

UNDERSTANDING THE COST OF COMPUTING IN THE CLOUD

CS 553 PROJECT REPORT
VIKRAM GAVISIDDESHWARA, MOUNA GIRI,
PRANAV SAI DEENUMSETTI

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)

PUBLIC CLOUD WITH AWS

- Please find below the configurations of d2.8xlarge instance

Model	vCPU	Memory(GiB)	Storage (GB)
d2.8xlarge	36	244	24 x 2000 HDD

- Cost of d2.8xlarge is \$5.52 per Hour,
so it will take $5.52 \times 24 \times 365 \times 5 = \241776 for 5 years
- For 1049 d2.8xlarge instances total cost = $1049 \times 241776 = \$253623024$
- Cost of Distributed storage with Amazon S3 for 100PB data is \$2275549.87 per month of 1 system

So,
 $\$2275549.87 \times 5 \times 12 = \136532992.2

- Total cost including distributed storage:

$$253623024 + 136532992.2 = \$390156016.2$$

PRIVATE CLOUD

TABLE 1: TABLE SUMMARIZING THE CONFIGURATION 1

	Description	Price Per Item	Quantity	Total Price
Compute Servers	<p>CPU: 2x Intel Xeon E5-2683v4 16C 2.1GHz 40MB Cache</p> <p>Memory: 1x 256GB DDR4 ECC Reg 2400MHz (8 x 32GB)</p> <p>OS Drives - Connected to on-board SATA controller: 1x Seagate Savvio 300GB 10K SAS 2.0 64MB 6Gb/s 2.5"</p> <p>SAS/SATA HDD - Data Drives: 5x Seagate Enterprise Capacity 10TB HE 7200RPM 256MB SAS</p> <p>RAID Controller: 1x LSI MegaRAID SAS 9361-4i 12Gb/s SAS Controller</p> <p>PCI Express Expansion: 1x Intel X520-DA2 10G Dual Port</p>	\$14,202	1000	\$14,202,000

	<p>SFP+ Network Adapter</p> <p>RAID Level: 1x Custom RAID</p> <p>Configuration - Add instructions to system notes</p> <p>Operating System: 1x CentOS 7 64bit</p> <p>Support Options: 1x Return to Depot Warranty (3 Year Hardware Warranty with NBD Advance Parts Replacement)</p>			
Network Switches	<p>2 X Huawei S6700 48 Ports 10G Switch</p> <p>46 X Huawei S6700 24 Ports 10G Switch</p> <p>47 X Mellanox MSN2700-BS2F 40GbE, 1U Open Ethernet Switch w/MLNX-OS, 32 QSFP28 ports</p> <p>Total - 95 ports</p>	<p>(17,900) + (9,500) + (11,826)</p>	<p>Total - 95 PORTS (2 X 17,900) + (46 X 9,500) + (47 X 11,826)</p>	\$10,28,622
Network Cables	Mellanox MCP2M00-A001 Passive Copper Cable, ETH, up	\$49	2704	\$1,32,496

	to 25Gb/s, SFP28, 1m			
Racks	42U 1000mm Depth Rack- mount Server Cabinet	\$1,195	137	\$1,63,715
Storage Servers	8 * Seagate Enterprise Capacity 10TB HE 7200 RPM 256 MB 3U Rackmount Chassis RAID Controller: 1x 3U 16 Bay 4G FC RAID with Single RAID Controller SATA HDD: 16x Western Digital Gold 8TB 7200RPM SATA 128MB 6Gb/s Warranty and Support: 1x Return to Depot Warranty (3 Year Hardware Warranty with Standard Advance Parts Replacement)	\$9,314	1250	\$11,642,500
Electric Power	Iris 228-12 requires 920Watts per hour For 5 years - 40,296 KW per	\$0.16 / KWH	4,02,96,00 0 KW	\$67,24,596

	system For 1000 Servers - 4,02,96,000			
Cooling	Intel LGA2011 Xeon E5- 2600/core i7 CPU active cooler (heatsink + side-Fan) for 3U+ (Square)	\$36	25	\$900
Administration	One administrator per 1000 systems	\$1,00,000/yea r	5 Years	\$5,00,000
TOTAL	N/A	N/A	N/A	\$3,43,94,82 9

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HARDWARE TO PURCHASE.

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FREE USAGE TIER: New Customers get free usage tier for first 12 months

Services **Estimate of your Monthly Bill (\$ 6616369.01)**

Estimate of Your Monthly Bill
 Show First Month's Bill (include all one-time fees, if any)

Below you will see an estimate of your monthly bill. Expand each line item to see cost breakout of each service. To save this bill and input values, click on 'Save and Share' button. To remove the service from the estimate, jump back to the service and clear the specific service's form.

Export to CSV **Save and Share**

Amazon EC2 Service (US-East)	\$ 4214387.52
Amazon S3 Service (US-East)	\$ 2202572.80
Standard Storage:	\$ 2202572.80
AWS Support (Business)	\$ 199408.81
Support for all AWS services:	\$ 199408.81
Free Tier Discount:	\$ -0.12
Total Monthly Payment:	\$ 6616369.01

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Services **Estimate of your Monthly Bill (\$ 6616369.01)**

Choose region: US-East / US Standard (Virginia) **Inbound Data Transfer is Free and Outbound Data Transfer is 1 GB free per region per month** **Clear Form**

Amazon S3 is storage for the Internet. It is designed to make web-scale computing easier for developers. Please check the [Amazon S3 Storage Classes](#) page details.

Standard Storage:

Storage:	100 PB
PUT/COPY/POST/LIST Requests:	0 Requests
GET and Other Requests:	0 Requests

Standard - Infrequent Access Storage:

Storage:	0 GB
PUT/COPY/POST/LIST Requests:	0 Requests
GET and Other Requests:	0 Requests
Lifecycle Transitions:	0 Transitions
Data Retrieval:	0 GB

Reduced Redundancy Storage:

Storage:	0 GB
PUT/COPY/POST/LIST Requests:	0 Requests
GET and Other Requests:	0 Requests

Storage Management:

Inventory:	0 Per Month Million Objects
Analytics:	0 Per Month Million Objects
Object Tagging:	0 Per Month 10,000 Tags

Glacier Requests:

Lifecycle Transition Requests into Glacier:	0 Requests
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Transfer Acceleration:

Inter-Region Acceleration Data Transfer Out:	0 GB/Month
Acceleration Data Transfer Out:	0 GB/Month
Accelerated Data Transfer In - over US, EU or JP locations:	0 GB/Month
Accelerated Data Transfer In - over all other locations:	0 GB/Month

Data Transfer:

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FREE USAGE TIER: New Customers get free usage tier for first 12 months

Services Estimate of your Monthly Bill (\$ 6616369.01)

Choose region: US-East / US Standard (Virginia)

Inbound Data Transfer is Free and Outbound Data Transfer is 1 GB free per region per month

Compute: Amazon EC2 Instances:

Description	Instances	Usage	Type	Billing Option	Monthly Cost
Cloud storage	1043	24 Hours/Day	Linux on d2.8xlarge	On-Demand (No Contract)	\$ 4214387.52

Compute: Amazon EC2 Dedicated Hosts:

Description	Number of Hosts	Usage	Type	Billing Option
Add New Row				

Storage: Amazon EBS Volumes:

Description	Volumes	Volume Type	Storage	IOPS	Baseline Throughput	Snapshot Storage
Add New Row						

Elastic IP:

Number of Additional Elastic IPs: 0

Elastic IP Non-attached Time: 0 Hours/Month

Number of Elastic IP Remaps: 0 Per Month

Data Transfer:

Inter-Region Data Transfer Out:	0 GB/Month
Data Transfer Out:	0 GB/Month
Data Transfer In:	0 GB/Month
VPC Peering Data Transfer:	0 GB/Month
Intra-Region Data Transfer:	0 GB/Month
Public IP/Elastic IP Data Transfer:	0 GB/Month

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Iris 228-12

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PROCESSOR AND MEMORY

CPU



2x Intel Xeon E5-2603v4 6C 1.7GHz 15MB Cache \$0.00

Memory

1x 16GB DDR4 ECC Reg 2400MHz (2 x 8GB) \$0.00

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PROCESSOR AND MEMORY

CPU
2x Intel Xeon E5-2603v4 6C 1.7GHz 15MB Cache \$0.00

Memory
1x 16GB DDR4 ECC Reg 2400MHz (2 x 8GB) \$0.00

HARD DISK DRIVES

OS Drives - Connected to on-board SATA controller
1x Seagate Savvio 300GB 10K SAS 2.0 64MB 6Gb/s 2.5

SAS/SATA HDD - Data Drives
5x Seagate Enterprise Capacity 10TB HE 7200RPM 256

PCI EXPRESS EXPANSION

RAID Controller
1x LSI MegaRAID SAS 9361-4i 12Gb/s SAS Controller

PCI Express Expansion
1x Intel X520-DA2 10G Dual Port SFP+ Network Adapter

PCI Express Expansion
1x none

RAID CONFIGURATION

RAID Level
1x Custom RAID Configuration - Add instructions to sys

OPERATING SYSTEM

Operating System
1x CentOS 7 64bit \$0.00

SUPPORT OPTIONS

Support Options
1x Return to Depot Warranty (3 Year Hardware Warranty)

SUBTOTAL AS CONFIGURED: \$7,842.76

Request a Quote
Obtain a formal quote for this configuration by clicking the "REQUEST A QUOTE" button. Then, enter your email address and provide any comments or suggestions in the notes. You will then receive an email with a link to a pdf of the quote. The Pogo Linux sales engineering team will review your configuration and respond via email with any comments or suggestions.

Submit for Review
Do you have questions about this configuration? Click "SUBMIT FOR REVIEW" then enter your email address and questions and/or concerns. The Pogo Linux sales engineer will personally review your configuration and respond to you directly.

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Processor/Cache	Chassis
CPU Intel® Xeon® Processor E5-2603v4	Form Factor 2U Rackmount
QPI up to 5.6 GT/s	
System Memory	Dimensions
Memory Capacity Supports up to 512GB DDR4 ECC Registered	Height 3.5" (89mm)
Memory Type 2400MHz Registered ECC DDR4 SDRAM	Width 17.2" (437mm)
DIMM Sizes 4GB, 8GB, 16GB, 32GB	Depth 25.6" (650mm)
On-Board Devices	Gross Weight 62 lbs (20.9kg)
Chipset Intel® C612 chipset	Available Colors Black
SATA Intel C612 SATA 6.0Gb/s Controller	Front Panel
Network Controller Intel PRO 1000 Dual-Port Gigabit Ethernet Controller	Power On/Off Button
IPMI Intel iDRAC30 Dual-Port KVM-over-LAN support	System Reset Button
Power Supply 900W Redundant AC to DC power supply w/ PFC	LEDs
Serial ATA 2x Serial ATA ports Six SATA hard drives supported	Power LED
LAN 2x RJ45 LAN ports 4x USB rear ports	Hard drive activity LED
USB 2x USB on-board 4x USB internal headers Total 8 USB 2.0 Compliant	2x System activity LEDs
	System Overheat LED
	Universal Information (UI) LED
	2x USB & DB9 COM port tray (Optional - in place of floppy drive)
	Ports
	Power On/Off Button
	System Reset Button
	LEDs
	Power LED
	Hard drive activity LED
	2x System activity LEDs
	System Overheat LED
	Universal Information (UI) LED
	2x USB & DB9 COM port tray (Optional - in place of floppy drive)
	Expansion Slots
	PCI-E 3 (x16) PCI-E 3.0 slots
	Express 3 (x8) PCI-E 3.0 slots
	Drive Bays
	Hot-swap 12 x 3.5" SATA Hot-swap drive trays
	SAS/SATA Backplane
	2U T2G SAS/SATA Backplane w/ single expander
	System Cooling
	Fans 3x 80mm Cooling Fans
	Shroud 1x Air Shroud
	Power Supply
	900W Redundant AC to DC power supply w/ PFC
	Certification
	80 PLUS Gold Certified

System Notes: *an email with a link to a pdf of the quote. The Pogo Linux sales engineer will personally review your configuration and respond to you directly.*

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PROCESSOR AND MEMORY

CPU

2x Intel Xeon E5-2603v4 6C 1.7GHz 15MB Cache \$0.00

Memory

1x 16GB DDR4 ECC Reg 2400MHz (2 x 8GB) \$0.00

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Brand

- Avocent (1)
- Cisco (1)
- D-Link (11)
- Hewlett-Packard (5)
- Huawei (5)
- Intel (63)
- Mellanox (141)
- Netgear (21)
- QLogic (25)
- Supermicro (51)
- Other (15)

Device Type

- Adapter (157)
- Network Security (1)
- Power Management (1)
- Switch/Hub (141)
- Transceiver (18)
- Accessories (53)

Network Type

- 10/100 Mb Ethernet (24)
- 1 Gbase Ethernet (20)

Features **Reviews**

Huawei S6700 24 Ports 10G Switch

Product Code: NW-HW-SW-S6700-24-EI
Manufacturer: Huawei
Best Seller!

List Price: \$15,912.72 / Each
Your Price: \$9,500 / Each

★★★★★ 0 Review(s)

1

Add to Cart

Brand: Huawei
Model: S6700-24-EI

Features

Large capacity and high density 10Gbps access, the S6700 supports up to a maximum of 48 line-speed 10GE ports and can be deployed in a data center to provide 10Gbps access to servers, or function as a core switch on a campus network to provide 10Gbps traffic aggregation. The S6700 Series of switches also provide a wide range of management and monitoring features to ensure reliable and efficient network performance.

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Device Type

- Adapter (157)
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- Power Management (1)
- Switch/Hub (141)
- Transceiver (18)
- Accessories (53)

Network Type

- 10/100 Mb Ethernet (24)
- 1 Gbase Ethernet (2)

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Huawei S6700-48-EI

Product Code: NW-HW-SW-S6700-48-EI
Manufacturer: Huawei
Best Seller!
List Price: \$31,825.44 / Each

Your Price: \$17,900 / Each

★★★★★ 0 Review(s)

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Features Reviews Related Products

Brand: Huawei
Model: S6700-48-EI

Features

Large capacity and high density 10Gbps access, the S6700 supports up to a maximum of 48 line-speed 10GE ports and can be deployed in a data center to provide 10Gbps access to servers, or function as a core switch on a campus network to provide 10GbE traffic aggregation. The S6700 Series of switches also provide a wide range of management and monitoring features.

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- Supermicro (51)
- Other (15)

Device Type

- Adapter (157)
- Network Security (1)
- Power Management (1)
- Switch/Hub (141)
- Transceiver (18)
- Accessories (53)

Network Type

- 10/100 Mb Ethernet (24)
- 1 Gbase Ethernet (2)

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Huawei S6700 48 Ports 10G Switch

Product Code: NW-HW-SW-S6700-48-EI
Manufacturer: Huawei
Best Seller!
List Price: \$31,825.44 / Each

Your Price: \$17,900 / Each

★★★★★ 0 Review(s)

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Features Reviews Related Products

Brand: Huawei
Model: S6700-48-EI

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Large capacity and high density 10Gbps access, the S6700 supports up to a maximum of 48 line-speed 10GE ports and can be deployed in a data center to provide 10Gbps access to servers, or function as a core switch on a campus network to provide 10GbE traffic aggregation. The S6700 Series of switches also provide a wide range of management and monitoring features.

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Mellanox MSN2700-BS2F 40GbE, 1U Open Ethernet Switch w/MLNX-OS, 32 QSFP28 ports, 2 PS(AC), x86 CPU, Standardepth, P2C airflow

Product Code: NW-ML-SN2700BS2F
Manufacturer: Mellanox

List Price: \$20,309 / Each
Your Price: \$11,826.23 / Each

★★★★★ 0 Review(s)

1 Add to Cart

Features Reviews

Mellanox SN2700 Open Ethernet Switch, SN2700B Series
SN2700B switches are priced comfortably for the 40/10GbE market and provide the superior feature set of Spectrum

Mfg. Model Number:

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Networking - Wireless, Switch, Router, NIC Adapter

Acmemicro delivers enhanced and energy-efficient performance networking devices such as 10-gigabit Ethernet (10GbE), infiniband and switch solutions.



Mellanox MCP2M00-A001 Passive Copper Cable, ETH, up to 25Gb/s, SFP28, 1m

Product Code: CAB-ML-CP2M00-A001

List Price: \$85.03
Your Price: \$48.99

Add to Cart

Page: ◀ 1 ▶

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)

PUBLIC CLOUD WITH AWS

- Please find below the configurations of r3.large instance

Model	vCPU	Memory(GiB)	SSD memory(GB)
r3.large	2	15	1*32

- Cost of r3.large is \$0.166 per Hour, so it will take $0.166 * 24 * 365 * 5 = \$7270.8$ for 5 years

- For 1000000 such r3.large instances total cost = 7270.8
 $*1000000=\$7270800000$
- Cost of Distributed storage with Amazon S3 for 10PB data is \$ 233702.25 per month
So,
 $233707.50*5*12= \$ 114022135$
- Total cost including distributed storage:

$$7270800000 + 114022135 = \$7284822135$$

PRIVATE CLOUD

TABLE 2: TABLE SUMMARIZING THE CONFIGURATIONS 2

	DESCRIPTION	PRICE PER ITEM	QUANTITY	TOTAL PRICE
Compute Servers	<p>Iris 1291</p> <p>Barebone Server:</p> <ul style="list-style-type: none"> 1x 1U DP Xeon SP, 4 x 3.5" SAS/SATA, 600W CPU: 2x Intel Xeon Gold 6152 22C 2.1GHz 30.25MB Cache Memory: 1x 384GB DDR4 2666MHz ECC Reg (12 x 32GB) SAS/SATA HDD 1: 1x Intel S4500 Series 240GB 3D1 TLC SATA SSD 6Gb/s SAS/SATA HDD 2: 1x Intel S4500 Series 240GB 3D1 TLC SATA SSD 6Gb/s SAS/SATA HDD 3: 1x Intel S4500 Series 240GB 3D1 TLC SATA SSD 6Gb/s 	\$15,198	45,454	\$690,809,892

	PCI Express Expansion: 1x Intel I350-T2v2 Dual Port Gigabit Ethernet Adapter Operating System: 1x CentOS 7 64bit Warranty and Support: 1x Return to Depot Warranty (3 Year Hardware Warranty with Standard Advance Parts Replacement)			
Network Switches	Cisco SMB SG350XG-48T-K9 48 Port Stackable Managed 10 Gb Ethernet Switch	\$5853.99	48	\$280,991
	Cisco SMB SG350XG-24T-K9 24 Port Stackable Managed 10 Gb Ethernet Switch	\$3177.99	2162	\$6,868,674

Network Cables	Ethernet Cable, VANDESAIL 2 Pack 6.5ft CAT7 RJ45 LAN Cable High Speed Gigabit Network Patch Cord Gold Plated (2m)	7.99	47664	\$380,835.36
	3m (10ft) Extreme Networks 10GB- C03-SFPP Compatible 10G SFP+ Passive Direct Attach Copper Twinax Cable	\$15	28	\$420
Racks	Tripp Lite 42U Rack Enclosure Server Cabinet Knock-Down w/ Doors & Sides	\$883.83	1083	\$956,289
Storage Servers	Iris 428-36	\$27,940	28	\$782,320

CPU: 2x Intel Xeon E5-2603v4
6C 1.7GHz 15MB Cache
Memory: 1x 16GB DDR4 ECC Reg 2400MHz (2 x 8GB)
Rear-mounted OS Disks: 1x Seagate Savvio 300GB 10K SAS 2.0 64MB 6Gb/s 2.5"
Data HDD: **30x HGST Ultrastar HE12 12TB 7200RPM SATA 6Gb/s**
PCI Express Expansion: 1x Intel 10 Gigabit Dual Port CX4 Server Adapter
Operating System: 1x CentOS 7 64bit
RAID Level: 1x Custom RAID Configuration - Add instructions to system notes
Warranty and Support: 1x Return to Depot Warranty (3 Year Hardware)

	Warranty with Standard Advance Parts Replacement)			
Electric Power	Compute server require 600W per hour Storage server require 1280W per hour	600W for 45454 systems at \$0.16 per KW 1280W for 28 systems at \$0.16 per KW		\$191,124,979 \$251,166.72
Cooling	AC Infinity CLOUDPLATE X7, Rack Mount Fan Panel 2U, for cooling Network, IT, Server 19" Racks	\$79. ⁹⁹	25,000	1,999,750
Administration	\$80,000/year /person	\$400,000	46	\$18,400,000
TOTAL	N/A	N/A		\$911,855,317 .08

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Qty	System	Description	\$15,198.82	\$15,198.82	Edit System Delete System
1	Iris 1291	view components	\$15,198.82	\$15,198.82	Edit System Delete System
1	Iris 428-36	view components	\$27,940.00	\$27,940.00	Edit System Delete System

Configuration Details for Iris 1291:

- CPU: 2x Intel Xeon E5-2603v4 4C 1.7GHz 15MB Cache
- Memory: 1x 16GB DDR4 ECC Reg 2400MHz (2x 8GB)
- Rear-mounted OS Disks: 1x Seagate Savvio 300GB 10K SAS 2.0 64MB 6Gb/s 2.5"
- Data HDD: 30x 1TB Ultrastar HE12 12TB 7200RPM SATA 6Gb/s
- PCI Express Expansion Cards: 1x Intel 10 Gigabit Dual Port CNA Server Adapter
- Operating System: 1x Red Hat Enterprise Linux Server 7.4
- RAID Levels: 1x Custom RAID Configuration - Add instructions to system notes
- Warranty and Support: 1x Return to Depot Warranty (3 Year Hardware Warranty with Standard Advance Parts Replacement)

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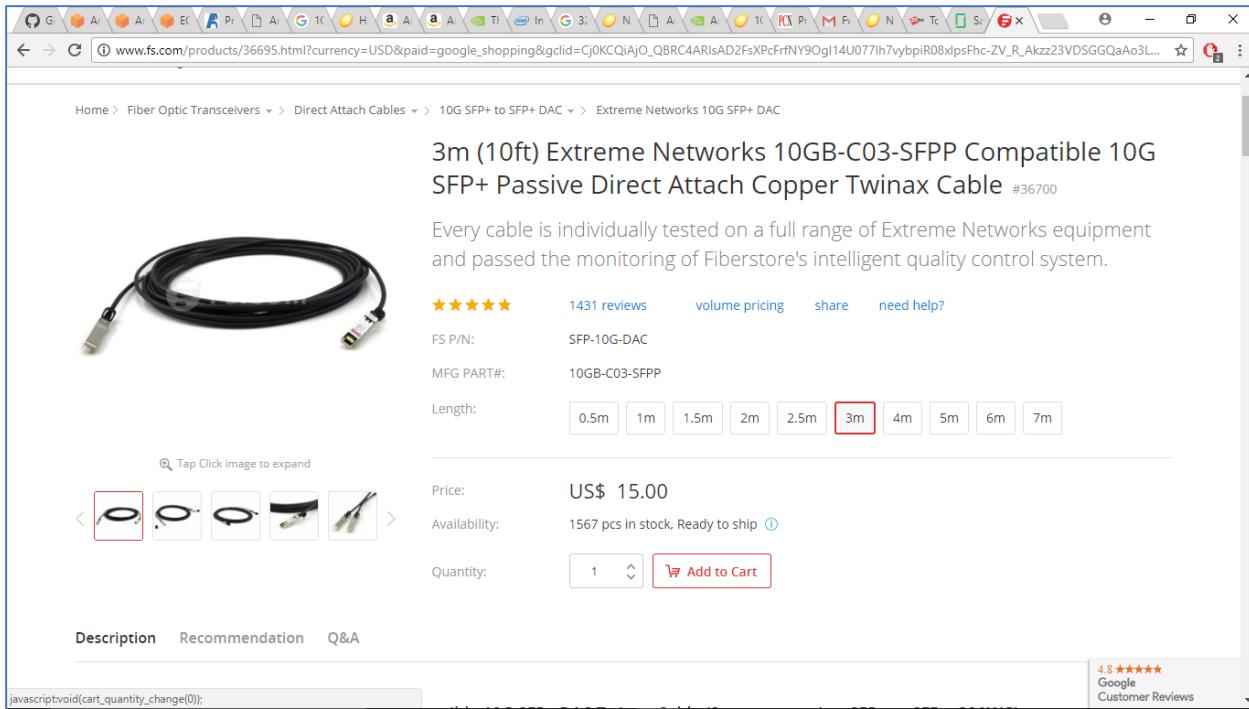
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Configuration 3: Support deep learning with 1 Exaflop of mixed precision performance (hint: each VM should be equivalent to p3.16xlarge instances; you will want to use the NVIDIA V100 GPUs (8 GPUs per node), and allocate 8-cores per GPU (64-cores per 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)

PUBLIC CLOUD WITH AWS

- Please find below the configurations of P3*16xlarge instance

Model	GPU's	vCPU	Memory(GiB)	GPU memory(GiB)
P3*16xlarge	8	64	488	128

- The P3 instance will give performance upto 1PetaFlops as mentioned in the below link
<https://aws.amazon.com/ec2/details/>
- Assume 1 p3 instance will give 1PetaFlops mixed precision performance, we need 1000 such instances to achieve 1 exaFlops performance.
- Cost of P3*16Xlarge is 24.48 per hour,
so, it will take $24.48 \times 24 \times 365 \times 5 = \$1072,224$ for 5 years
- For 1000, such p3 instances
total cost = $1072224 \times 1000 = \$1072,224,000$
- Cost of Distributed storage with Amazon S3 for 1PB data is \$1,467,840
- Total cost including distributed storage: $1072,224,000 + 1,467,840 = \$1,073,691,840$

PRIVATE CLOUD:

- Dgx-1 instances is taken for private setup as it matches the requirement.
- A dgx-1 system has 8 Nvidia Tesla V100 GPU's with GPU memory of 128 GB and system memory of 512 GB which matches with a single P3*16xlarge configuration.
- Each dgx-1 instance provides 960TFlops of performance for deep learning and hence we need 1042 systems to meet 1 exaFlop performance.

TABLE 3: TABLE SUMMARIZING THE CONFIGURATIONS 3

	Description	Price per item	Quantity	Total price

Computer servers	Nvidia Dgx-1 Tesla V100	\$149,000	1042	\$155,258,000
Network switches	Cisco SMB SG350XG-48T-K9 48 Port Stackable Managed 10 Gb Ethernet Switch	\$5,853 ^{.99}	1	\$5853.99
	Cisco SMB SG350XG-24T-K9 24 Port Stackable Managed 10 Gb Ethernet Switch	\$3,177 ^{.99}	46	\$146,142
	NETGEAR XS708Ev2 ProSAFE 8-Port 10-Gigabit Ethernet Web Managed (Plus) Switch	\$659 ^{.99}	1	\$659 ^{.99}
Network cables	3m (10ft) Extreme Networks 10GB-C03-SFPP Compatible 10G SFP+ Passive Direct Attach Copper Twinax Cable	\$15	1092	\$16,380
Racks	Tripp Lite 42U Rack Enclosure Server Cabinet Knock-Down w/ Doors & Sides	\$883.83	75	\$66,287.25
Storage servers	Iris 428-60 CPU: 2x Intel Xeon E5-2603v4 6C 1.7GHz 15MB Cache Memory: 1x 16GB DDR4 ECC Reg 2400MHz (2 x 8GB) Mirrored OS Disks - Mounted in Rear Bays: 2x Micron M510DC 480GB 2.5" Enterprise SSD Enterprise HDD: 50x HGST Ultrastar HE12	\$51,754.58	1	\$51,754.58

	<p>12TB 7200RPM SAS 12Gb/s</p> <p>Networking Options: 1x Dual Port 10G SFP+ Ethernet Module X520 PCIe Expansion: 1x Intel 10 Gigabit Dual Port CX4 Server Adapter OS: 1x CentOS 7 64bit Warranty: 1x Return to Depot Warranty (3 Year Hardware Warranty with Standard Advance Parts Replacement)</p>			
	<p>Iris 428-60</p> <p>CPU: 2x Intel Xeon E5-2603v4 6C 1.7GHz 15MB Cache</p> <p>Memory: 1x 16GB DDR4 ECC Reg 2400MHz (2 x 8GB)</p> <p>Mirrored OS Disks -</p> <p>Mounted in Rear Bays: 2x Micron M510DC 480GB 2.5" Enterprise SSD</p> <p>Enterprise HDD: 40x HGST Ultrastar HE12 12TB 7200RPM SAS 12Gb/s</p> <p>Networking Options: 1x Dual Port 10G SFP+ Ethernet Module X520 PCIe Expansion: 1x Intel 10 Gigabit Dual Port CX4 Server Adapter OS: 1x CentOS 7 64bit Warranty: 1x Return to Depot Warranty (3 Year Hardware Warranty with</p>	\$44,872.22	1	\$44,872.22

	Standard Advance Parts Replacement)			
Electric power	<ul style="list-style-type: none"> DGX-1 system requires 3200watts per hour. <p>For 5 years, it will take 1,40,160 KW for a single system. $1042 \times 1,40,160 = 146,046,720$ KW</p> <ul style="list-style-type: none"> For Iris storage servers and cooling system 	146,046,720 KWh with \$0.16/kwh 1,000,000 KWh with \$0.16/kwh		\$23,367,475.2 \$160,000
Cooling	AC Infinity CLOUDPLATE X7, Rack Mount Fan Panel 2U, for cooling Network, IT, Server 19" Racks	\$79.99	20	\$1599.8
Administration	Two administrators with \$1,000,000/year per person	\$5,00,000	2	\$1,000,000
Total	N/A	N/A	N/A	\$179,959,026

SCREENSHOTS:

SCREENSHOT OF YOUR SHOPPING CART SHOWING THE HARDWARE TO PURCHASE.

THE NVIDIA DGX-1 IS AVAILABLE FOR PURCHASE IN SELECT COUNTRIES

The NVIDIA DGX is available for purchase in select countries and is priced at:

- DGX with P100 at \$129,000*
- DGX with V100 at \$149,000*

When ordering DGX with V100, you can choose between getting DGX-1 with P100 now and receiving an upgrade to V100 as soon it's available, or getting a DGX with V100 when it starts shipping. DGX support plan is required and must be purchased separately.



SYSTEM SPECIFICATIONS

GPUs	8X Tesla V100	8X Tesla P100
TFLOPS (GPU FP16)	960	170
GPU Memory	128 GB total system	
CPU	Dual 20-Core Intel Xeon E5-2698 v4 2.2 GHz	
NVIDIA CUDA® Cores	40,960	28,672
NVIDIA Tensor Cores (on V100 based systems)	5,120	N/A
Maximum Power Requirements	3,200 W	
System Memory	512 GB 2,133 MHz DDR4 LRDIMM	
Storage	4X 1.92 TB SSD RAID 0	
Network	Dual 10 GbE, 4 IB EDR	
Software	Ubuntu Linux Host OS See Software Stack for Details	
System Weight	134 lbs	
System Dimensions	866 D x 444 W x 131 H (mm)	
Packing Dimensions	1,180 D x 730 W x 284 H (mm)	
Operating Temperature Range	10–35 °C	

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1	Iris 428-60	view components	\$51,754.58	\$51,754.58	Edit System Delete System
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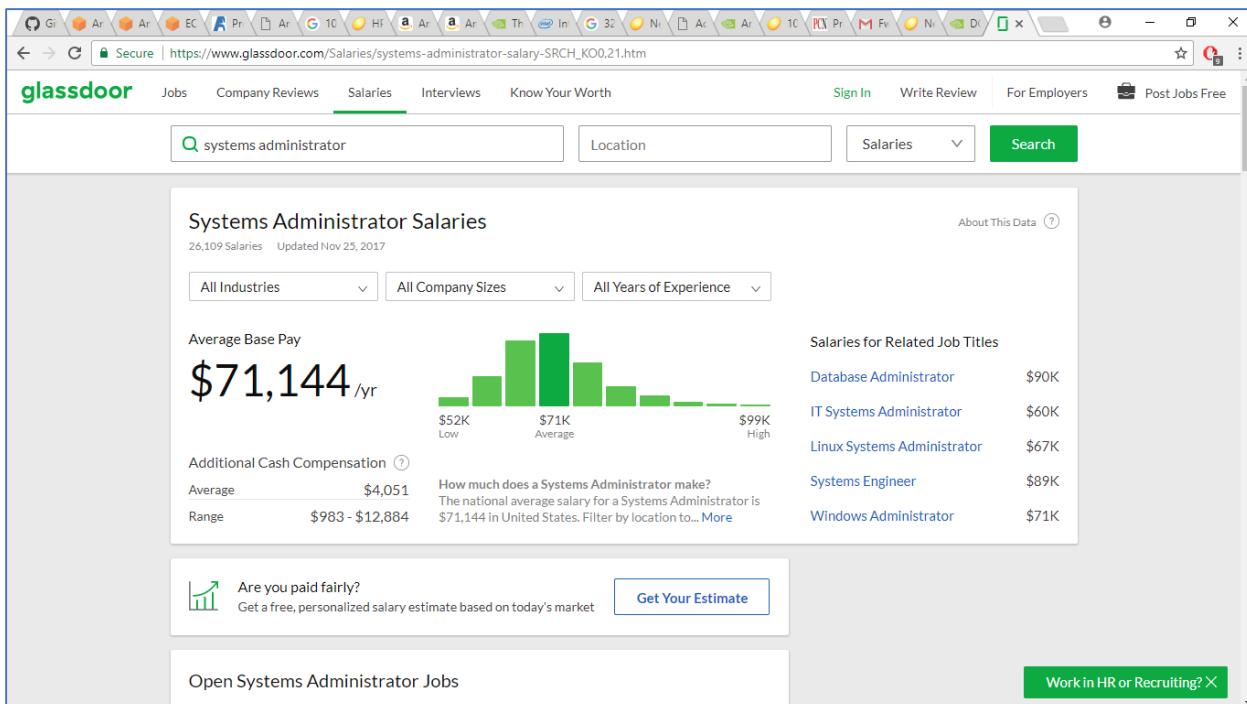


TABLE 4: SUMMARY TABLE COMPARING THE 3 CONFIGURATIONS BETWEEN THE PUBLIC AND PRIVATE CLOUD; YOUR COST OF POWER, COOLING, AND ADMINISTRATION COVERING 5 YEARS OF COSTS

	CONFIGURATION 1	CONFIGURATION 2	CONFIGURATION 3
Public Cloud (including EC2 and S3) Cost over 5 years, 24/7 operation, with 100% usage	\$390,156,016.2	\$728,482,213.5	\$1,073,691,840
Private Cloud cost over 5 years, 24/7 operation, with 100% usage	\$3,43,94,829	\$911,855,317.08	\$179,959,026
What utilization must be achieved with the private cloud to make the private cloud option more attractive than the public cloud?	WE achieved 8.8% Utilization of public cloud which equals to	WE achieved 12% Utilization of public cloud which equals to	WE achieved 16.76% Utilization of public cloud which equals to

	100% utilization of private cloud. So in order to make private cloud more attractive utilization should increase and be closer to 100 %. Then private will be more cheaper than public.	100% utilization of private cloud. So in order to make private cloud more attractive utilization should increase and be closer to 100 %. Then private will be more cheaper than public.	100% utilization of private cloud. So in order to make private cloud more attractive utilization should increase and be closer to 100 %. Then private will be more cheaper than public.
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EXPLAIN IN WORDS IF IT IS BETTER TO RENT OR BUY. IF IT IS BETTER TO BUY, WHAT UTILIZATION MUST YOU MAINTAIN OVER THE 5-YEAR LIFETIME OF THE PRIVATE CLOUD TO BREAK EVEN ON THE INVESTMENT?

$$\text{UTILIZATION \%} = (\text{Private Cloud Cost} / \text{Public Cloud Cost}) * 100$$

CONFIGURATION 1

Considering the data provided in the above two tables we can conclude that it is better to rent the configuration over buying it.

We have considered the most famous Amazon AWS instances for estimating public cloud renting cost. The data retrieved is through the Amazon's official website. We have considered d2.i8Xlarge type instance of AWS. It requires 1049 instances of d2.i8Xlarge instance to form our desired configuration. As in private cloud which is built from scratch requires 100 systems to form our configurations and relatively costs lesser amount.

Public cloud Cost of 5 years – \$390156016.2
 Private Cloud Cost for 5 years - \$3,43,94,829

Utilization that we must maintain over the 5-year lifetime of the private cloud to break even on the investment is

$$\text{Utilization} = (34394829 / 385017540) * 100$$

= 8.83 %

CONFIGURATION 2

Considering the data provided in the above two tables we can conclude that it is better to rent the configuration over buying it.

Utilization= (private cloud cost/public cost) *100

$$\begin{aligned} &= 911,855,317.08 / 7,284,822,135 \\ &= 0.12517 \\ &= 12\% \end{aligned}$$

CONFIGURATION 3

Considering the data provided in the above two tables we can conclude that it is better to rent the configuration over buying it.

Utilization= (private cloud cost/public cost) *100
= 179,959,026 / 1,073,691,840
= 16.76%

CONCLUSION

The private cloud should be utilized 100% and maintained throughout 5 year such that it matches almost 100% utilization of public cloud instances to be more effective.

REFERENCE :

[http://www.acmemicro.com/Product/15859/Mellanox-MSN2700-BS2F-40GbE-1U-Open-Ethernet-Switch-w-MLNX-OS-32-QSFP28-ports-2-PS\(AC\)-x86-CPU-Standardepth-P2C-airflow?c_id=69](http://www.acmemicro.com/Product/15859/Mellanox-MSN2700-BS2F-40GbE-1U-Open-Ethernet-Switch-w-MLNX-OS-32-QSFP28-ports-2-PS(AC)-x86-CPU-Standardepth-P2C-airflow?c_id=69)

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http://www.pogolinux.com/quotes/editsys?sys_id=1067897

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<http://clusterdesign.org/fat-trees/>