CS553 PROJECT

Understanding the Cost of Computing in the Cloud

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INTRODUCTION

There is consensus that a cloud computing software stack at the layer of IaaS will be used by the company who hired us, 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. Our task is to find the cost breakdown of a private cloud, and compare that to what Amazon would charge.

Estimate the cost of different configurations.

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)

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)

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)

CONFIGURATION 1 PUBLIC CLOUD:

- Instance information d2.8xlarge
- Processors: High-frequency Intel Xeon E5-2676 v3 (Haswell) processors
- Instance Storage: 24 x 2000 HDD GB
- RAM Memory: 244 GiB
- vCPU: 36
- vCore: 18
- https://aws.amazon.com/ec2/instance-types/ , https://aws.amazon.com/ec2/virtualcores/

Hadoop/Spark Cluster with 32K-cores, 256 TB 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)

Cost of AWS d2.8xlarge instance = $5.52/hour

HARDWARE ESTIMATION:

Instance	vCPU	ECU	Memory (GiB)	Instance Storage (GB)	Processor	Linux/UNIX Usage
d2.8xlarge	36	116	244	24 x 2000 HDD	Intel Xeon E52676 v3	$5.52/Hour

	Core (32K)	Memory (256 TB)	Storage (50 PB HDD)
Number of Instances	889	1074	1092

We have 36 vCPU, we require 32k cores cluster network so we will need 889 number of instances below we have a five-year cost calculation using the above data.

Submission details			
Manufacturer:	Intel	Measured frequency:	
CPU Family:	Xeon	Comment:	
Processor Number:	E5-2676 v3		
Part number (supplied):	CM8064401613101	Submitted by:	post-er
Part number (guessed):	CM8064401613101	Submitted on:	
S-Spec Number:		CWID version:	0.5

General information	
Vendor:	GenuineIntel
Processor name (BIOS):	Intel(R) Xeon(R) CPU E5-2676 v3 @ 2.40GHz
Cores:	12
Logical processors:	24
Processor type:	Original OEM Processor
CPUID signature:	306F2
Family:	6 (06h)
Model:	63 (03Fh)
Stepping:	2 (02h)
TLB/Cache details:	64-byte Prefetching Data TLB: 1-GB pages, 4-way set associative, 4 entries Data TLB: 4-KB Pages, 4-way set associative, 64 entries Instruction TLB: 4-KByte pages, 8-way set associative, 64 entries L2 TLB: 1-MB, 4-way set associative, 64-byte line size Shared 2nd-Level TLB: 4-KByte / 2-MB pages, 8-way associative, 1024 entries

http://www.cpu-world.com/CPUs/Xeon/Intel-Xeon%20E5-2676%20v3.html

Estimation of 5 years:

$5.52*(5*12*30*24) = $238464

Total cost for 889 Instances = 238464 * 889 = $211994496

Cost for 100PB distributed storage shared across the entire cloud S3(Glacier):

100 * 1024 * 1024 * 0.004 = $419430.4 / Month

5 Years Cost of S3 = 5 * 12 * 419430.4 = $25,165,824

Data Transfer Pricing (OUT from Amazon S3): 100 * 1024 * 1024 * 0.010 = $10,48,576

Data Transfer IN To Amazon S3	
All data transfer in	$0.000 per GB

Data Transfer OUT From Amazon S3 To	
US East (N. Virginia)	$0.010 per GB
Another AWS Region	$0.020 per GB
Amazon CloudFront	$0.000 per GB

Configuration-1: 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)

Storage Pricing (varies by region)

Region: US West (Oregon)

	Standard Storage	Standard - Infrequent Access Storage †	Glacier Storage
First 50 TB / month	$0.023 per GB	$0.0125 per GB	$0.004 per GB
Next 450 TB / month	$0.022 per GB	$0.0125 per GB	$0.004 per GB
Over 500 TB / month	$0.021 per GB	$0.0125 per GB	$0.004 per GB

https://aws.amazon.com/s3/pricing/

Total Cost Estimation of 5 years: $211994496+ $25,165,824 + $10,48,576 = **$238208896**

PRIVATE CLOUD:

	Description	Price per Item	Quantity	Total Price
Compute Servers	2 proc, 32GB x6 RAM, 4TB HDD, N/W adaptor, Motherboard, Chassis	$7248	1334	$9668832
Network Switches	MSN2700-CS2RC Spectrum 100GbE 1U switch w/Cumulus Linux 32 QSFP28 Ports	$22835	475	$5959935

Network Cables	Cat 7	$8817.4		111466.63
Racks	5U 4 Post Open Frame Rack	$156	89	$13884
Storage Servers	R1S108LS-NW	$3675+$700x8	6250	$57968750
Electric Power	Description given below			$17408857.5
Cooling	Description given below			$5802952.5
Administration	Description given below	$100000	10	$5000000
TOTAL				**$106821367.6**

Computer Server:

Processor**:** High-frequency Intel Xeon E5-2676 v3 (Haswell) processors → $2352

2 x Processor: $4704

RAM 32GB ($300) x6 → $1800

HDD 4TB (107$) → $107

Network Adaptor → $12.19

Chassis → $125

Motherboard → $500

Total cost: $7248.19

Network Switch:

Note: *For formulae refer* [1]

For FAT tree network with a Switch of 48 ports [1], we can have maximum of,

$$K^3/4 \rightarrow (32)^3/4 \rightarrow 8192 \text{ Servers}$$

So, for Servers we can have,

$$2x(N/32) \rightarrow 2x\ (1334)/32 \rightarrow 84 \text{ switches}$$

So, for Distributed storage we can have,

$$2x(N/48) \rightarrow 2x\ (6250)/32 \rightarrow 391 \text{ switches}$$

Network Cables:

Considering 15ft per server to connect to switches,

So, we need 15 x 1334 → 20010 ft.

For Distributed Storage, again considering 15ft per server to connect to switches,

So, we need 6250 x 15 → 93750 ft.

Total, we need 113760 ft., Cost per 1000 ft. is $8817.4 → **$1003067.424**

Racks:

In 1 rack, we can place 15 Servers,

So, for servers we need 1334/15 racks → 89 Racks

For Distributed Storage, we need 6250/15 → 417 Racks

Total, we need **506** Racks

Storage Servers:

1 storage server we can have 2TB x 8 SSD, 16TB SSD.

Cost of 2TB SSD is $700.

Cost of 1 storage box is $3675

So, for 100PB storage we need 6250 Storage boxes with each box consisting of 16TB SSD.

So, total Cost per storage box will be,

$700 x 8 + $3675 → **$9275**

Electric Power:

Note: *Refer [2] for Description on Power consumption*

On an average, a server consumes 200W - 450W per hour.

Considering 450W per hour,

Servers will consume 450*1334 → 600300 W per hour

Switches will consume 450*317 → 142650 W per hour

Storage Server will consume 450*6250 → 2812500 W per hour

Total, we need 3555450 W per hour → **3556 KW** per hour

For 5 years, we have 24 x 365 x 5 → 43800 hours

So, Total Power we need will be 155752800 **KWH**

Cost per **KWH** varies from 0.17, 0.15, 0.08, considering 0.15c per hour,

Total cost: $233629.2

Cooling Power:

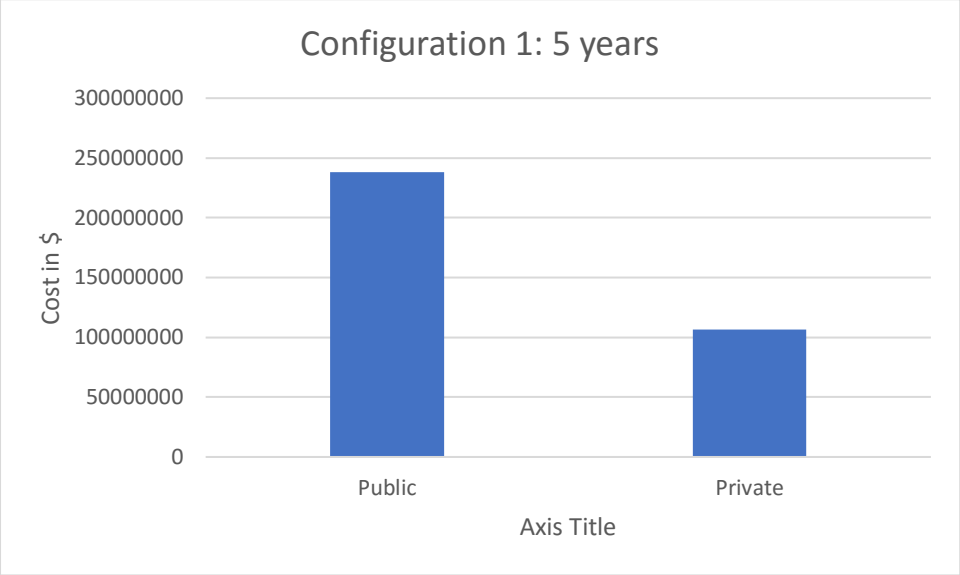
Considering cooling cost be ⅓ of Electric power,

Total cooling cost,

$233629.2/3 → $5802952.5

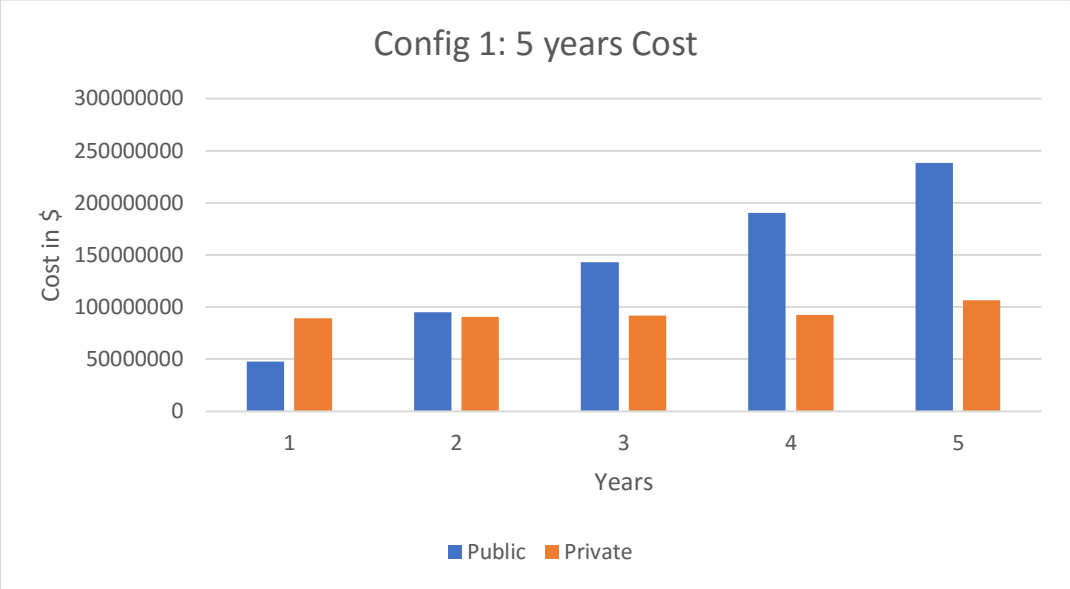
Comparison between AWS and Private cloud for Configuration 1:

We estimated for Configuration 1 with AWS we need **$238208896** and if we build our own datacentre we will be needing **$67,809,930.63,** which is far more less then compare to Amazon Public cloud.



Per year cost comparison for Public v/s Private cost.

Years	AWS (Public) Cost	Private Cost
1	$47641779.2	$89459235.94
2	$95283558.4	$90505961.78
3	$142925337.6	$91552687.62
4	$190567116.8	$92599413.46
5	$238208896	$106821367.6



We can easily conclude from the above graph, if the requirement was for 1 year then AWS must have been a good choice, however for a long term we will go for Private cloud.

Note: Even we take 2% of Damage cost the number is so big with AWS that it won't affect the decision that one will opt for Private Cloud.

CONFIGURATION 2 PUBLIC CLOUD:

- Instance information r3.large
- Processors: High Frequency Intel Xeon E5-2670 v2 (Ivy Bridge) Processors
- Instance Storage: 32 SSD GB
- RAM Memory: 15.25 GiB
- vCPU: 2
- vCore: 1
- https://aws.amazon.com/ec2/instance-types/ , https://aws.amazon.com/ec2/virtualcores/

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)

Cost of AWS r3.large instance = $0.166/hour

HARDWARE ESTIMATION:

Amazon EC2 Instances						
Instance	vCPU	ECU	Memory (GiB)	Instance Storage (GB)	Processor	Linux/UNIX Usage
r3.large	2	6.5	15	1 x 32 SSD	Intel Xeon E52670 v2	$0.166/Hour

We have 2 vCPU per Instance, and 1 VM needs 2 cores, i.e. 2 vCPU's, So in total we need 1Million Instances.

Estimation of 5 years:

$0.166*(24*365*5) = $7270.8

Total cost for 1M Instances = 1,000,000 * $7270.8= **$7,270,800,000**

Cost for 10PB distributed storage shared across the entire cloud S3(Glacier):

10 * 1024 * 1024 * 0.004 = $41943.04 / Month

5 Years Cost of S3 = 5 * 12 * 41943.04 = **$2,516,582.4**

Data Transfer Pricing (OUT from Amazon s3): 10 * 1024 * 1024 * 0.010 = **$104,857.6**

Data Transfer IN To Amazon S3

All data transfer in	$0.000 per GB

Data Transfer OUT From Amazon S3 To	
US East (N. Virginia)	$0.010 per GB
Another AWS Region	$0.020 per GB
Amazon CloudFront	$0.000 per GB

Storage Pricing (varies by region)

Region: US West (Oregon)

	Standard Storage	Standard - Infrequent Access Storage †	Glacier Storage
First 50 TB / month	$0.023 per GB	$0.0125 per GB	$0.004 per GB
Next 450 TB / month	$0.022 per GB	$0.0125 per GB	$0.004 per GB
Over 500 TB / month	$0.021 per GB	$0.0125 per GB	$0.004 per GB

https://aws.amazon.com/s3/pricing/

Total Cost Estimation of 5 years: **$7,270,800,000** + **$2,516,582.4** + **$104,857.6** = **$7,273,421,440**

PRIVATE CLOUD:

	Description	Price per Item	Qty	Total Price
Compute Servers	2 proc, 32GB x5 RAM, 240GB SSD + 120GB SSD, N/W adaptor, Motherboard, Chassis	$5130.19	111112	$570025671.3
Network Switches	CISCO SG500X-48-K9-NA SG500X-48 Layer 3 Switch	$4395	1054	$4632330
Network Cables	Cat 7	$8817.4	1676055	$14778447.36
Racks	5U 4 Post Open Frame Rack	$156	7450	$1162200
Storage Servers	R1S108LS-NW	$9275	625	$5796875
Electric Power	Comed	$0.15	1605576600KW	$240836490
Cooling	Comed	$0.15	1/3	$80278830

Administration	1 admin per 1000 Servers	$100000	112x5years	$56000000
TOTAL				**$973510843.7**

Computer Server:

Processor**:** High Frequency Intel Xeon E5-2670 v2 (Ivy Bridge) Processors → $1527.5

2 x Processor: $3055

RAM 150GB, 32GB ($300) x5 → $1500

SSD 240GB (98$) + 120GB (60$) → $158

Network Adaptor → $12.19

Chassis → $125

Motherboard → $280

Total cost: $5130.19

Network Switch:

Note: *For formulae refer [1]*

For FAT tree network with a Switch of 48 ports, we can have maximum of,

$$K^3/4 \rightarrow (48)^3/4 \rightarrow 27648 \text{ Servers}$$

So, for Servers we can have,

$$2x(N/48) \rightarrow 2 \times (111112)/48 \rightarrow 1027 \text{ switches}$$

So, for Distributed storage we can have,

$$2x(N/48) \rightarrow 2 \times (625)/48 \rightarrow 27 \text{ switches}$$

Network Cables:

Considering 15ft per server to connect to switches,

So we need 15 x 111112 → 1666680 ft

For Distributed Storage, again considering 15ft per server to connect to switches,

So we need 625 x 15 → 9375 ft

Total, we need 1676055 ft, Cost per 1000 ft is $8817.4 → **$14778447.36**

Racks:

In 1 rack we can place 15 Servers,

So, for servers we need 111112/15 racks → 7408 Racks

For Distributed Storage, we need 625/15 → 42 Racks

Total, we need **7450** Racks

Storage Servers:

1 storage server we can have 2TB x 8 SSD, 16TB SSD.

Cost of 2TB SSD is $700.

Cost of 1 storage box is $3675

So, for 10PB storage we need 625 Storage box with each box consisting of 16TB SSD.

So, total Cost per storage box will be,

$700 x 8 + $3675 → **$9275**

Electric Power:

Note: *Refer [2] for Description on Power consumption*

On an average an server consumes 200W - 450W per hour.

Considering 325W per hour,

Servers will consume 325*111112 → 36111400W per hour

Switches will consume 325*1054 → 342550W per hour

Storage Server will consume 325*625 → 203125W per hour

Total, we need 36657075W per hour → **36657 KW** per hour

For 5 years, we have 24 x 365 x 5 → 43800 hours

So, Total Power we need will be **1605576600 KW**

Cost per **KWH** varies from 0.17, 0.15, 0.08, considering 0.15c per hour,

Total cost: $240836490

Cooling Power:

Considering cooling cost be ⅓ of Electric power,

Total cooling cost,

$240836490/3 → $80278830

Admin:

Considering 1 admin per 1000 servers, we have total 111112 servers, 625 Storage servers

So, we need 112 admin.

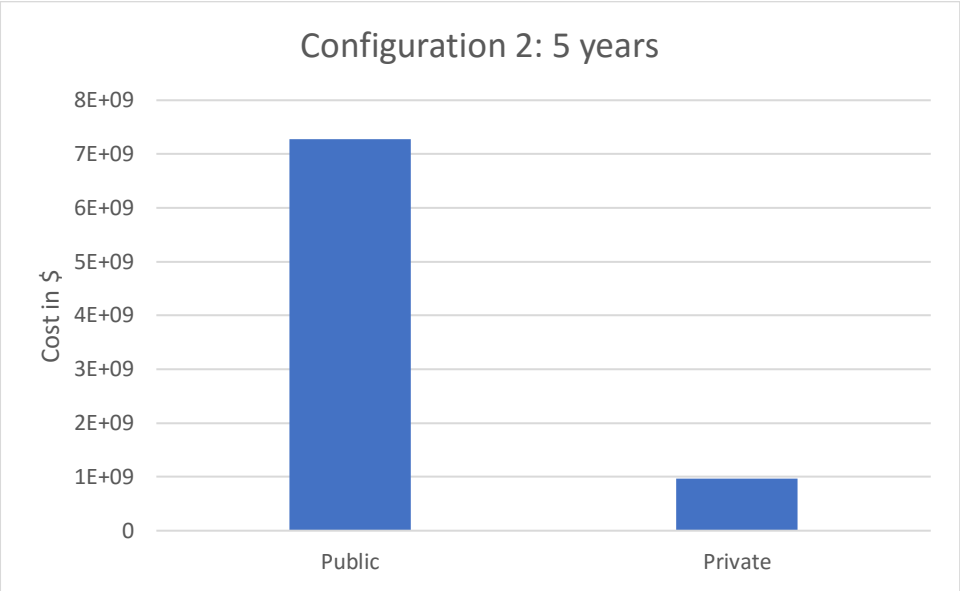
Salary per admin annually is $100,000.

So, for 5 years and for 112 admin, total cost

5 x 112 x $100,000 → $56000000

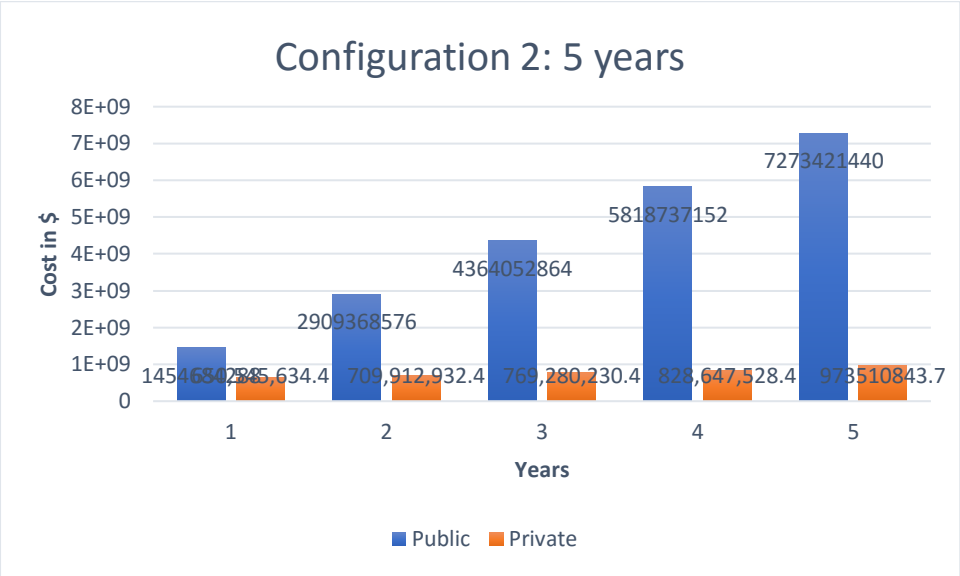
Comparison between AWS and Private cloud for Configuration 2:

We estimated for Configuration 1 with AWS we need **$7,273,421,440** and if we build our own datacentre we will be needing **$973,510,843.7,** which is far more less then compare to Amazon Public cloud.



Per year cost comparison for Public v/s Private cost.

Years	AWS (Public) Cost	Private
1	$47641779.2	$650,545,634.4
2	$95283558.4	$709,912,932.4
3	$142925337.6	$769,280,230.4
4	$190567116.8	$828,647,528.4
5	$7,273,421,440	$973,510,843.7



We can easily conclude from the above graph, For Configuration 2, one should always go for Private cloud.

Note: Even we take 2% of Damage cost the number is so big with AWS that it won't affect the decision that one will opt for Private Cloud.

CONFIGURATION 3 PUBLIC CLOUD:

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)

- Instance information p3.16xlarge
- GPU P2P: NVLink
- GPU Memory: 128 GB
- RAM Memory: 488GB
- GPU: GPUs - Tesla V100 - 8
- Core: 64
- Network Bandwidth: 25Gbps
- EBS Bandwidth: 14Gbps
- https://aws.amazon.com/ec2/instance-types/p3/

Cost of AWS p3.16xlarge instance =$24.48/Hour

https://www.ec2instances.info/?cost_duration=monthly&selected=p3.16xlarge

HARDWARE ESTIMATION:

Instance	vCPU	ECU	Memory (GiB)	GPU Memory (GB)	GPU	Linux/UNIX Usage
P3.16xlarge	64	188	488	128	GPUS-Tesla v100-8	$24.48/Hour

	GPU- ExaFlops
Number of GPU	Exaflops/125TFlops = 8000
Number of Instances	8000/8 = 1000

We require 1 exaflops cluster network and Tesla V100 GPUs provide 125 TFLOPS of mixed-precision performance. So We will need 8000 numbers of GPU. P3.16xlarge Instance has 8 GPU. So, we need 1000 total Instances.

Estimation of 5 years:

$24.48*(5*12*30*24) = $1,057,536

Total cost for 1000 Instances = 1057536* 1000 = $1,057,536,000

Cost for 1PB distributed storage shared across the entire cloud S3(Glacier):
1 * 1024 * 1024 * 0.004 = $4,194.3 / Month

5 Years Cost of S3 = 5 * 12 * 419430.4 = $251,658
Data Transfer Pricing (OUT from Amazon S3): 1 * 1024 * 1024 * 0.010 = $10,485

Total Cost Estimation of 5 years: $1057536000+ $251658+ $10485 = **$1,057,798,143**

Data Transfer IN To Amazon S3	
All data transfer in	$0.000 per GB

Data Transfer OUT From Amazon S3 To	
US East (N. Virginia)	$0.010 per GB
Another AWS Region	$0.020 per GB
Amazon CloudFront	$0.000 per GB

PRIVATE CLOUD:

	Description	Price per Item	Qty	Total Price
Compute Servers	2 proc, 2 GPU, 32GB x3 RAM + 64GB RAM, N/W adaptor, Motherboard, Chassis	$43,451.19	4000	$173,804,760
Network Switches	CISCO SG500X-48-K9-NA SG500X-48 Layer 3 Switch	$4395	170	$747,150
Network Cables	Cat 7	$8817.4	60945 ft	$537376.443
Racks	5U 4 Post Open Frame Rack	$156	272	$42432
Storage Servers	R1S108LS-NW	$9275	63	$584325
Electric Power	Comed	$0.15	83432430KW	$12514864.5

Cooling	Comed	$0.15	1/3	$4171621.5
Administration	1 admin per 1000 Servers	$100000	5	$25000000
TOTAL				$217402559.4

Computer Server:

Processor**:** High frequency Intel Xeon E5-2686 v4 (Broadwell) processors

2 x Processor: 2 x $2057 → $4114

GPU: NVIDIA Tesla V100 GPUs 2 x $18625 → $43451.19

RAM 32GB ($300) x3 + 64GB ($800) → $1700

Network Adaptor → $12.19

Chassis → $125

Motherboard**:** GIGABYTE GA-AX370-Gaming K7 (rev. 1.0) AMD X370 ATX Motherboards - AMD → $250

Total cost: $43451.19

We need 1 exaFlop, and from reference link we can achieve 125 Teraflop's for Deep Machine Learning with (https://www.nvidia.com/en-us/data-center/tesla-v100/)

So, 1 exaFlop is 10^6

So, we need 1000000 / 125 = **8000 NVidia v100s,** which can be achieved from 4000 Servers as each server will have 2 GPU's.

Network Switch:

Note: *For formulae refer [1]*

For FAT tree network with a Switch of 48 ports, we can have maximum of,

$K^3/4 \rightarrow (48)^3/4 \rightarrow 27648$ Servers

So, for Servers we can have,

$2x(N/48) \rightarrow 2 \times (4000)/48 \rightarrow 167$ switches

So, for Distributed storage we can have,

$2x(N/48) \rightarrow 2 \times (63)/48 \rightarrow 3$ switches

Network Cables:

Considering 15ft. per server to connect to switches,

So, we need 15 x 4000 → 60000 ft.

For Distributed Storage, again considering 15ft per server to connect to switches,

So, we need 63 x 15 → 945 ft.

Total, we need 60945 ft., Cost per 1000 ft. is $8817.4 → **$537376.443**

Racks:

In 1 rack, we can place 15 Servers,

So, for servers we need 4000/15 racks → 267 Racks

For Distributed Storage, we need 63/15 → 5 Racks

Total, we need **272** Racks

Storage Servers:

1 storage server we can have 2TB x 8 SSD, 16TB SSD.

Cost of 2TB SSD is $700.

Cost of 1 storage box is $3675

So, for 1PB storage we need 63 Storage boxes with each box consisting of 16TB SSD.

So, total Cost per storage box will be,

$700 x 8 + $3675 → **$9275**

Electric Power:

On an average, a server consumes 200W - 450W per hour.

Considering 450W per hour,

Servers will consume 450*4000 → 1800000W per hour

Switches will consume 450*170 → 76500W per hour

Storage Server will consume 450*63 → 28350W per hour

Total, we need 1904850W per hour → **1904.85 KW** per hour

For 5 years, we have 24 x 365 x 5 → 43800 hours

So, Total Power we need will be **83432430 KW**

Cost per **KWH** varies from 0.17, 0.15, 0.08, considering 0.15c per hour,

Total cost: $12514864.5

Cooling Power:

Considering cooling cost be ⅓ of Electric power,

Total cooling cost,

$12514864/3 → $4171621.5

Admin:

Considering 1 admin per 1000 servers, we have total 4000 servers, 63 Storage server

So, we need 5 admin.

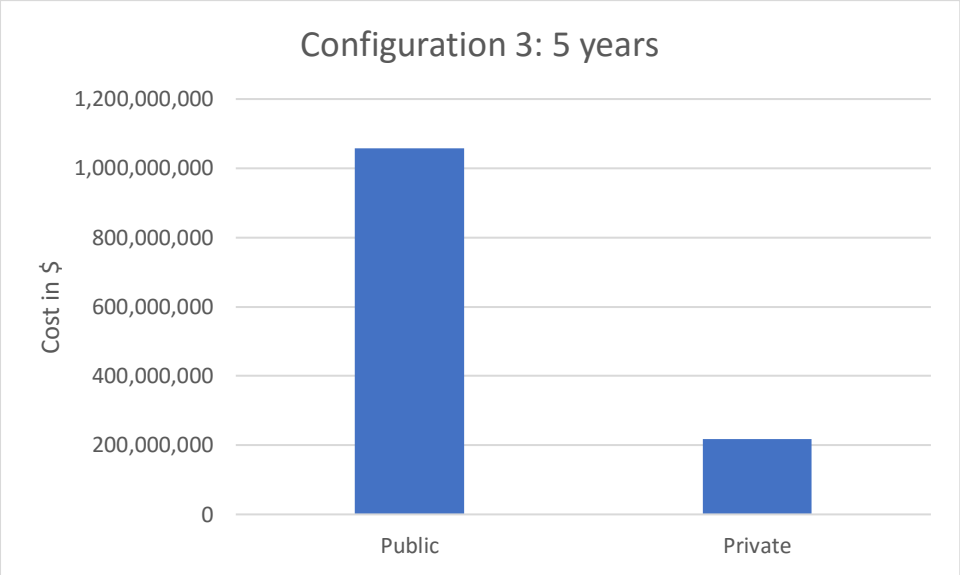
Salary per admin annually is $100,000.

So, for 5 years and for 5 admin, total cost

5 x 5 x $100,000 → $25000000

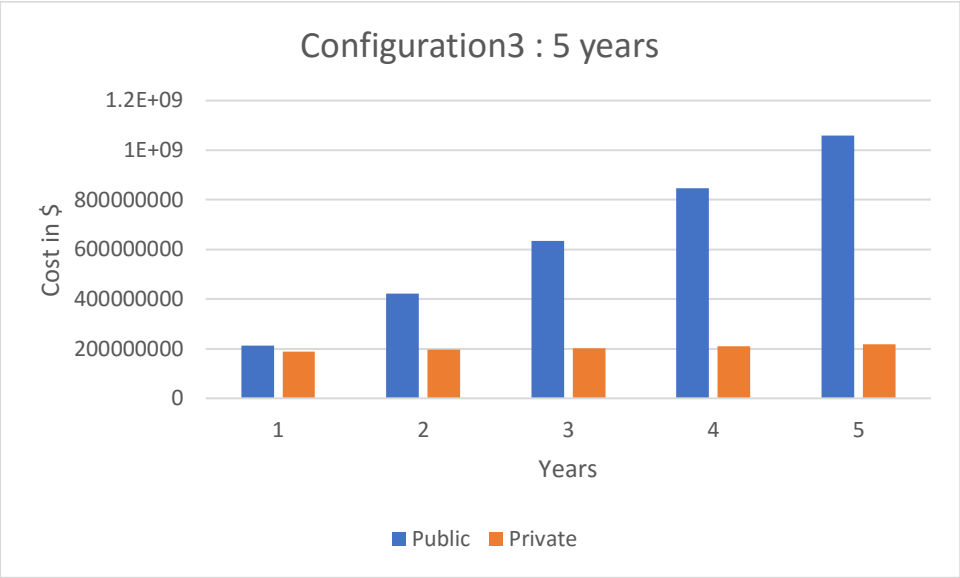
Comparison between AWS and Private cloud for Configuration 3:

We estimated for Configuration 1 with AWS we need **$1,057,798,143** and if we build our own datacentre we will be needing **$217,402,559.4,** which is far more less then compare to Amazon Public cloud.



Per year cost comparison for Public v/s Private cost.

Years	AWS (Public) Cost	Private Cost
1	$211559628.6	$187,490,637.8
2	$423119257.2	$194,993,610.7
3	$634678885.8	$202,496,583.6
4	$846238514.4	$209,999,556.5
5	$1,057,798,143	$217,402,559.4



We can easily conclude from the above graph, if the requirement was for 1 year then AWS must have been a good choice, however for a long term we will go for Private cloud.

Note: Even we take 2% of Damage cost the number is so big with AWS that it won't affect the decision that one will opt for Private Cloud.

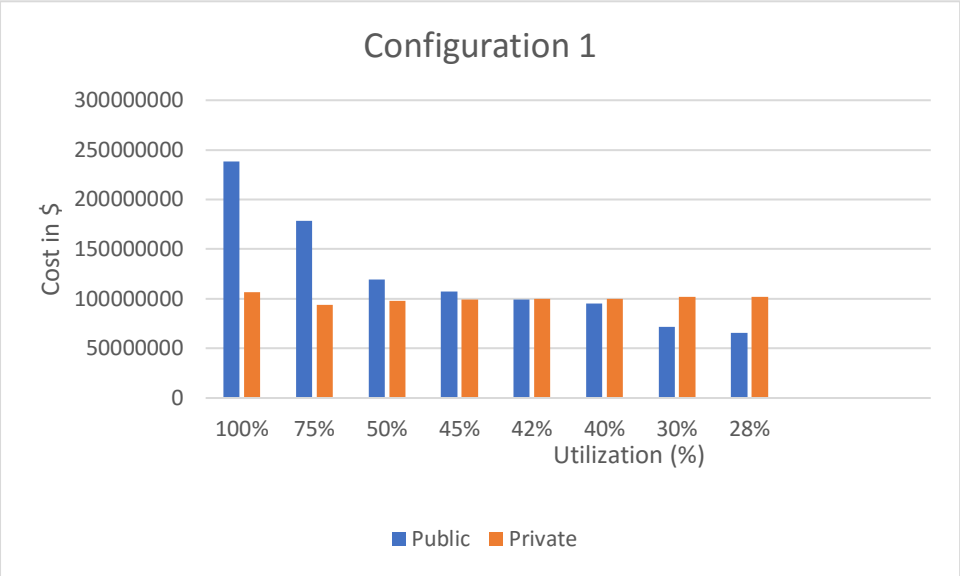
CONCLUSION

Configuration 1:

Utilization (%)	Public	Private
100%	238208896	106821367.6
75%	178656672	93764724.48
50%	119104448	98116938.85
45%	107194003.2	98987381.73
42%	99452214.08	99553169.59
40%	95283558.4	99857824.6
30%	71462668.8	101598710.4
28%	65507446.4	102033931.8

Above table compares the costs of public and private cloud based on utilization.

Threshold value = 42%



The above graph shows the comparison between AWS and private cloud the blue bar is the AWS cost and orange bar is the private cloud.

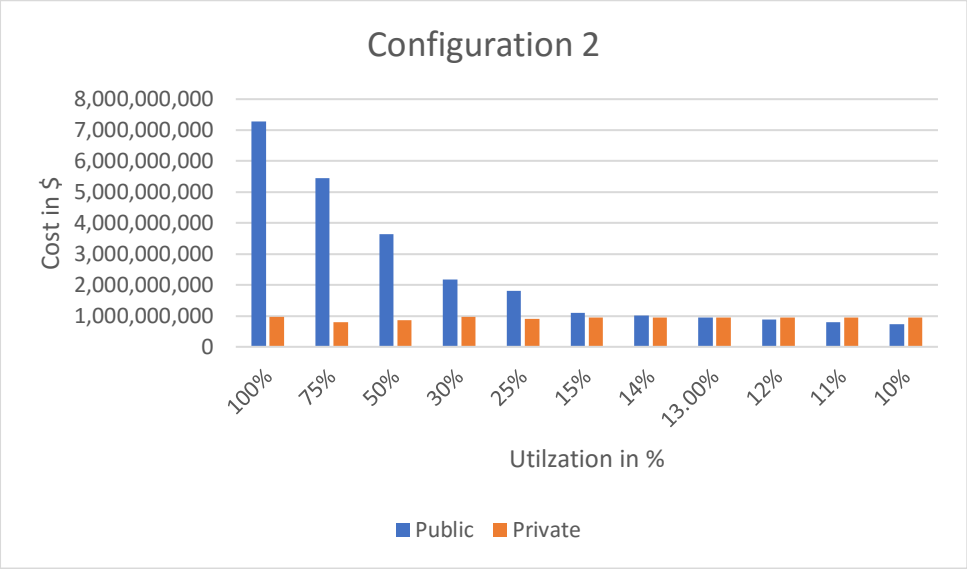
We can clearly see that at a utilization of 42% both cost almost the same. With the reduction of utilization percentage, the cost of AWS cloud reduces.

Configuration 2:

Utilization (%)	Public	Private
100%	7,273,421,440	973,510,844
75%	5455066080	792,883,476
50%	3636710720	853092598.7
30%	2182026432	973510843.7
25%	1818355360	913,301,721
15%	1091013216	937,385,370
14%	1018279002	939,793,735
13%	945544787.2	942,202,100
12%	872810572.8	944,610,465
11%	800076358.4	947,018,830
10%	727342144	949,427,195

Above table compares the costs of public and private cloud based on utilization.

Threshold value = 14%



The above graph shows the comparison between AWS and private cloud the blue bar is the AWS cost and orange bar is the private cloud.

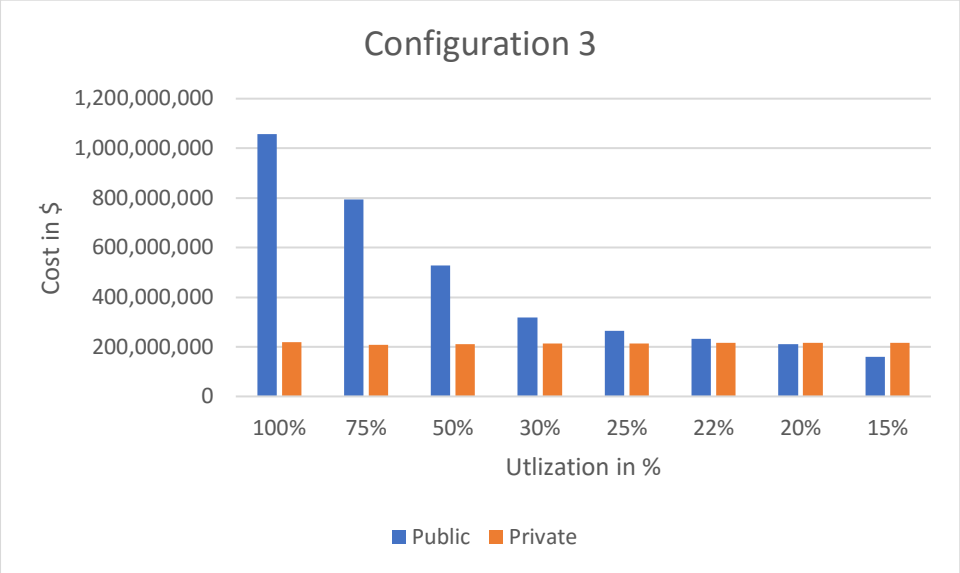
We can clearly see that at a utilization of 14% both cost almost the same. With the reduction of utilization percentage, the cost of AWS cloud reduces.

Configuration 3:

Utilization (%)	Public	Private
100%	1,057,798,143	217,402,559
75%	793348607.3	208,016,411
50%	528899071.5	211,145,127
30%	317339442.9	213,648,100
25%	264449535.8	214,273,843
22%	232715591.5	214,649,289
20%	211559628.6	214,899,587
15%	158669721.5	215,525,330

Above table compares the costs of public and private cloud based on utilization.

Threshold value = 20%



The above graph shows the comparison between AWS and private cloud the blue bar is the AWS cost and orange bar is the private cloud.

We can clearly see that at a utilization of 20% both cost almost the same. With the reduction of utilization percentage, the cost of AWS cloud reduces.

	Configuration 1	Configuration 2	Configuration 3
Public Cloud (including EC2 and S3) Cost over 5 years, 24/7 operation, with 100% usage.	**$238208896**	**$7,273,421,440**	**$1,057,798,143**
Private Cloud cost over 5 years, 24/7 operation, with 100% usage.	**$238208896**	**$972,460,393**	**$217,402,559.4**
What utilization must be achieved with the private cloud to make the private cloud option more attractive than the public cloud?	**26%**	**14%**	**20%**

REFERENCES

1. https://networkengineering.stackexchange.com/questions/16764/3-layer-clos-fat-tree-scaling-questionConsectetuer
2. https://www.datacenters.com/news/infrastructure/135-data-center-power-costs-and-requirements
3. http://www.vistaitgroup.com/cisco-nexus-n9k-c9372px-48-1-10g-sfp-6-40g-qsfp-switch?utm_source=google_shopping&gclid=EAIaIQobChMIre-gtLzO1wIVBARpCh33gwN2EAQYDiABEgKPQvD_BwE
4. https://aws.amazon.com/s3/pricing/
5. https://aws.amazon.com/ec2/instance-types/
6. https://ark.intel.com/products/75275/Intel-Xeon-Processor-E5-2670-v2-25M-Cache-2_50-GHz
7. http://www.cpu-world.com/CPUs/Xeon/Intel-Xeon E5-2676 v3.html
8. https://aws.amazon.com/about-aws/whats-new/2017/10/introducing-amazon-ec2-p3-instances/
9. https://en.wikichip.org/wiki/intel/xeon_e5/e5-2686_v4
10. https://www.nvidia.com/en-us/data-center/tesla-v100/
11. https://networkengineering.stackexchange.com/questions/16764/3-layer-clos-fat-tree-scaling-question
12. https://www.slideshare.net/AnkitaMahajan2/fattree-a-scalable-fauult-tolerant
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14. http://cpuboss.com/cpu/Intel-Xeon-E5-2670-v2
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16. https://www.cisco.com/c/en/us/products/collateral/switches/sge2010p-48-port-gigabit-switch-poe/data_sheet_c78-502075.pdf
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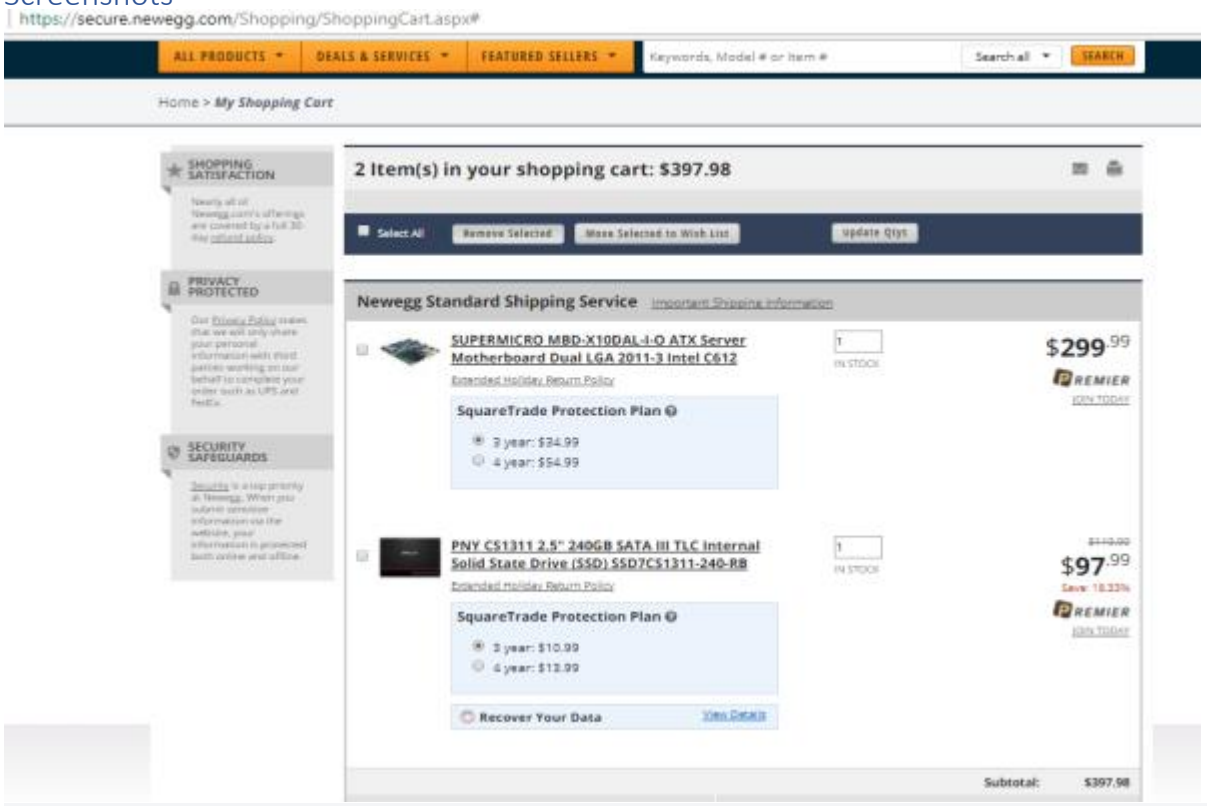
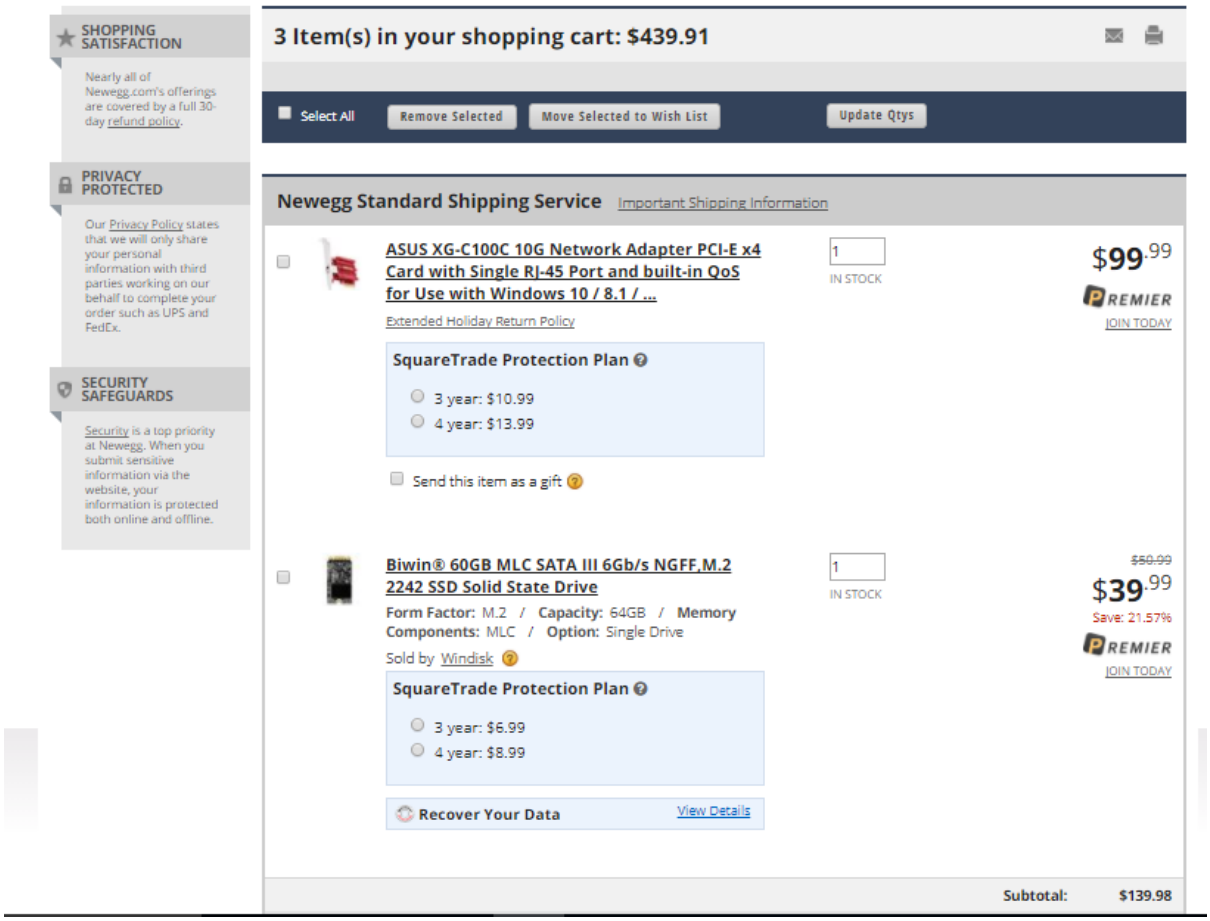
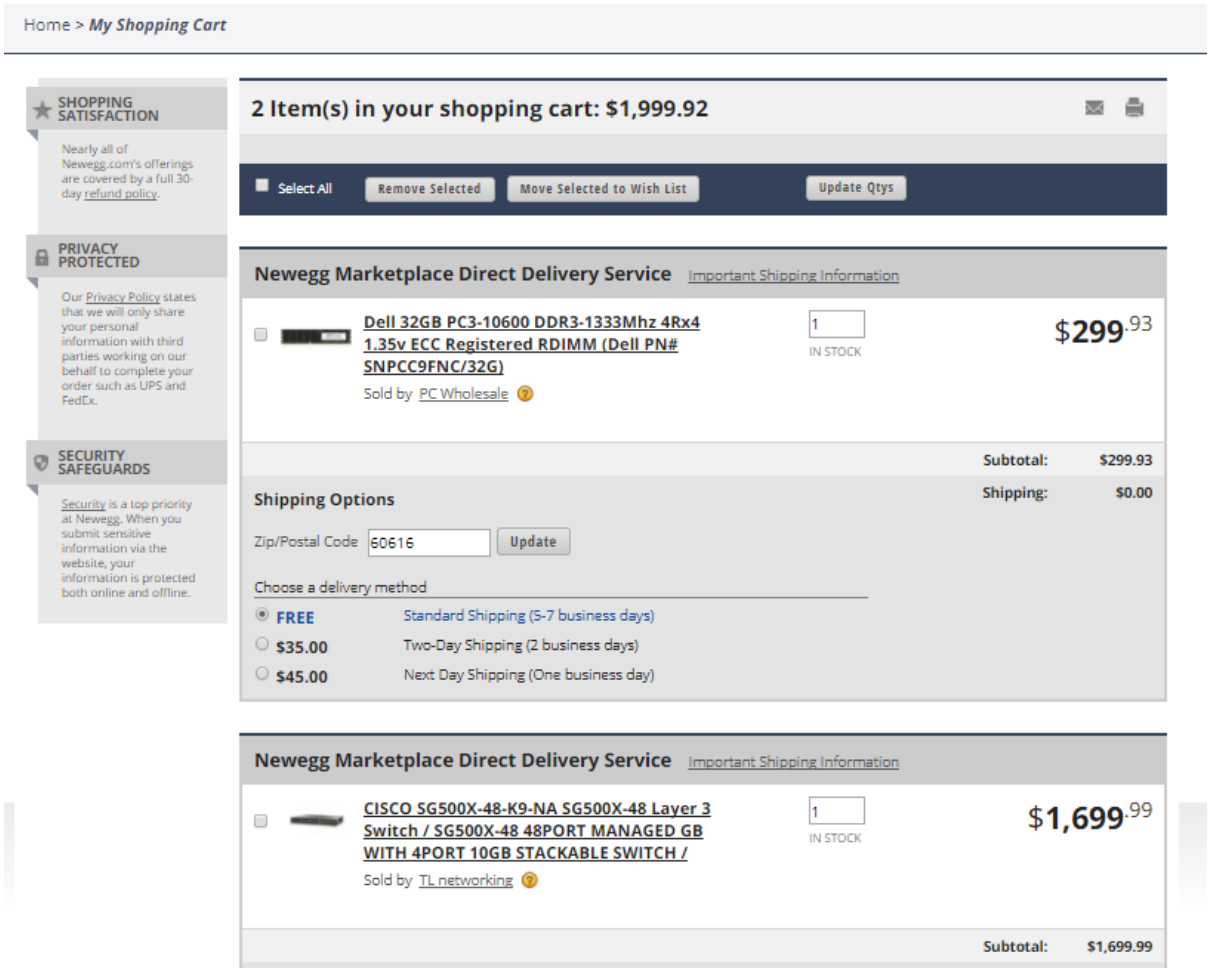
Screenshots



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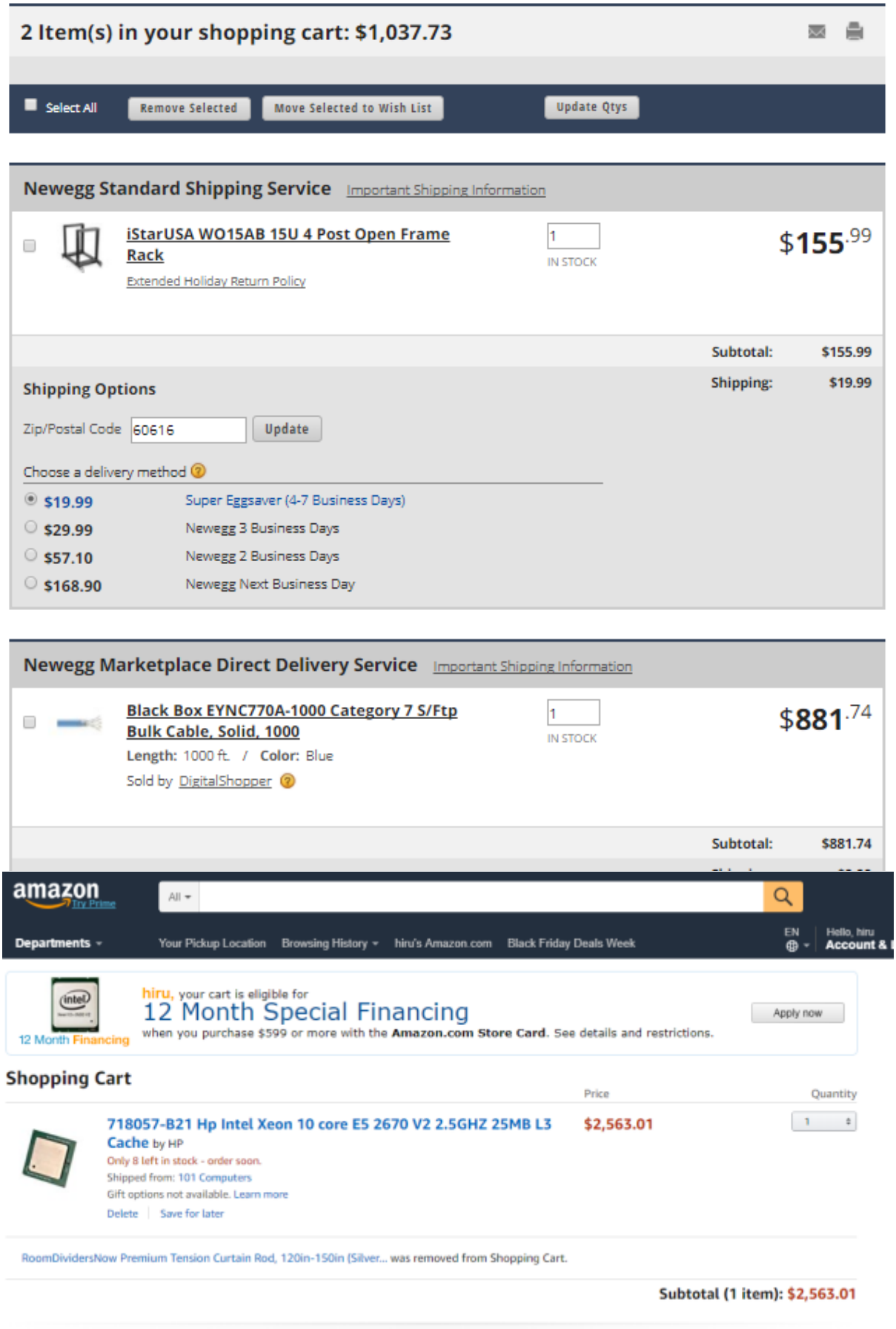
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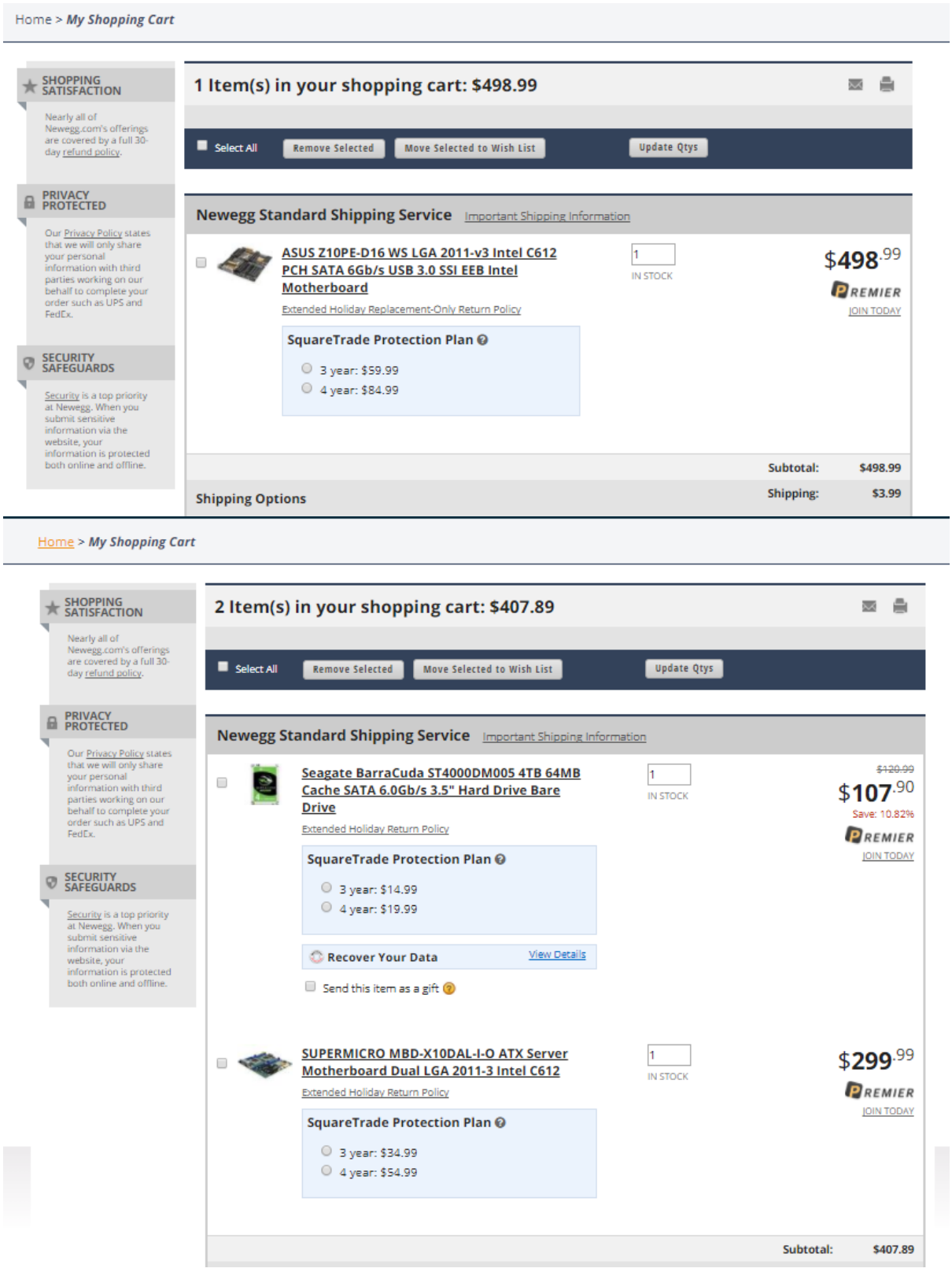
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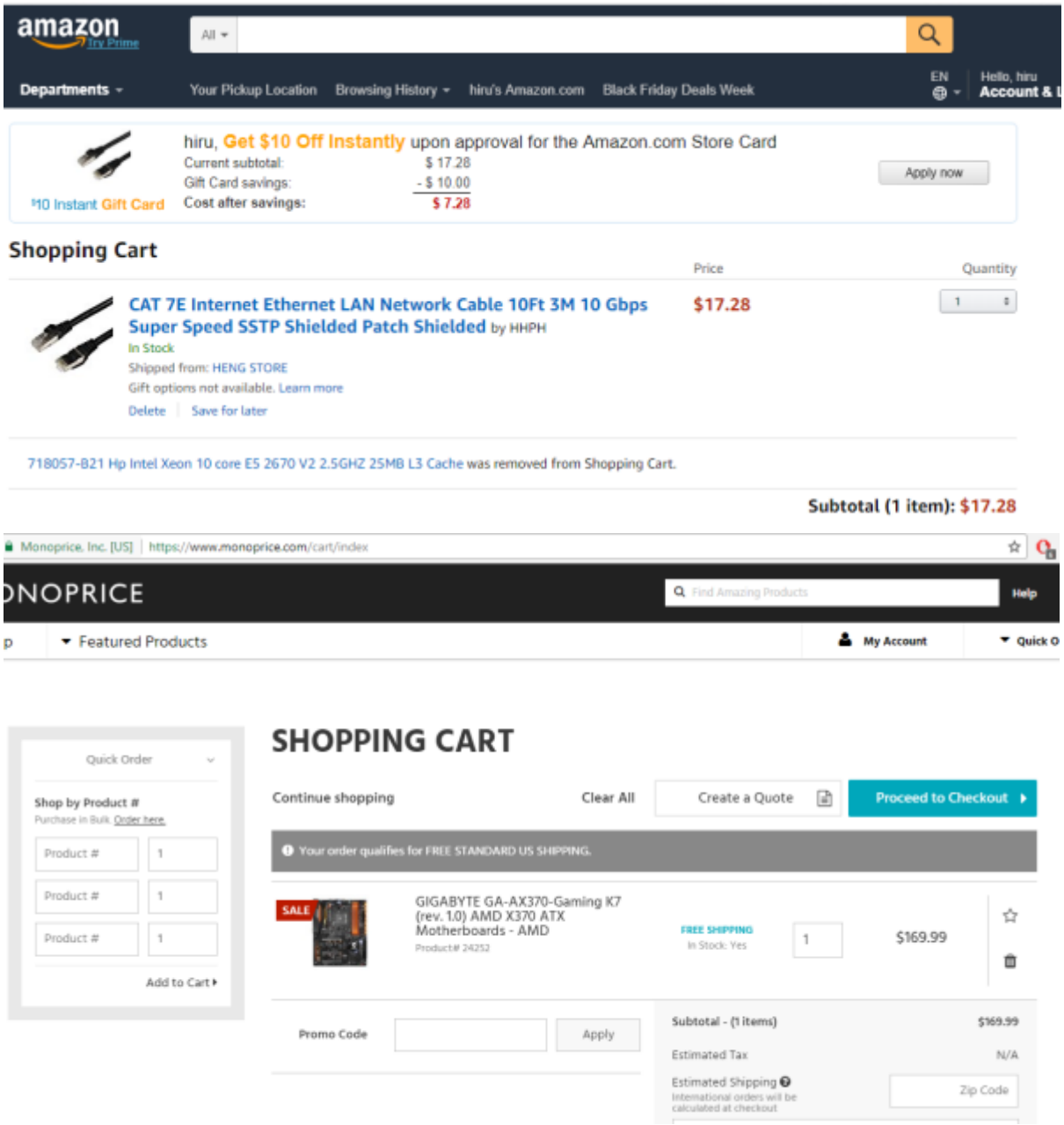
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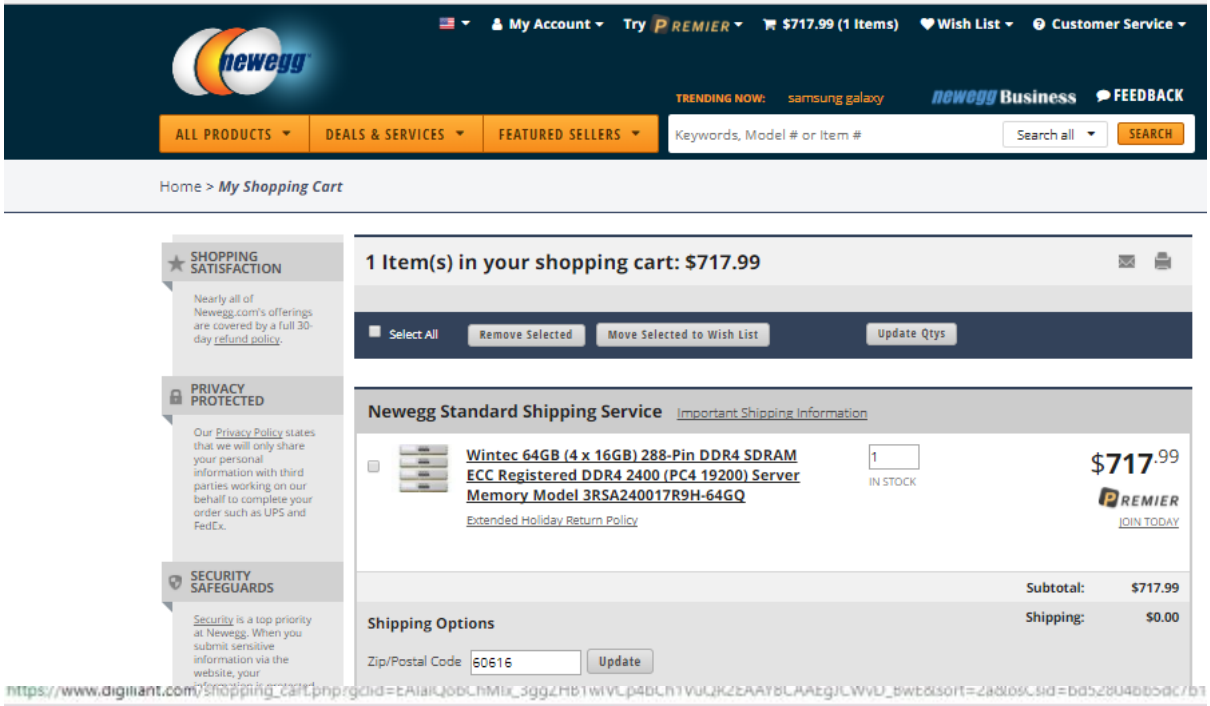

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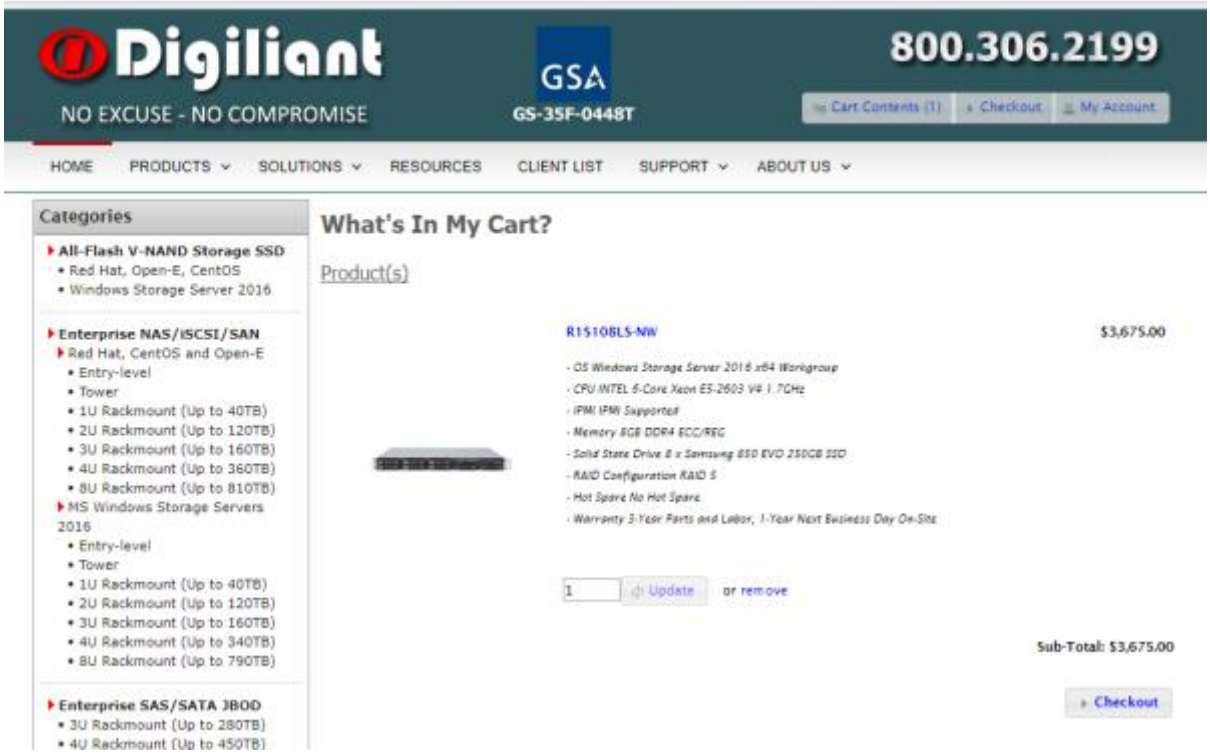

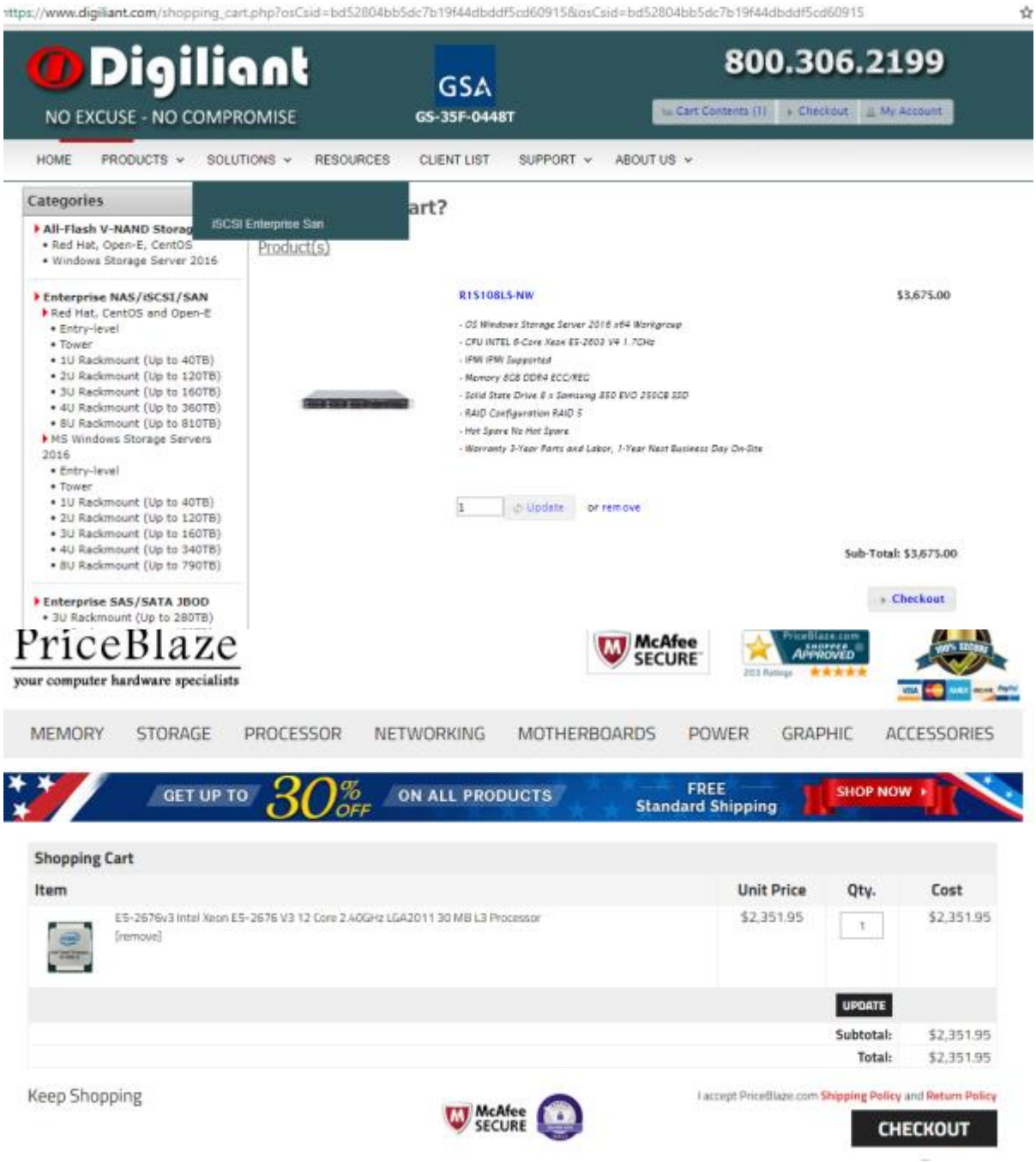
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ASUS X99 Deluxe Motherboard Review - Power Consumption

by Hilbert Hagedoorn on: 08/29/2014 04:58 PM | 7 COMMENT(S)

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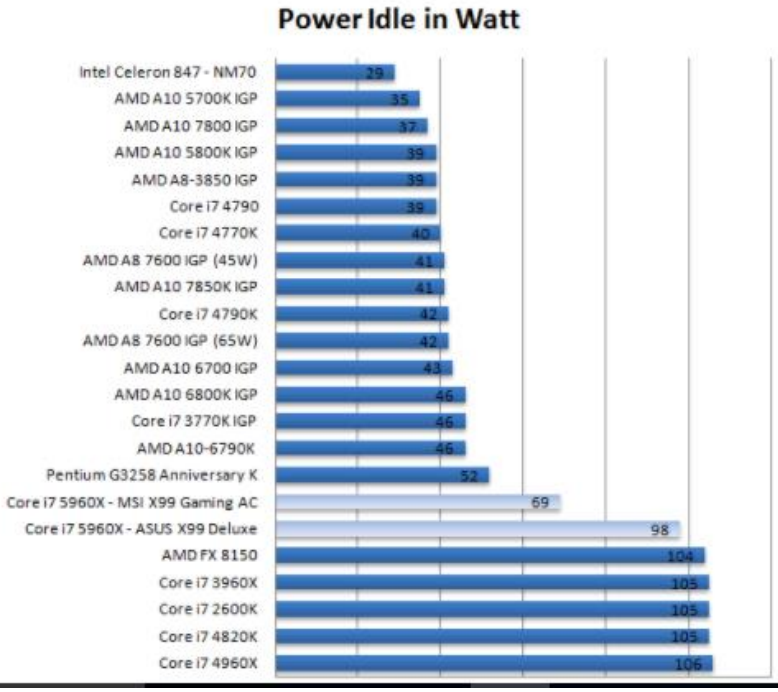
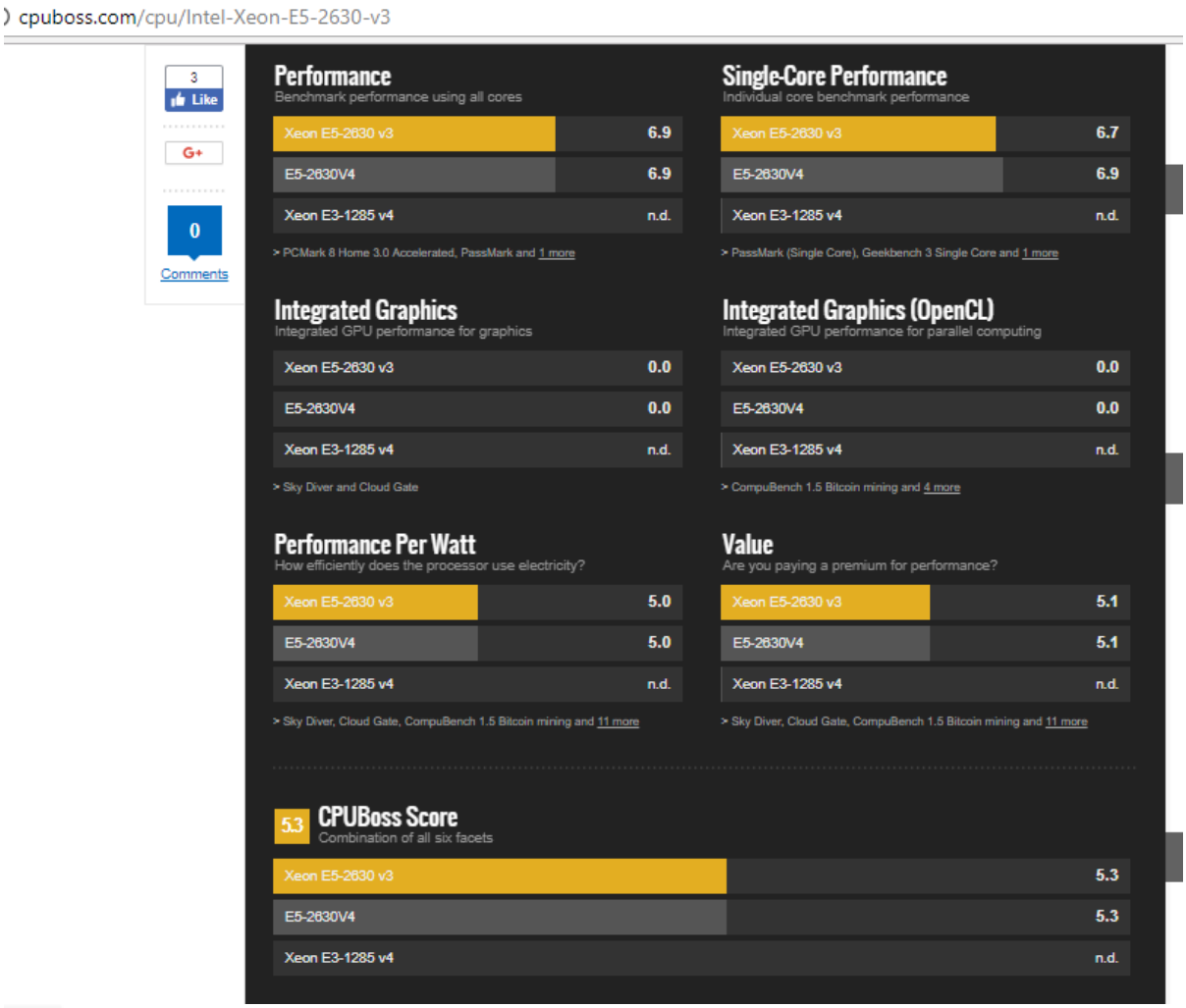
Power Consumption

Here's where we'll slowly move into physically testing the processors and respective motherboard. The new Ivy Bridge-E based processors are a bit of a redesign alright and as a result they are quite energy needy processors with a 140W TDP. What you'll notice a lot, is that in idle these things kick ass in matters of power consumption, whereas at peak TDP they behave quite normally.

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> PCMark 8 Home 3.0 Accelerated, PassMark and 1 more
Single-Core Performance
Individual core benchmark performance
Xeon E5-2630 v3 6.7
E5-2630V4 6.9
Xeon E3-1285 v4 n.d.
> PassMark (Single Core), Geekbench 3 Single Core and 1 more
Integrated Graphics
Integrated GPU performance for graphics
Xeon E5-2630 v3 0.0
E5-2630V4 0.0
Xeon E3-1285 v4 n.d.
> Sky Diver and Cloud Gate
Integrated Graphics (OpenCL)
Integrated GPU performance for parallel computing
Xeon E5-2630 v3 0.0
E5-2630V4 0.0
Xeon E3-1285 v4 n.d.
> CompuBench 1.5 Bitcoin mining and 4 more
Performance Per Watt
How efficiently does the processor use electricity?
Xeon E5-2630 v3 5.0
E5-2630V4 5.0
Xeon E3-1285 v4 n.d.
> Sky Diver, Cloud Gate, CompuBench 1.5 Bitcoin mining and 11 more
Value
Are you paying a premium for performance?
Xeon E5-2630 v3 5.1
E5-2630V4 5.1
Xeon E3-1285 v4 n.d.
> Sky Diver, Cloud Gate, CompuBench 1.5 Bitcoin mining and 11 more
5.3 CPUBoss Score
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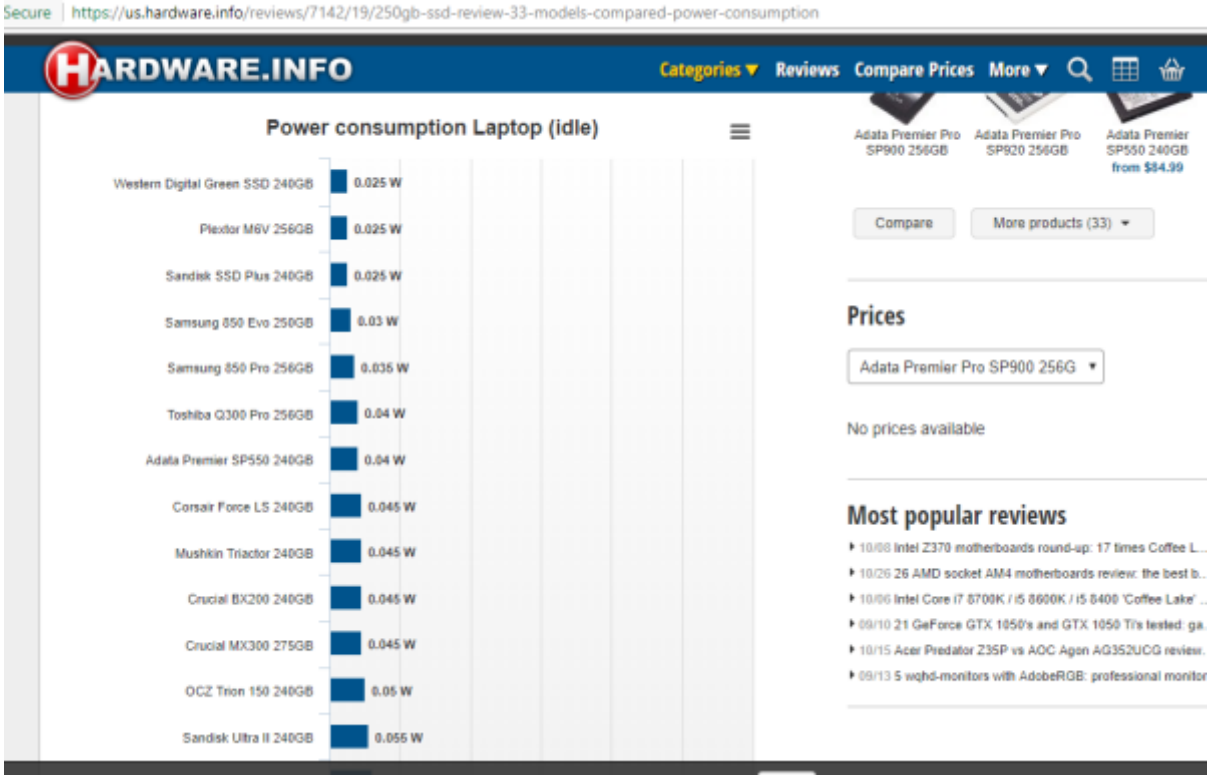
E5-2630V4 5.3
Xeon E3-1285 v4 n.d.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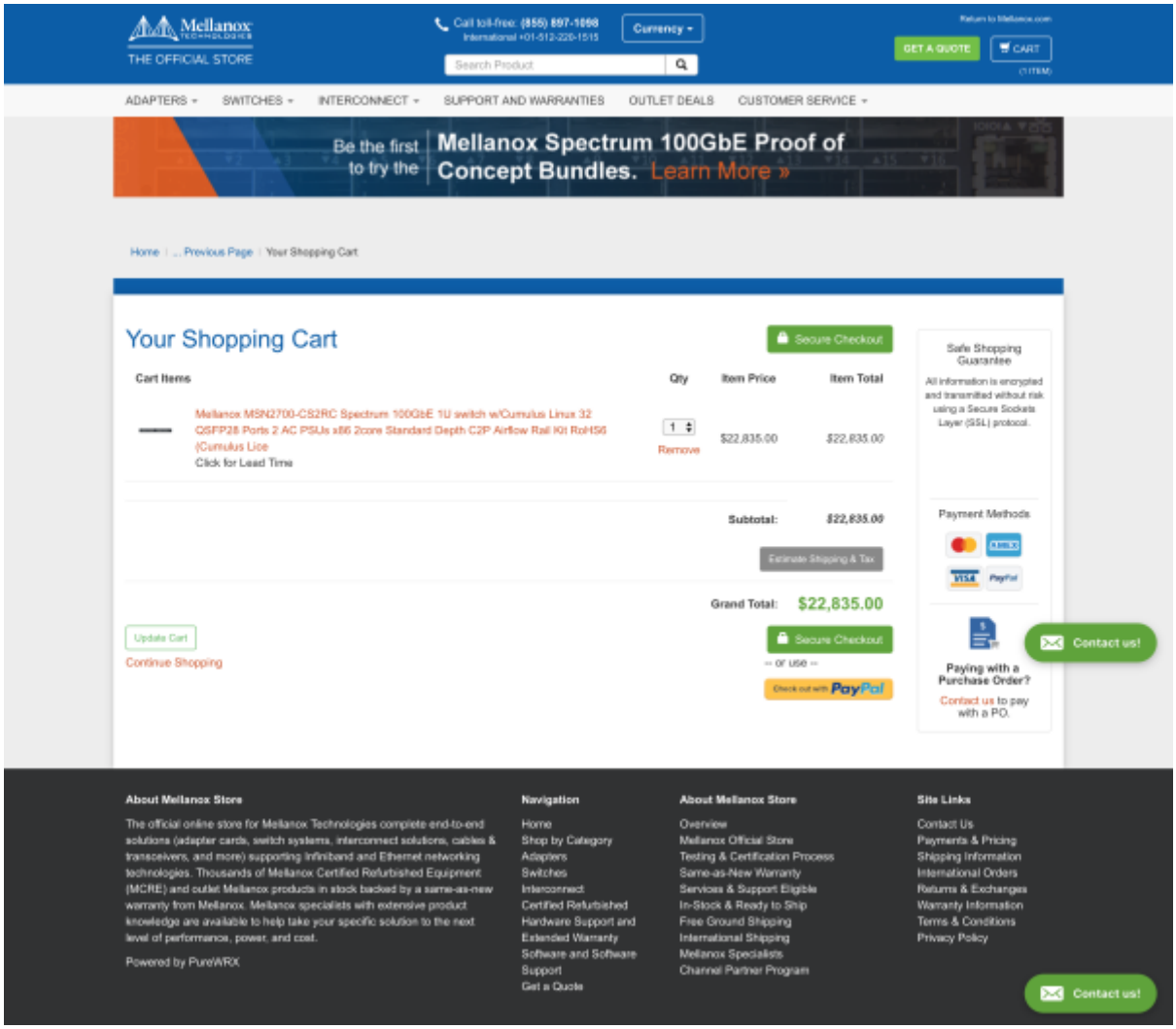
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