



Selection of Virtual Machines Based on Classification of MapReduce Jobs

Adam Pasqua Blaisse, Zachary Andrew Wagner, and Jie Wu

Department of Computer and Information Sciences, Temple University

Cloud Computing

- Large number of physical machines (PM)
- Strongly networked together
- Resources sold on an hourly basis as virtual machines (VM)
- Eucalyptus
- Amazon EC2

The logo for Eucalyptus, featuring a stylized green square icon to the left of the word "EUCALYPTUS" in a bold, blue, sans-serif font.

Region:

	vCPU	ECU	Memory (GiB)	Instance Storage (GB)	Linux/UNIX Usage
General Purpose - Current Generation					
t2.micro	1	Variable	1	EBS Only	\$0.013 per Hour
t2.small	1	Variable	2	EBS Only	\$0.026 per Hour
t2.medium	2	Variable	4	EBS Only	\$0.052 per Hour
m3.medium	1	3	3.75	1 x 4 SSD	\$0.070 per Hour
m3.large	2	6.5	7.5	1 x 32 SSD	\$0.140 per Hour
m3.xlarge	4	13	15	2 x 40 SSD	\$0.280 per Hour
m3.2xlarge	8	26	30	2 x 80 SSD	\$0.560 per Hour

Motivation

- Find the minimal virtual machine that will run a Map Reduce job as fast as possible

Map Reduce

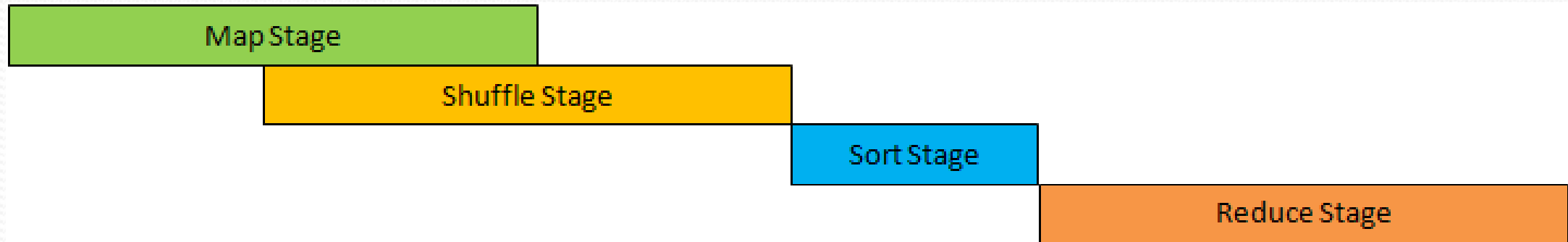
- Programming Paradigm for distributed computing
- Two phases
 - Map Phase
 - Reduce Phase
- Apache Hadoop
 - Open source implementation used

Map Reduce

- Map
 - Many small Map tasks
 - Each task takes a small chunk of data
 - Turn the data into Key value pair (i.e <the,1>)
 - Number of Map tasks varies based on input data size
 - When all Map task are finished data is Pasted to the Reduce Phase
- Reduce
 - Very few set number of Reduce tasks
 - Combine all the input key value pairs from the maps
 - Also takes care of shuffling data from Map Locations to Reduce Locations

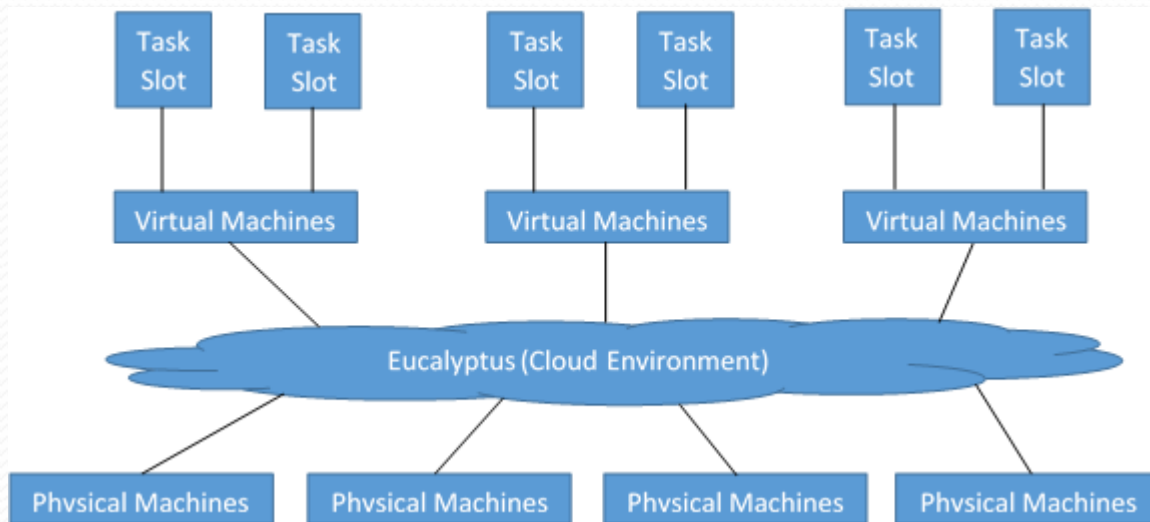
Map Reduce

- Reduce
 - All Mapping must finish before Reducing can start
 - Shuffling can start before Mapping ends



Issues when Used Together

- Some jobs run better on different configurations of virtual machines
- Different configurations of virtual machines have different costs
- Some jobs may need more CPU's while others may need I/O



TCloud Test Bed

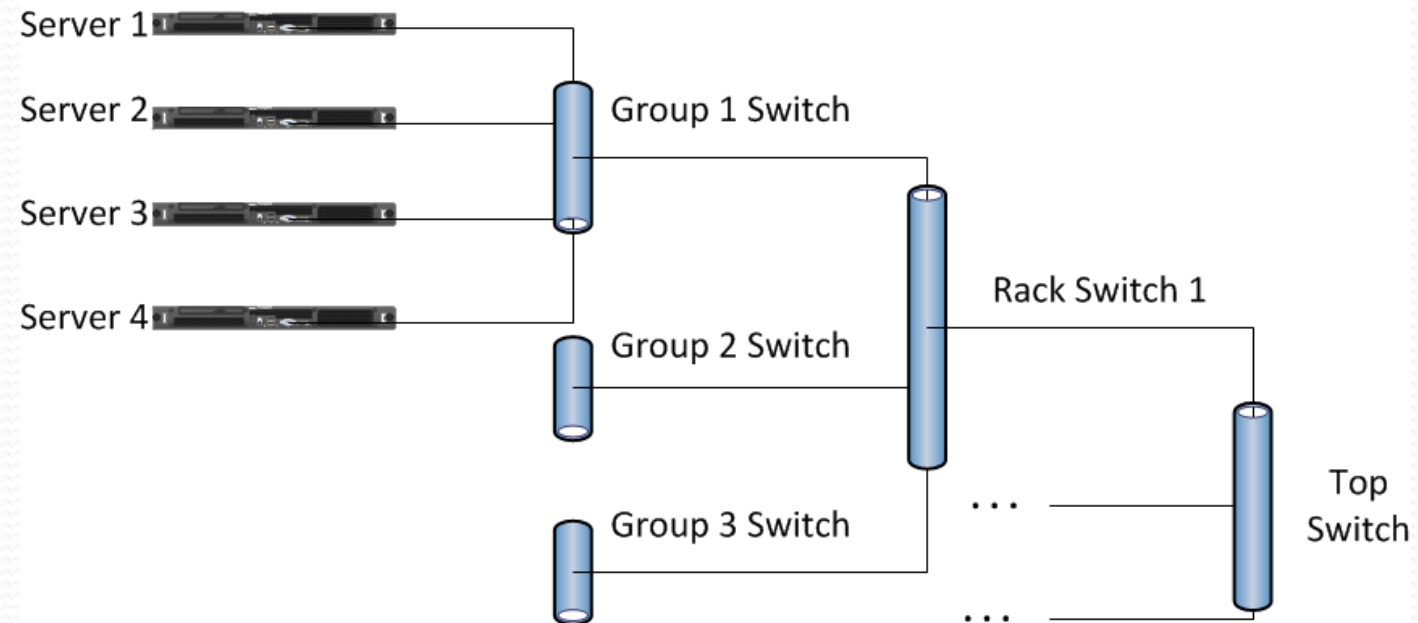
- Hardware
 - 12 Dell Power Edge R614 Servers
 - 96 conventional CPU Cores
 - 4-Way redundant 10 GB Ethernet
 - 2-Way redundant InfiniBand
- Software
 - Eucalyptus 3.3 (Amazon EC2 compatible)

Net Cloud (Physical Cluster)

- Hardware
 - 32 Dell PowerEdge R210 servers
 - Each server has
 - 4 GB of RAM Memory
 - 500 GB HDD
- Software
 - Hadoop version 1.2.1
 - CentOS 6.6

Net Cloud (continued)

- Networking
 - Tree like structure
 - 4 machines to 1 group switch
 - 4 group switches to 1 rack switch
 - 2 rack switches connected to 1 Top Switch



Our Approach

- Attempt to classify tasks into two types
 - CPU Based Jobs
 - Jobs spent more time doing CPU work then I/O
 - Jobs need more CPUS's and less I/O
 - Smaller more numerous machines
 - I/O Based Tasks
 - Jobs spent more time doing I/O work then CPU
 - Jobs need more I/O and less CPU
 - Less Larger Machines

Mapping to machines

- If a job is classified as
 - CPU Bound Job
 - Many virtual machines
 - Little memory per virtual machine
 - I/O Bound Job
 - Fewer virtual machines
 - Each virtual machine has larger amounts of memory

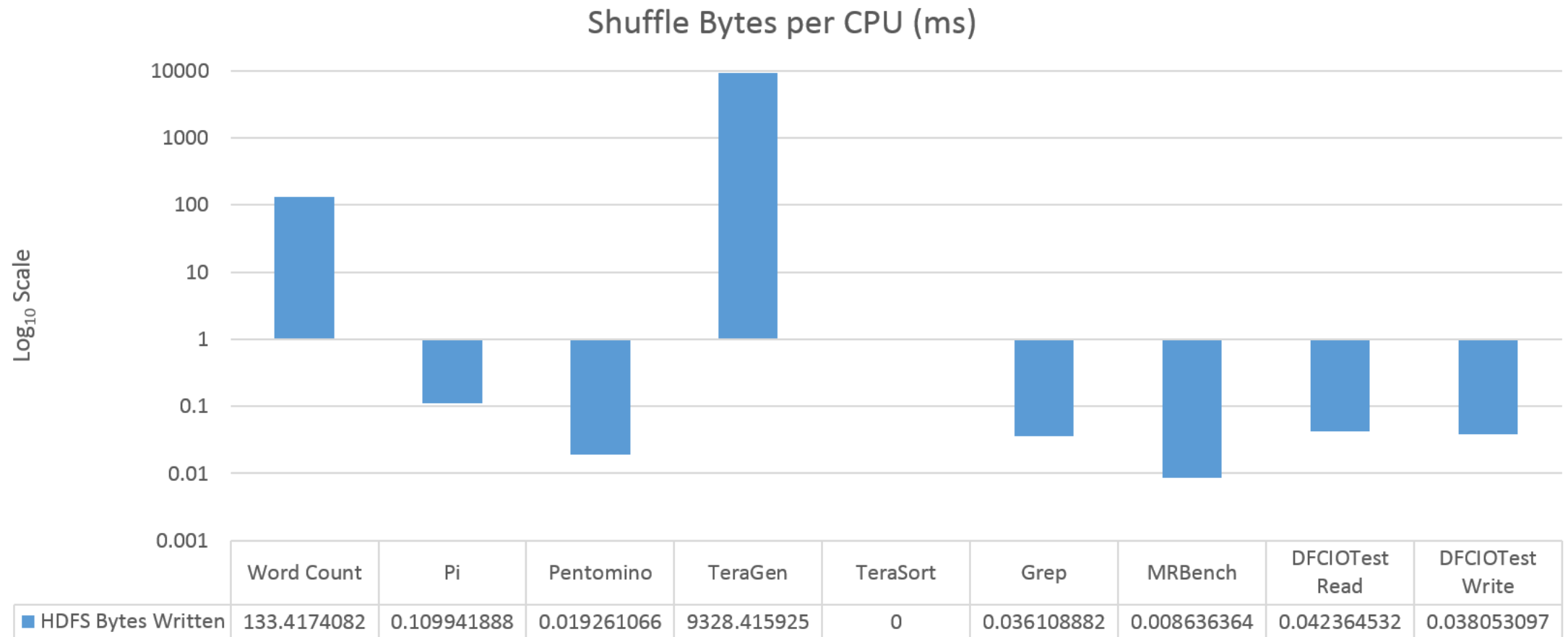
Why?

- If a job is I/O bound
 - Would like to keep job running in memory rather than hit HDD
 - I/O more important than number of cores
- If a job is CPU bound
 - More important to have many cores running the maps
 - Less likely to hit HDD while running

How to classify

- Metrics
 - Shuffle_bytes
 - CPU_time
- $(\text{Shuffle_bytes}/\text{CPU_time})$
 - Take the average of the map tasks
 - If value is over 1, then job is I/O Bound
 - Else CPU Bound

Results from Physical Machine runs



Results on the Virtual Clusters

Job	Large Time (S)	Small Time (S)
Word Count	257.2338	235.2299
PI	473.3364	419.88242
Pentomino	408.1599 &	355.0055
TeraSort	603.9358	183.1389
TeraGen	89.2324	116.62483
Grep	217.8305	188.0857
MRBench	21.0116	18.6668
DFSCIOtest read	24.5882	19.5072
DFSCIOtest write	25.2971	20.2712

Conclusion

- Selection is quick and simple
- Most jobs are mapped to the correct virtual machine type

Questions?

- Contact

- Adam.blaisse@temple.edu
- Astro.temple.edu/~tuc47904