Cs553 Project

Understanding the cost of Computing in the cloud

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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).

Public Cloud (D28xlarge Instance):

Model Type	CPU	ECU	Memory(GiB)	Instance Storage(GB)	Linux/Unix Storage
D2.8xLarge	36	116	244	24*2000 HDD	$5.52 per hour

- Cost for 1 Virtual machine D2.8xLarge for 5 years is:

  = cost per hour * number of hours in a day * no of days * no of years

  = 5.52*24*365*5 = $241776.

- To build a cluster with 32K-cores, 256TB memory, 50PB HDD, and 10Gb/s Ethernet Fat-Tree network we need have approximately 1092 Virtual machines.

  Cost for 1092 VMs for 5 years = 1092 * 241776 = $264019392.

- 100PB distributed storage cost:

  = .0225 * 100 *1024*1024 *12*5

  = $141557760

- Total cost of Public cloud:
  = cost of the vms + distributed storage cost
  = 264019392 + 141557760
  = $405577152

Private Cloud:

Requirements	Description	Price per item	Quantity	Total price
Compute Servers	64GB PC4-19200 DDR4-2400Mhz Load Reduced ECC Quad Ranked 1.2V Major Brand + 8TB Toshiba HDWF180XZSTA - SATA HDD 8TB Desktop SATA 6.0GB/s 7200rpm 128MB 3.5-inch Retail + Intel X557T2OCPG1P5/OCP X557-T2 Dual Port 10GBASE-T (RJ45) Ethernet Network Connection + AMD EPYC 7601 Processor PS7601BDVIHAF 32Cores 64Threads 2.20GHz 64MB L3 Cache 341GB/s 180W 2P/1P TRAY	$799.99 + $277.99 + $230 + $4763	4096 + 6400 + 1000 + 1000	$3276759 + $1779136 + $230000 + $4763000 = $10,048,895
Network Switches	Supermicro 48-port Managed Gigabit Switch SSE-X3348T 1U Layer-3 10/40GbE 48xRJ45 4xQSFP 1xRS232 Black Retail	$7896	22	$173,712
Network Cables	Supermicro CBL-NTWK-0719 QSFP+ (40GbE) to 4 SFP+ (10GbE) split cable 1m long	$185	1100	$203500
Racks	APC NetShelter SX 42U Server Rack Enclosure 600mm x 1070mm w/ Sides Black	$1325	1	$1325

Storage Servers	1x 2U Dual AMD EPYC 7000 Series 12x3.5" SAS/SATA 1600w Redundant + 2x AMD Epyc 7501 32C 2.0GHz 64MB Cache 155W/170W + 1x 256GB DDR4 2666MHz ECC Reg (8 x 32GB) + 1x HGST Ultrastar HE10 10TB 7200RPM SAS 12Gb/s + 1x No Operating System. Include testing and customer OS preference in notes. + 1x Custom RAID Configuration - Add instructions to system notes + 1x Return to Depot Warranty (3 Year Hardware Warranty with Standard Advance Parts Replacement) + 10TB Seagate ST10000VX0004 - SATA HDD 10TB Skyhawk Surveillance SATA 6.0GB/s 5900rpm 256MB 3.5-inch Bulk	$14894.26 + $359.99	834 + 10000	$131575892.8 + $3599900 = $13517579.28
Electric Power	Atlas 223-12 requires 1600 Watts per Hour +	$0.117/KWH	834	$6838266.24 + $922428 = $7760694.24

	AMD EPYC 7601 Processor requires 180 Watts per hour	$0.117/KWH	1000	
Cooling	Cooler Master Hyper 212 LED CPU Cooler w/ PWM Fan, Four Direct Contact Heat Pipes, Red LEDs	34.89	1000	$34890
Administration	One administrator for 1000 systems	$100000/year	2	$1000000
Total	-	-	-	**$3,27,40,596**

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 (R3. large Instance):

Model Type	CPU	Memory(GiB)	Instance Storage(GB)	Linux/Unix Storage
R3. Large	2	15	1*32	$0.183 per hour

- Cost of 1 R3. Large instance for 5 years is:

  = cost per hour * number of hours in a day * no of days * no of years

  = 0.183*24*365*5

  = $8015.4

- Cost of 1 million R3 instance is:

  = number of Vms * cost for 1 Vm

  = 1000000* 8015.4

  = $8,015,400,000

- 10PB distributed storage cost:

  = cost for 1PB Storage * number of months * number of years

  = 0.021*10*1024*1024*12*5

  = $13,212,057.6

- Total cost of Public cloud:

  = cost of the vms + distributed storage cost

  = 8,015,400,000 + 13,212,057.6

  = $8028612058

Private Cloud:

Requirements	Description	Price per item	Quantity	Total price
Compute Servers	Intel Core i3-7300 Desktop Processor LGA1151 4MB Cache 4.00 GHz 2 Core/ 4 Thread BX80677I37300 BOX + 16GB PC4-19200 DDR4-2400 260-pin SODIMM Unbuffered ECC 1.2V Main Brands + Intel 32GB MEMPEK1W032GAXT Optane Memory Series NVMe PCIe M.2 2280 1350MB/sec Read 20nm 3D Xpoint, Retail + Intel I357T4OCPG1P5/OCP I357-T4 Quad Port 1GBASE-T (RJ45) Ethernet Network Connection	$171.36 + $219.99 + $78.99 + $145	1,000,000	$615,340,000
Network Switches	Supermicro Layer 2 Ethernet 10/100/1000 Switch 48 x Gbe 4 x SFP 1G ports 16K MAC address SSE-G2252	$559	21740	$12,152,660
Network Cables	Ethernet Cat6a Cable 3 feet RJ45 10Gb/1Gb	$6.8	1021740	$6947832
Racks	NetShelter SV 42U 600mm Wide x 1060mm Deep Enclosure with Sides, Black, Single Rack Unassembled	$879	518	$455322

Storage Servers	1x Intel Xeon E5-2603v4 6C 1.7GHz 15MB Cache + 1x 8GB DDR4 ECC Reg 2400MHz (2 x 4GB) + 1x Intel S4500 Series 240GB 3D1 TLC SATA SSD 6Gb/s + 1x HGST Ultra star HE12 12TB 7200RPM SATA 6Gb/s + 1x No Operating System. Include testing and customer OS preference in notes. + 1x Custom RAID Configuration - Add instructions to system notes + 1x Return to Depot Warranty (3 Year Hardware Warranty with Standard Advance Parts Replacement)	$6345.44	854	$5419005.76
Electric Power	Intel Core i3-7300 Desktop Processor requires 51Watts per hour + Iris 418-36 requires 1280Watts per hour	$0.117/KWH $0.117/KWH	1000000 854	$51000000+ $5601802.75 = $56601802.75
Cooling	Cooler Master Hyper 212 EVO - CPU Cooler with 120mm PWM Fan	$29.99	1000000	$29990000

Administration	One administrator for 1000 systems	$80000/year	1001	$404000000
Total	-	-	-	**$**1,13,09,06,623

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 (R3. large Instance):

Model Type	CPU	ECU	Memory(GiB)	Instance Storage(GB)	Linux/Unix Storage
P3.16xlarge	64	188	488	EBS only	$24.48 per hour

- Cost of 1 P3.16xlarge instance for 5 years is:
  - = cost per hour * number of hours * number of days * no of years
  - = 24.48*24*365*5
  - = $1072224
- Cost of 8000 P3 instance to get 1exaflop performance because 1 P3 instance gives 125 TFLOPS of mixed-precision performance:
  - = Number of P3 Instance * cost of 1 P3 instance
  - = 8000*1072224
  - = $8577792000
- 1PB distributed storage cost:
  - = cost for 1PB Storage * number of months * number of years
  - = 0.021*1*1024*1024*12*5
  - = $13,212,05.76
- Total cost of Public cloud:
  - = P3 instance cost + distributed storage cost
  - = 8577792000+1,321,205.76
  - = $8579113206

Private Cloud:

Requirements	Description	Price per item	Quantity	Total price
Compute Servers	Nvidia Dgx-1 Tesla V100	$149000	1000	$149000000
Network Switches	Supermicro 48-port Managed Gigabit Switch SSE-X3348TR 1U Layer-3 10/40GbE 48xRJ45 4xQSFP 1xRS232 Reverse-airflow Black Retail	$7896	22	$173712
Network Cables	Ethernet cable 10000/1000 Base-T Cat7 RJ45 10 feet 10Gbps	$13	1022	$13286
Racks	TrippLite 42U SmartRack WIDE Premium enclosure	$1349.99	1	$1349.99
Storage Servers	2x Intel Xeon E5-2609v4 8C 1.7GHz 20MB Cache + 1x 64GB DDR4 ECC Reg 2400MHz (4 x 16GB) + 2x Micron M510DC 480GB 2.5” Enterprise SSD + 1x HGST Ultra star HE12 12TB 7200RPM SAS 12Gb/s + 1x Dual Port 10G SFP+ Ethernet Module X520 + 1x No Operating System. Include	$17861.92	84	$1500401.28

	testing and customer OS preference in notes. + 1x Return to Depot Warranty (3 Year Hardware Warranty with Standard Advance Parts Replacement)			
Electric Power	Iris 428-60 requires 2000Watts per Hour Nvidia Dgx-1 Tesla V100 requires 3500Watts per hour	$0.117/KWH $0.117/KWH	84 1000	$860932.8 + $17936100 = $18797032.8
Cooling	NZXT Kraken G12 GPU Cooler (Black)	$29.99	1000	$29990
Administration	One administrator for 1000 servers	$80000/year	2	$8000000
Total	-	-	-	**$**177515772

Summary table comparing the 3 configurations between the public and private cloud comparing cost of power, cooling, and administration over 5 Years:

Description	Configuration 1	Configuration 2	Configuration 3
Public Cloud (including EC2 and S3) Cost over 5 years, 24/7 operation, with 100% usage	$405577152	$8028612058	$8579113206
Private Cloud cost over 5 years, 24/7 operation, with 100% usage	$32740596	$1,13,09,06,623	$177515772
What utilization must be achieved with the private cloud to make the private cloud option more attractive than the public cloud?	Based on the calculations we achieved 8.07% utilization of public cloud is 100% utilization of private cloud. So, in order to make private cloud much more attractive than the public cloud utilization should be close to 100%.	Based on the calculations we achieved 14.09% utilization of public cloud is 100% utilization of private cloud. So, in order to make private cloud much more attractive than the public cloud utilization should be close to 100%.	Based on the calculations we achieved 2.07% utilization of public cloud is 100% utilization of private cloud. So, in order to make private cloud much more attractive than the public cloud utilization should be close to 100%.

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?

For all the three configurations we can conclude that Private cloud costs less than the public cloud over 5 years. So, for longer usage private cloud is better than the public cloud.

Utilization = (Private Cloud Cost / Public Cloud Cost) * 100

Configuration 1:

Utilization = 32740596/405577152 * 100

= 8.07 %

Configuration 2:

Utilization = 1,13,09,06,623/8028612058* 100

= 14.09 %

Configuration 3:

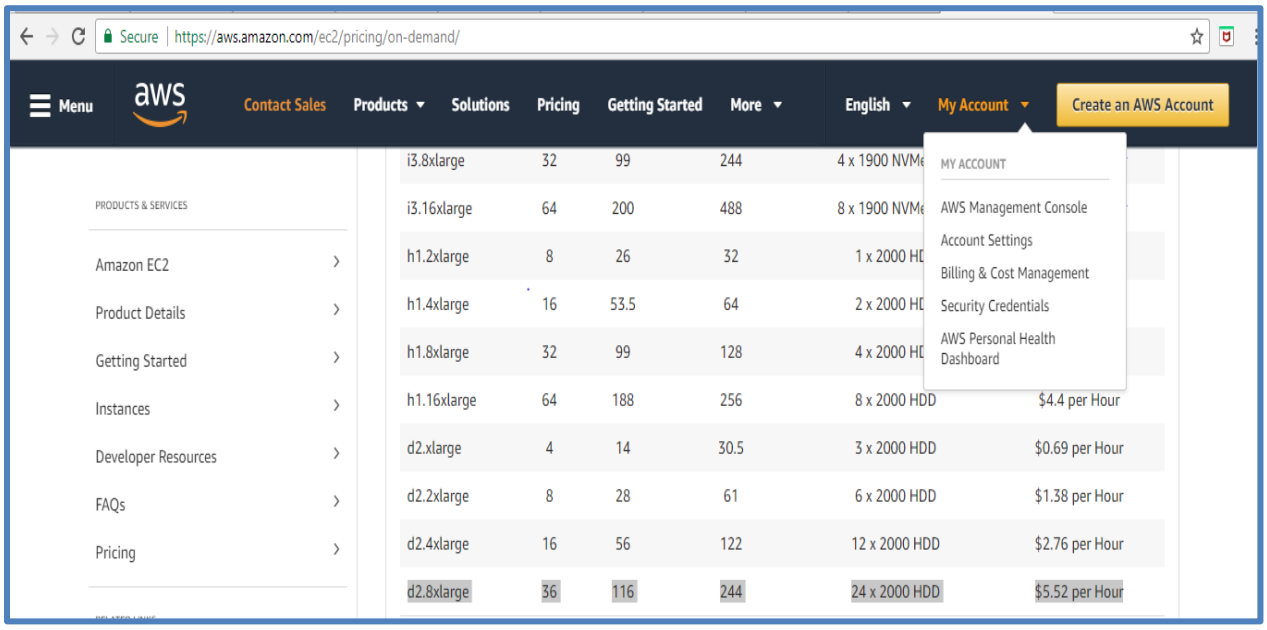
Utilization = 177515772/8579113206* 100

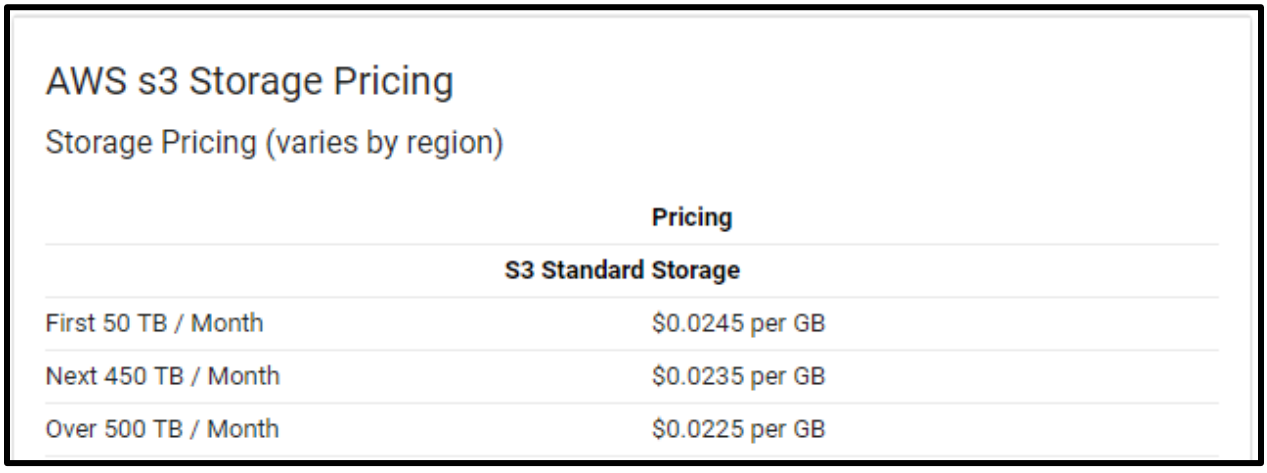
= 2.07 %

Appendix:

Configuration1:

Public Cloud (D28xlarge Instance):





AWS s3 Storage Pricing

Storage Pricing (varies by region)

	Pricing
	S3 Standard Storage
First 50 TB / Month	$0.0245 per GB
Next 450 TB / Month	$0.0235 per GB
Over 500 TB / Month	$0.0225 per GB

Private Cloud:

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Product	Product Code	Unit Price	Quantity	Sub Total
64GB PC4-19200 DDR4-2400Mhz Load Reduced ECC Quad Ranked 1.2V Major Brand  Remove Item	DR4-64G-LR19200E	$799.99	1	$799.99
8TB Toshiba HDWF180XZSTA - SATA HDD 8TB Desktop SATA 6.0GB/s 7200rpm 128MB 3.5-inch Retail  Remove Item	HD-TO-HDWF180XZSTA	$277.99	1	$277.99
Intel X557T2OCPG1P5/OCP X557-T2 Dual Port 10GBA SE-T (RJ45) Ethernet Network Connection  Remove Item	NW-IT-X557T2OCP	$230	1	$230
AMD EPYC 7601 Processor PS7601BDVIHAF 32Cores 64Threads 2.20GHz 64MB L3 Cache 341GB/s 180W 2P/1P TRAY  Remove Item	CP-AD-PS7601BDVIHAF	$4,763	1	$4,763

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Product	Product Code	Unit Price	Quantity	Sub Total
Supermicro CBL-NTWK-0719 QSFP+ (40GbE) to 4 SFP+ (10GbE) split cable 1m long  Remove Item	CAB-SM-0719	$185	1	$185

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Product	Product Code	Unit Price	Quantity	Sub Total
Supermicro 48-port Managed Gigabit Switch SSE-X3348T 1U Layer-3 10/40GbE 48xRJ45 4xQSFP 1xRS232 Black Retail  Remove Item	NW-SM-X3348T	$7,896	1	$7,896

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Description	Price	Quantity	Total	
 APC NetShelter SX 42U Server Rack Enclosure 600mm x 1070mm w/ Sides Black SKU: AR3100 APC NetShelter SX 42U Server Rack Enclosure 600mm x 1070mm w/ Sides Black See related products	$1,325.00	1 Update	$1,325.00	Remove Move to My List

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Cooler Master Hyper 212 LED CPU Cooler w/ PWM Fan, Four Direct Contact Heat Pipes, Red LEDs

Price: **$34.89**

Availability: In Stock

1 Update Qty X

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Product	Product Code	Unit Price	Quantity	Sub Total
10TB Seagate ST10000VX0004 - SATA HDD 10TB SkyHawk Surveillance SATA 6.0GB/s 5900rpm 256MB 3.5-inch Bulk  Remove Item	HD-ST-10000VX0004	$359.99	1	$359.99

Shopping Cart

Qty	System	Description			
1	**Atlas 223-12**	view components	$14,894.26	$14,894.26	Edit System Delete System
	Memory: 1x 2U Dual AMD EPYC 7000 Series 12x3.5" SAS/SATA 1600w Redundant **CPU:** 2x AMD Epyc 7501 32C 2.0GHz 64MB Cache 155W/170W **Memory:** 1x 256GB DDR4 2666MHz ECC Reg (8 x 32GB) **HDD:** 1x HGST Ultrastar HE10 10TB 7200RPM SAS 12Gb/s **Operating System:** 1x No Operating System. Include testing and customer OS preference in notes. **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)				close
Create Quote from Webcart Why create a quote?			**Total**	$14,894.26	Checkout

Configuration 2:

Public Cloud (R3. large Instance):

r3.large

STANDARD 1-YEAR TERM					
Payment Option	**Upfront**	**Monthly***	**Effective Hourly****	**Savings over On-Demand**	**On-Demand Hourly**
No Upfront	$0	$83.95	$0.115	37%	$0.183 per Hour
Partial Upfront	$565	$24.82	$0.099	46%	
All Upfront	$849	$0	$0.097	47%	

Storage Pricing (varies by region)

Region: US East (Ohio)

	Pricing
S3 Standard Storage	
First 50 TB / Month	$0.023 per GB
Next 450 TB / Month	$0.022 per GB
Over 500 TB / Month	$0.021 per GB

Private Cloud:

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Product	Product Code	Unit Price	Quantity	Sub Total
Intel Core i3-7300 Desktop Processor LGA1151 4MB Cache 4.00 GHz 2 Core/ 4 Thread BX80677I37300 BOX  Remove Item	CP-IT-CI37300BOX	$171.36	1	$171.36
16GB PC4-19200 DDR4-2400 260-pin SODIMM Unbuffered ECC 1.2V Main Brands  Remove Item	SO4-16G-19200E	$219.99	1	$219.99
Intel 32GB MEMPEK1W032GAXT Optane Memory Series NVMe PCIe M.2 2280 1350MB/sec Read 20nm 3D Xpoint, Retail  Remove Item	SSD-IT-PEK1W032GAXT	$78.99	1	$78.99
Intel I357T4OCPG1P5/OCP I357-T4 Quad Port 1GBASE-T (RJ45) Ethernet Network Connection Remove Item	NW-IT-I357T4OCP	$145	1	$145

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Product	Product Code	Unit Price	Quantity	Sub Total
Supermicro Layer 2 Ethernet 10/100/1000 Switch 48 x GbE 4 x SFP 1G ports 16K MAC address SSE-G2252  Remove Item	NW-SM-G2252	$559	1	$559

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Product	Product Code	Unit Price	Quantity	Sub Total
Ethernet Cat6a Cable 3 feet RJ45 10Gb/1Gb	CAB-AC-RJ456A.3	$6.8	1	$6.8

Remove Item

Description	Price	Quantity	Total	
 NetShelter SV 42U 600mm Wide x 1060mm Deep Enclosure with Sides, Black, Single Rack Unassembled SKU: AR2400FP1 NetShelter SV 42U 600mm Wide x 1060mm Deep Enclosure with Sides, Black, Single Rack Unassembled See related products	$879.00	1 Update	$879.00	Remove Move to My List

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Shopping Cart

Qty	System	Description			
1	Iris 418-36	view components	$6,345.44	$6,345.44	Edit System Delete System
CPU: 1x Intel Xeon E5-2603v4 6C 1.7GHz 15MB Cache **Memory:** 1x 8GB DDR4 ECC Reg 2400MHz (2 x 4GB) **Rear-mounted OS Disks:** 1x Intel S4500 Series 240GB 3D1 TLC SATA SSD 6Gb/s **Data HDD:** 1x HGST Ultrastar HE12 12TB 7200RPM SATA 6Gb/s **Operating System:** 1x No Operating System. Include testing and customer OS preference in notes. **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)					close
Create Quote from Webcart Why create a quote?			Total	$6,345.44	Checkout

Newegg Standard Shipping Service Important Shipping Information

Cooler Master Hyper 212 EVO - CPU Cooler with 120mm PWM Fan

Standard Return Policy

Send this item as a gift

1

IN STOCK
LIMIT 20

~~$34.99~~

$29.99

Save: 14.29%

PREMIER

JOIN TODAY

Subtotal: **$29.99**

Configuration 3:

Public Cloud (P3. 16xlarge Instance):

GPU Instances - Current Generation

p2.xlarge	4	12	61	EBS Only	$0.9 per Hour
p2.8xlarge	32	94	488	EBS Only	$7.2 per Hour
p2.16xlarge	64	188	732	EBS Only	$14.4 per Hour
p3.2xlarge	8	23.5	61	EBS Only	$3.06 per Hour
p3.8xlarge	32	94	244	EBS Only	$12.24 per Hour
p3.16xlarge	64	188	488	EBS Only	$24.48 per Hour

Introducing Amazon EC2 P3 Instances

Posted On: Oct 25, 2017

We are excited to announce the availability of Amazon EC2 P3 instances, the next-generation of EC2 compute-optimized GPU instances. P3 instances are powered by up to 8 of the latest-generation NVIDIA Tesla V100 GPUs and are ideal for computationally advanced workloads such as machine learning (ML), high performance computing (HPC), data compression, and cryptography. They are also ideal for specific industry applications for scientific computing and simulations, financial analytics, and image and video processing.

P3 instances provide a powerful platform for ML and HPC by also leveraging 64 vCPUs using the custom Intel Xeon E5 processors, 488 GB of RAM, and up to 25 Gbps of aggregate network bandwidth leveraging Elastic Network Adapter technology.

Based on NVIDIA's latest Volta architecture, each Tesla V100 GPUs provide 125 TFLOPS of mixed-precision performance, 15.7 TFLOPS of single precision (FP32) performance and 7.8 TFLOPS of double precision (FP64) performance. This is possible because each Tesla V100 GPUs contains 5,120 CUDA Cores and 640 Tensor Cores. A 300 GB/s NVLink hyper-mesh interconnect allows GPU-to-GPU communication at high speed and low latency.

Private Cloud:

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*

DGX support plan is required and must be purchased separately.

DGX-1 ARCHITECTURE ADVANCEMENTS

System Level Specifications	NVIDIA DGX-1 with Tesla P100	NVIDIA DGX-1 with Tesla V100
TFLOPS (deep learning)	170	1000

SYSTEM SPECIFICATIONS

GPUs	8X Tesla V100
Performance (Mixed Precision)	1 petaFLOPS
GPU Memory	256 GB total system
CPU	Dual 20-Core Intel Xeon E5-2698 v4 2.2 GHz
NVIDIA CUDA® Cores	40,960
NVIDIA Tensor Cores (on V100 based systems)	5,120
Power Requirements	3,500 W
System Memory	512 GB 2,133 MHz DDR4 RDIMM
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

ACME MICRO SYSTEMS

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Product	Product Code	Unit Price	Quantity	Sub Total
Supermicro 48-port Managed Gigabit Switch SSE-X3348TR 1U Layer-3 10/40GbE 48xRJ45 4xQSFP 1xRS232 Reverse-airflow Black Retail	NW-SM-X3348TR	$7,896	1	$7,896

Remove Item

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Product	Product Code	Unit Price	Quantity	Sub Total
Ethernet cable 10000/1000 Base-T Cat7 RJ45 10 feet 10Gbps	CAB-AC-RJ457.10	$13	1	$13

Remove Item

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Item		Quantity	Price
	TrippLite 42U SmartRack WIDE Premium Enclosure Save for later | Remove	1	$1,349.99

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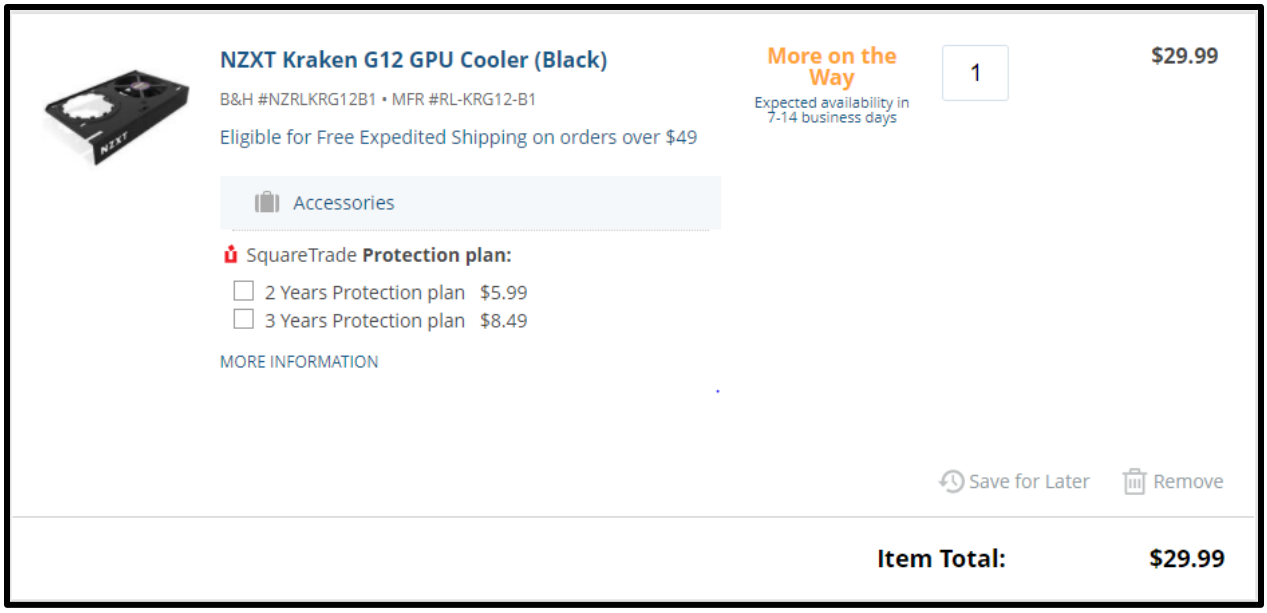
Qty	System	Description			
1	Iris 428-60	view components	$17,861.92	$17,861.92	Edit System Delete System
		CPU: 2x Intel Xeon E5-2609v4 8C 1.7GHz 20MB Cache **Memory:** 1x 64GB DDR4 ECC Reg 2400MHz (4 x 16GB) **Mirrored OS Disks - Mounted in Rear Bays:** 2x Micron M510DC 480GB 2.5" Enterprise SSD **Enterprise HDD:** 1x HGST Ultrastar HE12 12TB 7200RPM SAS 12Gb/s **Networking Options:** 1x Dual Port 10G SFP+ Ethernet Module X520 **OS:** 1x No Operating System. Include testing and customer OS preference in notes. **Warranty:** 1x Return to Depot Warranty (3 Year Hardware Warranty with Standard Advance Parts Replacement)			close
Create Quote from Webcart Why create a quote?			Total	$17,861.92	Checkout



Inference:

- Private cloud configuration cost is lower compared to renting a public cloud for 5 years.

Links Referred:

- https://aws.amazon.com/s3/pricing/
- https://aws.amazon.com/ec2/instance-types/
- https://aws.amazon.com/ec2/purchasing-options/dedicated-instances/
- http://www.dell.com/p/enterprise-products.aspx?c=ae&l=en&s=bsd&~ck=mn
- http://www.acmemicro.com/
- http://www.pogolinux.com/
- http://www.apc.com
- https://www.buydig.com
- https://secure.newegg.com
- https://www.bhphotovideo.com