Cloud Computing

CS553

Project Report

Understanding the Cost of Computing in the Cloud

Student

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Introduction:

The problem statement is to identify whether the computing resources should be rented from a public cloud on-demand or whether a private cloud should be purchased. The task is to estimate the cost breakdown of a private cloud and compare it with Amazon on demand instances cost. The instance types to consider for this project are t2.small, m3.large, c3.8xlarge, g2.2xlarge, r3.4xlarge, i2.8xlarge and d2.8xlarge.

Important Points:

- The cost of the hardware is taken from http://www.newegg.com/ and http://www.ebay.com/
- Power consumption cost is computed from http://energyusecalculator.com/electricity_computer.htm and the power consumption rate is taken from https://www.comed.com/Pages/default.aspx ($0.07/KWatts)
- The power consumption of different hardware components is taken from their specifications and from http://www.buildcomputers.net/power-consumption-of-pc-components.html
- The theoretical value of GFLOPs of different processors is compared with the GFLOPs mentioned at https://www.microway.com/hpc-tech-tips/intel-xeon-e5-2600-v3-haswell-processor-review/ just to make sure the GFLOPs are calculated correctly
- The cooling power is considered to be 1/3rd of the power cost.
- For private instances the processors are selected same as the processors used for the public instance
- The configuration of the hardware used for private instances is same or higher than the configuration of public instances
- The Administration cost is assumed to be $100,000 for 1000 instance per year
- For all the instances 1U rackmount is used and in each scenario 42U rack is used
- The total cost calculated is for 5 years
- Depending on the GFLOPs requirement the number of instances are calculated and based on number of instance the number of network switch and number of racks are calculated
- For g2.2xlarge instance I have considered the GFLOPs of CPU and GPU both.
- The power supply is not bought separately because it is available on the rackmount. The rackmount also has cooling fans so need to buy the cooling fan separately

Private m4.10xlarge Instance:

Hardware Components:

Component	Name	Qty	PricePerUnit	Price	Power(Watts)
Processor	Intel Xeon E5- 2676 v3	2	1,800.00	3600	120
Motherboard	Intel S2600GZ4 Custom Server Motherboard Dual LGA 2011 DDR3 1600	1	489.99	489.99	70
Memory	Black Diamond Memory 32GB (2 x 16GB) 240-Pin DDR3 SDRAM ECC Registered DDR3 1866 (PC3 14900) Server Memory Model BD16GX21866MTR26	5	209.99	1049.95	3 * 10 chips = 30
Chassis case	iStarUSA EX1M4 Heavy-duty SGCC Cold-rolled Steel 1U Rackmount 1U 4-Bay Storage Server Rackmount Chassis	1	212.9	212.9	1 * 5 fans = 5
Disk	SanDisk SD8SB8U-1T00-1122 X400 SATA 2.5" 1TB Internal SSD	1	257.99	257.99	2
Network card	Intel X540T2 Ethernet Converged Network Adapter 100Mbps/1Gbps/10Gbps PCI Express 2.1 x8 2 x RJ45	1	444.99	444.99	10.8
Network Switch	Netgear ProSAFE 52-Port Gigabit POE+ Managed Switch Layer 2+ With Static L3 Routing (GSM7252PS)	1	2248.99	2248.99	380
Rack	42U Free Standing Server Rack Cabinet. Fits Most of Servers, ACCESSORIES FREE!! Thermo Control System, 4 Fan Cooling Panel, Shelf, 6-Way PDU, Fully Lockable 39"Deep Network IT Server Rack Enclosure	1	999	999	

Cost estimation

GFLOPs	No of Instances	No of Switch	No Of Racks	Hardware Cost	Network H/w Cost	Admin Cost	Power Cost	N/w power cost	Rack Cost	Cooling Cost	Total Cost	Cost/hour	Cost / hour / GFLOP
1	1	1	1	6055.82	2248.99	500000	798.95	1276.75	999	266.3166667	511645.8267	11.68141157	0.012675143
10	1	1	1	6055.82	2248.99	500000	798.95	1276.75	999	266.3166667	511645.8267	11.68141157	0.012675143
100	1	1	1	6055.82	2248.99	500000	798.95	1276.75	999	266.3166667	511645.8267	11.68141157	0.012675143
1000	2	1	1	12111.64	2248.99	500000	1597.9	1276.75	999	532.6333333	518766.9133	11.84399346	0.006425778
10000	11	1	1	66614.02	2248.99	500000	8788.45	1276.75	999	2929.483333	582856.6933	13.30723044	0.001312661
100000	109	3	3	660084.38	6746.97	500000	87085.55	3830.25	2997	29028.51667	1289772.667	29.44686454	0.000293137
1000000	1086	23	26	6576620.52	51726.77	1000000	867659.7	29365.25	25974	289219.9	8840566.14	201.8394096	0.000201666

Private m3.large Instance:

Hardware Components:

Component	Name	Qty	PricePerUnit	Price	Power(Watts)
Processor	IntelXeon E5-2670 v2	1	1,559.99	1559.99	115
Motherboard	Supermicro X9SRA Server Motherboard - Intel C602 Chipset - Socket R LGA-2011 - Bulk Pack	1	292.99	292.99	50
Memory	HyperX FURY 8GB 240-Pin DDR3 SDRAM DDR3 1600 (PC3 12800) Memory Model HX316C10FB/8	1	34.99	34.99	3*1 chip = 3
Chassis case	SUPERMICRO SuperChassis CSE-512L-200B Black 1U Rackmount Server Case 200W	1	80.99	80.99	6 *1 fan = 6
Disk	SanDisk SD8SB8U-1T00-1122 X400 SATA 2.5" 1TB Internal SSD	1	96.99	96.99	2
Network card	StarTech ST2000SPEXI Dual Port PCI Express (PCIe x4) Gigabit Ethernet Server Adapter Network Card 10/ 100/ 1000Mbps PCI-Express 2 x RJ45	1	113.99	113.99	3.3
Network Switch	Netgear ProSAFE 52-Port Gigabit POE+ Managed Switch Layer 2+ With Static L3 Routing (GSM7252PS)	1	2248.99	2248.99	380
Rack	42U Free Standing Server Rack Cabinet. Fits Most of Servers, ACCESSORIES FREE!! Thermo Control System, 4 Fan Cooling Panel, Shelf, 6-Way PDU, Fully Lockable 39"Deep Network IT Server Rack Enclosure	1	999	999	

Cost estimation:

GFLOPs	No of Instances	No of Switch	No Of Racks	Hardware Cost	Network H/w Cost	Admin Cost	Power Cost	N/w power cost	Rack Cost	Cooling Cost	Total Cost	Cost/hour	Cost / hour / GFLOP
1	1	1	1	2179.94	2248.99	500000	602.4	1276.75	999	200.8	507507.88	11.5869379	0.057934689
10	1	1	1	2179.94	2248.99	500000	602.4	1276.75	999	200.8	507507.88	11.5869379	0.057934689
100	1	1	1	2179.94	2248.99	500000	602.4	1276.75	999	200.8	507507.88	11.5869379	0.057934689
1000	5	1	1	10899.7	2248.99	500000	3012	1276.75	999	1004	519440.44	11.85937078	0.011859371
10000	50	2	2	108997	4497.98	500000	30120	2553.5	1998	10040	658206.48	15.02754521	0.001502755
100000	500	11	12	1089970	24738.89	500000	301200	14044.25	11988	100400	2042341.14	46.62879315	0.000466288
1000000	5000	105	120	10899700	236143.95	2500000	3012000	134058.75	119880	1004000	17905782.7	408.8078242	0.000408808

Private m3.2xlarge Instance

Hardware Components:

Component	Name	Qty	PricePerUnit	Price	Power(Watts)
Processor	IntelXeon E5-2670 v2	1	1,559.99	1559.99	115
Motherboard	Supermicro X9SRA Server Motherboard - Intel C602 Chipset - Socket R LGA-2011 - Bulk Pack	1	292.99	292.99	50
Memory	G.SKILL Ripjaws X Series 32GB (4 x 8GB) 240-Pin DDR3 SDRAM DDR3 1600 (PC3 12800) Desktop Memory Model F3-1600C9Q-32GXM	1	134.99	134.99	3 * 4 chip = 12
Chassis case	SUPERMICRO SuperChassis CSE-512L-200B Black 1U Rackmount Server Case 200W	1	80.99	80.99	6 *1 fan = 6
Disk	Intel 320 Series 2.5" 160GB SATA II MLC Internal Solid State Drive (SSD) SSDSA2CW160G310 - OEM	1	85	85	2
Network card	StarTech ST2000SPEXI Dual Port PCI Express (PCIe x4) Gigabit Ethernet Server Adapter Network Card 10/ 100/ 1000Mbps PCI-Express 2 x RJ45	1	113.99	113.99	3.3
Network Switch	Netgear ProSAFE 52-Port Gigabit POE+ Managed Switch Layer 2+ With Static L3 Routing (GSM7252PS)	1	2248.99	2248.99	380
Rack	42U Free Standing Server Rack Cabinet. Fits Most of Servers, ACCESSORIES FREE!! Thermo Control System, 4 Fan Cooling Panel, Shelf, 6-Way PDU, Fully Lockable 39"Deep Network IT Server Rack Enclosure	1	999	999	

Cost estimation:

GFLOPs	No of Instances	No of Switch	No Of Racks	Hardware Cost	Network H/w Cost	Admin Cost	Power Cost	N/w power cost	Rack Cost	Cooling Cost	Total Cost	Cost/hour	Cost / hour / GFLOP
1	1	1	1	2267.95	2248.99	500000	632.65	1276.75	999	210.8833333	507636.2233	11.58986811	0.057949341
10	1	1	1	2267.95	2248.99	500000	632.65	1276.75	999	210.8833333	507636.2233	11.58986811	0.057949341
100	1	1	1	2267.95	2248.99	500000	632.65	1276.75	999	210.8833333	507636.2233	11.58986811	0.057949341
1000	5	1	1	11339.75	2248.99	500000	3163.25	1276.75	999	1054.416667	520082.1567	11.87402184	0.011874022
10000	50	2	2	113397.5	4497.98	500000	31632.5	2553.5	1998	10544.16667	664623.6467	15.17405586	0.001517406
100000	500	11	12	1133975	24738.89	500000	316325	14044.25	11988	105441.6667	2106512.807	48.0938997	0.000480939
1000000	5000	105	120	11339750	236143.95	3000000	3163250	134058.75	119880	1054416.667	19047499.37	434.8744148	0.000434874

Private c3.8xlarge Instance

Hardware Components:

Component	Name	Qty	PricePerUnit	Price	Power(Watts)
Processor	IntelXeon E5-2680 v2	2	1,769.99	3539.98	115
Motherboard	Intel DBS2600CP2 SSI EEB Server Motherboard Dual LGA 2011 DDR3 1600	1	489.99	489.99	70
Memory	Black Diamond Memory 32GB (2 x 16GB) 240-Pin DDR3 SDRAM ECC Registered DDR3 1866 (PC3 14900) Server Memory Model BD16GX21866MTR26	2	209.99	419.98	4 chip*3 = 12
Chassis case	iStarUSA EX1M4 Heavy-duty SGCC Cold-rolled Steel 1U Rackmount 1U 4-Bay Storage Server Rackmount Chassis	1	212.9	212.9	5 fans*1 = 5

Disk	SanDisk SD8SB8U-1T00-1122 X400 SATA 2.5" 1TB Internal SSD	1	257.99	257.99	2
Network card	StarTech ST2000SPEXI Dual Port PCI Express (PCIe x4) Gigabit Ethernet Server Adapter Network Card 10/ 100/ 1000Mbps PCI-Express 2 x RJ45	1	113.99	113.99	3.3
Network Switch	Netgear ProSAFE 52-Port Gigabit POE+ Managed Switch Layer 2+ With Static L3 Routing (GSM7252PS)	1	2248.99	2248.99	380
Rack	42U Free Standing Server Rack Cabinet. Fits Most of Servers, ACCESSORIES FREE!! Thermo Control System, 4 Fan Cooling Panel, Shelf, 6-Way PDU, Fully Lockable 39"Deep Network IT Server Rack Enclosure	1	999	999	

Cost Estimation:

GFLOPs	No of Instances	No of Switch	No Of Racks	Hardware Cost	Network H/w Cost	Admin Cost	Power Cost	N/w power cost	Rack Cost	Cooling Cost	Total Cost	Cost/hour	Cost / hour / GFLOP
1	1	1	1	5034.83	2248.99	500000	696.5	1276.75	999	232.1666667	510488.2367	11.65498257	0.026015586
10	1	1	1	5034.83	2248.99	500000	696.5	1276.75	999	232.1666667	510488.2367	11.65498257	0.026015586
100	1	1	1	5034.83	2248.99	500000	696.5	1276.75	999	232.1666667	510488.2367	11.65498257	0.026015586
1000	3	1	1	15104.49	2248.99	500000	2089.5	1276.75	999	696.5	522415.23	11.92728836	0.008874471
10000	23	1	1	115801.09	2248.99	500000	16019.5	1276.75	999	5339.833333	641685.1633	14.65034619	0.001421812
100000	224	5	6	1127801.92	11244.95	500000	156016	6383.75	5994	52005.33333	1859445.953	42.45310396	0.000423042
1000000	2233	47	54	11242775.39	105702.53	1500000	1555284.5	60007.25	53946	518428.1667	15036143.84	343.2909552	0.000343159

Private g2.2xlarge Instance

Hardware Component

Component	Name	Qty	PricePerUnit	Price	Power(Watts)
Processor	IntelXeon E5-2670	1	575.00	575	115
Motherboard	Supermicro X9SRA Server Motherboard - Intel C602 Chipset - Socket R LGA-2011 - Bulk Pack	1	292.99	292.99	50
Memory	HyperX FURY 8GB 240-Pin DDR3 SDRAM DDR3 1600 (PC3 12800) Memory Model HX316C10FB/8	2	34.99	69.98	2 chip * 3 = 6
Chassis case	SUPERMICRO SuperChassis CSE-512L-200B Black 1U Rackmount Server Case 200W	1	80.99	80.99	1 fan * 6 = 6
Disk	Kingston SSDNow V300 Series 2.5" 120GB SATA III Internal Solid State Drive (SSD) SV300S37A/120G	1	42.69	42.69	2
Network card	StarTech ST2000SPEXI Dual Port PCI Express (PCIe x4) Gigabit Ethernet Server Adapter Network Card 10/ 100/ 1000Mbps PCI-Express 2 x RJ45	1	113.99	113.99	3.3
Graphics Card	ASUS GeForce GTX 970 STRIX-GTX970-DC2OC-4GD5 4GB 256-Bit GDDR5 PCI Express 3.0 HDCP Ready SLI Support G-SYNC Support Video Card	1	318.99	318.99	120
Network Switch	Netgear ProSAFE 52-Port Gigabit POE+ Managed Switch Layer 2+ With Static L3 Routing (GSM7252PS)	1	2248.99	2248.99	380
Rack	42U Free Standing Server Rack Cabinet. Fits Most of Servers, ACCESSORIES FREE!! Thermo Control System, 4 Fan Cooling Panel, Shelf, 6-Way PDU, Fully Lockable 39"Deep Network IT Server Rack Enclosure	1	999	999	

Cost estimation:

GFLOPs	No of Instances	No of Switch	No Of Racks	Hardware Cost	Network H/w Cost	Admin Cost	Power Cost	N/w power cost	Rack Cost	Cooling Cost	Total Cost	Cost/hour	Cost / hour / GFLOP
1	1	1	1	1494.63	2248.99	500000	1015.7	1276.75	999	338.5666667	507373.6367	11.58387298	0.004121788
10	1	1	1	1494.63	2248.99	500000	1015.7	1276.75	999	338.5666667	507373.6367	11.58387298	0.004121788
100	1	1	1	1494.63	2248.99	500000	1015.7	1276.75	999	338.5666667	507373.6367	11.58387298	0.004121788
1000	1	1	1	1494.63	2248.99	500000	1015.7	1276.75	999	338.5666667	507373.6367	11.58387298	0.004121788
10000	4	1	1	5978.52	2248.99	500000	4062.8	1276.75	999	1354.266667	515920.3267	11.77900289	0.001047805
100000	36	1	1	53806.68	2248.99	500000	36565.2	1276.75	999	12188.4	607085.02	13.86038858	0.000136995
1000000	356	8	9	532088.28	17991.92	500000	361589.2	10214	8991	120529.7333	1551404.133	35.42018569	3.54024E-05

Private r3.4xlarge Instance

Hardware Component:

Component	Name	Qty	PricePerUnit	Price	Power(Watts)
Processor	IntelXeon E5-2670 v2	1	1,559.99	1559.99	115
Motherboard	Supermicro X9SRA Server Motherboard - Intel C602 Chipset - Socket R LGA-2011 - Bulk Pack	1	292.99	292.99	50
Memory	Black Diamond Memory 32GB (2 x 16GB) 240-Pin DDR3 SDRAM ECC Registered DDR3 1866 (PC3 14900) Server Memory Model BD16GX21866MTR26	4	209.99	839.96	3 * 8 chips = 24
Chassis case	SUPERMICRO SuperChassis CSE-512L-200B Black 1U Rackmount Server Case 200W	1	80.99	80.99	6 *1 fan= 6
Disk	Intel 535 Series 2.5" 360GB SATA III MLC SSDSC2BW360H6R5	1	199.99	199.99	2
Network card	StarTech ST2000SPEXI Dual Port PCI Express (PCIe x4) Gigabit Ethernet Server Adapter Network Card 10/ 100/ 1000Mbps PCI-Express 2 x RJ45	1	113.99	113.99	3.3
Network Switch	Netgear ProSAFE 52-Port Gigabit POE+ Managed Switch Layer 2+ With Static L3 Routing (GSM7252PS)	1	2248.99	2248.99	380
Rack	42U Free Standing Server Rack Cabinet. Fits Most of Servers, ACCESSORIES FREE!! Thermo Control System, 4 Fan Cooling Panel, Shelf, 6-Way PDU, Fully Lockable 39"Deep Network IT Server Rack Enclosure	1	999	999	

Cost estimation:

GFLOPs	No of Instances	No of Switch	No Of Racks	Hardware Cost	Network H/w Cost	Admin Cost	Power Cost	N/w power cost	Rack Cost	Cooling Cost	Total Cost	Cost/hour	Cost / hour / GFLOP
1	1	1	1	3087.91	2248.99	500000	672.95	1276.75	999	224.3166667	508509.9167	11.60981545	0.058049077
10	1	1	1	3087.91	2248.99	500000	672.95	1276.75	999	224.3166667	508509.9167	11.60981545	0.058049077
100	1	1	1	3087.91	2248.99	500000	672.95	1276.75	999	224.3166667	508509.9167	11.60981545	0.058049077
1000	5	1	1	15439.55	2248.99	500000	3364.75	1276.75	999	1121.583333	524450.6233	11.97375852	0.011973759
10000	50	2	2	154395.5	4497.98	500000	33647.5	2553.5	1998	11215.83333	708308.3133	16.17142268	0.001617142
100000	500	11	12	1543955	24738.89	500000	336475	14044.25	11988	112158.3333	2543359.473	58.06756788	0.000580676
1000000	5000	105	120	15439550	236143.95	3000000	3364750	134058.75	119880	1121583.333	23415966.03	534.6110967	0.000534611

Private i2.8xlarge Instance

Hardware Component:

Component	Name	Qty	PricePerUnit	Price	Power(Watts)
Processor	IntelXeon E5-2670 v2	2	1,559.99	3119.98	115
Motherboard	Intel S2600GZ4 Custom Server Motherboard Dual LGA 2011 DDR3 1600	1	489.99	489.99	70
Memory	Kingston 32GB 240-Pin DDR3 SDRAM ECC DDR3 1600 (PC3 12800) Server Memory Model KVR16LL11Q4/32	8	275.99	2207.92	3 * 8 chips = 24
Chassis case	iStarUSA EX1M4 Heavy-duty SGCC Cold-rolled Steel 1U Rackmount 1U 4-Bay Storage Server Rackmount Chassis	1	212.9	212.9	1 * 5 fans = 5
Disk	SAMSUNG 850 EVO 2.5" 2 TB SATA III 3-D Vertical Internal Solid State Drive (SSD) MZ-75E2T0B/AM	4	602.73	2410.92	2
Network card	StarTech ST2000SPEXI Dual Port PCI Express (PCIe x4) Gigabit Ethernet Server Adapter Network Card 10/ 100/ 1000Mbps PCI-Express 2 x RJ45	1	113.99	113.99	3.3
Network Switch	Netgear ProSAFE 52-Port Gigabit POE+ Managed Switch Layer 2+ With Static L3 Routing (GSM7252PS)	1	2248.99	2248.99	380
Rack	42U Free Standing Server Rack Cabinet. Fits Most of Servers, ACCESSORIES FREE!! Thermo Control System, 4 Fan Cooling Panel, Shelf, 6-Way PDU, Fully Lockable 39"Deep Network IT Server Rack Enclosure	1	999	999	

Cost estimation:

GFLOPs	No of Instances	No of Switch	No Of Racks	Hardware Cost	Network H/w Cost	Admin Cost	Power Cost	N/w power cost	Rack Cost	Cooling Cost	Total Cost	Cost/hour	Cost / hour / GFLOP
1	1	1	1	8555.7	2248.99	500000	736.8	1276.75	999	245.6	514062.84	11.73659452	0.029341486
10	1	1	1	8555.7	2248.99	500000	736.8	1276.75	999	245.6	514062.84	11.73659452	0.029341486
100	1	1	1	8555.7	2248.99	500000	736.8	1276.75	999	245.6	514062.84	11.73659452	0.029341486
1000	3	1	1	25667.1	2248.99	500000	2210.4	1276.75	999	736.8	533139.04	12.1721242	0.010143437
10000	25	1	1	213892.5	2248.99	500000	18420	1276.75	999	6140	742977.24	16.96295068	0.001696295
100000	250	6	6	2138925	13493.94	500000	184200	7660.5	5994	61400	2911673.44	66.47656256	0.000664766
1000000	2500	53	60	21389250	119196.47	1500000	1842000	67667.75	59940	614000	25592054.22	584.2934753	0.000584293

Private d2.8xlarge Instance

Hardware Component:

Component	Name	Qty	PricePerUnit	Price	Power(Watts)
Processor	IntelXeon E5-2676 v3	2	1,800.00	3600	120
Motherboard	Intel S2600GZ4 Custom Server Motherboard Dual LGA 2011 DDR3 1600	1	489.99	489.99	70
Memory	Kingston 32GB 240-Pin DDR3 SDRAM ECC DDR3 1600 (PC3 12800) Server Memory Model KVR16LL11Q4/32	8	275.99	2207.92	3*8 chips = 24
Chassis case	iStarUSA EX1M4 Heavy-duty SGCC Cold-rolled Steel 1U Rackmount 1U 4-Bay Storage Server Rackmount Chassis	1	212.9	212.9	5 fans*1 = 5
Disk	SAMSUNG 850 EVO 2.5" 2 TB SATA III 3-D Vertical Internal Solid State Drive (SSD) MZ-75E2T0B/AM	24	602.73	14465.52	2
Network card	Intel X540T2 Ethernet Converged Network Adapter 100Mbps/1Gbps/10Gbps PCI Express 2.1 x8 2 x RJ45	1	444.99	444.99	10.8
Network Switch	Netgear ProSAFE 52-Port Gigabit POE+ Managed Switch Layer 2+ With Static L3 Routing (GSM7252PS)	1	2248.99	2248.99	380
Rack	42U Free Standing Server Rack Cabinet. Fits Most of Servers, ACCESSORIES FREE!! Thermo Control System, 4 Fan Cooling Panel, Shelf, 6-Way PDU, Fully Lockable 39"Deep Network IT Server Rack Enclosure	1	999	999	

Cost estimation:

GFLOPs	No of Instances	No of Switch	No Of Racks	Hardware Cost	Network H/w Cost	Admin Cost	Power Cost	N/w power cost	Rack Cost	Cooling Cost	Total Cost	Cost/hour	Cost / hour / GFLOP
1	1	1	1	21421.32	2248.99	500000	778.8	1276.75	999	259.6	526984.46	12.03160868	0.013055131
10	1	1	1	21421.32	2248.99	500000	778.8	1276.75	999	259.6	526984.46	12.03160868	0.013055131
100	1	1	1	21421.32	2248.99	500000	778.8	1276.75	999	259.6	526984.46	12.03160868	0.013055131
1000	2	1	1	42842.64	2248.99	500000	1557.6	1276.75	999	519.2	549444.18	12.54438767	0.006805766
10000	11	1	1	235634.52	2248.99	500000	8566.8	1276.75	999	2855.6	751581.66	17.15939863	0.001692649
100000	109	3	3	2334923.88	6746.97	500000	84889.2	3830.25	2997	28296.4	2961683.7	67.61834932	0.000673125
1000000	1086	23	26	23263553.52	51726.77	1000000	845776.8	29365.25	25974	281925.6	25498321.94	582.1534689	0.000581655

PLOT#1

Comparing Cost/hr/FLOP for Public Cloud Vs Private Cloud:

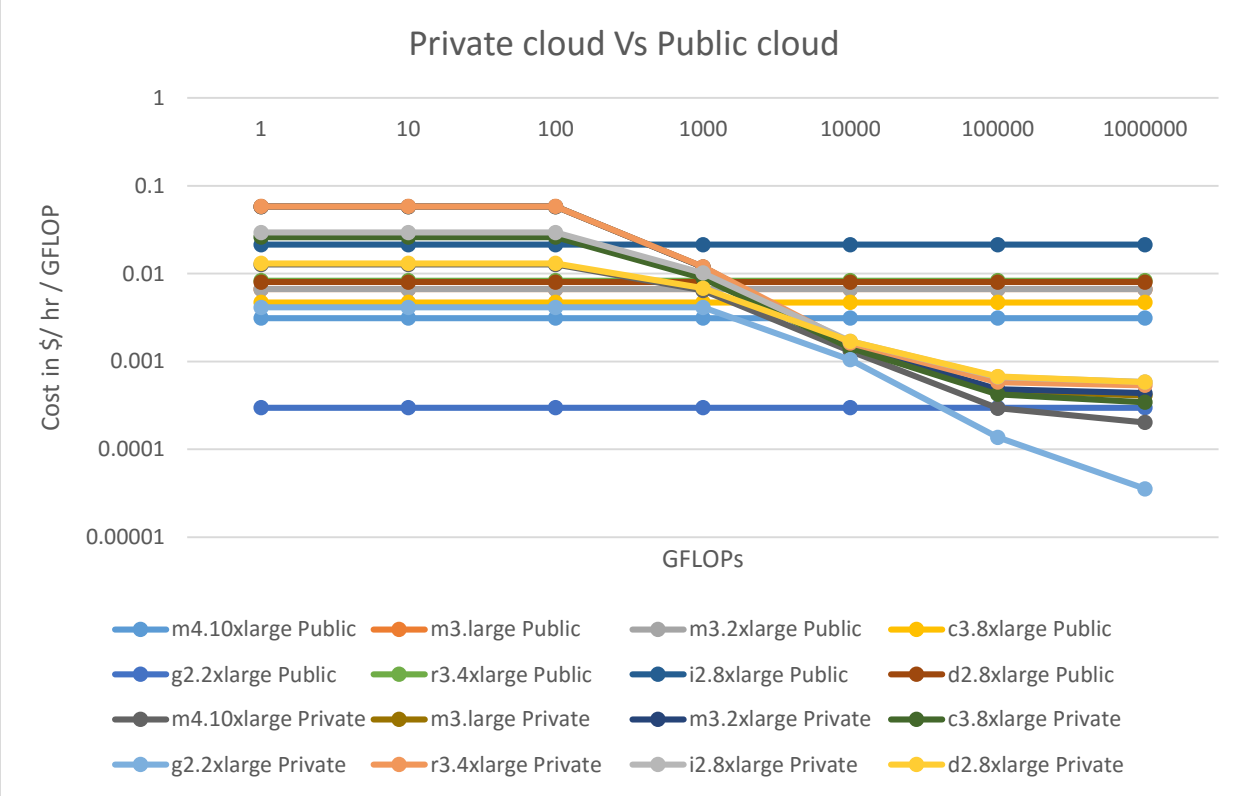
Private Cloud:

GFLOPs	m4.10xlarge	m3.large	m3.2xlarge	c3.8xlarge	g2.2xlarge	r3.4xlarge	i2.8xlarge	d2.8xlarge
1	0.003117188	0.00665	0.00665	0.0046875	0.000297728	0.0083125	0.0213125	0.007986111
10	0.003117188	0.00665	0.00665	0.0046875	0.000297728	0.0083125	0.0213125	0.007986111
100	0.003117188	0.00665	0.00665	0.0046875	0.000297728	0.0083125	0.0213125	0.007986111
1000	0.003117188	0.00665	0.00665	0.0046875	0.000297728	0.0083125	0.0213125	0.007986111
10000	0.003117188	0.00665	0.00665	0.0046875	0.000297728	0.0083125	0.0213125	0.007986111
100000	0.003117188	0.00665	0.00665	0.0046875	0.000297728	0.0083125	0.0213125	0.007986111
1000000	0.003117188	0.00665	0.00665	0.0046875	0.000297728	0.0083125	0.0213125	0.007986111

Public Cloud:

GFLOPs	m4.10xlarge	m3.large	m3.2xlarge	c3.8xlarge	g2.2xlarge	r3.4xlarge	i2.8xlarge	d2.8xlarge
1	0.012675143	0.057934689	0.057949341	0.026015586	0.004121788	0.058049077	0.029341486	0.013055131
10	0.012675143	0.057934689	0.057949341	0.026015586	0.004121788	0.058049077	0.029341486	0.013055131
100	0.012675143	0.057934689	0.057949341	0.026015586	0.004121788	0.058049077	0.029341486	0.013055131
1000	0.006425778	0.011859371	0.011874022	0.008874471	0.004121788	0.011973759	0.010143437	0.006805766
10000	0.001312661	0.001502755	0.001517406	0.001421812	0.001047805	0.001617142	0.001696295	0.001692649
100000	0.000293137	0.000466288	0.000480939	0.000423042	0.000136995	0.000580676	0.000664766	0.000673125
1000000	0.000201666	0.000408808	0.000434874	0.000343159	0.000035402	0.000534611	0.000584293	0.000581655

Cost Comparison Plot:



Observation and Conclusion from Plot#1:

- The cost rate of the public cloud is constant for different levels of computation power whereas the cost rate of private cloud goes down with increased level of computation power
- For smaller computation needs the public cloud should be used
- For high computation power for longer period of time, private cloud should be used
- After certain time and compute power the initial investment done for private cloud is recovered and beyond that the computation power is available just at the cost of power consumption and administration cost
- The cost of private cloud decreases with increasing in compute power because there are factors like administration which do not increases linearly with increase in compute power. Hence the overall cost gets amortized over increasing period of time

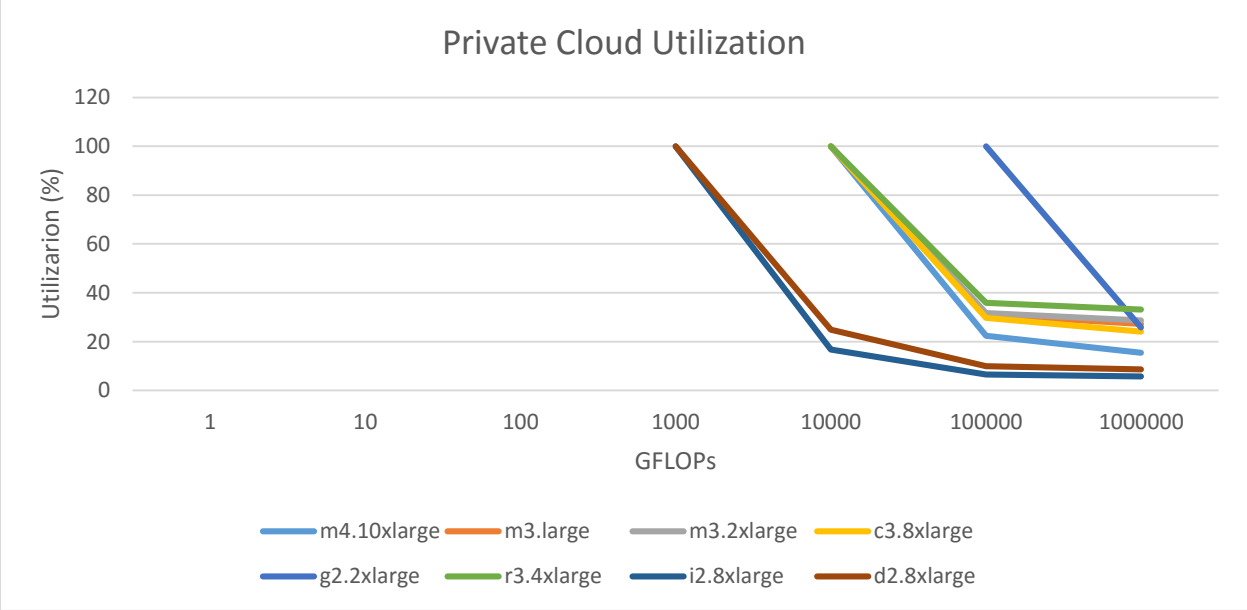
PLOT#2

Private Cloud Utilization Table:

The below table gives the percentage utilization needed

	1	10	100	1000	10000	100000	1000000
m4.10xlarge					99.99999	22.33148029	15.36318
m3.large					99.99997	31.0288724	27.20389
m3.2xlarge					99.99997	31.69481318	28.65907
c3.8xlarge					99.99997	29.75371793	24.13534
g2.2xlarge						100.000012	25.84211
r3.4xlarge					100	35.90752567	33.05901
i2.8xlarge				100	16.72308	6.553652629	5.760311
d2.8xlarge				100	24.87081	9.890507755	8.546498

Private Cloud Utilization Plot:



Observation and Conclusion from Plot#2:

- The graph shows the percentage utilization needed after the breakeven point.
- It is the minimum percentage utilization needed to recommend the use of private cloud
- The cost of private and public cloud is same at a specific compute power beyond that compute power if the percentage utilization is equal to or more than the figures mentioned in the utilization table then the private cloud should be used.
- The minimum utilization needed goes down because with increasing compute power the cost decreases as we have seen in the PLOT#1

Appendix

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