T-110.5121 Mobile Cloud Computing
Introduction
07.09.2011
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Outline

- Definition
- Motivation
- Practical issues
  - Targets
  - Requirements
  - Grading
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Definition

“Mobile Cloud computing is a model for enabling convenient, on-demand mobile network access to a shared pool of configurable mobile computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”

Motivation
Server problems are common.

Power outage in the machine hall poured services
published on 12/27/2010 at 22:41

IT services company Logica machine room power failure occurred is hampered by several companies and public organization in today. For example, VR's e-ticketing was off in the afternoon a couple of hours, and Neste Oil's Naantali refinery tank cars are not able to refill several hours.

Power failure occurred in one of the Logica machine room after noon. Lasted one hour break is likely due to back-up power equipment testing, "says Leena-Mari from Logica."

Services restored after a power cut gradually, and the last services were the source country, been corrected, at to 19 of the latest.

Logica is one of the largest data center service providers in Finland.

YLE News
Another Outage / More Lessons: Geo-redundancy Couldn’t Prevent Verizon LTE Service Disruption

Elisa’s mobile network had a large disturbance is corrected. Tampere, an electrical fault occurred in the area of one million mobile phone Mikkeli, Vaasa, north of a line for several hours on Saturday. Elisa, all mobile phones are normally operated on that data.

Dysfunction related to 2G and 3G mobile network in the north of Tampere. Southern Finland and the West Coast had not been for the inconvenience.

At 7 o’clock in the morning revealed the fault was corrected at the time of 10.30. Most of the phones to operate normally, shortly after noon and all.

Elisa’s broadband service was in Tampere, Khiitin Parkonon areas and problems. Elisa, Sauna and Columbus in the Gulf has a total of about three million mobile phone subscriptions.
Operators have challenges ahead: decreasing ARPU and increasing churn

## Massive data volumes

<table>
<thead>
<tr>
<th>Item in 2003</th>
<th>WAN bandwidth/mo.</th>
<th>CPU hours (all cores)</th>
<th>disk storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Mbps WAN link</td>
<td>2 GHz CPU, 2 GB DRAM</td>
<td>200 GB disk, 50 Mb/s transfer rate</td>
</tr>
<tr>
<td>Cost in 2003</td>
<td>$100/mo.</td>
<td>$2000</td>
<td>$200</td>
</tr>
<tr>
<td>$1 buys in 2003</td>
<td>1 GB</td>
<td>8 CPU hours</td>
<td>1 GB</td>
</tr>
<tr>
<td>Item in 2008</td>
<td>100 Mbps WAN link</td>
<td>2 GHz, 2 sockets, 4 cores/socket, 4 GB DRAM</td>
<td>1 TB disk, 115 MB/s sustained transfer</td>
</tr>
<tr>
<td>Cost in 2008</td>
<td>$3600/mo.</td>
<td>$1000</td>
<td>$100</td>
</tr>
<tr>
<td>$1 buys in 2008</td>
<td>2.7 GB</td>
<td>128 CPU hours</td>
<td>10 GB</td>
</tr>
</tbody>
</table>

- **Cost/performance improvement**: 2.7x, 16x, 10x

| Cost to rent $1 worth on AWS in 2008 | $0.27–$0.40 ($0.10–$0.15/GB × 3 GB) | $2.56 (128 × 2 VM’s@$0.10 each) | $1.20–$1.50 ($0.12–$0.15/GB-month × 10 GB) |

### Bottleneck: Bandwidth

Example: Facebook 1 PB totally, 2-3 TB added each day

1 TB drive, 1 Gbit/s I/O = 2 h 13 min

\[ T = 10^{12} \]
\[ P = 10^{15} \]

Mobile capabilities are improving but battery capacity is still a bottleneck

- Less new services
- More frequent charging
- Physically larger battery
- More efficient chips in energy wise
- Radical battery inventions
- Intelligent methods to save energy

Source: professor Jukka K. Nurminen
Traffic load can vary a lot

Data Lifecycle Management

Data Security Lifecycle

Create
- Classify
- Assign Rights

Store
- Access Controls
- Encryption
- Rights Management
- Content Discovery

Use
- Activity Monitoring and Enforcement
- Rights Management
- Logical Controls
- Application Security

Share
- CMP (DLP)
- Encryption
- Logical Controls
- Application Security

Archive
- Encryption
- Asset Management

Destroy
- Crypto-Shredding
- Secure Deletion
- Content Discovery

Open APIs exist everywhere

- Public transportation
- Travelling
- Hobbies
- Social media
- Ecommerce & advertising
- B2B
- Emergency
- Payment
- Identity
- Location
- Message
- Profile
- Context
- SLA
- Open TELCO APIs

[Diagram showing various APIs and their applications]
Mobile Cloud Computing research topics

- Private Cloud
  - SaaS
  - PaaS
  - IaaS

- Public Cloud
  - SaaS
  - PaaS
  - IaaS

- Hybrid Cloud

- Adhoc Cloud
  - Eucalyptus
  - OpenStack
  - OpenNebula

- End users
  - Mobile Offloading

- Telecom Cloud
  - Service Delivery (SMSC)
  - Storage (HBase)
  - Computation (HLR)
  - Communication

- Mobile Offloading

- Open Telco

- Amazon EC2

- Support Systems (MVNO/BSS)
Practical issues
Targets

• “You have a clear view of the advantages of distributed computing technologies, such as cloud computing, in the mobile space. You understand the core properties as well as the strengths and limitations of mobile cloud computing. You have a vision how clouds will change the mobile ecosystem, reviewed both from technology and business angles.”

• (Mobile) Disruption
• Neutral, scientific and critical view, over the hype
• Technology, Business, Theoretical and Practical approach
Requirements

- **5 ECTS: 24 + 0 (2 + 0), not applicable to post graduate studies**
  - Lectures 24 h, Lecture preparation 24 h, Assignments 48 h, Exam preparation 36 h, Exam 3 h
  - Lectures are not obligatory but highly recommendable
- **Exam**
  - Tue 13.12.2011, 9-12, Tue 03.01.2012, 9-12 or Tue 29.05.2012, 9-12
  - Initial structure (all rights reserved!):
    - 3 questions, 2 must be answered
    - 1 obligatory question: 6 definitions
    - 1 obligatory essay
    - 6 points from each: 0-11=0, 12-13=1, 14-15=2, 16-18=3, 19-21=4, 22-24=5
- **3 Assignments in pairs**
- **Course feedback**
Grading

- Exam 50% + Assignments all together 50%
- Each assignment has the same weight, e.g. 1/3
- All parts evaluated 0-5
- To pass the whole course, each component must be passed at least with grade 1
- Example:
  - Exam: 3
  - Assignment 1: 3 = 3/3
  - Assignment 2: 4 = 4/3
  - Assignment 3: 5 = 5/3
  Total: 50% x 3 + 50% x 12/3 = 3.5 = grade 4 (rounded to closest integer)
Lecture schedule

07.09 Introduction, Yrjö R
14.09 Basics, Yrjö R
21.09 IaaS (1st Assignment), Yrjö R and Karthik M
28.09 Mobile Networks, Jukka K. Nurminen
05.10 Business, Sakari Luukkainen
12.10 Mobile Cloud, Yrjö R
19.10 Mobile Offloading (2nd Assignment), Matti Kemppainen
02.11 Hybrid Cloud, Yrjö R and Koushik Annapureddy
09.11 Cloud Interoperability, Yrjö R and Karthik M
16.11 Encapsulated Security in Cloud (3rd Assignment), Jukka Ylitalo, Ericsson
23.11 Industry keynote, NN
30.11 Summary, Yrjö R
07.12 Spare
Assignment schedule

- Assignments in pairs, inform your pair to assistant by 21.09
- 1. Assignment, Public IaaS
  - Period: 21.09-16.10
  - Target is to learn how to run a simple scheduling application with storage services (MySQL) in public cloud (Amazon EC2)
- 2. Assignment, Mobile Cloud using Private IaaS
  - Period: 19.10-13.11
  - Target is to learn how mobile and cloud computing can benefit from each others, the primary task is to make a simple mobile mashup that utilizes a private cloud (OpenNebula) and open APIs
- 3. Assignment, Proof of Concept -report
  - Period: 16.11-11.12
  - Design a proof of concept for a mobile cloud computing service, define an architecture, make a business plan with an optimal cost structure, identify risks and carbon foot print, output as a report using Latex
Tools

- Registering to course: Oodi, deadline by 19.9
- Information sharing, also presentations (partly behind password) and News to your email: Noppa
- Contact course staff: Email to t-110.5121(at)list.hut.fi or visit A122 or PlayRoom (best available 10-16)
- Public cloud: Amazon EC2
  - Each student will get an account created by course staff
  - Accounts have a limit
- Private cloud: OpenNebula
  - 16 blades á 8 cores, each with 8 GB memory
  - Each blade has a common 146 GB memory
- Document storage: Optima, tbc
Plagiarism

• Copying is strictly prohibited, including Assignments (code, text)
• All assignments will be checked against that
• If you are stuck with the assignment, ask course assistant first
• In your report you may extract text or pictures, but the source must be always defined and shown
• If fraud is detected, Dean will be informed and in the worst case you are expelled for one year
Reading material (updates in Noppa)


Related and recommended courses

- **T-110.5130** Mobile Systems Programming (5 cr), Spring, Sakari Luukkainen
- **T-110.5140** Network Application Frameworks P (5 cr), Spring, Jukka K. Nurminen
- **T-110.5150** Applications and Services in Internet P (5 cr), Autumn, Zhonghong Ou
- **T-110.5241** Network Security (5 cr), Autumn, Tuomas Aura
- **T-110.6130** Systems Engineering in Data Communications Software P (2-10 cr), Autumn, Andrey Lukyanenko
- **T-110.7111** Internet Technologies for Mobile Computing P (2-10 cr), Spring, Sasu Tarkoma
- **T-79.5308** Scalable Cloud Computing P (5 cr), Autumn, Keijo Heljanko
Questions?

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