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 (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., Yieldex, eharmony.com, etc.
  - NoSQL: MySQL is an industry standard, but Cassandra is 2400 times faster!