.0019
prd2.8xlarge	14.9593	1.4959	0.1496	0.0161	0.0027	0.0014	0.0014



The above graph shows the cost per instance per hour in dollars for each of the amazon instances and the private cloud across 1Gflop to 1PFlop. The instance prm3.large is never cost effective to buy compared to the amazon small instances. It is observed that as the compute capacity is scaled from 1GFLOP to 1PFLOP, the cost per instance per hour decreases gradually, as the initial administration cost and other fixed costs are amortized.

Plot 2:

	1	10	100	1000	10000	100000	1000000
prm4.10xlarge	264745	26476	2990	707	469	493	448
prm3.large	1172921	117286	13032	2778	1746	1857	1698
prm3.2xlarge	512048	51203	5121	545	90	45	41
prc3.8xlarge	356893	35690	3569	386	69	36	36
prg2.2xlarge	407831	40783	4078	408	42	6	6
prr3.4xlarge	212407	21241	2125	229	42	23	22
pri2.8xlarge	68013	6801	680	76	15	9	9
prd2.8xlarge	196833	19683	1968	212	36	18	18



The above plot depicts the utilization of the private cloud as the compute capacity is scaled from 1GFLOP to 1PFLOP. It describes how much of the private instances are used to break-even the cost. The instance prm3.large is not cheap enough to buy compared to what amazon EC2 has to offer.

The prm3.2xlarge instance breaks even between10000Gflops and 100000GFlops. At 100Tflop the utilization is 90% which means if it is recommended to buy this instance if the work load present uses more than 90% of the instance compute capacity. At 1PFlop the utilization is 41% which means if it is recommended to buy this instance if the work load present uses more than 41% of the instance compute capacity.

The prc3.8large instance breaks even between10000Gflops and 100000GFlops. At 100Tflop the utilization is 69% which means if it is recommended to buy this instance if the work load present uses more than 69% of the instance compute capacity. At 1PFlop the utilization is 36% which means if it is recommended to buy this instance if the work load present uses more than 36% of the instance compute capacity.

The prg2.2xlarge GPU instance is utilized 6% around 1Pflop.

The prr3.4xlarge memory instance breaks even between 10000Gflops to 100000Gflops. At 100Tflop the utilization is 42% which means if it is recommended to buy this instance if the work load present uses more than 42% of the instance compute capacity. At 1PFlop the utilization is 22% which means if it is recommended to buy this instance if the work load present uses more than 22% of the instance compute capacity.

The pri2.8xlarge storage optimized instance breaks even round 100GFlops. At 10Tflop the utilization is 15% which means if it is recommended to buy this instance if the work load present uses more than 15% of the instance compute capacity. At 100TFlop the utilization is 9% which means if it is recommended to buy this instance if the work load present uses more than 9% of the instance compute capacity. At 1PFlop the utilization is 9% which means if it is recommended to buy this instance if the work load present uses more than 9% of the instance compute capacity.

The prd.8xlarge storage optimized instance breaks even between 1000Gflops and 10000GFlops. At 10Tflop the utilization is 36% which means if it is recommended to buy this instance if the work load present uses more than 36% of the instance compute capacity. At 100TFlop the utilization is 18% which means if it is recommended to buy this instance if the work load present uses more than 18% of the instance compute capacity. At 1PFlop the utilization is 18% which means if it is recommended to buy this instance if the work load present uses more than 18% of the instance compute capacity.

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