Mobile Computing and Internet of Things

LTAT.06.009

Fall 2019

Satish Srirama
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Course Purpose

• Introduce mobile application development
• Introduce mobile platforms
  – Android OS
  – Multi-platform mobile app development
• Working with inbuilt and external sensors
• Introduce Internet of Things
• Provide overview of research at Mobile & Cloud Lab

Questions

• Have you ever programmed for mobile devices?

• How comfortable are you with programming?
  – Java?
    • External APIs?
  – Arduino / C?
  – Web programming?

• Have you heard of cloud computing?
Related Courses

• **MTAT.03.262** Mobile Application Development (3 ECTS)
  – Delivered till Fall 2018
  – Extended to the current course

• **MTAT.03.280** Mobile and Cloud Computing Seminar (3 ECTS)
  – Thu. 12.15 - 14.00, Ülikooli 17 - 219

• **LTAT.06.008** Cloud Computing (6 ECTS)
  – Spring 2020
Outline

• Mobile application development with Android
• Testing Android applications
• Web Services, Cloud Computing and Mobile Cloud
• Working with sensors and Location based services
• Embedded Systems and hardware
• Communication protocols
• IoT applications & platforms
• Multiplatform mobile application development
• Fog Computing and Research at Mobile & Cloud Lab
Grading

- No written exam
- Active participation in the lectures
  - 50% attendance is compulsory
- Homework – 40%
  - 8 Home works
- Home Assignments – 30%
  - 2 Home Assignments
- Group project – 30%
  - 2 to 3 persons per group
- You should score 50% in each subsection

- Lectures will introduce you concepts and references will be provided
  - It is expected that the student does read through additional material online
Grading policy

• Finish Homeworks by Wednesday 23:55 of the next week
  – Ideal case, we encourage you to finish lab before coming to the next lecture
    • To better understand next session
• HomeAssignment deadlines will be specified accordingly

• Up to 2 days delay exercises will be graded for 80%
• 3-7 days delay exercises will be graded for 50%

• After the 1 week delay
  – Your submission will not be graded
Course schedule

• **Lectures:** Wed 10.15 - 12.00, J. Liivi 2 - 111.

• **Practice sessions:**
  – Wednesday 16.15 - 18.00 (Ülikooli 17 - 220 & J. Liivi 2-206) **Merged to Ülikooli 17 - 220**
  – Thursday 14.15 - 16.00 (J. Liivi 2 – 206 & 404) **Merged to J. Liivi 2 - 404.**

• **Schedule of the lectures**
  [https://courses.cs.ut.ee/2019/MCIoT/fall/Main/Lectures](https://courses.cs.ut.ee/2019/MCIoT/fall/Main/Lectures)
References & Books

• Android developer portal

• Books
    • (1 copy at J.Liivi library)
    • 2015 version is free (CC license)
      https://commonsware.com/Android/4-2-free
References & Books - continued

• Reference papers

• Relevant reference research papers will be mentioned in respective lectures
Dealing with problems & Help

Practical Assistants:

• Jakob Mass (jakob.mass@ut.ee)
• Mohan Liyanage (liyanage@ut.ee)

Google Group

• Post any questions & technical issues
• Help out others!
Lecture 1

INTRODUCTION TO MOBILE COMPUTING AND INTERNET OF THINGS
The Seven Mass Media

First Mass Media Channel - Print from the 1500s
Second Mass Media Channel - Recordings from 1900s
Third Mass Media Channel - Cinema from 1910s
Fourth Mass Media Channel - Radio from 1920s
Fifth Mass Media Channel - TV from 1950s
Sixth Mass Media Channel - Internet from 1990s
Seventh Mass Media Channel - Mobile from 2000s

[Tomi T Ahonen]

<table>
<thead>
<tr>
<th>Rankings</th>
<th>Country or regions</th>
<th>Number of mobile phones</th>
<th>Population</th>
<th>Connections/100 citizens</th>
<th>Date of evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>World</td>
<td>7,000,000,000+</td>
<td>7,324,782,000</td>
<td>96</td>
<td>2015[1][2]</td>
</tr>
<tr>
<td>1</td>
<td>China</td>
<td>1,321,930,000</td>
<td>1,371,220,000</td>
<td>96.40</td>
<td>December 2016[3][4]</td>
</tr>
<tr>
<td>2</td>
<td>India</td>
<td>1,183,408,611</td>
<td>1,131,005,994</td>
<td>86.89</td>
<td>May 2018[5][6]</td>
</tr>
<tr>
<td>3</td>
<td>United States</td>
<td>327,577,529</td>
<td>317,874,628</td>
<td>103.1</td>
<td>April 2014[7][7]</td>
</tr>
<tr>
<td>4</td>
<td>Brazil</td>
<td>284,200,000</td>
<td>201,032,714</td>
<td>141.3</td>
<td>May 2015[8][9]</td>
</tr>
<tr>
<td>5</td>
<td>Russia</td>
<td>256,116,000</td>
<td>142,960,250</td>
<td>155.5</td>
<td>July 2013[10][10]</td>
</tr>
<tr>
<td>6</td>
<td>Indonesia</td>
<td>236,800,000</td>
<td>237,556,363</td>
<td>99.68</td>
<td>September 2013[10]</td>
</tr>
<tr>
<td>7</td>
<td>Nigeria</td>
<td>167,371,945</td>
<td>177,155,754</td>
<td>94.5</td>
<td>February 2014[11]</td>
</tr>
<tr>
<td>8</td>
<td>Bangladesh</td>
<td>150,945,000</td>
<td>157,497,000</td>
<td>95.54</td>
<td>June 2018[12][13][14][15]</td>
</tr>
<tr>
<td>9</td>
<td>Japan</td>
<td>146,649,600</td>
<td>127,300,000</td>
<td>115.2</td>
<td>2013[16]</td>
</tr>
<tr>
<td>10</td>
<td>Pakistan</td>
<td>150,169,643</td>
<td>207,774,520</td>
<td>74.21</td>
<td>April 2018[17][18][19][20]</td>
</tr>
</tbody>
</table>

NEWS

Mobile IoT market set to expand 27% by 2026

By Rene Millman - July 9, 2018

NEWBYTE The worldwide market for cellular Internet of Things (IoT) technologies will be worth $7.6 billion by 2026, according to a new forecast from analyst firm Persistence Market Research.

Maribel Lopez, Contributor

Tech from mobile changes engagement and business strategies + Follow (87)

TECH | 4/18/2012 7:43AM | 10,835 views

Verizon's Stratton: The Future Of IT Is Mobile And Cloud

+ Comment Now + Follow Comments

Satish Srirama 13
Popular consumer mobile applications

• Location-based services (LBS)
  – Deliver services to users based on his location

• Mobile social networking
  – Most popular social networking platforms have apps for mobiles

• Mobile commerce
  – An extension of e-commerce

• Mobile payment
  – Near field communication (NFC) payment
Popular consumer mobile applications - continued

• Context-aware services
  – Context means person's interests, history, environment, connections, preferences etc.
  – Proactively serve up the most appropriate content, product or service

• Mobile instant messaging (MIM)
  – Skype for mobiles

• Mobile e-mail

• Mobile video
## Variety of languages and platforms to choose from

<table>
<thead>
<tr>
<th>Programming language</th>
<th>Debuggers available</th>
<th>Emulator available</th>
<th>Integrated development environment available</th>
<th>Cross-platform deployment</th>
<th>Installer packaging options</th>
<th>Development tool cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adobe AIR</td>
<td>Yes</td>
<td>Yes</td>
<td>Flash Builder, Flash Professional</td>
<td>iOS (iPhone, iPad, iPod touch), Android, BlackBerry</td>
<td>The native distribution format of each platform</td>
<td>Flash Builder, Flash Professional - Commercial licenses available Adobe AIR SDK (command line tool) Free</td>
</tr>
<tr>
<td>Airplay SDK (Now Marmalade)</td>
<td>Yes</td>
<td>Yes</td>
<td>Visual Studio, XCode</td>
<td>All native: Android, BlackBerry, BREW, iOS (iPhone), Maemo, Palm/WEBOS, Samsung bada, Symbian, Windows Mobile 6.x and desktop, OSX</td>
<td>The native distribution format of each platform</td>
<td>Commercial licenses available</td>
</tr>
<tr>
<td>alcheMo</td>
<td>Yes</td>
<td>Yes</td>
<td>Visual Studio, Eclipse, XCode</td>
<td>Android, BREW, iOS (iPhone), Windows Mobile</td>
<td>The native distribution format of each platform</td>
<td>Commercial licenses available</td>
</tr>
<tr>
<td>Android</td>
<td>Yes, in Eclipse, standalone debugging monitor available</td>
<td>Yes, in Eclipse, standalone debugging monitor available</td>
<td>Eclipse, Project Kanai Android plugin for NetBeans</td>
<td>Android only, because of Dalvik VM, March 2009</td>
<td>apk</td>
<td>Free</td>
</tr>
<tr>
<td>Appcelerator</td>
<td>Yes</td>
<td>Yes</td>
<td>Internal SDK</td>
<td>Android, Blackberry (BlackBerry dropped)</td>
<td>The native distribution format of each platform</td>
<td>Apache 2.0 license, commercial licenses</td>
</tr>
</tbody>
</table>

[http://en.wikipedia.org/wiki/Mobile_application_development](http://en.wikipedia.org/wiki/Mobile_application_development)
[http://en.wikipedia.org/wiki/Mobile_operating_system](http://en.wikipedia.org/wiki/Mobile_operating_system)
Popular platforms – Market share

http://en.wikipedia.org/wiki/Mobile_operating_system
Mobile application development with Android

- Basic concepts of mobile application development in Android
  - UI, Application Components, intents, Content providers, data storage, Services and background tasks – Lect 1 – 5 & 7
- Testing Android applications – Lect 6
- Invoking third party services from mobiles – Lect 8
- Multiplatform mobile application development – Lect 13
The devices we use
Internet of Things (IoT)

- IoT allows people and things to be connected
  - *Anytime, Anyplace, with Anything and Anyone*, ideally using *Any path/network and Any service*
  [European Research Cluster on IoT]

- More connected devices than people

- Cisco believes the market will be $19$ trillion by 2025

Source: Cisco IBSG, April 2011
Internet of Things – Challenges

- How to provide energy efficient services?
- How do we communicate automatically?
- How to interact with ‘things’ directly?

Sensors

Tags

Mobile Things

Appliances & Facilities

9/4/2019
Learning IoT

• Working with sensors and location based services – Lect 9
• Embedded Systems and hardware – Lect 10
• Communication protocols – Lect 11
• IoT applications & platforms – Lect 12
• Fog Computing and Research at Mobile & Cloud Lab – Lect 14
MOBILE APPLICATION DEVELOPMENT WITH ANDROID