



CLOUD COMPUTING CONCEPTS

with Indranil Gupta (Indy)

INTRODUCTION TO CLOUDS

Lecture E

NEW ASPECTS OF CLOUDS

II. ON-DEMAND ACCESS: ★AAS CLASSIFICATION

On-demand: renting a cab vs. (previously) renting a car, or buying one. Ex.:

- AWS Elastic Compute Cloud (EC2): a few cents to a few \$ per CPU hour
- AWS Simple Storage Service (S3): a few cents to a few \$ per GB-month
- **HaaS: Hardware as a Service**
 - You get access to barebones hardware machines, do whatever you want with them, ex: your own cluster
 - Not always a good idea because of security risks
- **IaaS: Infrastructure as a Service**
 - You get access to flexible computing and storage infrastructure. Virtualization is one way of achieving this (what's another way, e.g., using Linux). Often said to subsume HaaS.
 - Ex: Amazon Web Services (AWS: EC2 and S3), Eucalyptus, Rightscale, Microsoft Azure



II. ON-DEMAND ACCESS: ★AAS CLASSIFICATION

- PaaS: Platform as a Service
 - You get access to flexible computing and storage infrastructure, coupled with a software platform (often tightly)
 - Ex: Google' s AppEngine/Compute Engine (Python, Java, Go)
- SaaS: Software as a Service
 - You get access to software services, when you need them. Often said to subsume SOA (Service-Oriented Architectures).
 - Ex: Google docs, MS Office on demand

III. DATA-INTENSIVE COMPUTING

- Computation-Intensive Computing
 - Example areas: MPI-based, high-performance computing, grids
 - Typically run on supercomputers (e.g., NCSA Blue Waters)
- Data-Intensive
 - Typically store data at datacenters
 - Use compute nodes nearby
 - Compute nodes run computation services
- In data-intensive computing, the **focus shifts from computation to the data**: CPU utilization no longer the most important resource metric, instead I/O is (disk and/or network)

IV. NEW CLOUD PROGRAMMING PARADIGMS

- Easy to write and run highly parallel programs in new cloud programming paradigms:
 - Google: MapReduce and Sawzall
 - Amazon: Elastic MapReduce service (pay-as-you-go)
 - Google (MapReduce)
 - Indexing: a chain of 24 MapReduce jobs
 - ~200K jobs processing 50PB/month (in 2006)
 - Yahoo! (Hadoop + Pig)
 - WebMap: a chain of 100 MapReduce jobs
 - 280 TB of data, 2500 nodes, 73 hours
 - Facebook (Hadoop + Hive)
 - ~300TB total, adding 2TB/day (in 2008)
 - 3K jobs processing 55TB/day
 - Similar numbers from other companies, e.g., Yeldex, eharmony.com, etc.
 - NoSQL: MySQL is an industry standard, but Cassandra is 2400 times faster!

