# CS-553

# Cloud Project

## Understanding the Cost of Computing in the Cloud


**By:**

**Himanshu Singh**

**A20365395**

**Hsingh34@hawk.iit.edu**

## Index:


- Problem Statement
- Amazon Instances description
- Private Instances
- Cost Comparison of both Private and Public Cloud:
- Percentage Utilization of private cloud from public cloud
- Final Conclusion
- Assumptions
- References
- Appendix

# Problem Statement:

You are hired by a startup company who is considering to use cloud computing instead of building its own infrastructure. There is consensus that a cloud computing software stack at the layer of IaaS will be used, but it's not clear whether the computing resources should be rented from a public cloud on-demand, or whether a private cloud should be purchased. You are tasked to find the cost breakdown of a private cloud, and compare that to what Amazon would charge for the following instance types: t2.small, m3.large, c3.8xlarge, g2.2xlarge, r3.4xlarge, i2.8xlarge, and d2.8xlarge. These instance types are defined at http://aws.amazon.com/ec2/instance-types/, and their prices are set at http://aws.amazon.com/ec2/pricing/. For pricing purposes, please stick to Linux on-demand pricing.

Since you have to estimate the cost of the hardware when building a private cloud, you can use hardware prices found at Newegg.com (http://www.newegg.com/) as a good source for low cost and large variety of hardware. If you cannot find some particular hardware here, please cite whatever site you find where you obtained the pricing information. You must include a printout of your shopping cart in your final write-up report for this assignment; include this as an appendix at the end of your report.

# Amazon EC2 instance types:

Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instance types comprise varying combinations of CPU, memory, storage, and networking capacity and give you the flexibility to choose the appropriate mix of resources for your applications. Each instance type includes one or more instance sizes, allowing you to scale your resources to the requirements of your target workload.

| Instance Type | vCPU | Memory (GiB) | Storage (GB) | Networking Performance | Physical Processor | Clock Speed (GHz) | Price |
|---|---|---|---|---|---|---|---|
| m4.10xlarge | 40 | 160 | EBS Only | 10Gbps | Intel Xeon E5-2676 v3 | 2.4 | $2.394 |
| m3.large | 2 | 7.5 | 1 x 32 SSD | Moderate (500Mbps) | Intel Xeon E5-2670 v2 | 2.5 | $0.133 |
| m3.2xlarge | 8 | 30 | 2 x 80 SSD | High (1Gbps) | Intel Xeon E5-2670 v2 | 2.5 | $0.532 |
| c3.8xlarge | 32 | 60 | 2 x 320 SSD | 10Gbps | Intel Xeon E5-2680 v2 | 2.8 | $1.680 |
| g2.2xlarge | 8 | 15 | 1 x 60 SSD | High (1Gbps) | Intel Xeon E5-2670 | 2.6 | $0.650 |
| r3.4xlarge | 16 | 122 | 1 x 320 SSD | High (1Gbps) | Intel Xeon E5-2670 v2 | 2.5 | $1.33 |
| i2.8xlarge | 32 | 244 | 8 x 800 SSD | 10Gbps | Intel Xeon E5-2670 v2 | 2.5 | $6.82 |
| d2.8xlarge | 36 | 244 | 24 x 2,000 | 10Gbps | Intel Xeon E5-2676 v3 | 2.4 | $5.52 |

# Private Instances:

I have created private instances based on the above given amazon instances specification. Most of the hardware I have purchased from www.newegg.com and for the sake of keeping the balance between price and quality I have mostly picked the best-selling products.

I have considered the following Factors in the creation of instances (I have assumed the amortized cost for 5 years):

**Hardware Cost:** This is the Hardware cost used to make the instances:
Hardware's used per Device:

- CPU Processor
- Storage
- Memory
- Motherboard
- Server Case

Hardware's used per Rack:

- UPS
- Network Switch
- Cooling Fan
- Rack

**Administrator Cost:** An Administrator is required to maintains the data center. I have assumed that one administrator will manage 1000 machines. And the annual cost to hire one administrator is $78,000.
**Cooling Cost:** The cost required to cool the system. This cost is the sum cost of external fans mounted on racks including internal fans of the system.
**Electricity Cost:** This is the electricity cost to power the whole system. Cost includes Power Dissipation Cost of Processor, UPS, Cooling Fans and Racks, Motherboard, Network Switches and adaptors.
Electricity cost : A + B + C + D

Where A is power dissipation cost of Processor
B is Power dissipation cost of UPS and racks
C is power dissipation cost of Storage and memory
D is power dissipation cost of Network switches and adaptor

We have used these Relations to calculate power:
Power = $POWER = VI \; OR \; I^2R \; V^2/R$

**Note:** I haven't included the cost of Building infrastructure and land cost.

# GFlOPS Calculations :

Gflops = IPC * Processor speed * Hyper Threading Factor * number of cores

| Instances | IPC | GFLOPS | GFLOPS/instance |
|---|---|---|---|
| m4.10xlarge | 16 | 921.1 | 768 |
| m3.large | 8 | 200 | 20 |
| m3.2xlarge | 8 | 200 | 100 |
| c3.8xlarge | 8 | 448 | 358.2 |
| g2.2xlarge | 8 | 166.7 | 83.5 |
| r3.4xlarge | 8 | 200 | 160 |
| i2.8xlarge | 8 | 400 | 320 |
| d2.8xlarge | 16 | 920.9 | 692.1 |

**Pr.m4.10xlarge:**

**Hardware Cost Breakdown:**

| Pr.m4.10xlarge | | | | |
|---|---|---|---|---|
| **Per Device Cost** | **Details** | **Quantity** | **Cost Per device** | **Total Cost** |
| **Processor** | 2.4 GHz Intel Xeon® E5-2676 v3 (Haswell) processors | 2 | 1800 | 3600 |
| **Storage** | SanDisk Optimus Ascend SDLKOCDM-800G-5CA1 2.5" 800GB SAS 6Gb/s eMLC Enterprise Solid State Disk | 1 | 1154.54 | 1154.15 |
| **Memory** | NEMIX RAM 64GB PC3-12800 Load Reduced Memory for Dell PowerEdge R920 Server | 3 | 1159.99 | 3479.97 |
| **Mother Board** | ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066 | 1 | 299.99 | 299.99 |
| **Network Adapter** | D-Link 10-Port 10-Gigabit Ethernet Smart Managed Switch | 1 | 865.9 | 865.9 |
| **Server Case** | iStarUSA D-213-MATX Black Aluminum / Steel 2U Rackmount microATX Server Chassis | 2 | $59.99 | $119.98 |
| **Total Cost per device =** | | | | **$9,519.99** |
| **Per Rack Cost** | | | | |
| **UPS** | CyberPower CP1500AVRLCD 1500VA 900W UPS | 1 | $139.95 | 139.95 |
| **Network Switch** | ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch | 1 | 451.89 | 451.89 |
| **Cooling** | Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers(Value 4-Pack) | 1 | $11.99 | 11.99 |
| **Rack** | SUPERMICRO CSE-502L-200B Black 1U Rackmount Mini Server Chassis | 1 | $72.99 | $72.99 |
| **Total Cost per Rack =** | | | | **676.82** |

**Total Cost Breakdown:**

| m4.10xlarge | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GFLOPS | No. of Instances | No. of Machines | No. of Racks | Total Hardware Cost | Cooling Cost($) | Electricity Cost(A+B+C+D) | Admin Cost | Total Cost | Cost/hour | Cost/hour/gflop |
| 1 | 1 | 1 | 1 | $10,196.81 | 760.65 | 11686.3 | 390000 | $412,643.76 | $9.42 | $9.421090 |
| 10 | 1 | 1 | 1 | $10,196.81 | 760.65 | 11686.3 | 390000 | $412,643.76 | $9.42 | $0.942109 |
| 100 | 1 | 1 | 1 | $10,196.81 | 760.65 | 11686.3 | 390000 | $412,643.76 | $9.42 | $0.094211 |
| 1000 | 2 | 2 | 1 | $19,716.80 | 760.65 | 11686.3 | 390000 | $422,163.75 | $9.64 | $0.009638 |
| 10000 | 11 | 11 | 1 | $105,396.71 | 760.65 | 1989.24 | 390000 | $498,146.60 | $11.37 | $0.001137 |
| 100000 | 109 | 109 | 3 | $1,039,709.37 | 2281.95 | 12185.34 | 390000 | $1,444,176.66 | $32.97 | $0.000330 |
| 1000000 | 1086 | 1086 | 26 | $10,356,306.46 | 19776.9 | 141868.42 | 390000 | $10,907,951.78 | $249.04 | $0.000249 |

THEORITICAL GFLOPS: 737.68

## Pr.m3.xlarge:

## Hardware Cost Breakdown:

| Pr.m3.xlarge | | | | |
|---|---|---|---|---|
| **Per Device Cost** | **Details** | **Quantity** | **Cost Per device** | **Total Cost** |
| **Processor** | Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor | 1 | $1,559.99 | $1,559.99 |
| **Storage** | Intel 320 Series 2.5" 80GB SATA II MLC Internal Solid State Drive (SSD) SSDSA2CW080G310 - OEM | 2 | $148.99 | $297.98 |
| **Memory** | SAMSUNG 32GB 288-Pin DDR4 SDRAM DDR4 2133 (PC4 17000) Server Memory Model M386A4G40DM0-CPB | 1 | $221.99 | $221.99 |
| **Mother Board** | ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066 | 1 | $299.99 | $299.99 |
| **Network Adapter** | Planet GSW-1602SF 16-port 10/100/1000Mbps Gigabit with 2-port shared Gigabit SFP Web Smart ethernet switch | 1 | $192.00 | $192.00 |
| **Server Case** | SUPERMICRO CSE-502L-200B Black 1U Rackmount Mini Server Chassis | 1 | $72.99 | $72.99 |
| **Total Cost per device =** | | | | **$2,644.94** |
| **Per Rack Cost** | | | | |
| **UPS** | CyberPower CP1500AVRLCD 1500VA 900W UPS | 1 | $139.95 | 139.95 |
| **Network Switch** | ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch | 1 | 451.89 | 451.89 |
| **Cooling** | Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack)1 | 1 | $11.99 | 11.99 |
| **Rack** | Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet | 1 | 1013.99 | 1013.99 |
| **Total Cost per Rack =** | | | | **1617.82** |

## Total Cost Breakdown:

| Pr.m3.large | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GFLOPS | No. of Instances | No. of Machines | No. of Racks | Total Hardware Cost | Cooling Cost | Electricity Cost(A+B+C+D) | Admin Cost | Total Cost | Cost/hour | Cost/hour/gflop |
| 1 | 1 | 1 | 1 | $4,262.76 | 1398.23 | 7865.73 | 390000 | $403,526.72 | $9.21 | $9.212939 |
| 10 | 1 | 1 | 1 | $4,262.76 | 1398.23 | 7865.73 | 390000 | $403,526.72 | $9.21 | $0.921294 |
| 100 | 5 | 1 | 1 | $4,262.76 | 1398.23 | 7865.73 | 390000 | $403,526.72 | $9.21 | $0.092129 |
| 1000 | 50 | 5 | 2 | $16,460.34 | 2697.32 | 16665.73 | 390000 | $425,823.39 | $9.72 | $0.009722 |
| 10000 | 500 | 50 | 12 | $151,660.84 | 15863.35 | 149858.53 | 390000 | $707,382.72 | $16.15 | $0.001615 |
| 100000 | 5000 | 500 | 120 | $1,516,608.40 | 195346.32 | 1124865.73 | 1950000 | $4,786,820.45 | $109.29 | $0.001093 |
| 1000000 | 50000 | 5000 | 1191 | $15,151,523.62 | 1827789.23 | 11836746.34 | 19500000 | $48,316,059.19 | $1,103.11 | $0.001103 |

THEORITICAL GFLOPS: 200

## Pr.m3.2xlarge

## Hardware Cost Breakdown:

| Pr.m3.2xlarge | | | | |
|---|---|---|---|---|
| **Per Device Cost** | **Details** | **Quantity** | **Cost Per device** | **Total Cost** |
| **Processor** | Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor | 1 | $1,559.99 | $1,559.99 |
| **Storage** | Intel 320 Series 2.5" 80GB SATA II MLC Internal Solid State Drive (SSD) SSDSA2CW080G310 - OEM | 2 | $148.99 | $297.98 |
| **Memory** | SAMSUNG 32GB 288-Pin DDR4 SDRAM DDR4 2133 (PC4 17000) Server Memory Model M386A4G40DM0-CPB | 1 | $221.99 | $221.99 |
| **Mother Board** | ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066 | 1 | $299.99 | $299.99 |
| **Network Adapter** | Planet GSW-1602SF 16-port 10/100/1000Mbps Gigabit with 2-port shared Gigabit SFP Web Smart ethernet switch | 1 | $192.00 | $192.00 |
| **Server Case** | SUPERMICRO CSE-502L-200B Black 1U Rackmount Mini Server Chassis | 1 | $72.99 | $72.99 |
| **Total Cost per device =** | | | | **$2,644.94** |
| **Per Rack Cost** | | | | |
| **UPS** | CyberPower CP1500AVRLCD 1500VA 900W UPS | 1 | $139.95 | 139.95 |
| **Network Switch** | ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch | 1 | 451.89 | 451.89 |
| **Cooling** | Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack) | 1 | $11.99 | 11.99 |
| **Rack** | Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet | 1 | 1013.99 | 1013.99 |
| **Total Cost per Rack =** | | | | **1617.82** |

## Total Cost Breakdown:

| Pr.m3.2xlarge | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **GFLOPS** | **No. of Instances** | **No. of Machines** | **No. of Racks** | **Total Hardware Cost** | **Cooling Cost** | **Electricity Cost** | **Admin Cost** | | **Cost/hour** | **Cost/hour/gflop** |
| **1** | 1 | 1 | 1 | $4,262.76 | 1365.34 | 7434.23 | 390000 | $403,062.33 | $9.20 | $9.202336 |
| **10** | 1 | 1 | 1 | $4,262.76 | 1365.34 | 7434.23 | 390000 | $403,062.33 | $9.20 | $0.920234 |
| **100** | 1 | 1 | 1 | $4,262.76 | 1365.34 | 7434.23 | 390000 | $403,062.33 | $9.20 | $0.092023 |
| **1000** | 10 | 5 | 1 | $14,842.52 | 1365.34 | 17734.22 | 390000 | $423,942.08 | $9.68 | $0.009679 |
| **10000** | 100 | 50 | 3 | $137,100.46 | 3896.43 | 89573.26 | 390000 | $620,570.15 | $14.17 | $0.001417 |
| **100000** | 1000 | 500 | 24 | $1,361,297.68 | 31974.43 | 984725.37 | 390000 | $2,767,997.48 | $63.20 | $0.000632 |
| **1000000** | 10000 | 5000 | 239 | $13,611,358.98 | 276973.24 | 9842583.13 | 3900000 | $27,630,915.35 | $630.84 | $0.000631 |

THEORITICAL GFLOPS PER INSTANCE **:** 20

## Pr.c3.8xlarge

## Hardware Cost Breakdown:

| Pr.c3.8xlarge | | | | |
|---|---|---|---|---|
| **Per Device Cost** | **Details** | **Quantity** | **Cost Per device** | **Total Cost** |
| **Processor** | Intel Xeon E5-2680 v2 Ivy Bridge-EP 2.8 GHz 25MB L3 Cache LGA 2011 115W BX80635E52680V2 Server Processor | 2 | 1769 | 3538 |
| **Storage** | KODDM-400G-5CA1 2.5" 400GB SAS 6Gb/s eMLC Enterprise Solid State Disk + Intel DC S3510 2.5" 240GB SATA III M | 2 | 599.99+184.99 | 784.98 |
| **Memory** | NEMIX RAM 64GB PC3-12800 Load Reduced Memory for Dell PowerEdge M820 R820 Server | 1 | 1159.99 | 1159.99 |
| **Mother Board** | SUPERMICRO MBD-X10SRI-F Server Motherboard LGA 2011 R3 | 1 | 279.99 | 279.99 |
| **Network Adapter** | D-Link 10-Port 10-Gigabit Ethernet Smart Managed Switch | 1 | 865.9 | 865.9 |
| **Server Case** | iStarUSA D-213-MATX Black Aluminum / Steel 2U Rackmount microATX Server Chassis | 1 | $59.99 | $59.99 |
| **Total Cost per device =** | | | | **6688.85** |
| **Per Rack Cost** | | | | |
| **UPS** | CyberPower CP1500AVRLCD 1500VA 900W UPS | 1 | $139.95 | 139.95 |
| **Network Switch** | ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch | 1 | 451.89 | 451.89 |
| **Cooling** | Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack) | 1 | $11.99 | 11.99 |
| **Rack** | Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet | 1 | 1013.99 | 1013.99 |
| **Total Cost per Rack =** | | | | **1617.82** |

## Total Cost Breakdown:

| Pr.c3.8xlarge | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GFLOPS | No. of Instances | No. of Machines | No. of Racks | Total Hardware Cost | Cooling Cost | Electricity Cost | Admin Cost | | Cost/hour | Cost/hour/gflop |
| 1 | 1 | 1 | 1 | 8306.67 | 1683.45 | 6183.13 | 390000 | 406173.25 | 9.27 | 9.273362 |
| 10 | 1 | 1 | 1 | 8306.67 | 1683.45 | 6183.13 | 390000 | 406173.25 | 9.27 | 0.927336 |
| 100 | 1 | 1 | 1 | 8306.67 | 1683.45 | 6183.13 | 390000 | 406173.25 | 9.27 | 0.092734 |
| 1000 | 3 | 3 | 1 | 21684.37 | 1683.45 | 9123.92 | 390000 | 422491.74 | 9.65 | 0.009646 |
| 10000 | 23 | 23 | 1 | 155461.37 | 1683.45 | 52763.53 | 390000 | 599908.35 | 13.70 | 0.001370 |
| 100000 | 224 | 224 | 6 | 1508009.32 | 8493.56 | 489274.25 | 390000 | 2395777.13 | 54.70 | 0.000547 |
| 1000000 | 2233 | 2233 | 54 | 15023564.33 | 88247.12 | 4987241.87 | 1170000 | 21269053.32 | 485.59 | 0.000486 |

THEORITICAL GFLOPS PER INSTANCE: 363.9

## Pr.g2.2xlarge

## Hardware Cost Breakdown:

| Pr.g2.2xlarge | | | | |
|---|---|---|---|---|
| Per Device Cost | Details | Quantity | Cost Per device | Total Cost |
| Processor | Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor | 1 | 1559.9 | 1559.9 |
| Storage | Transcend MTS600 M.2 64GB SATA III MLC Internal Solid State Drive (SSD) TS64GMTS600 | 1 | 50.37 | 50.37 |
| Memory | SAMSUNG 16GB 288-Pin DDR4 SDRAM ECC Registered DDR4 2133 (PC4 17000) Server Memory Model M393A2G40DB0-CPB | 1 | 109.99 | 109.99 |
| Mother Board | ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066 | 1 | $299.99 | $299.99 |
| Network Adapter | Planet GSW-1602SF 16-port 10/100/1000Mbps Gigabit with 2-port shared Gigabit SFP Web Smart ethernet switch | 1 | $192.00 | $192.00 |
| Server Case | SUPERMICRO CSE-502L-200B Black 1U Rackmount Mini Server Chassis | 1 | $72.99 | $72.99 |
| Total Cost per device = | | | | **2285.24** |
| Per Rack Cost | | | | |
| UPS | CyberPower CP1500AVRLCD 1500VA 900W UPS | 1 | $139.95 | 139.95 |
| Network Switch | ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch | 1 | 451.89 | 451.89 |
| Cooling | Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack) | 1 | $11.99 | 11.99 |
| Rack | Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet | 1 | 1013.99 | 1013.99 |
| Total Cost per Rack = | | | | **1617.82** |

## Total Cost Breakdown:

| Pr.g2.2xlarge | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GFLOPS | No. of Instances | No. of Machines | No. of Racks | Total Hardware Cost | Cooling Cost | Electricity Cost | Admin Cost | | Cost/hour | Cost/hour/gflop |
| 1 | 1 | 1 | 1 | 3903.06 | 1583.23 | 5873.23 | 390000 | 401359.52 | 9.1634594 | 9.163459361 |
| 10 | 1 | 1 | 1 | 3903.06 | 1583.23 | 5873.23 | 390000 | 401359.52 | 9.1634594 | 0.916345936 |
| 100 | 2 | 1 | 1 | 3903.06 | 1583.23 | 5873.23 | 390000 | 401359.52 | 9.1634594 | 0.091634594 |
| 1000 | 13 | 7 | 1 | 17614.5 | 1583.23 | 14836.33 | 390000 | 424034.06 | 9.6811429 | 0.009681143 |
| 10000 | 121 | 61 | 2 | 142635.28 | 4862.34 | 119742.35 | 390000 | 657239.97 | 15.005479 | 0.001500548 |
| 100000 | 1202 | 601 | 29 | 1420346.02 | 38947.52 | 1192754.12 | 780000 | 3432047.66 | 78.357253 | 0.000783573 |
| 1000000 | 12020 | 6010 | 287 | 14198606.74 | 384719.36 | 13947511.23 | 5070000 | 33600837.33 | 767.1424 | 0.000767142 |

THEORITICAL GFLOPS PER INSTANCE **:** 84.2

## Pr.r3.4xlarge

## Hardware Cost Breakdown:

| Pr.r3.4xlarge | | | | |
|---|---|---|---|---|
| Per Device Cost | Details | Quantity | Cost Per device | Total Cost |
| Processor | Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor | 1 | 1559.99 | 1559.99 |
| Storage | SanDisk Optimus Ascend SDLKODDM-400G-5CA1 2.5" 400GB SAS 6Gb/s eMLC Enterprise Solid State Disk | 1 | 599.99 | 599.99 |
| Memory | Crucial 128GB (4 x 32GB) 288-Pin DDR4 SDRAM ECC Registered DDR4 2133 (PC4 17000) Server Memory Model | 1 | 1151.07 | 1151.07 |
| Mother Board | StarTech.com PCI Express (PCIe) Gigabit Ethernet Multimode SC Fiber Network Card Adapter NIC - 550m | 1 | $140.99 | $140.99 |
| Network Adapter | Planet GSW-1602SF 16-port 10/100/1000Mbps Gigabit with 2-port shared Gigabit SFP Web Smart ethernet switch | 1 | $192.00 | $192.00 |
| Server Case | SUPERMICRO CSE-502L-200B Black 1U Rackmount Mini Server Chassis | 1 | $72.99 | $72.99 |
| Total Cost per device = | | | | **3717.03** |
| Per Rack Cost | | | | |
| UPS | CyberPower CP1500AVRLCD 1500VA 900W UPS | 1 | $139.95 | 139.95 |
| Network Switch | ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch | 1 | 451.89 | 451.89 |
| Cooling | Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack) | 1 | $11.99 | 11.99 |
| Rack | Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet | 1 | 1013.99 | 1013.99 |
| Total Cost per Rack = | | | | **1617.82** |

## Total Cost Breakdown:

| Pr.r3.4xlarge | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GFLOPS | No. of Instances | No. of Machines | No. of Racks | Total Hardware Cost | Cooling Cost | Electricity Cost | Admin Cost | | Cost/hour | Cost/hour/gflop |
| 1 | 1 | 1 | 1 | 5335.85 | 1435.33 | 6352.46 | 390000 | 403123.64 | 9.2037361 | 9.203736073 |
| 10 | 1 | 1 | 1 | 5335.85 | 1435.33 | 6352.46 | 390000 | 403123.64 | 9.2037361 | 0.920373607 |
| 100 | 1 | 1 | 1 | 5335.85 | 1435.33 | 6352.46 | 390000 | 403123.64 | 9.2037361 | 0.092037361 |
| 1000 | 5 | 5 | 1 | 20203.97 | 1435.33 | 14737.21 | 390000 | 426376.51 | 9.7346235 | 0.009734624 |
| 10000 | 50 | 50 | 2 | 187471.32 | 2683.74 | 89473.14 | 390000 | 669628.2 | 15.288315 | 0.001528832 |
| 100000 | 500 | 500 | 12 | 1860144.82 | 17362.21 | 893514.12 | 390000 | 3161021.15 | 72.169433 | 0.000721694 |
| 1000000 | 5000 | 5000 | 120 | 18586887.82 | 1735352.21 | 9162825.65 | 1950000 | 31435065.68 | 717.69556 | 0.000717696 |

THEORITICAL GFLOPS PER INSTANCE: 160

## Pr.i2.8xlarge

## Hardware Cost Breakdown:

| Pr.i2.8xlarge | | | | |
|---|---|---|---|---|
| **Per Device Cost** | **Details** | **Quantity** | **Cost Per device** | **Total Cost** |
| **Processor** | Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz 25MB L3 Cache LGA 2011 115W BX80635E52670V2 Server Processor | 2 | 1559.99 | 3119.98 |
| **Storage** | SAMSUNG 845DC PRO MZ-7WD800EW 2.5" 800GB SATA III MLC Enterprise Solid State Drive | 8 | 921.39 | 7371.12 |
| **Memory** | Crucial 128GB (4 x 32GB) 288-Pin DDR4 SDRAM ECC Registered DDR4 2133 (PC4 17000) Server Memory Model | 2 | 1151.07 | 2302.14 |
| **Mother Board** | ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066 | 2 | $299.99 | $599.98 |
| **Network Adapter** | D-Link 10-Port 10-Gigabit Ethernet Smart Managed Switch | 1 | 865.9 | 865.9 |
| **Server Case** | iStarUSA D-213-MATX Black Aluminum / Steel 2U Rackmount microATX Server Chassis | 1 | $59.99 | $59.99 |
| **Total Cost per device =** | | | | **14319.11** |
| **Per Rack Cost** | | | | |
| **UPS** | CyberPower CP1500AVRLCD 1500VA 900W UPS | 1 | $139.95 | 139.95 |
| **Network Switch** | ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch | 1 | 451.89 | 451.89 |
| **Cooling** | Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack) | 1 | $11.99 | 11.99 |
| **Rack** | Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet | 1 | 1013.99 | 1013.99 |
| **Total Cost per Rack =** | | | | **1617.82** |

## Total Cost Breakdown:

| Pr.i2.8xlarge | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **GFLOPS** | **No. of Instances** | **No. of Machines** | **No. of Racks** | **Total Hardware Cost** | **Cooling Cost** | **Electricity Cost** | **Admin Cost** | | **Cost/hour** | **Cost/hour/gflop** |
| **1** | 1 | 1 | 1 | 15936.93 | 1573.12 | 6193.41 | 390000 | 413703.46 | 9.4452845 | 9.445284475 |
| **10** | 1 | 1 | 1 | 15936.93 | 1573.12 | 6193.41 | 390000 | 413703.46 | 9.4452845 | 0.944528447 |
| **100** | 1 | 1 | 1 | 15936.93 | 1573.12 | 6193.41 | 390000 | 413703.46 | 9.4452845 | 0.094452845 |
| **1000** | 3 | 3 | 1 | 44575.15 | 1573.12 | 10342.15 | 390000 | 446490.42 | 10.193845 | 0.010193845 |
| **10000** | 25 | 25 | 1 | 359595.57 | 1573.12 | 59748.12 | 390000 | 810916.81 | 18.514082 | 0.001851408 |
| **100000** | 250 | 250 | 6 | 3589484.42 | 9352.45 | 513848.62 | 390000 | 4502685.49 | 102.80104 | 0.00102801 |
| **1000000** | 2500 | 2500 | 60 | 35894844.2 | 91374.21 | 5914781.51 | 1170000 | 43070999.92 | 983.35616 | 0.000983356 |

THEORITICAL GFLOPS PER INSTANCE: 321

## Pr.d2.8xlarge

## Hardware Cost Breakdown:

| Pr.d2.8xlarge | | | | |
|---|---|---|---|---|
| **Per Device Cost** | **Details** | **Quantity** | **Cost Per device** | **Total Cost** |
| **Processor** | PAIR INTEL XEON E5-2676 V3 2.40GHz SR1Y5 30Mb 12 Cores 24 Thread E5-2670 | 2 | 1800 | 3600 |
| **Storage** | Seagate NAS HDD ST8000VN0002 8TB 256MB Cache SATA 6.0Gb/s 3.5" Internal Hard Drive | 6 | 348.99 | 2093.94 |
| **Memory** | Crucial 128GB (4 x 32GB) 288-Pin DDR4 SDRAM ECC Registered DDR4 2133 (PC4 17000) Server Memory Model | 2 | 1151.07 | 2302.14 |
| **Mother Board** | ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066 | 2 | 299.99 | 599.98 |
| **Network Adapter** | D-Link 10-Port 10-Gigabit Ethernet Smart Managed Switch | 1 | 865.9 | 865.9 |
| **Server Case** | iStarUSA D-213-MATX Black Aluminum / Steel 2U Rackmount microATX Server Chassis - OEM | 1 | $59.99 | $59.99 |
| **Total Cost per device =** | | | | **9521.95** |
| **Per Rack Cost** | | | | |
| **UPS** | CyberPower CP1500AVRLCD 1500VA 900W UPS | 1 | $139.95 | 139.95 |
| **Network Switch** | ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch | 1 | 451.89 | 451.89 |
| **Cooling** | Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack) | 1 | $11.99 | 11.99 |
| **Rack** | Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet | 1 | 1013.99 | 1013.99 |
| **Total Cost per Rack =** | | | | **1617.82** |

## Total Cost Breakdown:

| Pr.d2.8xlarge | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **GFLOPS** | **No. of Instances** | **No. of Machines** | **No. of Racks** | **Total Hardware Cost** | **Cooling Cost** | **Electricity Cost** | **Admin Cost** | | **Cost/hour** | **Cost/hour/gflop** |
| 1 | 1 | 1 | 1 | 11139.77 | 1736.61 | 5974.12 | 390000 | 408850.5 | 9.3344863 | 9.334486301 |
| 10 | 1 | 1 | 1 | 11139.77 | 1736.61 | 5974.12 | 390000 | 408850.5 | 9.3344863 | 0.93344863 |
| 100 | 1 | 1 | 1 | 11139.77 | 1736.61 | 5974.12 | 390000 | 408850.5 | 9.3344863 | 0.093344863 |
| 1000 | 2 | 2 | 1 | 20661.72 | 1736.61 | 8184.24 | 390000 | 420582.57 | 9.6023418 | 0.009602342 |
| 10000 | 11 | 11 | 1 | 106359.27 | 1736.61 | 29771.43 | 390000 | 527867.31 | 12.051765 | 0.001205177 |
| 100000 | 109 | 109 | 3 | 1042746.01 | 55937.55 | 284742.51 | 390000 | 1773426.07 | 40.48918 | 0.000404892 |
| 1000000 | 1086 | 1086 | 26 | 10382901.02 | 46252.12 | 2249484.52 | 780000 | 13458637.66 | 307.27483 | 0.000307275 |

THEORITICAL GFLOPS PER INSTANCE **:**691.2

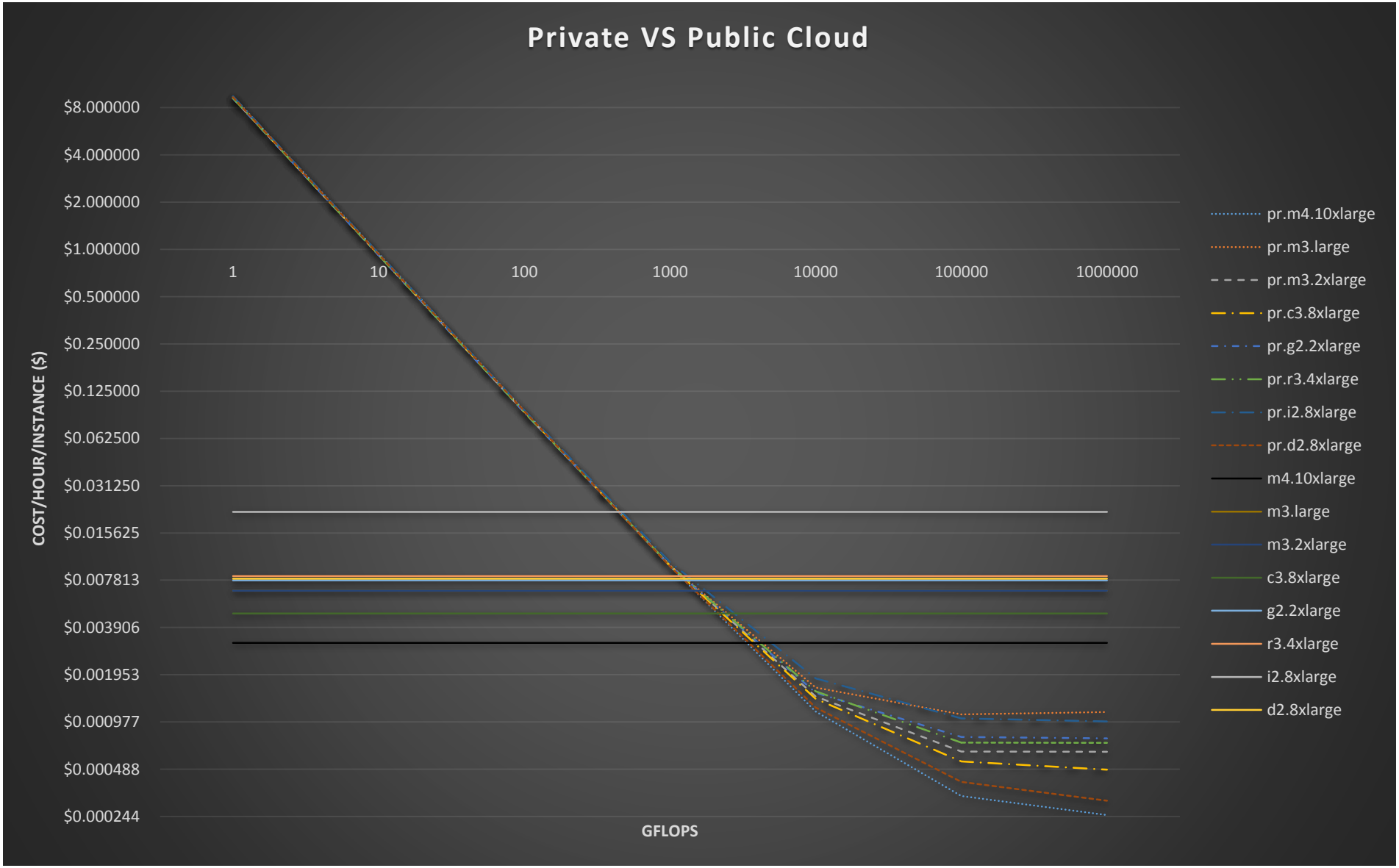
# Cost Comparison of both Private and Public Cloud:

| GFLOPS | pr.m4.10xlarge | pr.m3.large | pr.m3.2xlarge | pr.c3.8xlarge | pr.g2.2xlarge | pr.r3.4xlarge | pr.i2.8xlarge | pr.d2.8xlarge | m4.10xlarge | m3.large | m3.2xlarge | c3.8xlarge | g2.2xlarge | r3.4xlarge | i2.8xlarge | d2.8xlarge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $9.421090 | $9.212939 | $9.202336 | 9.273362 | 9.163459361 | 9.203736073 | 9.4452845 | 9.334486301 | 0.0031 | 0.0067 | 0.0067 | 0.0048 | 0.0078 | 0.0083 | 0.0213 | 0.008 |
| 10 | $0.942109 | $0.921294 | $0.920234 | 0.927336 | 0.916345936 | 0.920373607 | 0.9445284 | 0.93344863 | 0.0031 | 0.0067 | 0.0067 | 0.0048 | 0.0078 | 0.0083 | 0.0213 | 0.008 |
| 100 | $0.094211 | $0.092129 | $0.092023 | 0.092734 | 0.091634594 | 0.092037361 | 0.0944528 | 0.093344863 | 0.0031 | 0.0067 | 0.0067 | 0.0048 | 0.0078 | 0.0083 | 0.0213 | 0.008 |
| 1000 | $0.009638 | $0.009722 | $0.009679 | 0.009646 | 0.009681143 | 0.009734624 | 0.0101938 | 0.009602342 | 0.0031 | 0.0067 | 0.0067 | 0.0048 | 0.0078 | 0.0083 | 0.0213 | 0.008 |
| 10000 | $0.001137 | $0.001615 | $0.001417 | 0.001370 | 0.001500548 | 0.001528832 | 0.0018514 | 0.001205177 | 0.0031 | 0.0067 | 0.0067 | 0.0048 | 0.0078 | 0.0083 | 0.0213 | 0.008 |
| 100000 | $0.000330 | $0.001093 | $0.000632 | 0.000547 | 0.000783573 | 0.000721694 | 0.001028 | 0.000404892 | 0.0031 | 0.0067 | 0.0067 | 0.0048 | 0.0078 | 0.0083 | 0.0213 | 0.008 |
| 1E+06 | $0.000249 | $0.001129 | $0.000631 | 0.000486 | 0.000767142 | 0.000717696 | 0.0009834 | 0.000307275 | 0.0031 | 0.0067 | 0.0067 | 0.0048 | 0.0078 | 0.0083 | 0.0213 | 0.008 |

# Percentage Utilization of private cloud from public cloud:

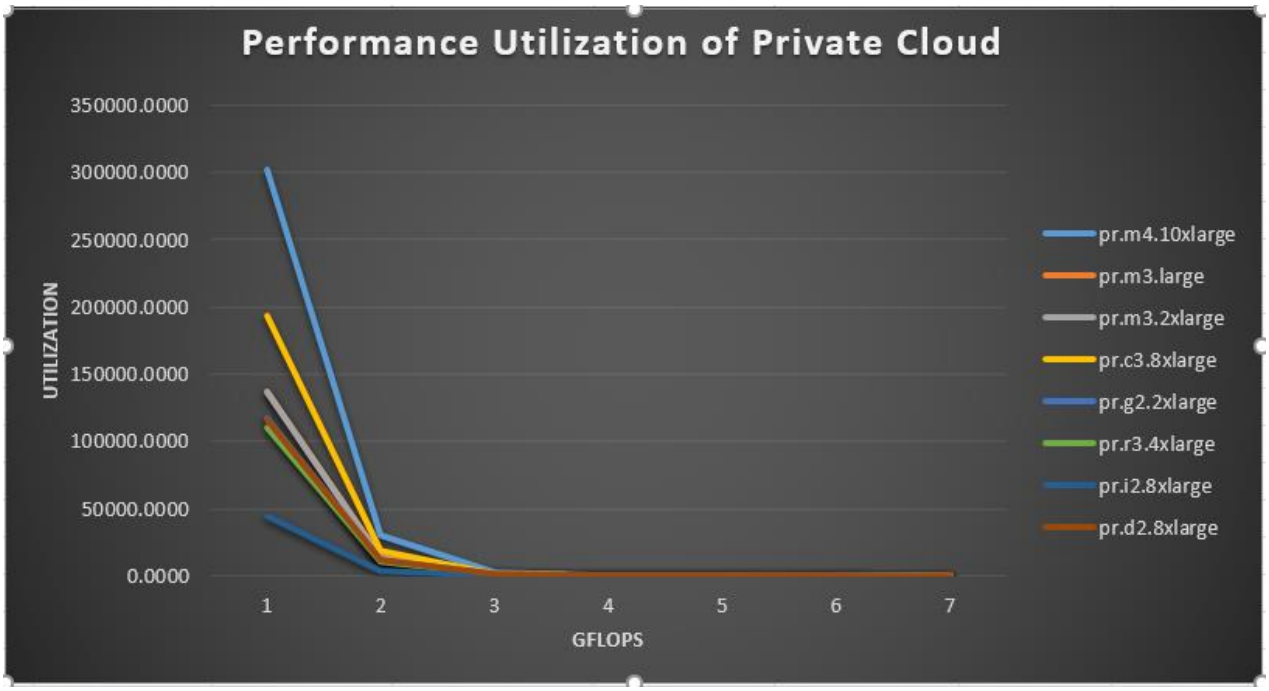
| GFLOPS | pr.m4.10xlarge | pr.m3.large | pr.m3.2xlarge | pr.c3.8xlarge | pr.g2.2xlarge | pr.r3.4xlarge | pr.i2.8xlarge | pr.d2.8xlarge |
|---|---|---|---|---|---|---|---|---|
| 1 | 302230.4693 | 137506.5494 | 137348.3030 | 193195.0390 | 117480.2482 | 110888.3864 | 44344.0586 | 116681.0788 |
| 10 | 30223.0469 | 13750.6549 | 13734.8303 | 19319.5039 | 11748.0248 | 11088.8386 | 4434.4059 | 11668.1079 |
| 100 | 3022.3047 | 1375.0655 | 1373.4830 | 1931.9504 | 1174.8025 | 1108.8839 | 443.4406 | 1166.8108 |
| 1000 | 309.2031 | 145.1044 | 144.4633 | 200.9569 | 124.1172 | 117.2846 | 47.8584 | 120.0293 |
| 10000 | 36.4855 | 24.1049 | 21.1467 | 28.5345 | 19.2378 | 18.4197 | 8.6921 | 15.0647 |
| 100000 | 10.5775 | 16.3117 | 9.4323 | 11.3954 | 10.0458 | 8.6951 | 4.8263 | 5.0611 |
| 1000000 | 7.9893 | 16.4643 | 9.4156 | 10.1166 | 9.8352 | 8.6469 | 4.6167 | 3.8409 |

**PLOT 1 :**The below Graph shows the Cost/hours/instance in dollars of amazon instances verses Private cloud from 1 GFlops to 1 PFlops.

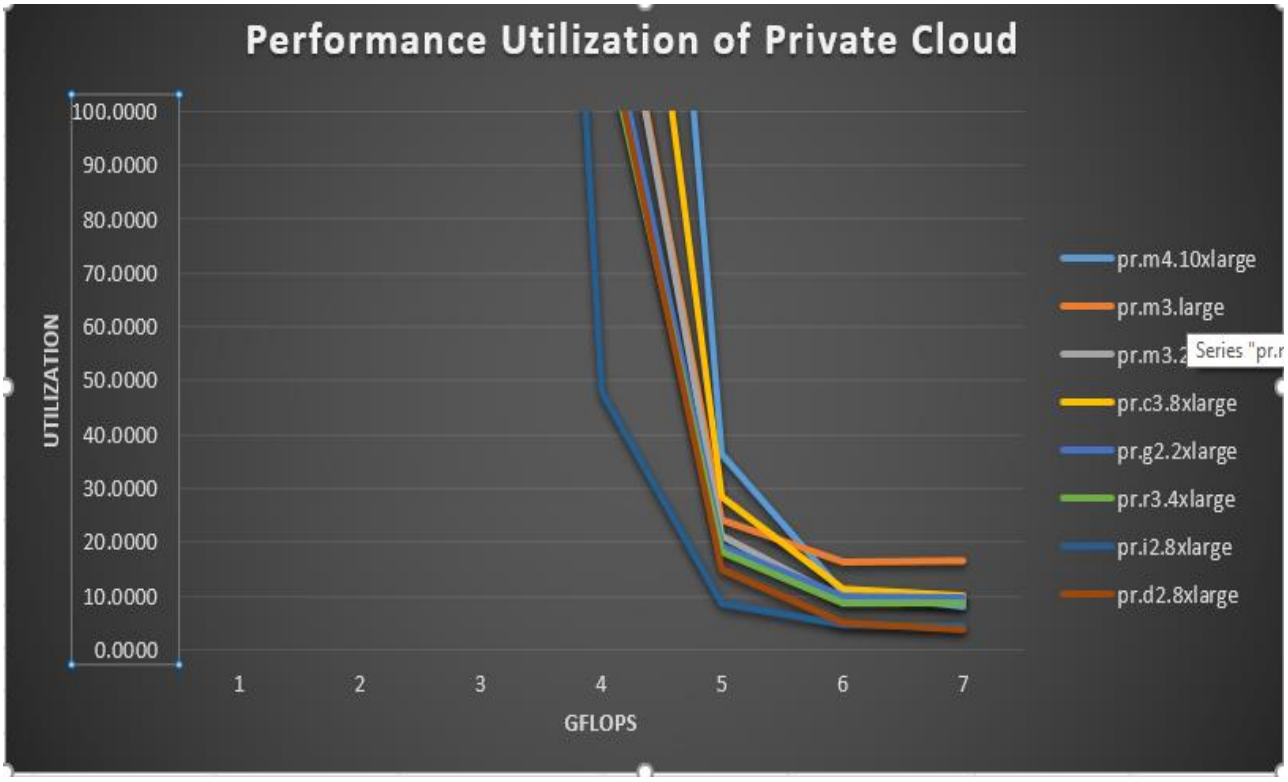



**Note : I have taken logarithmic scale , so that we can analyze more clearly.**

**PLOT 2: Un-Zoomed:**




**Zoomed to show more clearly:**



**Conclusion:** Performance utilization is calculated by Gflops of private instances divided by cost of public instances multiplied by 100.We can see that for most of instances breakeven point is coming in range of 1000 to 10000 GFLOPS. The Primary reason for this is the cost of administrative cost. The administrative cost is dominating factor, basically we are appointing one administrator for managing few hundreds machine. Also if we see the utilization factor, for smaller GFlops values it is very low, because we have run an entire instance just to harvest 1 GFLOPS.

The best Percentage utilization is of Pr.d2.8xlarge instance for 1 Petaflops Range and the least percentage utilization is of pr.m3.large instance for 1 petaflops range. The following nature is occurring because for this instances the hardware cost comes into play ignoring all other factors.

**Note: Breakeven point is point where cost of private cloud matches to cost of public cloud.**

# Final Conclusion:

Performance utilization is Performance utilization of most of the private instances for smaller GFLOPS is very poor and it gets better as we increase the GFLOPS. The utilization

After understanding the concepts of Cloud Costs, I can say that for small loads public loud is better than private clouds, for medium to large load I would prefer a mixed balance between private cloud and public cloud. And for very large load I will suggest building the private cloud as it be more cost effective.

There are other factors in taking this decision like safety, security, Data privacy etc but I have neglected those factors while taking my decision.

Other Factors are Geolocation of the Data center, Climate , Human Resource cost etc which we have not consider while doing this project.

# Assumptions:

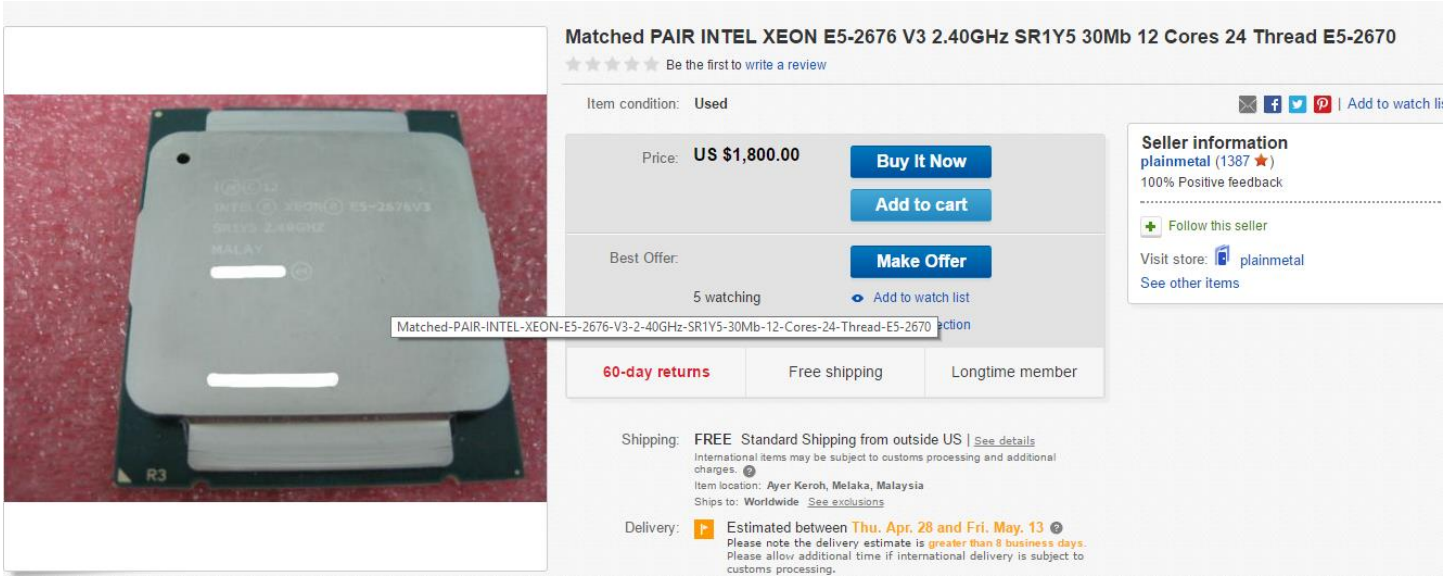
- I have used double precision IPC for processors.
- Land and Infrastructure is neglected.
- No data Security concerns.
- Remaining few flops are wasted and are not utilized.
- Electricity cost Rate is taken of Chicago area which is 7cents/KWatts.
- No Electricity is utilized other than cooling and powering the devices.
- Each Administrator handles 1000 machines.

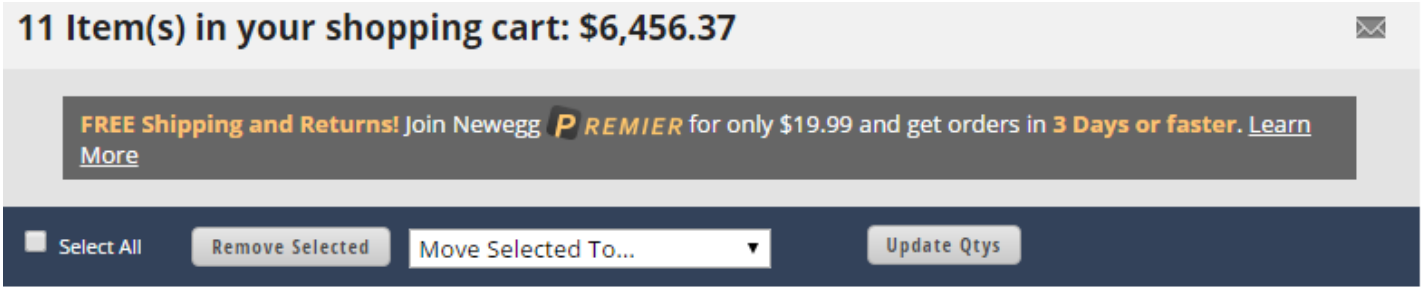
# References:

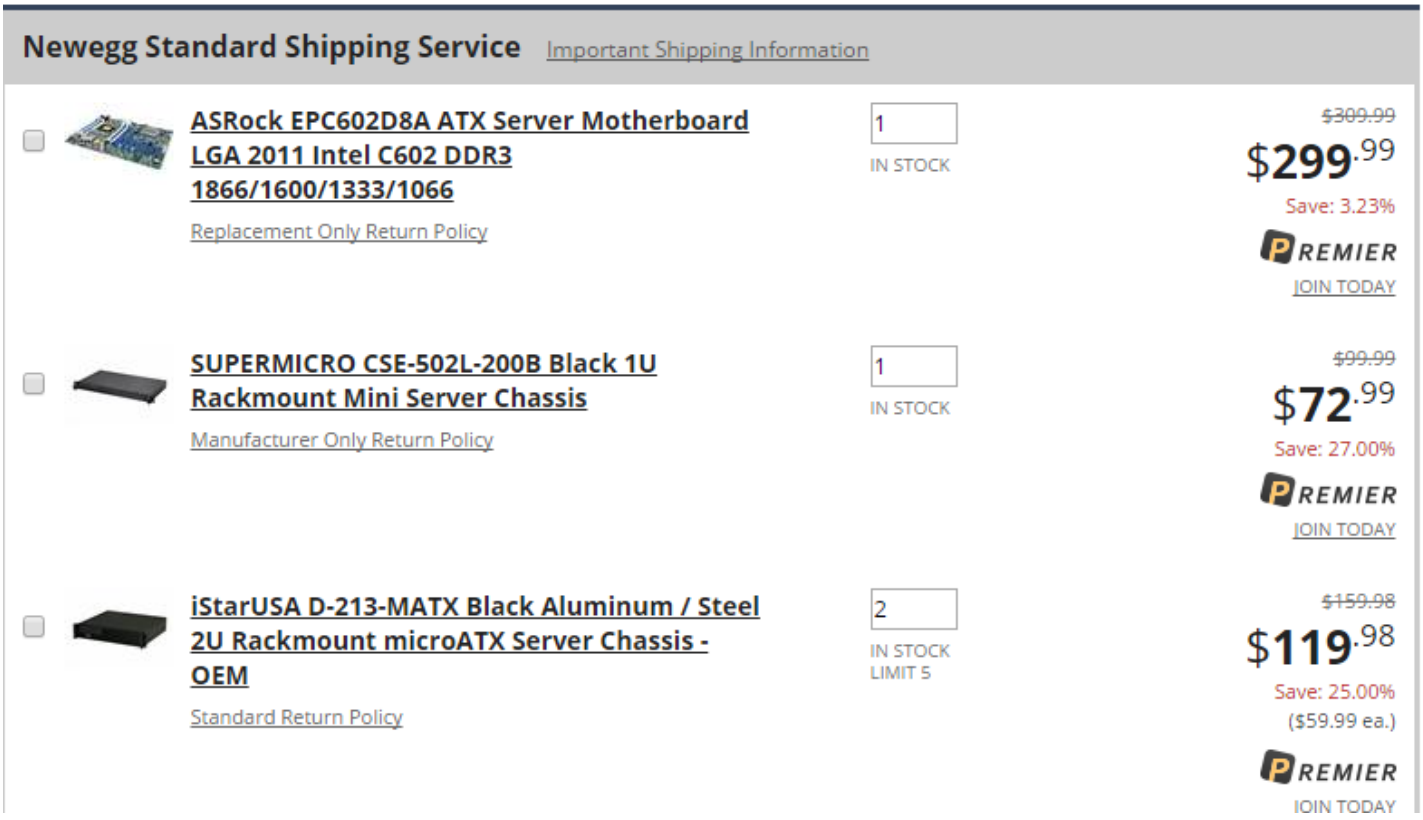

- http://datasys.cs.iit.edu/projects/CloudStorage_summary12.pdf.
- http://aws.amazon.com/ec2/instance-types/
- http://aws.amazon.com/ec2/pricing/
- http://www.newegg.com/
- https://power2switch.com/IL/Chicago/
- http://www.mcrinc.com/Documents/Newsletters/201207_CloudComputing_E-Guide.pdf

# Appendix:

## M4.10xlarge



**Newegg Marketplace Direct Delivery Service** Important Shipping Information

D-Link 10-Port 10-Gigabit Ethernet Smart Managed Switch

Sold by PC Rush

1 IN STOCK

$865.41

| | |
|---|---|
| Subtotal: | $865.41 |
| Shipping: | $0.00 |

**Shipping Options**

Choose a delivery method

- FREE — Standard Shipping (5-7 business days)
- $30.68 — Expedited Shipping (3-5 business days)
- $48.34 — Two-Day Shipping (2 business days)

**Newegg Marketplace Direct Delivery Service** Important Shipping Information

ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch

Sold by IPC Store

Protect Your Investment View Details

1 IN STOCK

$451.89

| | |
|---|---|
| Subtotal: | $451.89 |
| Shipping: | $9.99 |

**Shipping Options**

Choose a delivery method

- $9.99 — Standard Shipping (5-7 business days)
- $11.99 — Expedited Shipping (3-5 business days)

**Newegg Marketplace Direct Delivery Service** Important Shipping Information

NEMIX RAM 64GB PC3-12800 Load Reduced Memory for Dell PowerEdge R920 Server

Sold by NEMIX RAM

3 IN STOCK

$3,479.97 ($1,159.99 ea.)

**Newegg Marketplace Direct Delivery Service** Important Shipping Information

NEMIX RAM 64GB PC3-12800 Load Reduced Memory for Dell PowerEdge R920 Server

Sold by NEMIX RAM

3 IN STOCK

$3,479.97 ($1,159.99 ea.)

| | |
|---|---|
| Subtotal: | $3,479.97 |
| Shipping: | $0.00 |

**Shipping Options**

Choose a delivery method

- FREE — Standard Shipping (5-7 business days)
- $8.95 — Expedited Shipping (3-5 business days)
- $19.98 — Two-Day Shipping (2 business days)
- $49.56 — Next Day Shipping (One business day)

**Newegg Marketplace Direct Delivery Service** Important Shipping Information

SanDisk Optimus Ascend SDLKOCDM-800G-5CA1 2.5" 800GB SAS 6Gb/s eMLC Enterprise Solid State Disk

**Form Factor:** 2.5" / **Capacity:** 800GB

Sold by Compute4Less Corp

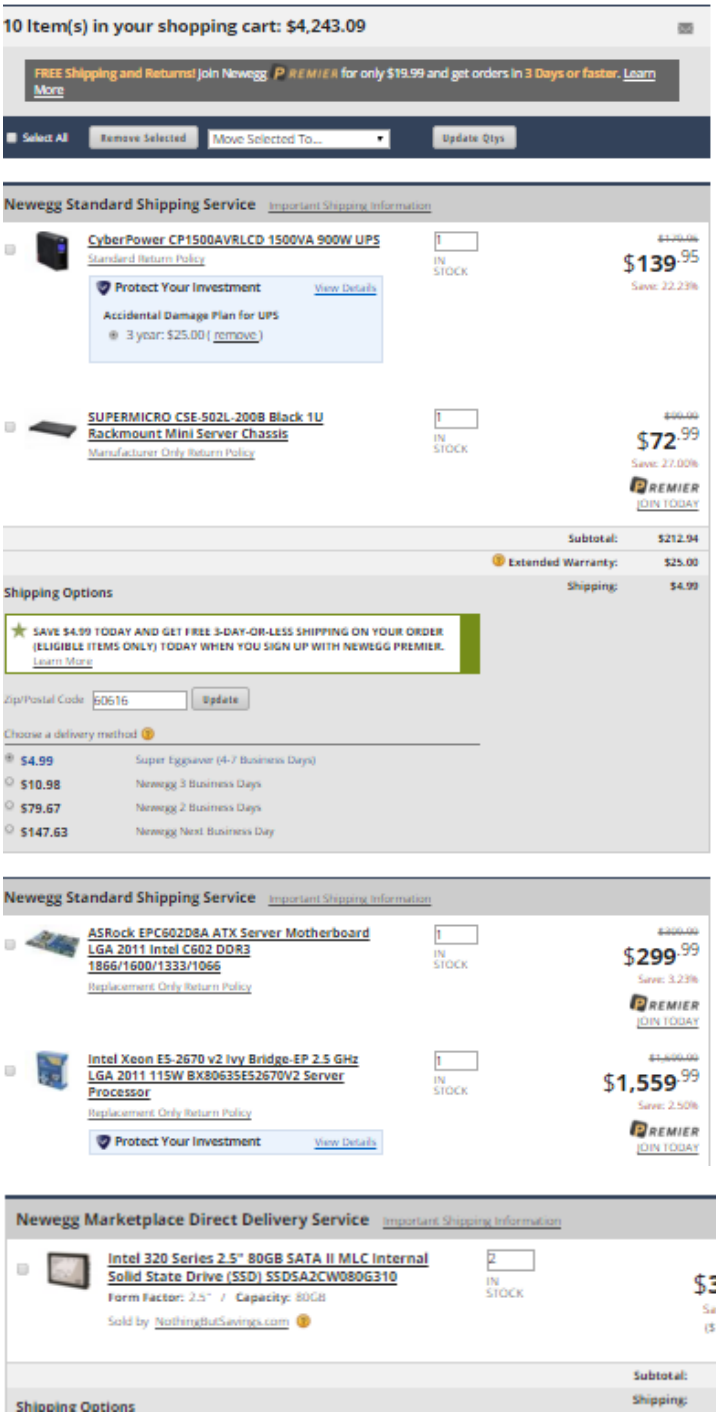
1 IN STOCK

$1,154.15

| | |
|---|---|
| Subtotal: | $1,154.15 |
| Shipping: | $0.00 |

**Shipping Options**

## m3.large


10 Item(s) in your shopping cart: $4,243.09
FREE Shipping and Returns! Join Newegg PREMIER for only $19.99 and get orders in 3 Days or faster. Learn More
Select All
Remove Selected
Move Selected To...
Update Qtys
Newegg Standard Shipping Service
Important Shipping Information
CyberPower CP1500AVRLCD 1500VA 900W UPS
Standard Return Policy
Protect Your Investment
View Details
Accidental Damage Plan for UPS
3 year: $25.00 ( remove )
IN STOCK
$139.95
Save: 22.23%
SUPERMICRO CSE-502L-200B Black 1U Rackmount Mini Server Chassis
Manufacturer Only Return Policy
IN STOCK
$72.99
Save: 27.00%
PREMIER
JOIN TODAY
Subtotal: $212.94
Extended Warranty: $25.00
Shipping: $4.99
Shipping Options
SAVE $4.99 TODAY AND GET FREE 3-DAY-OR-LESS SHIPPING ON YOUR ORDER (ELIGIBLE ITEMS ONLY) TODAY WHEN YOU SIGN UP WITH NEWEGG PREMIER.
Learn More
Zip/Postal Code 60616
Update
Choose a delivery method
$4.99 Super Eggsaver (4-7 Business Days)
$10.98 Newegg 3 Business Days
$79.67 Newegg 2 Business Days
$147.63 Newegg Next Business Day


Newegg Standard Shipping Service
Important Shipping Information
ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066
Replacement Only Return Policy
IN STOCK
$299.99
Save: 3.23%
PREMIER
JOIN TODAY
Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz LGA 2011 115W BX80635E52670V2 Server Processor
Replacement Only Return Policy
Protect Your Investment
View Details
IN STOCK
$1,559.99
Save: 2.50%
PREMIER
JOIN TODAY


Newegg Marketplace Direct Delivery Service
Important Shipping Information
Intel 320 Series 2.5" 80GB SATA II MLC Internal Solid State Drive (SSD) SSDSA2CW080G310
Form Factor: 2.5" / Capacity: 80GB
Sold by NothingButSavings.com
IN STOCK
$300.40
Save: 13.91%
($150.20 ea.)
Subtotal: $300.40
Shipping: $0.00
Shipping Options

Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet

Replacement Only Return Policy

1 IN STOCK

~~$1,278.99~~

$1,010.99

Save: 20.64%

Subtotal: $1,010.99

Shipping: $49.99

**Shipping Options**

Choose a delivery method

- **$49.99** Large Item Delivery – Front Door (Adult Signature Required)
- **$169.99** Large Item Delivery – White Glove (Adult Signature Required)

**Newegg Marketplace Direct Delivery Service** Important Shipping Information

ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch

Sold by IPC Store

Protect Your Investment View Details

1 IN STOCK

$451.89

Subtotal: $451.89

Shipping: $9.99

**Shipping Options**

Choose a delivery method

- **$9.99** Standard Shipping (5-7 business days)
- **$11.99** Expedited Shipping (3-5 business days)

**Newegg Marketplace Direct Delivery Service** Important Shipping Information



Planet GSW-1602SF 16-port 10/100/1000Mbps Gigabit with 2-port shared Gigabit SFP Web Smart ethernet switch

Sold by Business Systems Connection

1 IN STOCK

$192.00

Subtotal: $192.00

Shipping: $0.00

**Shipping Options**

Choose a delivery method

- **FREE** Expedited Shipping (3-5 business days)
- **$25.00** Two-Day Shipping (2 business days)

**Newegg Marketplace Direct Delivery Service** Important Shipping Information



SAMSUNG 32GB 288-Pin DDR4 SDRAM DDR4 2133 (PC4 17000) Server Memory Model M386A4G40DM0-CPB

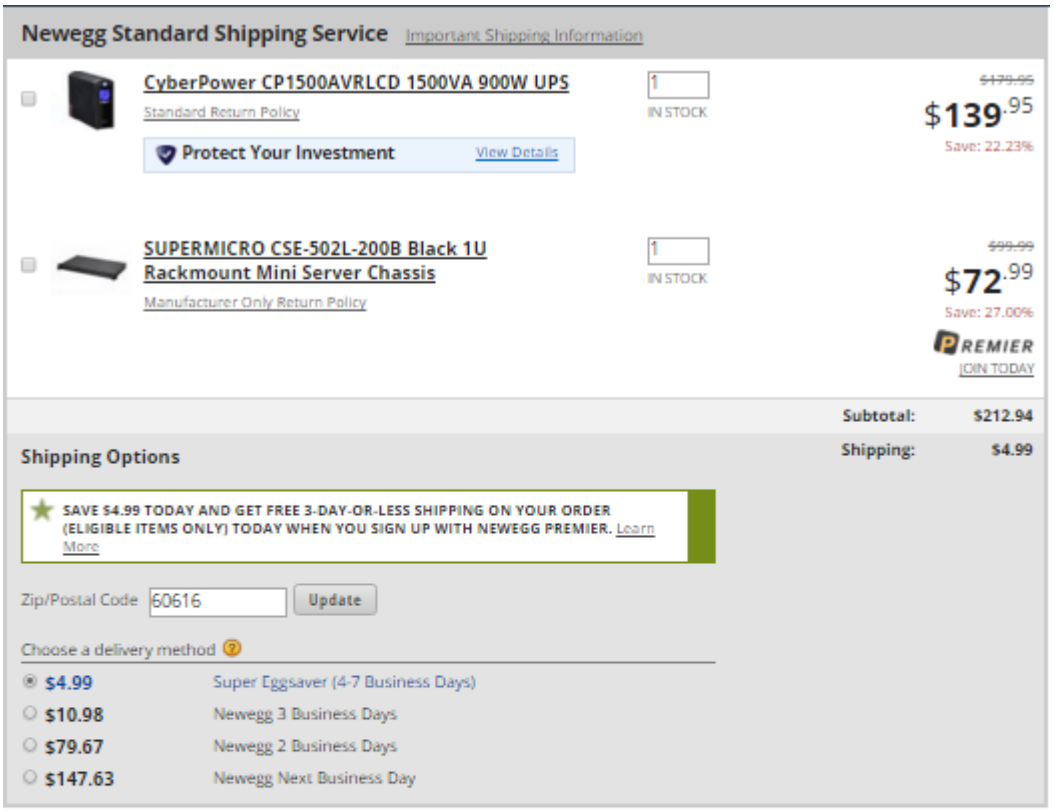
**Capacity:** 32GB / **Type:** 288-Pin DDR4 SDRAM

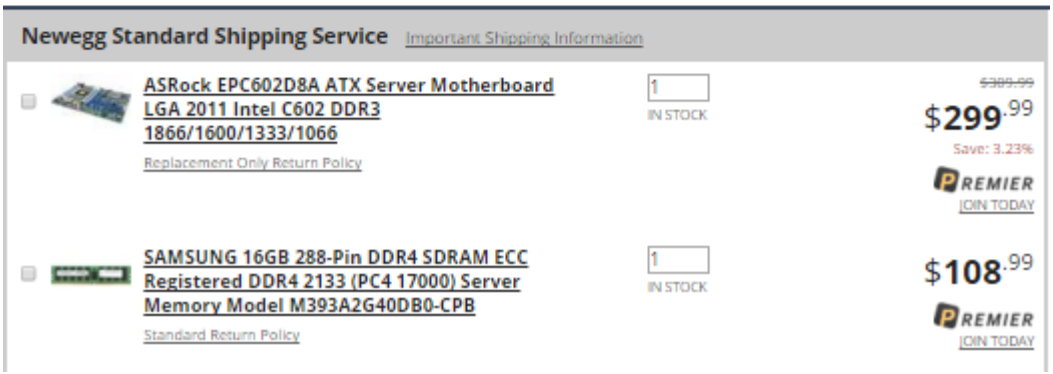
Sold by TECH EXPERTS

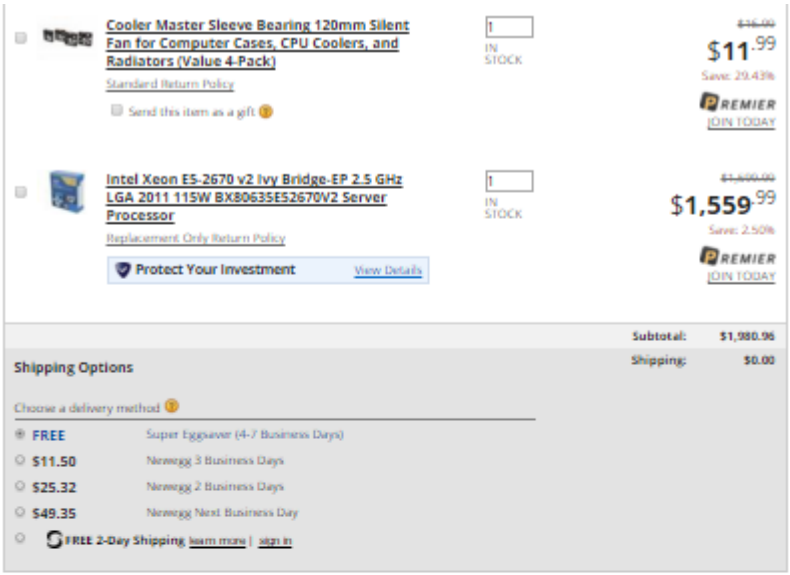
1 IN STOCK

$214.89

## G2.2xlarge


Newegg Standard Shipping Service
Important Shipping Information
CyberPower CP1500AVRLCD 1500VA 900W UPS
Standard Return Policy
Protect Your Investment
View Details
1
IN STOCK
$179.95
$139.95
Save: 22.23%
SUPERMICRO CSE-502L-200B Black 1U Rackmount Mini Server Chassis
Manufacturer Only Return Policy
1
IN STOCK
$99.99
$72.99
Save: 27.00%
PREMIER
JOIN TODAY
Subtotal: $212.94
Shipping Options
Shipping: $4.99
SAVE $4.99 TODAY AND GET FREE 3-DAY-OR-LESS SHIPPING ON YOUR ORDER (ELIGIBLE ITEMS ONLY) TODAY WHEN YOU SIGN UP WITH NEWEGG PREMIER. Learn More
Zip/Postal Code 60616 Update
Choose a delivery method
$4.99 Super Eggsaver (4-7 Business Days)
$10.98 Newegg 3 Business Days
$79.67 Newegg 2 Business Days
$147.63 Newegg Next Business Day


Newegg Standard Shipping Service
Important Shipping Information
ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066
Replacement Only Return Policy
1
IN STOCK
$389.99
$299.99
Save: 3.23%
PREMIER
JOIN TODAY
SAMSUNG 16GB 288-Pin DDR4 SDRAM ECC Registered DDR4 2133 (PC4 17000) Server Memory Model M393A2G40DB0-CPB
Standard Return Policy
1
IN STOCK
$108.99
PREMIER
JOIN TODAY

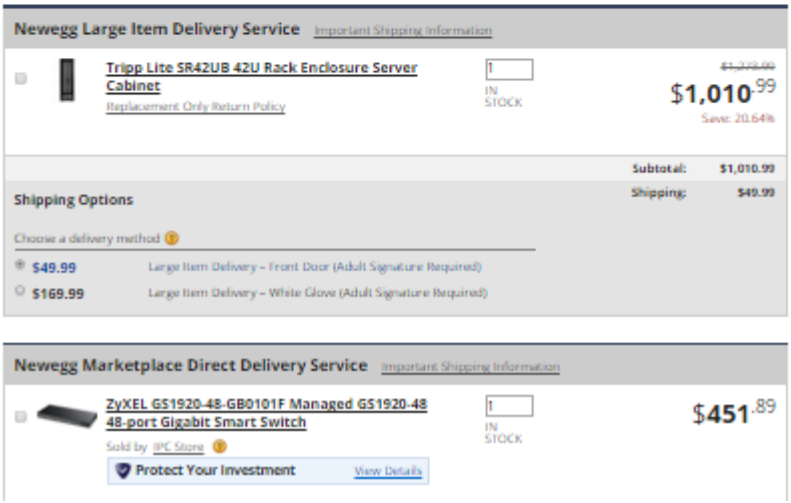


Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack)
Standard Return Policy
Send this item as a gift
1 IN STOCK
$11.99
Save: 29.43%
PREMIER JOIN TODAY

Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz LGA 2011 115W BX80635E52670V2 Server Processor
Replacement Only Return Policy
Protect Your Investment View Details
1 IN STOCK
$1,559.99
Save: 2.50%
PREMIER JOIN TODAY

Subtotal: $1,980.96
Shipping: $0.00

Shipping Options
Choose a delivery method
- FREE — Super Eggsaver (4-7 Business Days)
- $11.50 — Newegg 3 Business Days
- $25.32 — Newegg 2 Business Days
- $49.35 — Newegg Next Business Day
- FREE 2-Day Shipping learn more | sign in



Newegg Large Item Delivery Service Important Shipping Information

Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet
Replacement Only Return Policy
1 IN STOCK
$1,010.99
Save: 20.64%

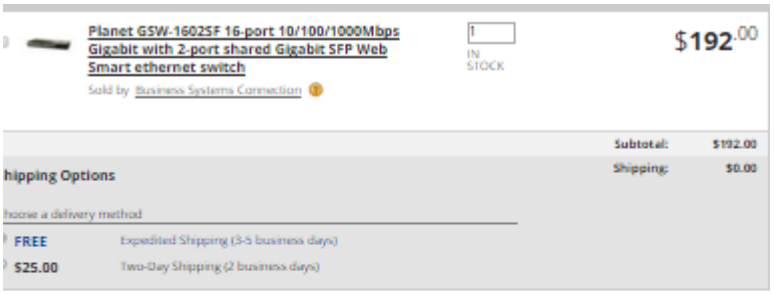
Subtotal: $1,010.99
Shipping: $49.99

Shipping Options
Choose a delivery method
- $49.99 — Large Item Delivery – Front Door (Adult Signature Required)
- $169.99 — Large Item Delivery – White Glove (Adult Signature Required)



Newegg Marketplace Direct Delivery Service Important Shipping Information

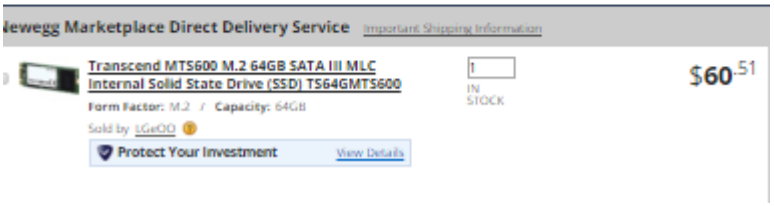
ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch
Sold by IPC Store
Protect Your Investment View Details
1 IN STOCK
$451.89



Planet GSW-1602SF 16-port 10/100/1000Mbps Gigabit with 2-port shared Gigabit SFP Web Smart ethernet switch
Sold by Business Systems Connection
1 IN STOCK
$192.00

Subtotal: $192.00
Shipping: $0.00

hipping Options
hoose a delivery method
- FREE — Expedited Shipping (3-5 business days)
- $25.00 — Two-Day Shipping (2 business days)

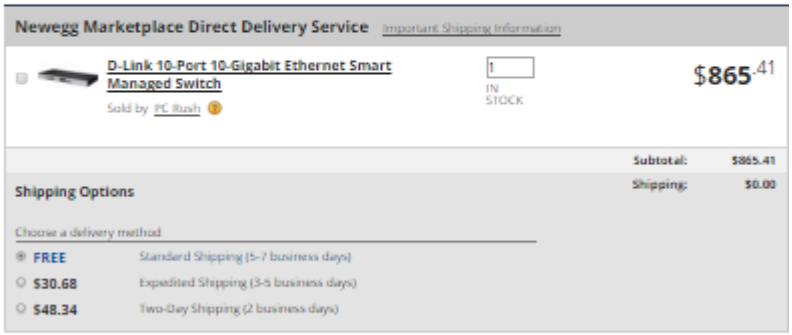


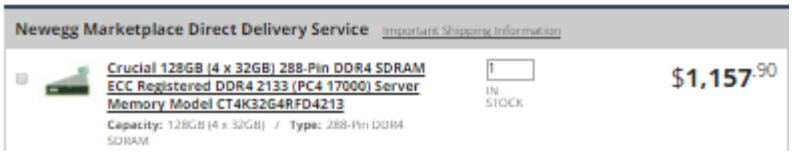
lewegg Marketplace Direct Delivery Service Important Shipping Information

Transcend MTS600 M.2 64GB SATA III MLC Internal Solid State Drive (SSD) TS64GMTS600
Form Factor: M.2 / Capacity: 64GB
Sold by LGeOO
Protect Your Investment View Details
1 IN STOCK
$60.51

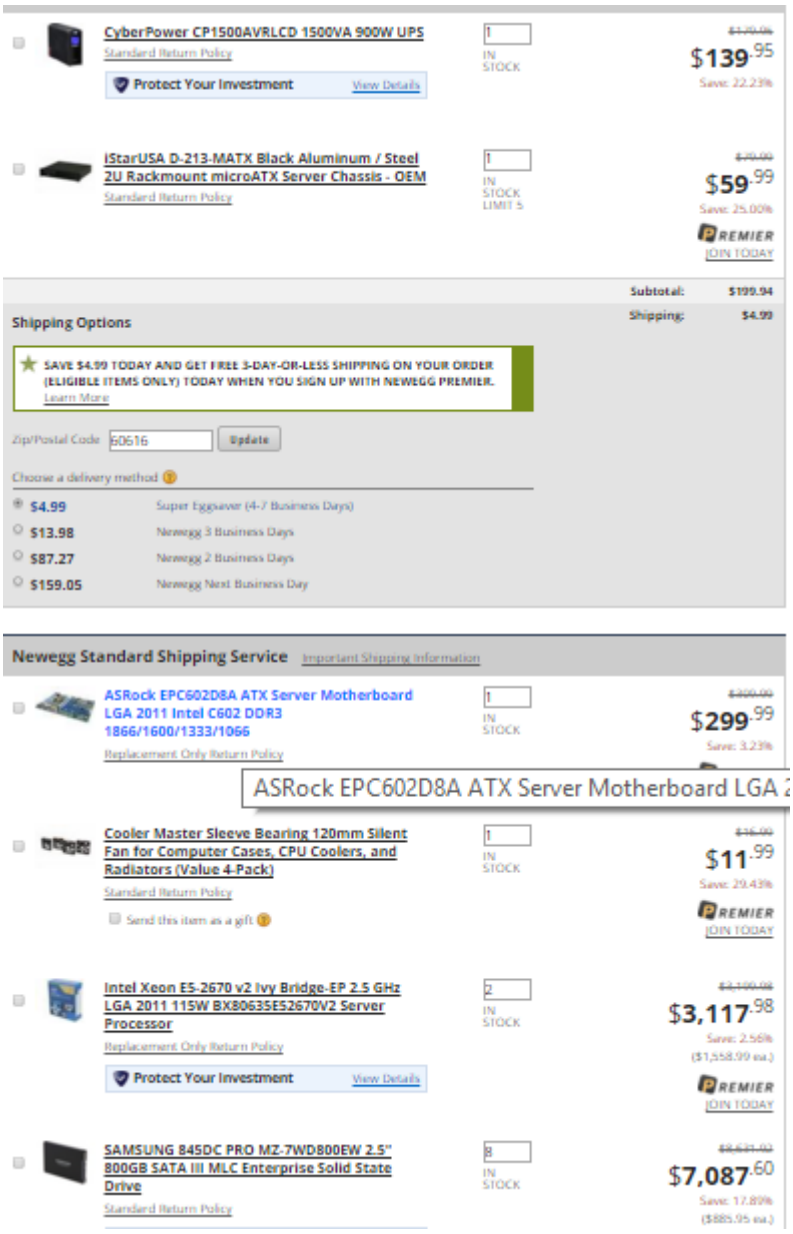
## I2.8xlarge

Tripp Lite SR42UB 42U Rack Enclosure Server Cabinet
Replacement Only Return Policy
1
IN STOCK
$1,010.99
Save 20.64%
Subtotal: $1,010.99
Shipping: $49.99
Shipping Options
Choose a delivery method
$49.99 Large Item Delivery – Front Door (Adult Signature Required)
$169.99 Large Item Delivery – White Glove (Adult Signature Required)


Newegg Marketplace Direct Delivery Service
Important Shipping Information
D-Link 10-Port 10-Gigabit Ethernet Smart Managed Switch
Sold by PC Rush
1
IN STOCK
$865.41
Subtotal: $865.41
Shipping: $0.00
Shipping Options
Choose a delivery method
FREE Standard Shipping (5-7 business days)
$30.68 Expedited Shipping (3-5 business days)
$48.34 Two-Day Shipping (2 business days)


Newegg Marketplace Direct Delivery Service
Important Shipping Information
Crucial 128GB (4 x 32GB) 288-Pin DDR4 SDRAM ECC Registered DDR4 2133 (PC4 17000) Server Memory Model CT4K32G4RFD4213
Capacity: 128GB (4 x 32GB) / Type: 288-Pin DDR4 SDRAM
1
IN STOCK
$1,157.90

ZyXEL GS1920-48-GB0101F Managed GS1920-48 48-port Gigabit Smart Switch
Sold by IPC Store
Protect Your Investment
View Details
1
IN STOCK
$451.89



CyberPower CP1500AVRLCD 1500VA 900W UPS
Standard Return Policy
Protect Your Investment View Details
1 IN STOCK
$139.95
Save: 22.23%

iStarUSA D-213-MATX Black Aluminum / Steel 2U Rackmount microATX Server Chassis - OEM
Standard Return Policy
1 IN STOCK LIMIT 5
$59.99
Save: 25.00%
PREMIER JOIN TODAY

Subtotal: $199.94
Shipping: $4.99

Shipping Options

SAVE $4.99 TODAY AND GET FREE 3-DAY-OR-LESS SHIPPING ON YOUR ORDER (ELIGIBLE ITEMS ONLY) TODAY WHEN YOU SIGN UP WITH NEWEGG PREMIER.
Learn More

Zip/Postal Code 60616 Update

Choose a delivery method

- $4.99 Super Eggsaver (4-7 Business Days)
- $13.98 Newegg 3 Business Days
- $87.27 Newegg 2 Business Days
- $159.05 Newegg Next Business Day

Newegg Standard Shipping Service Important Shipping Information

ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066
Replacement Only Return Policy
1 IN STOCK
$299.99
Save: 3.23%

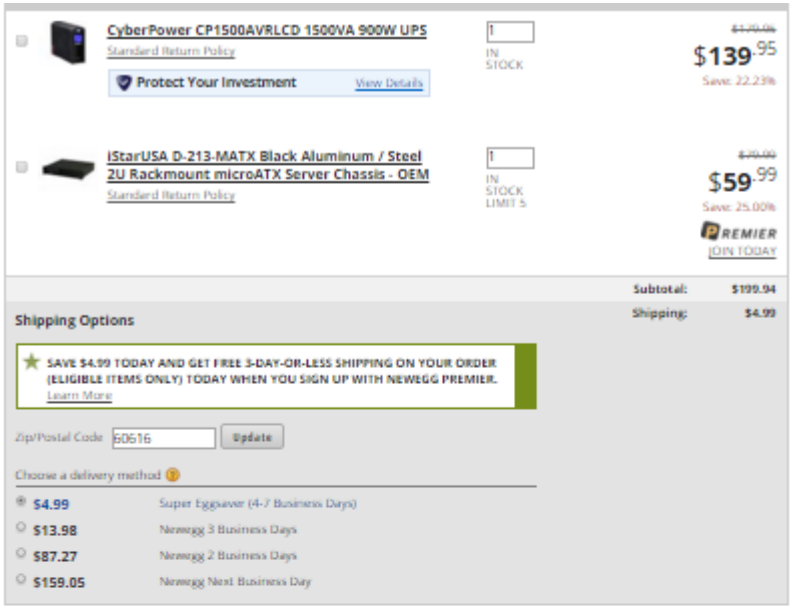
ASRock EPC602D8A ATX Server Motherboard LGA 2

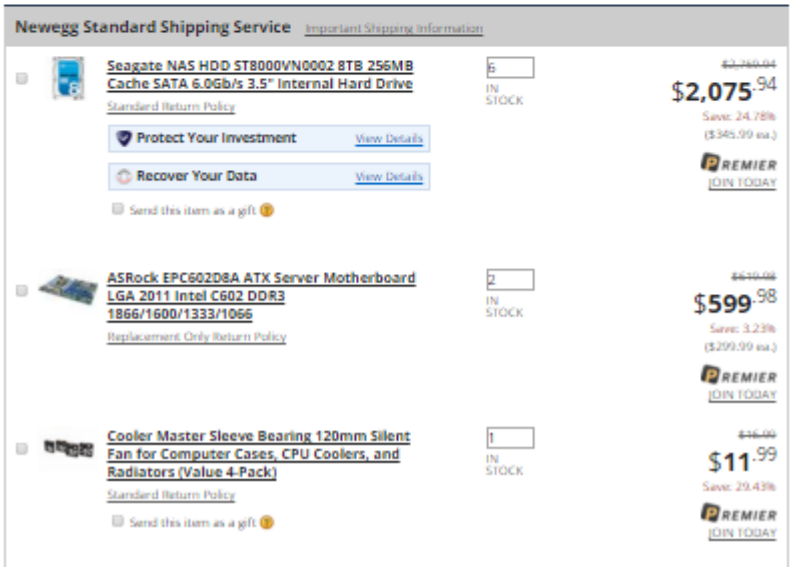
Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack)
Standard Return Policy
Send this item as a gift
1 IN STOCK
$11.99
Save: 29.43%
PREMIER JOIN TODAY

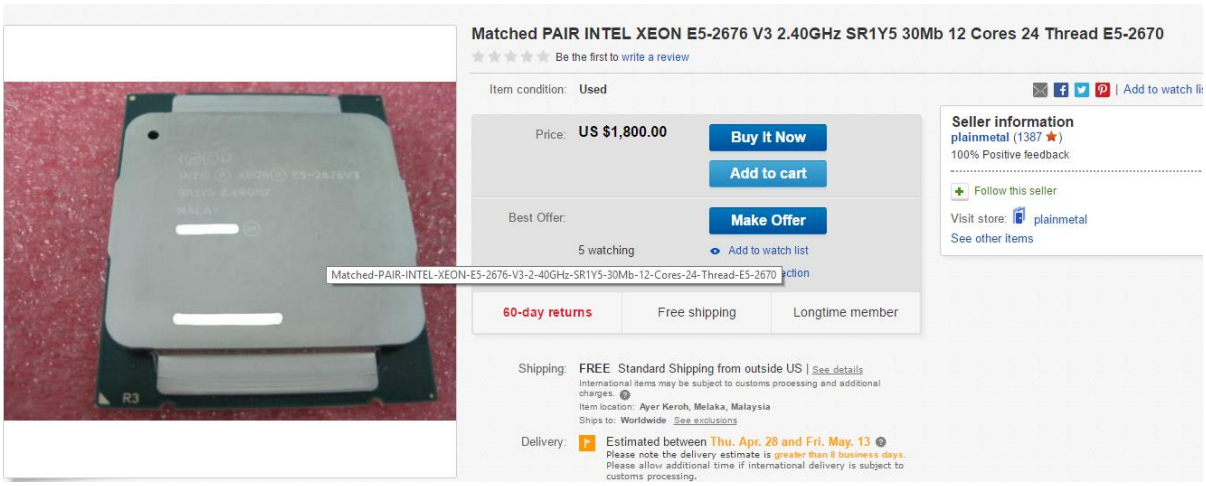
Intel Xeon E5-2670 v2 Ivy Bridge-EP 2.5 GHz LGA 2011 115W BX80635E52670V2 Server Processor
Replacement Only Return Policy
Protect Your Investment View Details
2 IN STOCK
$3,117.98
Save: 2.56%
($1,558.99 ea.)
PREMIER JOIN TODAY

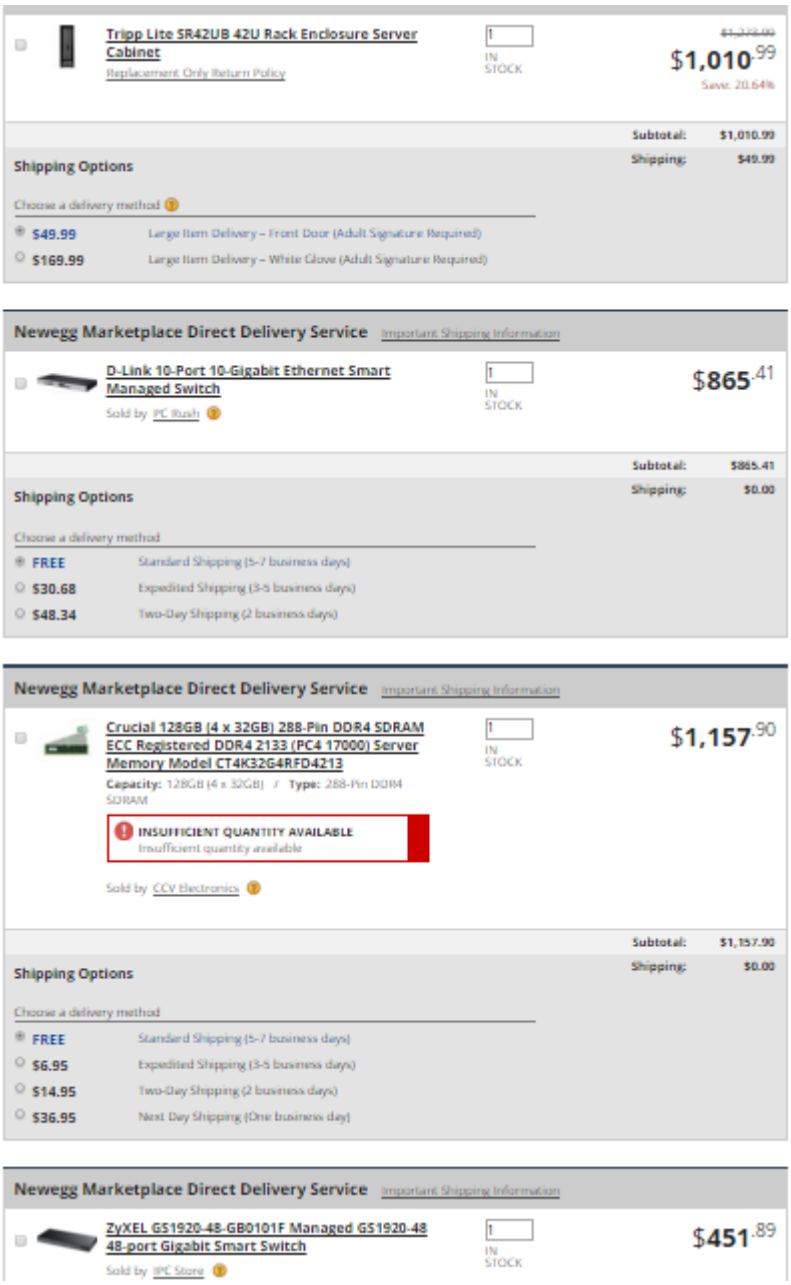
SAMSUNG 845DC PRO MZ-7WD800EW 2.5" 800GB SATA III MLC Enterprise Solid State Drive
Standard Return Policy
8 IN STOCK
$7,087.60
Save: 17.89%
($885.95 ea.)

## D2.8xlarge


CyberPower CP1500AVRLCD 1500VA 900W UPS
Standard Return Policy
Protect Your Investment
View Details
IN STOCK
$139.95
Save: 22.23%
iStarUSA D-213-MATX Black Aluminum / Steel 2U Rackmount microATX Server Chassis - OEM
Standard Return Policy
IN STOCK LIMIT 5
$59.99
Save: 25.00%
PREMIER JOIN TODAY
Subtotal: $199.94
Shipping: $4.99
Shipping Options
SAVE $4.99 TODAY AND GET FREE 3-DAY-OR-LESS SHIPPING ON YOUR ORDER (ELIGIBLE ITEMS ONLY) TODAY WHEN YOU SIGN UP WITH NEWEGG PREMIER.
Learn More
Zip/Postal Code 60616
Update
Choose a delivery method
$4.99 Super Eggsaver (4-7 Business Days)
$13.98 Newegg 3 Business Days
$87.27 Newegg 2 Business Days
$159.05 Newegg Next Business Day


Newegg Standard Shipping Service
Important Shipping Information
Seagate NAS HDD ST8000VN0002 8TB 256MB Cache SATA 6.0Gb/s 3.5" Internal Hard Drive
Standard Return Policy
Protect Your Investment
View Details
Recover Your Data
View Details
Send this item as a gift
IN STOCK
$2,075.94
Save: 24.78%
($345.99 ea.)
PREMIER JOIN TODAY
ASRock EPC602D8A ATX Server Motherboard LGA 2011 Intel C602 DDR3 1866/1600/1333/1066
Replacement Only Return Policy
$599.98
Save: 3.23%
($299.99 ea.)
Cooler Master Sleeve Bearing 120mm Silent Fan for Computer Cases, CPU Coolers, and Radiators (Value 4-Pack)
Standard Return Policy
$11.99
Save: 29.43%


Matched PAIR INTEL XEON E5-2676 V3 2.40GHz SR1Y5 30Mb 12 Cores 24 Thread E5-2670
Be the first to write a review
Item condition: Used
Add to watch list
Price: US $1,800.00
Buy It Now
Add to cart
Best Offer:
Make Offer
5 watching
Add to watch list
Matched-PAIR-INTEL-XEON-E5-2676-V3-2-40GHz-SR1Y5-30Mb-12-Cores-24-Thread-E5-2670
60-day returns
Free shipping
Longtime member
Seller information
plainmetal (1387 ★)
100% Positive feedback
Follow this seller
Visit store: plainmetal
See other items
Shipping: FREE Standard Shipping from outside US | See details
International items may be subject to customs processing and additional charges.
Item location: Ayer Keroh, Melaka, Malaysia
Ships to: Worldwide See exclusions
Delivery: Estimated between Thu. Apr. 28 and Fri. May. 13
Please note the delivery estimate is greater than 8 business days.
Please allow additional time if international delivery is subject to customs processing.




**Note : Below I am providing the link of Google drive where I have kept images of carts of all the instances.**

**Link : [https://drive.google.com/a/iit.edu/folderview?id=0B39rurUrl0X8NGNsUi1sVW5KYXM&usp=sharing](https://drive.google.com/a/iit.edu/folderview?id=0B39rurUrl0X8NGNsUi1sVW5KYXM&usp=sharing)**