Understanding the cost of Computing in the Cloud:

The assignment aims to find the break-even point for the cost of computing in private cloud compared to public cloud for following instance type:

m4.10xlarge:

Break-up for hardware bought for the instance:

Device	Details	calculated Price
processor	Intel Xeon E5-2670 v3 Haswell 2.3 GHz 12 x 256KB L2 Cache 30 MB L3 Cache LGA 2011-3 120W BX80644E52670V3 Server Processor	2784.983333
motherboard	ASUS RO RAMPAE I BLACK EDITION LA 2011 Intel 79 SATA 6b/s USB 3.0 Extended AT Intel aming Motherboad+Intel BOXDX79TO LGA 2011 Intel X79 SATA 6Gb/s USB 3.0 ATX Intel Motherboard	623.99
memory	Crucial 96GB (3 x 32GB) 240-Pin DDR3 SDRAM ECC DDR3 1866 (PC3 14900) Server Memory Model CT3K32G3ELSDQ4186D +Black Diamond Memory 64GB (2 x 32GB) 240Pin DDR3 SDRAM ECC Registered DDR3 1066 (PC3 8500) Server Memory Model BD32GX21066MTR26	1439.98
network Interface Card	Intel X520-DA2 Dual Ports 10 Gigabit Ethernet Converged Network Adapter, PCI Express 2.0 x8, Low Pro꽁쳇le - OEM	325.99
storage	ebs(very small, less price need not be considered)	0
total cost:		5174.943333

Computing cost/hr /flop:

Gflops	instance required	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/flops	pu.m410xlarge	% utilization
1	1	0.020833333	0	5174.943333	25	0.118720167	0.0583395	9.589041096	9.766100763	0.012716277	0.003117188	407.9407
10	1	0.020833333	0	5174.943333	25	0.118720167	0.0583395	9.589041096	9.766100763	0.012716277	0.003117188	407.9407
100	1	0.020833333	0	5174.943333	25	0.118720167	0.0583395	9.589041096	9.766100763	0.012716277	0.003117188	407.9407
1000	2	0.041666667	1	10349.88667	7750	0.413239422	0.1100895	9.589041096	10.11237002	0.006583574	0.003117188	211.2024
100	14	0.2916	1	72449.	8050	1.8378	0.110	9.5890	11.537	0.0010	0.00311	34.4

Gflops	instance required	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/flops	pu.m3.large	#VALUE!
00		66667		20667		81431	0895	41096	01203	73011	7188	224
100000	131	2.729166667	7	677917.5767	57175	16.78293554	0.4205895	9.589041096	26.79256614	0.000266307	0.003117188	8.543166
1000000	1303	27.14583333	58	6742951.163	479175	164.8887252	3.0598395	19.17808219	187.1266469	0.000186995	0.003117188	5.998837

m3.large:

Break-up for hardware bought for the instance:

processor	Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor	155.999
motherboard	Intel BOXDX79TO LGA 2011 Intel X79 SATA 6Gb/s USB 3.0 ATX Intel Motherboard	249
memory	Kingston 8GB 240-Pin DDR3 SDRAM ECC Unbu ered DDR3 1600 Server Memory w/TS Model KVR16E11/8	51.99
network Interface Card	SEDNA - PCIE 10/100/1000Mbs Gigabit LAN 68.90adapter (Intel 82574L chipset)	68.9
storage	Crucial M4 32B Mini-SATA (mSATA) MLC Internal Solid State Drive (SSD) CT032M4SSD3	109.99
total cost:		635.879

Gflops	instance required	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/flops	pu.m3.large	#VALUE!
1	1	0.020833333	0	635.879	25	0.01508862	0.018828375	9.589041096	9.622958033	0.481147902	0.00665	7235.307
10	1	0.020833333	0	635.879	25	0.01508862	0.018828375	9.589041096	9.622958033	0.481147902	0.00665	7235.307
100	5	0.104166667	1	3179.395	814.99	0.091196005	0.032628375	9.589041096	9.712865475	0.097128655	0.00665	1460.581
1000	50	1.041666667	2	31793.95	2629.98	0.785934475	0.046428375	9.589041096	10.42140395	0.010421404	0.00665	156.7128
10000	500	10.41666667	11	317939.5	20089.89	7.717565982	0.170628375	9.589041096	17.47723545	0.001747724	0.00665	26.28156
100000	5000	104.1666667	105	3179395	197448.95	77.09689384	1.467828375	47.94520548	126.5099277	0.001265099	0.00665	19.02405
1000000	50000	1041.666667	1042	31793950	1968969.58	770.8429128	14.39842838	479.4520548	1264.693396	0.001264693	0.00665	19.01795

Computing cost/hr /flop

m3.2xlarge:

Break-up for hardware bought for the instance:

processor	Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor	623.996
motherboard	Intel BOXDX79TO LGA 2011 Intel X79 SATA 6Gb/s USB 3.0 ATX Intel Motherboard	249
memory	Kingston 24GB (3 x 8GB) 240-Pin DDR3 SDRAM ECC Registered DDR3 1866 Server Memory Model KVR18R13S4K3/24 +Axiom 6GB (3 x 2GB) 240-Pin DDR3 SDRAM ECC Unbu ered DDR3 1333 (PC3 10600) Server Memory Model SO.D94GB.M20-AX	269.98
network Interface Card	SEDNA - PCIE 10/100/1000Mbs Gigabit LAN 68.90adapter (Intel 82574L chipset)	68.9
storage	Intel 320 Series 2.5 80B SATA II MLC Internal Solid State Drive (SSD) SSDSA2CW0803K5 *2	279.98
total cost:		1491.856

Computing cost/hr /flop:

Gflops	instance requried	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/flops	pu.m3.2xlarge	#VALUE!
1	1	0.020833333	0	1491.856	25	0.034631416	0.02696175	9.589041096	9.650634261	0.120632928	0.00665	1814.029
10	1	0.020833333	0	1491.856	25	0.034631416	0.02696175	9.589041096	9.650634261	0.120632928	0.00665	1814.029
100	2	0.041666667	1	2983.712	739.99	0.085016027	0.04076175	9.589041096	9.714818873	0.060717618	0.00665	913.0469
1000	13	0.270833333	1	19394.128	1014.99	0.465961598	0.04076175	9.589041096	10.09576444	0.009707466	0.00665	145.9769
10000	125	2.604166667	3	186482	5194.97	4.37618653	0.06836175	9.589041096	14.03358938	0.001403359	0.00665	21.10314
100000	1250	26.04166667	27	1864820	49879.73	43.71460571	0.39956175	19.17808219	63.29224965	0.000632922	0.00665	9.517632
1000000	12500	260.41666667	261	18648200	492587.39	437.0042783	3.62876175	124.6575342	565.2905743	0.000565291	0.00665	8.50061

c3.8xlarge:

Break-up for hardware bought for the instance:

processor	Intel Xeon E5-2680 v2 Ivy Bridge-EP 2.8 GHz 25MB L3 Cache LGA 2011 115W BX80635E52680V2 Server Processor	2831.984
motherboard	Intel BOXDX79TO LGA 2011 Intel X79 SATA 6Gb/s USB 3.0 ATX Intel Motherboard	249
Memory	Crucial 48GB (3 x 16GB) 240-Pin DDR3 SDRAM ECC Registered DDR3 1600 (PC3 12800) Server Memory Model CT3K16G3ERSLD4160B+ Axiom 12GB (3 x 4GB) 240-Pin DDR3 SDRAM ECC Registered DDR3 1333 (PC3 10600) Server Memory Model SO.D98GB.M2R-AX	478.99
network Interface Card	Intel X520-DA2 Dual Ports 10 Gigabit Ethernet Converged Network Adapter, PCI Express 2.0 x8, Low Pro꼼쳅le - OEM	325.99
Storage	Intel 320 Series 2.5 600B SATA II MLC Internal Solid State Drive (SSD) SSDSA2CW600310 +Intel 320 Series 2.5 40B SATA II MLC Internal Solid State Drive (SSD) SSDSA2CT040310	199.99
total cost:		4085.954

Gflops	instance requried	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/flops	pu.c3.8xlarge	#VALUE!
1	1	0.020833333	0	4085.954	25	0.093857397	0.05249175	9.589041096	9.735390243	0.027163477	0.0046875	579.4875
10	1	0.020833333	0	4085.954	25	0.093857397	0.05249175	9.589041096	9.735390243	0.027163477	0.0046875	579.4875
100	1	0.020833333	0	4085.954	25	0.093857397	0.05249175	9.589041096	9.735390243	0.027163477	0.0046875	579.4875
1000	3	0.0625	1	12257.862	7775	0.457371279	0.10424175	9.589041096	10.15065412	0.009440713	0.0046875	201.4019
10000	28	0.583333333	1	114406.712	8400	2.803800621	0.10424175	9.589041096	12.49708906	0.001245325	0.0046875	26.566694
100000	280	5.833333333	13	1144067.12	107100	28.56545936	0.72524175	9.589041096	38.87974221	0.000387434	0.0046875	8.265251
1000000	2791	58.14583333	123	11403897.61	1016875	283.5792834	6.41774175	28.76712329	318.7641485	0.0003181867	0.0046875	6.7983

Computing cost/hr /flop

g2.2xlarge:

Break-up for hardware bought for the instance:

processor	Intel Xeon E5-2670 Sandy Bridge-EP 2.6GHz (3.3GHz Turbo Boost) 20MB L3 Cache LGA 2011 115W BX80621E52670 Server Processor	287.5
motherboard	Intel BOXDX79TO LGA 2011 Intel X79 SATA 6Gb/s USB 3.0 ATX Intel Motherboard	249
memory	compare Axiom 12GB (3 x 4GB) 240-Pin DDR3 SDRAM ECC Registered DDR3 1333 (PC3 10600) Server Memory Model SO.D98GB.M2R-AX+ Refurbished: HP 2GB 240-Pin DDR3 SDRAM Registered DDR3 1333 (PC3 10600) Memory (Server Memory) Model 500202-061-RF +Axiom 1GB 240-Pin DDR3 SDRAM Unbu ered DDR2 667 (PC2 5300) Server Memory Model 73P4984-A	215.48
network Interface Card	SEDNA - PCIE 10/100/1000Mbs Gigabit LAN 68.90adapter (Intel 82574L chipset)	68.9
storage	Kingston SSDNow KC380 60 B 1.8 Internal Solid State Drive	138.99
total cost:		959.87

Computing cost/hr /flop:

Gflops	instance requried	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/flops	pu.g2.2xlarge	#VALUE!
1	1	0.020833333	0	959.87	25	0.022485616	0.018569625	9.589041096	9.630096337	0.11574635	0.0078125	1481.553
10	1	0.020833333	0	959.87	25	0.022485616	0.018569625	9.589041096	9.630096337	0.11574635	0.0078125	1481.553
100	2	0.041666667	1	1919.74	739.99	0.060724429	0.032369625	9.589041096	9.68213515	0.058185908	0.0078125	744.7796
1000	13	0.270833333	1	12478.31	1014.99	0.30806621	0.032369625	9.589041096	9.929476931	0.00918036	0.0078125	117.5086
10000	121	2.520833333	3	116144.27	5094.97	2.768019178	0.059969625	9.589041096	12.4170299	0.001233414	0.0078125	15.7877
100000	1202	25.04166667	26	1153763.74	47989.74	27.43729406	0.377369625	19.17808219	46.99274588	0.000469897	0.0078125	6.014687
1000000	12020	250.4166667	251	11537637.4	473687.49	274.2311619	3.482369625	124.6575342	402.3710657	0.000402345	0.0078125	5.15002

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Break-up for hardware bought for the instance:

processor	Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor	1247.992
motherboard	ASUS RO RAMPAE I BLACK EDITION LA 2011 Intel 79 SATA 6b/s USB 3.0 Extended AT Intel aming Motherboard	374.99
memory	Crucial 96GB (3 x 32GB) 240-Pin DDR3 SDRAM ECC DDR3 1866 (PC3 14900) Server Memory Model CT3K32G3ELSDQ4186D +Kingston 24GB (3 x 8GB) 240-Pin DDR3 SDRAM ECC Registered DDR3 1866 Server Memory Model KVR18R13S4K3/24 +Refurbished: HP 2GB 240-Pin DDR3 SDRAM Registered DDR3 1333 (PC3 10600) Memory (Server Memory) Model 500202-061-RF	1214.47
network Interface Card	SEDNA - PCIE 10/100/1000Mbs Gigabit LAN 68.90adapter (Intel 82574L chipset)	68.9
storage	Intel 320 Series 2.5 300B SATA II MLC Internal Solid State Drive (SSD) SSDSA2CW3003K5 +ntel 313 Series Hawley Creek SSDMAEXC020G301 mSATA 20GB SATA II SLC Internal Solid State Drive (SSD)	431.42
total cost:		3337.772

Computing cost/hr /flop:

Gflops	instance required	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/flops	pu.r3.4 xlarge	#VALUE!
1	1	0.020833333	0	3337.772	25	0.076775616	0.038778	9.589041096	9.704594712	0.060653717	0.0083125	729.6688
10	1	0.020833333	0	3337.772	25	0.076775616	0.038778	9.589041096	9.704594712	0.060653717	0.0083125	729.6688
100	1	0.020833333	0	3337.772	25	0.076775616	0.038778	9.589041096	9.704594712	0.060653717	0.0083125	729.6688
1000	7	0.1458	1	23364	864.99	0.5531	0.05	9.5890	10.194	0.0091	0.0083	109.

		33333		.404		82511	2578	41096	80161	02501	125	5038
10000	63	1.3125	2	210279.636	2954.98	4.868370228	0.066378	9.589041096	14.52378932	0.001440852	0.0083125	17.33356
100000	625	13.02083333	14	2086107.5	25284.86	48.20530502	0.231978	9.589041096	58.02632412	0.000580263	0.0083125	6.98061
1000000	6250	130.2083333	131	20861075	246638.69	481.9112715	1.846578	67.12328767	550.8811371	0.000550881	0.0083125	6.627141

i2.8xlarge:

Break-up for hardware bought for the instance:

processor	Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor	2495.984
motherboard	ASUS RO RAMPAE I BLACK EDITION LA 2011 Intel 79 SATA 6b/s USB 3.0 Extended AT Intel aming Motherboad*2	749.98
memory	Crucial 96GB (3 x 32GB) 240-Pin DDR3 SDRAM ECC DDR3 1866 (PC3 14900) Server Memory Model CT3K32G3ELSDQ4186D +Black Diamond Memory 64GB (2 x 32GB) 240Pin DDR3 SDRAM ECC Registered DDR3 1066 (PC3 8500) Server Memory Model BD32GX21066MTR26 *2	1879.97
network Interface Card	Intel X520-DA2 Dual Ports 10 Gigabit Ethernet Converged Network Adapter, PCI Express 2.0 x8, Low Pro꽁챌le - OEM	325.99
Storage	HP 632506-B21 800 B Internal Solid State Drive *8	10559.6
total cost:		16011.524

Computing cost/hr /flop:

Gflops	instance requried	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/flops	pu.i2.8 xlarge	#VALUE!
1	1	0.020833333	0	16011.524	25	0.366130685	0.07377825	9.589041096	10.02895003	0.031340469	0.0213125	147.0521
10	1	0.020833333	0	16011.524	25	0.366130685	0.07377825	9.589041096	10.02895003	0.031340469	0.0213125	147.0521
100	1	0.020833333	0	16011.524	25	0.366130685	0.07377825	9.589041096	10.02895003	0.031340469	0.0213125	147.0521
1000	4	0.083333333	1	64046.096	7800	1.640321826	0.12552825	9.589041096	11.35489117	0.008871009	0.0213125	41.6235

10000	32	0.66666667	1	512368.768	8500	11.891981	0.12552825	9.589041096	21.60655035	0.002110015	0.0213125	9.900362
100000	313	6.52083333	15	5011607.012	123325	117.2358907	0.85002825	9.589041096	127.67496	0.00127471	0.0213125	5.981044
1000000	3125	65.10416667	137	50036012.5	1133025	1168.242865	7.16352825	38.35616438	1213.762558	0.00121313763	0.0213125	5.695074

d2.8xlarge:

Break-up for hardware bought for the instance:

Processor	Intel Xeon E5-2670 v3 Haswell 2.3 GHz 12 x 256KB L2 Cache 30 MB L3 Cache LGA 2011-3 120W BX80644E52670V3 Server Processor	2506.485
Motherboard	ASUS RO RAMPAE I BLACK EDITION LA 2011 Intel 79 SATA 6b/s USB 3.0 Extended AT Intel aming Motherboad*2	749.98
Memory	Crucial 96GB (3 x 32GB) 240-Pin DDR3 SDRAM ECC DDR3 1866 (PC3 14900) Server Memory Model CT3K32G3ELSDQ4186D +Black Diamond Memory 64GB (2 x 32GB) 240Pin DDR3 SDRAM ECC Registered DDR3 1066 (PC3 8500) Server Memory Model BD32GX21066MTR26 *2	1879.97
network Interface Card	Intel X520-DA2 Dual Ports 10 Gigabit Ethernet Converged Network Adapter, PCI Express 2.0 x8, Low Pro꿍챌le - OEM	325.99
Storage	WD Black 2TB Performance Desktop Hard Disk Drive - 7200 RPM SATA 6 Gb/s 64MB Cache 3.5 Inch - WD2003FZEX*24	2711.76
total cost:		8174.185

Gflops	instance required	# of server racks	# of switchs	hardware instance type cost	server_rack+switch cost	per hr total hardware cost	per hr power cost	per hr admin cost	per hr total cost	$/hr/ flops	pu.d 2.8xlarge	#VALUE!
1	1	0.020833333	0	8174.185	25	0.187196005	0.10186125	9.589041096	9.87809835	0.0142912 3	0.007986111	178.95 11
10	1	0.020833333	0	8174.185	25	0.187196005	0.10186125	9.589041096	9.87809835	0.0142912 3	0.007986111	178.95 11
100	1	0.020833333	0	8174.185	25	0.187196005	0.10186125	9.589041096	9.87809835	0.0142912 3	0.007986111	178.95 11

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1000	2	0.0416666667	1	16348.37	7750	0.550191096	0.15361125	9.589041096	10.2928434	0.007445633	0.007986111	93.23228
1000	15	0.3125	1	122612.775	8075	2.983739155	0.15361125	9.589041096	12.7263915	0.001227468	0.007986111	15.37004
1000	145	3.02083333	8	1185256.825	65225	28.54981336	0.51586125	9.589041096	38.6547157	0.000385683	0.007986111	4.829425
1000	1447	30.14583333	64	11828045.7	528975	282.1237602	3.41386125	19.17808219	304.7157036	0.000304665	0.007986111	3.814936

Assumptions & Cost-calculations:

- Processors for all instance-type are specially made for amazon. The cost for processor are calculated on per core basis with reference to purchases. The processors Intel Xenon 2676 V3 is replaced with processors Intel Xenon 2670 V3 with same specifications.
- The hardware cost is divided in two- Instance specific hardware cost and other hardware such as cost for Cooling- server racks & switches (again specific to instance speed). Such hardware is common for all instance type with exception of switches.
- The hardware cost is aromatized for 5 years.
- The cost for power includes the power consumed by hardware + cooling (0.5 * hardware power) + network for a rate of 11.5 cents with reference to power cost of Illinois state.
- Administrative cost is taken as 7000$ a month (84 K per annum) , where each admin can handle 1000 instances
- All cost are calculate per hour basis

Plot#1:
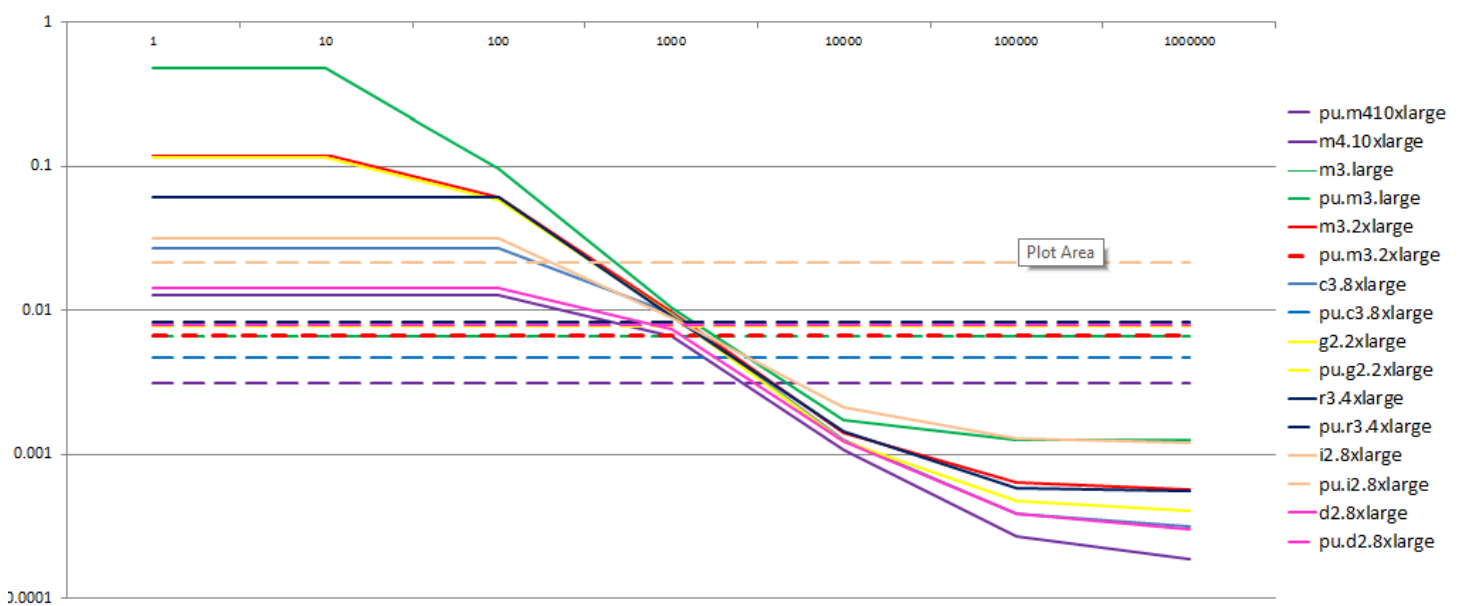
This graph denotes the cost of public cloud Vs the cost for going private scaling for 1G-1P flops. All straight lines denote the cost of public instances; this is cause the cost is fixed per hour. The curved lines denote the costs private instance. We can see that the cost for private instances is greater than 10X of public instance for small scale, but as the number of instances increases it is cost effective to have private cloud. The nature of the plot is attributed mainly to administrative cost which scales in increments unlike other cost which scale linearly.

Plot#2:
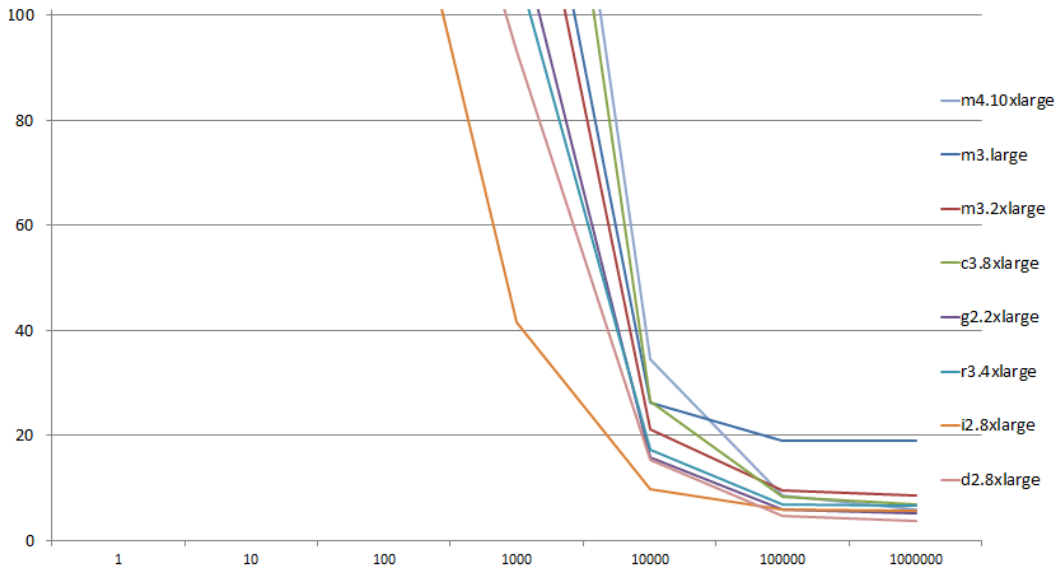
The graphs is plotted for % utilization of private cloud. After the break-even point the cost of computing in private cloud is less. Cost effectiveness & % utilization decreases with increases in number of instances.

Both graphs conclude that public cloud though cost less & reasonable; private cloud is better for larger scales.