



CLOUD COMPUTING

CS 553, FALL'17

PROJECT TITLE

Understanding the Cost of Computing in Cloud

Submitted By:

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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 find the cost breakdown of a private cloud, and compare that to what Amazon would charge. The comparison is done for three configurations where each VM is equivalent to d2.xlarge instance, r3.large instances and p3.16xlarge instances respectively.

Assumptions

- For the hardware prices, following sources have been used:
 - Dell (<http://www.dell.com/p/enterprise-products.aspx?c=ae&l=en&s=bsd&~ck=mn>),
 - AcmeMicro (<http://www.acmemicro.com>)
 - Pogolinux (<http://www.pogolinux.com>)
- For the private cloud, same processors have been considered as that of the respective public instance.
- The salary of a system administrator is considered as 90,000 \$ per annum from https://www.glassdoor.com/Salaries/chicago-senior-systems-administrator-salary-SRCH_IL.0,7_IM167_KO8,36.htm
- For the electric power, the consumption rate is considered for the city of Chicago and taken from <https://www.comed.com/MyAccount/MyBillUsage/Pages/CurrentRatesTariffs.aspx>. and for the industrial usage we referred the electricity rates from <https://www.electricitylocal.com/states/illinois/chicago/>
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Configuration 1

Hadoop/Spark Cluster with 32K-cores, 256TB memory, 50PB HDD, and 10Gb/s Ethernet Fat-Tree network (each VM should be equivalent to the **d2.8xlarge instance**); in addition to the compute resources, a 100PB distributed storage shared across the entire cloud should be procured, with enough capacity for 100GB/sec throughput (for pricing comparison, see S3)

- Fat Tree network:
 - We are setting up a 48-port switch on top and attaching 29 switches to the second layer thus getting total 1363 nodes which is approx equal to the number of motherboards
 - No. of cables = 1 + 29 + 1334 cables.

	Description	Price per Item	Quantity	Total Price
Compute Servers	Processor High-frequency Intel Xeon E5-2676 v3 (Haswell) processor 12 cores	\$ 2197	2667	5,859,399
	Motherboard Supermicro Motherboard MBD-X10DRW-ET DP Xeon E5-2600v3 LGA2011-3 DDR4 SuperDOM SATA3 RAID IPMI 10GbE PCIe3 12.3"x13"	\$ 469	1334	625,646
	Memory 64GB PC4-21300 DDR4-2666Mhz Load Reduced ECC Quad Ranked 1.2V Major Brand	\$ 899.99	4000	3,599,960
	HDD 10TB HGST 0F27454 / HUH721010ALE604 - Ultrastar He10 512E SE Enterprise SATA 6.0 Gb/s 7200rpm 256MB 3.5-inch HDD Bulk	\$ 460.99	5336	2,459,842.64
	Network Adapter Intel X710T4BLK 10Gbit Ethernet Converged Network Adapter RJ45 Direct Attach Copper, Quad Ports, PCIe v3.0x8, LP/FH, Bulk	\$682.11	1334	909,934.74
Network Switches	Supermicro 48-port Managed Gigabit Switch SSE-X3348T 1U Layer-3 10/40GbE 48xRJ45 4xQSFP 1xRS232 Black Retail	\$7,896	30	236880
	<i>For Storage Servers:</i> Mellanox Ethernet SwitchX®-2 based 48-port SFP+ 10GbE 12 port QSFP 40/56GbE 1U 1PS MSX1024B-1BFS	\$14,187	134	1,901,058
Network Cables	Ethernet cable 10000/1000 Base-T Cat7 RJ45 10 feet 10Gbps	\$ 13	1364	17,732
Racks	SERVER RACK 42U2, WITH FAN	\$ 589	67	39,463
	<i>For Storage Servers:</i> SERVER RACK 42U2, WITH FAN	\$ 589	625	368,125
Chassis	Supermicro SC826BAC4-R920LPB 2U Chassis 12x3.5-in SAS3/NVMe Hot-Swap eATX R920W 80PLUS CSE-826BAC4-R920LPB Black	\$899	1334	1,199,266
Storage Servers	Promise VessRAID 1840f SAN Storage VR1840FNAC2C 3U FC/iSCSI-to-SAS 2xFC 2xiSCSI 16x3.5-in SAS 6Gb/s RAID Hot-Swap 8x2TB R450W	\$ 8577	6250	\$ 53,606,250
Electric Power	The current ComEd supply rate is 1.39¢/kWh.	2.19 B kWh	5 years	\$ 30,441,000
Cooling	Cooling power	¼ rd of 2.19 B	5 years	\$ 10,147,000
Administration	System administrator	90,000	2	180,000
TOTAL	N/A	N/A	N/A	42,780,253.4

Configuration 2

Support 1 million virtual machines (VM) where each VM requires 2-core, 15GB RAM, 32GB SSD storage, and 1Gb/s Fat-Tree network (each VM should be equivalent to the **r3.large instances**); in addition to the compute resources, a 10PB distributed storage shared across the entire cloud should be procured, with enough capacity for 10GB/sec throughput (for pricing comparison, see S3)





- Fat Tree network
 - We are setting up a 3 -layer Network with a 48-port switch on top and attaching 47 switches to the second layer and 47 to each switch on the 3rd layer.
 - Total ports on third layer = $47 * 47 * 47 = 100,000$ approximately.
 - No. of cables = $48 + 47 * 47 + 100,000 = 102257$
 - No. of switches = $1 + 47 + 47 * 47 = 2257$

	Description	Price per Item	Quantity	Total Price
Compute Servers	Processor High Frequency Intel Xeon E5-2670 v2 (Ivy Bridge) Processors	\$ 1,538.90	200,000	\$ 307,780,000
	Motherbord Intel® Server Board S2600CP2	\$ 518.56	100,000	\$ 51,856,000
	Memory 32GB DDR3 PC3-12800 240-pin DIMM DDR3-1600 Load Reduced ECC 1.35V, Quad Ranked	\$433.2	500,000	\$ 216,600,000
	Networking Adapter Intel X710T4BLK 10Gbit Ethernet Converged Network Adapter RJ45 Direct Attach Copper, Quad Ports, PCIe v3.0x8, LP/FH, Bulk	\$682.11	100,000	\$ 68,211,000
	SSD Intel SATA 512GB SSD SSDSC2KW512G8X1 545s Series 2.5-inch 7mm SATA 6Gb/s 550MB/s Read 3D TLC	\$199.99	100,000	\$ 19,999,000
Network Switches	Netgear 48-Port Stackable Gigabit Managed Switch GSM7352S-200NAS 1U 48xRJ-45 Gigabit 4xSFP 2xSFP+ USB RS- 232 Grey Retail	\$ 3270	2257	\$ 7,380,390
	<i>For Storage Servers:</i> Mellanox Ethernet SwitchX®-2 based 48- port SFP+ 10GbE 12 port QSFP 40/56GbE 1U 1PS MSX1024B-1BFS	\$14,187	15	\$212,805
Network Cables	Ethernet cable 10000/1000 Base-T Cat7 RJ45 10 feet 10Gbps	\$ 13	102257	\$ 1,329,341
	<i>For Storage Servers:</i> 10GB copper cable SFP+ to SFP+ 5 meter long	\$98	640	\$ 62,720
Racks	SERVER RACK 42U2, WITH FAN	\$ 589	10,000	\$ 5,890,000
	<i>For Storage Servers:</i> SERVER RACK 42U2, WITH FAN	\$ 589	63	\$ 37,107
Chassis	Intel P4308XXMFEN Pedestal/4U Chassis 8x3.5-in Fixed 550W 80PLUS Black	\$390	100,000	\$ 39,000,000
Storage Servers	Promise VessRAID 1840f SAN Storage VR1840FNAC2C 3U FC/iSCSI-to-SAS 2xFC 2xiSCSI 16x3.5-in SAS 6Gb/s RAID	\$ 8577	625	\$ 5,360,625

	Hot-Swap 8x2TB R450W			
Electric Power	The current ComEd supply rate is 1.39¢/kWh.	2.19 B kWh	5 years	\$ 30,441,000
Cooling	Cooling power	¼ rd of 2.19 B	5 years	\$ 10,147,000
Administration	System administrator	\$ 90,000 p.a.	100 for 5 years	\$ 45,000,000
TOTAL	N/A	N/A	N/A	\$809,306,988.00

Cart Screenshots:

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Product	Product Code	Unit Price	Quantity	Sub Total
Netgear 48-Port Stackable Gigabit Managed Switch GSM7352S-200NAS 1U 48xRJ-45 Gigabit 4xSFP 2xSFP+ USB RS-232 Grey Retail  Remove Item	NW-NG-GSM7352S	\$3,270	2257	\$7,380,390
Promise VessRAID 1840f SAN Storage VR1840FNAC2C 3U FC/iSCSI-to-SAS 2xFC 2xiSCSI 16x3.5-in SAS 6Gb/s RAID Hot-Swap 8x2TB R450W  Remove Item	SR-PM-1840FC2C	\$8,577	625	\$5,360,625
Intel P4308XXMFEN Pedestal/4U Chassis 8x3.5-in Fixed 550W 80PLUS Black  Remove Item	CS-IT-P4308XXMFEN	\$390	100000	\$39,000,000
Ethernet cable 10000/1000 Base-T Cat7 RJ45 10 feet 10Gbps  Remove Item	CAB-AC-RJ457.10	\$13	102257	\$1,329,341
Intel Server Board DBS2600CP2 DP Xeon E5-2600 LGA2011 8-Core DDR3 SATA3 RAID IPMI GbE PCIe EEB Retail	MB-IT-S2600CP2	\$518.56	100000	\$51,856,000

Shopping Cart



Intel Xeon E5-2670 v2 2.50 GHz Processor - Socket FCLGA2011 BX80635E52670V2
 by Intel

Only 11 left in stock - order soon.
 Shipped from: Mega Micro Devices Inc.
 Gift options not available. [Learn more](#)

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Price

\$1,538.90

 Best Deal
 

Quantity

1

Subtotal (1 item): \$1,538.90



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32GB DDR3 PC3-12800 240-pin DIMM DDR3-1600 Load Reduced ECC 1.35V, Quad Ranked



[Remove Item](#)

Intel SATA 512GB SSD SSDSC2KW512G8X1 545s Series 2.5-inch 7mm SATA 6Gb/s 550MB/s Read 3D TLC



[Remove Item](#)

Intel X710T4BLK 10Gbit Ethernet Converged Network Adapter RJ45 Direct Attach Copper, Quad Ports, PCIe v3.0x8, LP/FH, Bulk



[Remove Item](#)

Mellanox Ethernet SwitchX®-2 based 48-port SFP+ 10GbE 12 port QSFP 40/56GbE 1U 1PS MSX1024B-1BFS



[Remove Item](#)

10GB copper cable SFP+ to SFP+ 5 meter long



DR3-32G-LR12800E2	\$433.2	<input type="text" value="500000"/>	\$216,600,000
SSD-IT-2KW512G8X1	\$199.99	<input type="text" value="100000"/>	\$19,999,000
NW-IT-X710T4BLK	\$682.11	<input type="text" value="100000"/>	\$68,211,000
NW-ML-124B1BFS	\$14,187	<input type="text" value="15"/>	\$212,805
CAB-AA-10GC5SF	\$98	<input type="text" value="640"/>	\$62,720

Seller **dataminisystems** (61★)

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SERVER RACK 42U2 , WITH FAN

Condition: New

LAST ONE

Quantity: 1

\$589.00

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Subtotal (1 item): \$589.00
Shipping to 136132: --

Total: \$589.00

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Configuration 3

Support deep learning with 1 exaflop of mixed precision performance (hint: each VM should be equivalent to **p3.16xlarge instances**; you will want to use the NVIDIA V100 GPUs (8 GPUs per node), and allocate 8-cores per GPU (64-cores per node) with 8GB of memory per core (512GB per node); the network to use is at least 10Gb/s per GPU (100Gb/s should work), and should be organized in a Fat-Tree network; in addition to the compute resources, a 1PB distributed storage shared across the entire cloud should be procured, with enough capacity for 10GB/sec throughput (for pricing comparison, see S3)

NVIDIA DGX-1 with Tesla V100 has 960 TFLOPS and we need 10^6 TFLOPS so total devices needed=

$$1000000/960 = 1042$$

Size 3U

	Description	Price per Item	Quantity	Total Price
Compute Servers	NVIDIA DGX-1 v100	\$149,000	1042	\$ 4,275,347,200
Network Switches	Supermicro 48-port Managed Gigabit Switch SSE-X3348T 1U Layer-3 10/40GbE 48xRJ45 4xQSFP 1xRS232 Black Retail	\$9,500	1	\$ 9,500
	Supermicro 24-port 10 Gigabit Ethernet Switch SSE-X24S SFP+ ports	\$4,367	47	\$ 205,249
Network Cables	100 ft Ethernet Cable Cat 7 Ethernet Cable, SNANSHI CAT 7 LAN Network Cable RJ45 Patch Cord STP Gigabit 10/100/1000Mbit/s with Gold Plated Lead for Switch/ Router/ Modem/ Patch Panel	\$38.99	1090	\$ 42,499.1
Racks	SERVER RACK 42U2, WITH FAN	\$ 589 Nvidia dgx-1 size is 3U so 42U/3U in one rack	75	\$ 44,175
Storage Servers				
Electric Power	The current ComEd supply rate is 1.39¢/kWh.	3,285,000 kWh for one year	5 years	\$ 16,425,000
Cooling	1/3 rd of electric power	1095000 kWh for one year	5 years	\$ 5,475,000
Administration	System administrator	90,000 p.a.	2 for 5 years	\$ 9,000,000

TOTAL	N/A	N/A	N/A	
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