Mobile and Cloud Computing Seminar

MTAT.03.280

Spring 2015

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Course Purpose

• To have a platform to discuss the research developments of Mobile & Cloud Lab
• Introduce students to newest concepts and advances in the respective research fields
• To give students a feel of theses topics available from Mobile & Cloud Lab
• Preliminary platform for the students to understand their prospective Master/Bachelor theses better
• Help students in preparing proper technical reports
• Help students in making proper presentations
To pass the course

- Write a report on a chosen topic
  - At least 6 pages of ACM double column format
- Peer review the work of your colleagues
- Give an oral presentation on the topic
- Demonstrate their work
- Participate actively in all the seminars
Course schedule

• Thursday 14.15 - 16.00, J. Liivi 2- 611

• Schedule of the sessions

https://courses.cs.ut.ee/2015/mcsem/spring
Related Courses

• **MTAT.08.027** Basics of Cloud Computing (3 ECTS)

• **MTAT.08.036** Large-scale Data Processing on the Cloud (3 ECTS)

• **MTAT.03.266** Mobile Application Development Projects (3 ECTS)

• **MTAT.03.262** Mobile Application Development (3 ECTS)
RESEARCH AT MOBILE & CLOUD LAB
Cloud Computing

• Computing as a utility
  – Utility services e.g. water, electricity, gas etc
  – Consumers pay based on their usage

• Cloud Computing characteristics
  – Illusion of infinite resources
  – No up-front cost
  – Fine-grained billing (e.g. hourly)

• Gartner: “Cloud computing is a style of computing where massively scalable IT-related capabilities are provided ‘as a service’ across the Internet to multiple external customers”
Cloud based Research

• We are one among the top 10 producers of cloud based research results [Heilig and Voß, TCC 2014]

• Migrating enterprise applications to the cloud
  – Optimal Resource Provisioning for Scaling Enterprise Applications on the Cloud
  – Based on LP mathematical model

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CloudML

• Deployment description of cloud based applications [REMICS]
  – Developed to tame cloud heterogeneity
• DSL based on Java-based metamodel
  – Nodes, artefacts and bindings can be defined
• Different means to manipulate CloudML models
  – Programmatically via Java API
  – Declaratively, via serialized model (JSON)
• Models@Runtime
  – Dynamic deployment of CloudML based models

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Scientific Computing on the Cloud (SciCloud)

• Scientific computing is usually associated with large scale computer modeling and simulation
  – Usually requires large amounts of computer resources

• Clouds promise virtually infinite resources
  – Probably good for HPC!!! Are they?

• Scientific Computing on the Cloud
  – Benefit from Cloud characteristics like elasticity, scalability and software maintenance
  – Cost-to-value of the experiments
SciCloud – continued

• Project established at University of Tartu in 2009 [Srirama et al, CCGrid 2010]

• Studied migrating and adapting scientific computing applications to the cloud
  – Migration of several benchmarks like NAS PB and domain specific applications [Srirama et al, SPJ 2011]
  – Adapt applications using MapReduce to successfully exploit the cloud’s commodity infrastructure [Srirama et al, FGCS 2012]
Communication pattern of Cluster vs Cloud

- Cloud has huge troubles with communication/transmission latencies
  - Virtualization technology is the culprit
- Performance Comparison of virtual machines and Linux containers (e.g. Docker)

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Migrating Scientific Workflows to the Cloud

- Scientific Workflows have lately become a standard
  - Used for managing and representing complicated scientific computations
- Data and processes are brought together into a structured set of steps
- Each computation may contain thousands of tasks
  - Tasks are executed, in an order, on top of programs such as Pegasus or Kepler
- A lot of data is exchanged across these tasks/jobs
  - So migrating scientific workflows to cloud is a trouble !!!
Approach

• Problem: How to reduce the data exchange across tasks so that cloud can be exploited?

• Solution: Partitioning and scheduling scientific workflows
  – in such a way that it increases the intra-instance communication while reducing inter-instance communication
The Overall Migration Process

- Can we partition and schedule enterprise applications/workflows in this model and join our auto-scale models?
- Refactoring enterprise applications for the cloud

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Adapting Scientific Computing Application for Cloud Migration

• Research the utilization of cloud computing platforms for HPC
• Compare different Cloud computing frameworks for algorithms used in scientific computing
  – MapReduce
    • Replicate data and computation
  – MapReduce implementations
    • Hadoop
    • Twister
    • Spark
  – Bulk Synchronous Parallel (BSP)
    • Fault-tolerance
**Synthetic Aperture Radar (SAR) Image Processing**

Imaging technique based on receiving electromagnetic wave echoes reflected from the monitored surface.

Collected data shows granular patterns caused by interference of multiple echoes returned from the same pixel.

Requires large scale processing for speckle noise suppression on the resulting images.

12/02/15

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Data Analytics on the Cloud

- Cloud scale data storage solutions
- Cloud scale data analytics
  - Pig & Hive
- NoSQL
- Implementing graph algorithms on graph databases

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Mobile Application development

• Mobile is the 7th mass media
  – 6.8 bn subscriptions / Global population of 7.2 bn
• Some popular application domains
  – Location-based services (LBS), mobile social networking, mobile commerce, etc.
• Multiple languages and platforms to choose from
  – Android, Apple iOS, Windows Phone 7 etc.
• Real time system development
  – Mobile Apps using sensors
  – Mobiles in biometry
The devices we use
Mobile Web Services

• Provisioning of services from the smart phones
• Invocation of web services from smart phones
• Mobile web service discovery
• Addressing mobiles in 3G/4G networks
• Push notification mechanisms
Mobile Cloud Computing

• One can do interesting things on mobiles directly
  – Today’s mobiles are far more capable
  – We can even provide services from smart phones
• However, some applications need to offload certain activities to servers
  – Processing sensor data
• Resource-intensive processing on the cloud
  – To enrich the functionality of mobile applications
Mobile Cloud Access Schemes

Delegation

Code Offloading

[Flores & Srirama, JSS 2014]

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Code offloading

• Decision making
  – When is it ideal to offload a task from mobile to cloud?
  – Fuzzy logic
  – Linear Programming

• We also think the decision making should be a continuous learning process
  – Machine learning

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Internet of Things (IoT)

“The Internet of Things allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service”—(Guillemin and Friess, 2009)

US National Intelligence Council has predicted that “by 2025 Internet nodes may reside in everyday things—food packages, furniture, paper documents, and more”

UK + Germany governments supported £73 million for IoT (2014). China government is planning to invest $800 million by 2015.
How to interact with ‘things’ directly?

How to provide energy efficient services?

Internet of Things

Sensors

Tags

Mobile Things

Appliances & Facilities
Mobile Resource Composition Mediation Framework (MRCMF)

Mobile Hosted Cloud Middleware (MHCM)

Mobile-Hosted Things Middleware (MHTM)

Lightweight Service Provisioning Middleware

Cloud Services

• Resource Awareness
• Business Process Model
• Cloud Service Adaptors
• Mobility Support

Surrounding Things

• Machine-to-Machine (M2M) Communication
• Constrained Application Protocol (CoAP)
• 6LoWPAN / BLE / WiFi Direct
• RFID / NFC / QR Code Reader / EPC
• SensorML / SSI / EXI
• Etc.

• Service/Resource Bus
• Context-Awareness
• QoS
• Semantic Reasoning

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Large Scale Data Mining

- Text mining using Parallel R
- Parallel algorithms for scalability using multicore and cluster
- Knowledge model for large scale data integration
- Mining bibliographic social networks for collaboration prediction and recommendation system

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WE ALWAYS WELCOME NEW IDEAS!
Seminar topics

• Listed at https://courses.cs.ut.ee/2015/mcsem/spring/Main/Topics

• Session 2 (19.02)
  – Second meeting to finalize the topics
  – Email
    • Jakovits@ut.ee
    • srirama@ut.ee
    • and your topic supervisor