

CS441 - HW3

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Documentation for cloud simulations built and performed:

Cloud Architecture:

Data centers: 6

SCHEDULING_INTERVAL = 10

COST_PER_SECOND = 0.001 - 0.01

COST_PER_MEM = 0.007

COST_PER_STORAGE = 0.0001

COST_PER_BW = 0.01

Hosts: 10

HOST_PES = 8 - 16

Host MIPS: 2000 - 50000

HOST_RAM = 16000 - 64000

HOST_BW = 10000 - 100000

HOST_STORAGE = 100000

Logback is used for logging.

Log files are generated in the Log folder.

7 different simulations are performed whose results can be seen as following:

1) Space Shared VM scheduling:

SIMULATION RESULTS												
Cloudlet	Status	DC	Host	Host PEs	VM	VM PEs	CloudletLen	FinishedLen	CloudletPEs	StartTime	FinishTime	ExecTime
-----	-----	--	----	-----	--	-----	-----	-----	-----	-----	-----	-----
ID	ID	ID	CPU cores	ID	CPU cores	MI	MI	CPU cores	Seconds	Seconds	Seconds	Seconds
20	SUCCESS	3	1	8	21	4	100000	100000	4	21	220	200
30	SUCCESS	3	1	8	31	4	100000	100000	4	21	220	200
21	SUCCESS	3	2	8	22	4	100000	100000	4	21	220	200
31	SUCCESS	3	2	8	32	4	100000	100000	4	21	220	200
22	SUCCESS	3	3	8	23	4	100000	100000	4	21	220	200
32	SUCCESS	3	3	8	33	4	100000	100000	4	21	220	200
23	SUCCESS	3	4	8	24	4	100000	100000	4	21	220	200
33	SUCCESS	3	4	8	34	4	100000	100000	4	21	220	200
24	SUCCESS	3	5	8	25	4	100000	100000	4	21	220	200
34	SUCCESS	3	5	8	35	4	100000	100000	4	21	220	200
25	SUCCESS	3	6	8	26	4	100000	100000	4	21	220	200
35	SUCCESS	3	6	8	36	4	100000	100000	4	21	220	200
26	SUCCESS	3	7	8	27	4	100000	100000	4	21	220	200
36	SUCCESS	3	7	8	37	4	100000	100000	4	21	220	200
27	SUCCESS	3	8	8	28	4	100000	100000	4	21	220	200
37	SUCCESS	3	8	8	38	4	100000	100000	4	21	220	200
28	SUCCESS	3	9	8	29	4	100000	100000	4	21	220	200
38	SUCCESS	3	9	8	39	4	100000	100000	4	21	220	200
29	SUCCESS	3	10	8	30	4	100000	100000	4	21	220	200
39	SUCCESS	3	10	8	40	4	100000	100000	4	21	220	200
40	SUCCESS	4	1	8	41	4	100000	100000	4	21	220	200
50	SUCCESS	4	1	8	51	4	100000	100000	4	21	220	200
41	SUCCESS	4	2	8	42	4	100000	100000	4	21	220	200
51	SUCCESS	4	2	8	52	4	100000	100000	4	21	220	200
42	SUCCESS	4	3	8	43	4	100000	100000	4	21	220	200
52	SUCCESS	4	3	8	53	4	100000	100000	4	21	220	200

Costs:

Vm 77 costs (\$)	for	210.32	execution seconds - CPU:	2.10\$	RAM:	28.00\$	Storage:	1.00\$	BW:	10.00\$	Total:	41.10\$
Vm 100 costs (\$)	for	210.32	execution seconds - CPU:	2.10\$	RAM:	28.00\$	Storage:	1.00\$	BW:	10.00\$	Total:	41.10\$
Total cost (\$): processingTotalCost: 214.52\$ memoryTotalCost: 2800.00\$ storageTotalCost: 100.00\$ bwTotalCost: 1000.00\$ totalCost: 4114.52\$												

Power:

VM	20	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	30	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	40	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	50	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	60	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	70	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	80	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	90	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	100	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W

2) Time Shared VM scheduling:

SIMULATION RESULTS												
Cloudlet	Status	DC	Host	Host PEs	VM	VM PEs	CloudletLen	FinishedLen	CloudletPEs	StartTime	FinishTime	ExecTime
-----	-----	--	----	-----	--	-----	-----	-----	-----	-----	-----	-----
ID		ID	ID	CPU cores	ID	CPU cores	MI	MI	CPU cores	Seconds	Seconds	Seconds
40	SUCCESS	3	1	8	41	4	100000	100000	4	20	220	200
50	SUCCESS	3	1	8	51	4	100000	100000	4	20	220	200
60	SUCCESS	3	1	8	61	4	100000	100000	4	20	220	200
61	SUCCESS	3	1	8	62	4	100000	100000	4	20	220	200
41	SUCCESS	3	2	8	42	4	100000	100000	4	20	220	200
51	SUCCESS	3	2	8	52	4	100000	100000	4	20	220	200
62	SUCCESS	3	2	8	63	4	100000	100000	4	20	220	200
63	SUCCESS	3	2	8	64	4	100000	100000	4	20	220	200
42	SUCCESS	3	3	8	43	4	100000	100000	4	20	220	200
52	SUCCESS	3	3	8	53	4	100000	100000	4	20	220	200
64	SUCCESS	3	3	8	65	4	100000	100000	4	20	220	200
65	SUCCESS	3	3	8	66	4	100000	100000	4	20	220	200
43	SUCCESS	3	4	8	44	4	100000	100000	4	20	220	200
53	SUCCESS	3	4	8	54	4	100000	100000	4	20	220	200
66	SUCCESS	3	4	8	67	4	100000	100000	4	20	220	200
67	SUCCESS	3	4	8	68	4	100000	100000	4	20	220	200
44	SUCCESS	3	5	8	45	4	100000	100000	4	20	220	200
54	SUCCESS	3	5	8	55	4	100000	100000	4	20	220	200
68	SUCCESS	3	5	8	69	4	100000	100000	4	20	220	200
69	SUCCESS	3	5	8	70	4	100000	100000	4	20	220	200
45	SUCCESS	3	6	8	46	4	100000	100000	4	20	220	200
55	SUCCESS	3	6	8	56	4	100000	100000	4	20	220	200
70	SUCCESS	3	6	8	71	4	100000	100000	4	20	220	200
71	SUCCESS	3	6	8	72	4	100000	100000	4	20	220	200
46	SUCCESS	3	7	8	47	4	100000	100000	4	20	220	200
56	SUCCESS	3	7	8	57	4	100000	100000	4	20	220	200
72	SUCCESS	3	7	8	73	4	100000	100000	4	20	220	200
73	SUCCESS	3	7	8	74	4	100000	100000	4	20	220	200
47	SUCCESS	3	8	8	48	4	100000	100000	4	20	220	200
57	SUCCESS	3	8	8	58	4	100000	100000	4	20	220	200
74	SUCCESS	3	8	8	75	4	100000	100000	4	20	220	200

Costs:

Vm 99 costs (\$)	for	210.32	execution seconds - CPU:	2.10\$	RAM:	28.00\$	Storage:	1.00\$	BW:	10.00\$	Total:	41.10\$
Vm 100 costs (\$)	for	210.32	execution seconds - CPU:	2.10\$	RAM:	28.00\$	Storage:	1.00\$	BW:	10.00\$	Total:	41.10\$
Total cost (\$): processingTotalCost: 218.44\$ memoryTotalCost: 2800.00\$ storageTotalCost: 100.00\$ bwTotalCost: 1000.00\$ totalCost: 4118.44\$												

Power:

VM	79	CPU Usage Mean:	95.2%	Power Consumption Mean:	16 W
VM	80	CPU Usage Mean:	95.2%	Power Consumption Mean:	16 W
VM	90	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W
VM	100	CPU Usage Mean:	95.2%	Power Consumption Mean:	31 W

Observation: Both Space Shared and Time Shared simulations were run with similar configurations. The Space Shared policy cloud turned out to be slightly cost effective.

3) IaaS Simulation:

```
SIMULATION RESULTS

|Cloudlet|Status |DC|Host|Host PEs |VM|VM PEs  |CloudletLen|FinishedLen|CloudletPEs|StartTime|FinishTime|ExecTime
|-----|-----|--|----|-----|--|-----|-----|-----|-----|-----|-----|-----
|      ID|      |ID| ID|CPU cores|ID|CPU cores|      MI|      MI| CPU cores|  Seconds|  Seconds| Seconds

SIMULATION RESULTS

|Cloudlet|Status |DC|Host|Host PEs |VM|VM PEs  |CloudletLen|FinishedLen|CloudletPEs|StartTime|FinishTime|ExecTime
|-----|-----|--|----|-----|--|-----|-----|-----|-----|-----|-----|-----
|      ID|      |ID| ID|CPU cores|ID|CPU cores|      MI|      MI| CPU cores|  Seconds|  Seconds| Seconds

SIMULATION RESULTS

|Cloudlet|Status |DC|Host|Host PEs |VM|VM PEs  |CloudletLen|FinishedLen|CloudletPEs|StartTime|FinishTime|ExecTime
|-----|-----|--|----|-----|--|-----|-----|-----|-----|-----|-----|-----
|      ID|      |ID| ID|CPU cores|ID|CPU cores|      MI|      MI| CPU cores|  Seconds|  Seconds| Seconds

Host 1 CPU Usage mean:      NaN% | Power Consumption mean:      NaN W
Host 2 CPU Usage mean:      NaN% | Power Consumption mean:      NaN W
Host 3 CPU Usage mean:      NaN% | Power Consumption mean:      NaN W
Host 4 CPU Usage mean:      NaN% | Power Consumption mean:      NaN W
Host 5 CPU Usage mean:      NaN% | Power Consumption mean:      NaN W
Host 6 CPU Usage mean:      NaN% | Power Consumption mean:      NaN W
Host 7 CPU Usage mean:      NaN% | Power Consumption mean:      NaN W
Host 8 CPU Usage mean:      NaN% | Power Consumption mean:      NaN W
```

Hosts are created, waiting for the creation of VMs and Cloudlets by the brokers.

Datacenter 6 is designated for IaaS clouds.

All IaaS brokers connect to Datacenter 6.

```
INFO Host is using Space Shared Policy for Scheduling VMs.
INFO Automatically enabling computation of utilization statistics for
INFO BrokerBroker 7 connecting to Datacenter 6
INFO BrokerBroker 8 connecting to Datacenter 6
INFO BrokerBroker 9 connecting to Datacenter 6
INFO
===== Starting CloudSim Plus 7.3.0 =====
```

4) PaaS Simulation:

Website Hosting Service:

This simulation shows that the VMs are created for the user and that there is some power consumed by the running VMs. There is no cost accrued yet as there is nothing deployed on the service.

SIMULATION RESULTS

Cloudlet	Status	DC	Host	Host PEs	VM	VM PEs	CloudletLen	FinishedLen	CloudletPEs	StartTime	FinishTime	ExecTime
-----	-----	--	----	-----	--	-----	-----	-----	-----	-----	-----	-----
	ID	ID	ID	CPU cores	ID	CPU cores	MI	MI	CPU cores	Seconds	Seconds	Seconds
VM	1	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	2	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	3	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	4	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	5	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	6	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	7	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	8	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	9	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	10	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			

SIMULATION RESULTS

Cloudlet	Status	DC	Host	Host PEs	VM	VM PEs	CloudletLen	FinishedLen	CloudletPEs	StartTime	FinishTime	ExecTime
-----	-----	--	----	-----	--	-----	-----	-----	-----	-----	-----	-----
	ID	ID	ID	CPU cores	ID	CPU cores	MI	MI	CPU cores	Seconds	Seconds	Seconds
VM	1	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	2	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	3	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	4	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	5	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	6	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	7	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	8	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	9	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			
VM	10	CPU Usage	Mean:	0.0%		Power Consumption	Mean:	8	W			

5) SaaS Simulations:

1) Email Application:

This is a large application with a lot of users worldwide, so the data centers have higher configurations and lower service costs.

New datacenter is assigned, once the previous is overloaded.

SIMULATION RESULTS												
Cloudlet	Status	DC	Host	Host PEs	VM	VM PEs	CloudletLen	FinishedLen	CloudletPEs	StartTime	FinishTime	ExecTime
-----	-----	--	----	-----	--	-----	-----	-----	-----	-----	-----	-----
ID		ID	ID	CPU cores	ID	CPU cores	MI	MI	CPU cores	Seconds	Seconds	Seconds
150	SUCCESS	5	1	8	151	8	100000	100000	8	21	120	100
350	SUCCESS	5	1	8	151	8	100000	100000	8	21	120	100
160	SUCCESS	5	1	8	161	8	100000	100000	8	21	120	100
360	SUCCESS	5	1	8	161	8	100000	100000	8	21	120	100
161	SUCCESS	5	1	8	162	8	100000	100000	8	21	120	100
361	SUCCESS	5	1	8	162	8	100000	100000	8	21	120	100
162	SUCCESS	5	1	8	163	8	100000	100000	8	21	120	100
362	SUCCESS	5	1	8	163	8	100000	100000	8	21	120	100
163	SUCCESS	5	1	8	164	8	100000	100000	8	21	120	100
363	SUCCESS	5	1	8	164	8	100000	100000	8	21	120	100
151	SUCCESS	5	2	8	152	8	100000	100000	8	21	120	100
351	SUCCESS	5	2	8	152	8	100000	100000	8	21	120	100
164	SUCCESS	5	2	8	165	8	100000	100000	8	21	120	100
364	SUCCESS	5	2	8	165	8	100000	100000	8	21	120	100
165	SUCCESS	5	2	8	166	8	100000	100000	8	21	120	100
365	SUCCESS	5	2	8	166	8	100000	100000	8	21	120	100
166	SUCCESS	5	2	8	167	8	100000	100000	8	21	120	100
366	SUCCESS	5	2	8	167	8	100000	100000	8	21	120	100
167	SUCCESS	5	2	8	168	8	100000	100000	8	21	120	100
367	SUCCESS	5	2	8	168	8	100000	100000	8	21	120	100
152	SUCCESS	5	3	8	153	8	100000	100000	8	21	120	100
352	SUCCESS	5	3	8	153	8	100000	100000	8	21	120	100
168	SUCCESS	5	3	8	169	8	100000	100000	8	21	120	100
368	SUCCESS	5	3	8	169	8	100000	100000	8	21	120	100
169	SUCCESS	5	3	8	170	8	100000	100000	8	21	120	100
369	SUCCESS	5	3	8	170	8	100000	100000	8	21	120	100
170	SUCCESS	5	3	8	171	8	100000	100000	8	21	120	100
370	SUCCESS	5	3	8	171	8	100000	100000	8	21	120	100

Costs and power:

Vm 199 costs (\$)	for	184.11	execution seconds - CPU:	0.17\$	RAM:	28.00\$	Storage:	1.00\$	BW:	10.00\$	Total:	39.17\$
Vm 200 costs (\$)	for	184.11	execution seconds - CPU:	0.17\$	RAM:	28.00\$	Storage:	1.00\$	BW:	10.00\$	Total:	39.17\$
Total cost (\$):	processingTotalCost:	26.15\$	memoryTotalCost:	5600.00\$	storageTotalCost:	200.00\$	bwTotalCost:	2000.00\$	totalCost:	7826.15\$		
VM	1	CPU Usage Mean:	0.0%	Power Consumption Mean:	5	W						
VM	11	CPU Usage Mean:	0.0%	Power Consumption Mean:	5	W						
VM	12	CPU Usage Mean:	0.0%	Power Consumption Mean:	5	W						

2) Video Editing Application:

An application with less use but more required cloud resources. It has a lesser cost compared to the Email application but it gets costlier as the number of cloudlets increase.

SIMULATION RESULTS												
Cloudlet	Status	DC	Host	Host PEs	VM	VM PEs	CloudletLen	FinishedLen	CloudletPEs	StartTime	FinishTime	ExecTime
-----	-----	--	----	-----	--	-----	-----	-----	-----	-----	-----	-----
ID		ID	ID	CPU cores	ID	CPU cores	MI	MI	CPU cores	Seconds	Seconds	Seconds
40	SUCCESS	4	1	16	41	4	100000	100000	4	21	220	200
140	SUCCESS	4	1	16	41	4	100000	100000	4	21	220	200
50	SUCCESS	4	1	16	51	4	100000	100000	4	21	220	200
150	SUCCESS	4	1	16	51	4	100000	100000	4	21	220	200
60	SUCCESS	4	1	16	61	4	100000	100000	4	21	220	200
160	SUCCESS	4	1	16	61	4	100000	100000	4	21	220	200
70	SUCCESS	4	1	16	71	4	100000	100000	4	21	220	200
170	SUCCESS	4	1	16	71	4	100000	100000	4	21	220	200
41	SUCCESS	4	2	16	42	4	100000	100000	4	21	220	200
141	SUCCESS	4	2	16	42	4	100000	100000	4	21	220	200
51	SUCCESS	4	2	16	52	4	100000	100000	4	21	220	200
151	SUCCESS	4	2	16	52	4	100000	100000	4	21	220	200
61	SUCCESS	4	2	16	62	4	100000	100000	4	21	220	200
161	SUCCESS	4	2	16	62	4	100000	100000	4	21	220	200
71	SUCCESS	4	2	16	72	4	100000	100000	4	21	220	200
171	SUCCESS	4	2	16	72	4	100000	100000	4	21	220	200
42	SUCCESS	4	3	16	43	4	100000	100000	4	21	220	200
142	SUCCESS	4	3	16	43	4	100000	100000	4	21	220	200
52	SUCCESS	4	3	16	53	4	100000	100000	4	21	220	200
152	SUCCESS	4	3	16	53	4	100000	100000	4	21	220	200

Costs and power:

Vm 98 costs (\$)	for 204.21 execution seconds	- CPU: 0.20\$ RAM: 28.00\$ Storage: 0.50\$ BW: 20.00\$ Total: 48.70\$
Vm 99 costs (\$)	for 204.21 execution seconds	- CPU: 0.20\$ RAM: 28.00\$ Storage: 0.50\$ BW: 20.00\$ Total: 48.70\$
Vm 100 costs (\$)	for 204.21 execution seconds	- CPU: 0.20\$ RAM: 28.00\$ Storage: 0.50\$ BW: 20.00\$ Total: 48.70\$
Total cost (\$): processingTotalCost: 12.82\$ memoryTotalCost: 2800.00\$ storageTotalCost: 50.00\$ bwTotalCost: 2000.00\$ totalCost: 4862.82\$		
VM 1 CPU Usage Mean:	0.0% Power Consumption Mean:	6 W
VM 11 CPU Usage Mean:	0.0% Power Consumption Mean:	6 W
VM 21 CPU Usage Mean:	0.0% Power Consumption Mean:	6 W

7) Cloud Network Simulation:

This network example has 5 edge switches configured between 20 hosts. It makes use of a network datacenter, network hosts, network VMs and network cloudlets to make the data transfers possible.

SIMULATION RESULTS												
Cloudlet	Status	DC	Host	Host PEs	VM	VM PEs	CloudletLen	FinishedLen	CloudletPEs	StartTime	FinishTime	ExecTime
-----	-----	--	----	-----	--	-----	-----	-----	-----	-----	-----	-----
ID		ID	ID	CPU cores	ID	CPU cores	MI	MI	CPU cores	Seconds	Seconds	Seconds
0	SUCCESS	1	0	8	1	4	100000	100000	2	0	100	100
1	SUCCESS	1	1	8	2	4	100000	100000	2	0	100	100
2	SUCCESS	1	2	8	3	4	100000	100000	2	0	100	100
3	SUCCESS	1	3	8	4	4	100000	100000	2	0	100	100
4	SUCCESS	1	4	8	5	4	100000	100000	2	0	100	100
5	SUCCESS	1	5	8	6	4	100000	100000	2	0	100	100
6	SUCCESS	1	6	8	7	4	100000	100000	2	0	100	100
7	SUCCESS	1	7	8	8	4	100000	100000	2	0	100	100
8	SUCCESS	1	8	8	9	4	100000	100000	2	0	100	100
9	SUCCESS	1	9	8	10	4	100000	100000	2	0	100	100
10	SUCCESS	1	10	8	11	4	100000	100000	2	0	105	105
11	SUCCESS	1	11	8	12	4	100000	100000	2	0	105	105
12	SUCCESS	1	12	8	13	4	100000	100000	2	0	105	105
13	SUCCESS	1	13	8	14	4	100000	100000	2	0	105	105
14	SUCCESS	1	14	8	15	4	100000	100000	2	0	105	105
15	SUCCESS	1	15	8	16	4	100000	100000	2	0	105	105
16	SUCCESS	1	16	8	17	4	100000	100000	2	0	105	105
17	SUCCESS	1	17	8	18	4	100000	100000	2	0	105	105
18	SUCCESS	1	18	8	19	4	100000	100000	2	0	105	105
19	SUCCESS	1	19	8	20	4	100000	100000	2	0	105	105
Host 0 data transferred: 1000 bytes												
Host 1 data transferred: 1000 bytes												
Host 2 data transferred: 1000 bytes												
Host 3 data transferred: 1000 bytes												
Host 4 data transferred: 1000 bytes												
Host 5 data transferred: 1000 bytes												
Host 6 data transferred: 1000 bytes												