Mobile Software Systems (part 2)

8.

Mobile Applications: Operating Systems
Introduction

• Design and capabilities of a Mobile OS (Operating System) is very different than a general purpose OS running on desktop machines: mobile devices have
  – Significant constraints and restrictions on their physical characteristic such as screen size (output devices), keyboard (or, input devices) memory, processing power, etc.
  – Limited amount of computing power (CPU, RAM) and communication capabilities
  – Limited battery power

• In general case, various mobile devices may need different types of operating systems depending on the capabilities they support, e.g. a PDA OS is different from a Smartphone OS.

• OS features
  – Multitasking
  – Scheduling
  – Memory Allocation
  – File System Interface
  – Keypad Interface
  – I/O Interface
  – Protection and Security
  – Multimedia features

Operating System Structure

• A mobile OS is a software platform on top of which other programs – applications - can run on mobile devices such as PDA, cellular phones, smart phones, and etc.
Google Android Platform and OS

- It is a platform and an operating system for mobile devices based on the Linux operating system.
- It allows developers design applications in a Java-like language using Google-developed Java libraries.
- It supports a wide variety of connectivity such as GSM, WiFi, 3G, ...

Google Android Platform

The Android platform contains the following layers:
- Linux Kernel: Android relies on Linux for core system services such as security, memory management, process management and etc.
- Android Runtime: it provides a set of core libraries which supports most of the functionality in the core libraries of Java.
- The Android Virtual Machine known as VM relies on the Linux kernel for some underlying functionality such as threading, ...

Libraries: Android includes a set of C/C++ libraries. These libraries are exposed to developers through the Android application framework. They include media libraries, system C libraries, surface manager, 3D libraries, SQLite and etc.
For more details, please visit the following link:
http://code.google.com/android/what-is-android.html

Application Framework:
It provides an access layer to the framework APIs used by the core applications. It allows components to be used by the developers.

Source: http://code.google.com/android/what-is-android.html
Critical Issues with Android


1. The Fragmentation is Real

Google likes to deny the Android “fragmentation” issue in which mobile vendors manufacturers are pushing two products for the multiple concurrent versions of the Android OS. This major issue for software developers who have invested in those products, and it even became an issue as the company was trying to move to a single platform. In fact, according to a recent survey conducted by NPD, 21 percent of respondents said it was a “huge problem”, while 15 percent of respondents said it was a “minority problem”. Only 10 percent of respondents said it wasn’t a problem at all. If that’s not a good enough reason for Google to start making Android “fragmentation” relevant.

2. The Update process is Painful

Apple users know the feeling of getting an update to their smartphone, a pain, a suffered process that is not a problem for the Android user, who has a difficult process of enabling and disabling updates. Preempting the update process from the Android user is not a good thing.

3. There must be better consumer education

Android is undoubtedly a new operating system that consumers are not used to. But Google just hasn’t done a good enough job of educating the public on the differences between the version of its operating system. This major issue for Android app developers. It’s going to take a long time for Android to get things right.

6. Making Honeycomb line up to the hype

Where Google unveiled Android 3.0 “Honeycomb” last month, many were excited. The tablet experienced full touch-screen supporting, improved multitasking and a suite of features that on paper, makes it look impressive. The only issue is “honeycomb” as it is being marketed, does not come in some cases. Google Copes analysis revealed many features that were expected to be in Honeycomb are not there. It’s going to take a long time for Honeycomb to get things right.

7. It’s still the iOS

Google and Android fans might not want to hear it, but Android is still not on the same level as iOS. The operating system is still lacking in areas that iOS is excelling in such as battery life, and apps that are fully enjoyed. Honeycomb is going to take a long time for Google to get things right.

8. Security enhancements

Last week, Google was forced to remove several applications from the Android Market to protect users from malicious apps. While in all, they were killed because developers over 300GB monthly, Google removed apps that were found to be malicious. The reason is not clear, but it’s likely the apps were found to be spreading in the security space. Several developers reviewing their apps and others, have discovered Android malware apps to help them contain malware.

In Mc OS X, each application has access to its own 4 GB address space.

Source: http://cmer.cis.uoguelph.ca

iPhone OS

- iPhone OS is an operating system run on iPhone and iPod.
- It is based on Mach Kernel and Drawin core as Mac OS X.
- The Mac OS X kernel includes the following component:
  - Mach Kernel
  - BSD
  - I/O component
  - File Systems
  - Networking components
- Mac OS X has a preemptive multitasking environment.
- Preempting is the act of taking the control of operating system from one task and giving it to another task.
- It supports real-time behavior.
- In Mac OS X, each application has access to its own 4 GB address space.
### iPhone OS

- The following is Mac OS X Architecture:
  - BSD - Berkeley Software Distribution (BSD) series of Unix variants
  - JDK - Java Development Kit
  - Cocoa - Apple's native object-oriented application programming interface (API)
  - Carbon - Apple Inc.'s procedural application programming interfaces (APIs) for the MAC operating system
  - QuickTime - an extensible multimedia framework developed by Apple Inc., capable of handling various formats of digital video, picture, sound, panoramic images, etc.

### Problems with iOS

Problems updating to iOS 5? Here’s what you need to know

*Internal Error 3200*

This is an error message that pops up during the iOS 5 upgrade process that indicates Apple's authentication server isn't responding.

The fix: The problem hasn't really fixed itself. The problem originated from the entire world trying to download the new iOS right out of the gate. Apple has opened up more server space, and the demand is dying down slowly due to efforts of developers.

*Error -34*

If you get this error, it's iTunes reporting to the Apple server that you are out of disk space. As some of you have figured out, this may not be the case.

The fix: There isn't one yet, but it was discovered that the problem originates mostly with users who compress their files in WinRar so that they can fit more music on their iPad. When upgrading, it seems that the files were being removed by the compression tool. Apologize if aware of the issue.

*Error 1603*

Although this error is to be expected, it's supposed to put your device into recovery mode shortly after you see it. It's not doing that in all cases with this new update. This is what most users refer to as a bricked iOS or iPad device.

The fix: You'll have to put your phones into forced recovery mode. You stand a good chance of losing all data on your phone forever. This is why you always need a good backup of your data before doing a new iOS update.

Putting your iPhone or iPod Touch into forced recovery mode

Disconnect the USB cable from the device, but leave the other end connected to your computer.

Turn off the device by holding down the Sleep/Wake button. A red slide will appear next. Slide the slider and the screen on the device will shut off. If it doesn't work, don't turn off the device, press the home/lock button.
Mobile Applications for Entertainment

Mobile applications can be found in any industry, they have been developed for:
- Mobile Gaming (see gameloft)
- Mobile Banking (see RBC)
- Mobile Text, Presentation, and Spreadsheet (see Microsoft Office Mobile)
- Social Networking (see Facebook)
- Mobile News (see Yahoo! Mobile News)
- Location Aware Services (see Loopt)

Most Popular Downloaded Mobile Apps

[Chart showing the most popular mobile apps]

- Games
- News
- Social Networking
- Music
- Mobile Banking
- Maps/Navigation
- Weather
- Mobile Text/Presentation/Spreadsheet
- Entertainment/Travel
- Sports
- Communication
- Shopping/Finance
- Health/Fitness
- Productivity
- Travel/Baytrix

Most Popular Downloaded Mobile Apps (Smartphone vs. Feature Phone)
10.

Mobile Applications for Education
(Mobile Games for Education/Training)
Digital games in education

Examples of use:

- Historical simulations
- Planning and architecture
- Problem solving (instant response)
- Economics and financial management
- Literacy (major success with Myst)
- Physics (gravity, vectors, acceleration)
- Chemistry
- Cultural studies and religion

Cross-curricula games very popular
1) Online courses that are big – but designed in very small, consumable chunks

A perfect example of this is the course on "Get Started with E-learning," offered on Coursera. The course is divided into small modules with quizzes and videos included in each module. Students can learn at their own pace and take the course at any time.

Massive Open Online Courses (MOOCs) offer another model that is widely used in the industry today. The latest trend in MOOCs is the "micro-courses," which are short courses designed to be completed in a few hours to a few days. These courses are targeted towards specific skills and knowledge areas, making them more accessible to a wider audience.

Finally, there’s the increasing use of micro-learning platforms that offer bite-sized lessons that can be consumed at any time. These platforms are designed to help learners stay engaged and motivated, with features like notifications and reminders to encourage participation.

As a result, these major types of learning solutions are emerging, offering flexibility and accessibility to learners.
Zoo Tycoon

• Build a zoo and populate it with animals
• Stay on budget
• Pay for feed, staff, animals, vets bills

Used in schools for:
• Maths
• Economics and finance
• Biome
• Ethics (should animals be caged?)
• Planning and design
11.

Mobile Applications in Enterprise Management
Mobile Enterprise Management

12.

Mobile Applications
(including Mobile Games)
in Health
Digital games in health

Examples of use:

• Pain relief and distraction
• Rehabilitation
• Surgery skill increase
• Diabetes awareness
• Easing carpal tunnel syndrome
• Mental health and sharpness (Brain Train!)
• Acting out domestic and social situations
• Social and communication development

www.gamesforhealth.org
10 Cutting-Edge Mobile Applications for 2012
by Gartner Inc.

• Gartner, Inc. has identified what it believes will be the most important mobile applications in 2012. Focusing on high-end devices with an average selling price of more than $300, analysts have identified the top 10 cutting-edge technologies and trends for 2012.

• Winning mobile apps will have unique features that cater to the mobile environment rather than act as a mobile extension of their online peers.

• “Mobile applications will be a highly competitive marketplace that attracts the interest of many stakeholders,” said Sandy Shen, research director at Gartner. “Increasingly, mobile applications will define the user experience on high-end devices and device vendors that proactively integrate innovative apps and technologies at the platform layer will have the competitive edge.”

• Mobile apps themselves will not only generate good revenue ($15.9 billion in expected end-user spending in 2012) but will also drive hardware sales, advertising spending and technology innovation. Gartner expects brand companies to increasingly shift their marketing budget to the mobile channel, and experiment with cutting-edge apps to capture marketing and sales opportunities. Companies, as well as technology and service providers, that stay abreast of the latest developments could make their products stand out from the pack, enhance brand image and retain user loyalty.
Location is one of the main elements that deliver services to users based on their context and. Gartner expects the total user base of consumer location-based services to reach 1.4 billion users by 2016. Location-based services return to deliver features and functionalities in sync with the user’s context, taking into account the user’s location, personal preference, gender, age, personality, interests and so on, thus offering a more intelligent user experience than basic location services can. Gartner analysts believe context-aware services are a key trend for mobile apps, and location is a key enabler of that.

Mobile social networking is the fastest-growing consumer mobile app category of the 19 tracked by Gartner. Social-networking platforms are generating increasing amounts of network traffic. They are becoming portals for travel and ticket sales, and social networks are increasing in use for music and commerce. As mainstream adoption progresses, global social media will be driven forward by developers and partners in partnership with third parties using open APIs, and they will be able to offer a role as digital service providers acting as data warehouses and providing user data and access to the more customer-facing brands.
Mobile search

Visual search is usually related with product search to enable price comparisons or to check product information. To bring mobile search to the next level, the app would allow users to take actions based on the result, such as making a call or reservations, buying a ticket, placing an order, and so on. Different search providers in the experience around mobile to allow users access to immediate results and to take actions, given the short time spans users have. Mobile commerce vendors should partner with other prominent search providers to integrate the technology, probably at the platform layer, to offer a differentiated user experience.

Mobile commerce

Today, mobile commerce is more of an extension of e-commerce but in a smaller form factor and with a more streamlined experience. However, over the next 24 months, Commerce expects the emergence of uniquely mobile functions, such as the ability to “check in” to a store to alert a retailer that you are there, or the ability to add items to a shopping cart simply by taking a photo of an item or bar code in the physical store. In the future, Commerce expects richer mobile commerce capabilities to expand from native apps to the mobile browser as HTML5 starts to be deployed, though this will happen at a much later stage.
Although near field communication (NFC) payment will be included in high-end phones from 2011, Gartner does not believe that it will become mainstream before 2013. In order to get consumers on board, payment solution providers need to address ease-of-use for users and ease-of-implementation for customers without compromising security. They also need to increase user awareness, extend the service coverage and address ease-of-use to appeal to end users.

Context-aware applications provide improved user experiences by using the information about a person's interests, intentions, history, environment, activities, schedule, priorities, connections and preferences to anticipate their needs and proactively come up with the most appropriate content, product or service. Mobile carriers, along with handset manufacturers, should provide expanded location services to include, among others, directory assistance, mapping, advertising and privacy controls.
Internet of Things

Applications Empowered by Internet of Things

Global Environmental Observation
- GIS systems
  - Atmospheric
  - Vegetation / Ground Water
  - Surface / Water Temperature
- GHG Tracking
  - Consumption monitoring
  - Atmospheric measurements
- Reporting Systems
  - Mash-ups / SOA / Web 2.0

Global Action / Management Plans
- Early Warning Systems
  - Famine / Drought
  - Natural Disasters
- Environmental Mitigation
  - Carbon trading
  - Conservation Planning
- International Agreements
  - Ratification
  - Implementation

Local Environmental Observation
- Capacity building
  - Awareness of threats
  - Identifying impact
- Data Entry
  - Web 2.0 / Wiki data logs
- Appropriate Technology
  - SMS / Mobile Phone usage
  - Cultural adaptation

Local Action / Management Plans
- Resource Management
  - Access / Allocation
  - Enforcement
  - Support and Funding
- Professional Development
- Response Planning
  - Early warning response
  - Conflict avoidance

High-end devices have an increased sensor and processing capability that enable sophisticated applications to recognize the user’s surroundings, including specific objects of interest. Because OR provides an easy-to-use interface, more apps will come to the market with enhanced capabilities by 2012. Users will rely on the camera, as well as other device sensors as a communication tool when OR capabilities are combined with more traditional app functions, giving users advanced search capabilities and a plethora of entertainment and productivity functionality.
GoToh expects MIM to attract consumers to new types of unified communication (UC) clients, provided by over-the-top (OTT) service providers such as Skype. These service providers are threatening traditional communications service provider voice revenue. Companies that consider including MIM in their new products should consider integrating it with other communications types, such as location and presence, but be careful about developing other functionality, such as integration of social network activity.

Mobile e-mail

Smartphones have begun to drive the mainstream adoption of mobile e-mail through a series of technology enhancements enabling low-cost mobile extensions to existing e-mail services. GoToh expects mobile e-mail users worldwide to increase from 354 million in 2009 to 753 million in 2014. To account for 19.8 percent of the global mobile user base, e-mail addresses are personal and potentially extremely sticky, their providers cannot abandon e-mail service providers and OTT players with an opportunity to rock in consumers. Technology and service providers should consider how they can make it easier for consumers to use their affiliated mobile e-mail services as a way of ensuring long-term engagement with customers.

Technology and service providers should consider how they can make it easier for consumers to use their affiliated mobile e-mail services as a way of ensuring long-term engagement with customers.
14.

10 Hot Windows 7 Business Applications

15.

10 Hot Android Collaboration Mobile Apps


16.

Mobile Devices: Challenges

(Source: http://cmer.cis.uoguelph.ca)
Challenge: Mobile Devices

- Mobile devices display a wide range of characteristics that will greatly affect a mobile application's performance, usability, functionality, etc.

- Display/Screen Size
  - Mobile devices come in many different screen sizes
  - Consider the differentiating screen sizes between smartphones and cell phones
  - Smartphones offer the user a generally larger and higher resolution display screen, contrasted to cell phones which generally provide lower resolution and smaller display size

- Memory
  - Just as screen size differs from device to device, the amount of available memory and differs from device to device
  - Developers must create applications which have a minimal memory footprint on the device while being of service to the user
  - Memory must also be carefully managed during the execution of any mobile application as it can potentially render the phone unusable until termination of the application

- Processing Power
  - Another sign of the heterogeneity of mobile devices is the processing power
  - The CPUs differ from phone to phone and this must be taken into consideration by developers
  - Developers cannot create applications that require the user to wait an unreasonable amount of time for the service to load

- Input Devices
  - The input devices on mobile devices range from full QWERTY keyboards to three letter button inputs
  - This means developers must take into account how much text is required by the user to input into their application and what kind of difficulties they may experience based on their device

- Transmission Errors
  - When creating mobile applications that utilize network connections there is a variety of issues that can effect the application
  - Wireless networks are exposed to interference which can alter the message received by the client or the server then what was originally sent
  - Applications must take into account these potential problems especially in financially sensitive services
Challenge: Mobile Devices

• Communication Delays, Message Latency
  – Messages that are to be sent to clients or servers can be delayed due to a variety of reasons such as overloaded network nodes or servers, dead or turned off cell phones, distance to travel
  – Applications must take this into account so as to avoid sending servers or clients stale information

• Bandwidth Usage
  – Wireless customers are forced to pay fees to access the wireless network and internet
  – While phones with WIFI capabilities allow for some users to have free connectivity at times it is important to keep messages to a minimum and compact
  – Applications that cost a lot to use will not be popular with many of the financially conscious users

17.

Mobile Software and Web Security
Challenge: Security

- Wireless networks by default are not as secure as wired networks, it is important to note that message can be intercepted when traveling through the air.
- Mobile applications must secure the sensitive data that is being transmitted over the air.
- There are different methods to implement security but it must be relative to the information we want to secure and the resources that we wish to use for securing it.

Computer Attacks Experienced by Organizations
(from the "2010-2011 Computer Crime and Security Survey Report" by CSI)

<table>
<thead>
<tr>
<th>Type of Attack</th>
<th>2010</th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malware infection</td>
<td>67%</td>
<td>64%</td>
<td>67%</td>
</tr>
<tr>
<td>Being fraudulently represented as sender of phishing messages</td>
<td>39%</td>
<td>34%</td>
<td>31%</td>
</tr>
<tr>
<td>Laptop or mobile hardware theft or loss</td>
<td>29%</td>
<td>23%</td>
<td>21%</td>
</tr>
<tr>
<td>Botnet/infected within organization</td>
<td>25%</td>
<td>23%</td>
<td>21%</td>
</tr>
<tr>
<td>Insider abuse of Internet access or e-mail (i.e., pirated software, etc.)</td>
<td>23%</td>
<td>23%</td>
<td>23%</td>
</tr>
<tr>
<td>Denial of service</td>
<td>17%</td>
<td>17%</td>
<td>21%</td>
</tr>
<tr>
<td>Unauthorized access or privilege escalation by insider</td>
<td>13%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Password sniffing</td>
<td>12%</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td>System penetration by outsider</td>
<td>11%</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>Theft of or unauthorized access to personal identifiable information (PII) or personal health information (PHI)</td>
<td>11%</td>
<td>13%</td>
<td>8%</td>
</tr>
<tr>
<td>Exploit of client Web browser</td>
<td>10%</td>
<td>10%</td>
<td>9%</td>
</tr>
<tr>
<td>Web site defacement</td>
<td>7%</td>
<td>14%</td>
<td>6%</td>
</tr>
<tr>
<td>Other exploit of public-facing Web site</td>
<td>7%</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Exploit of wireless network</td>
<td>7%</td>
<td>8%</td>
<td>14%</td>
</tr>
</tbody>
</table>

*"... The respondents’ concern about visibility into their networks has more to do with stealthier forms of data exfiltration and with newer, more complex attacks... The outermost sphere... called an Attack 2.0 layer, is the Advanced Persistent Threats. ... There’s continued evidence that attackers are spending more energy customizing malware to make it more effective in targeted attacks..."
Most Actively Exploited Web Vulnerabilities

In accordance with the 2012 Application Security Trends Report, the most actively used classes of Web-related vulnerabilities are:

- Cross Site Scripting (CSS or XSS) - 37%
- SQL Injection - 16%
- other - 15%
- denial-of-service (DoS) - 5%
- code execution - 4%
- Cross-Site Request Forgery (CSRF) - 4%
- memory corruption - 4%
- arbitrary file - 3%
- information disclosure - 3%
- etc.


2010 UK Security Breach Report by the 7Safe company – a leading UK Computer Security and Forensics company:

- 86% of attacks were achieved through Web applications;
- SQL injection computer attacks have used in 60% of all cases;
- 80% of security breaches came from outside the organization.

Cross-Site Scripting (XSS): An Overview

Malicious scripts are usually hidden in poorly-written (in terms of Web security) user-created content (e.g., MySpace), blogs, forums, wikis, etc.

Source: www.cs.utexas.edu/~shmat/
XSS Attack: Step-by-Step

Case 1: Normal user:
http://myserver.com/test.jsp?name=Alex

Example of poorly-written code
(on Web server)

Case 2: Attacker
http://myserver.com/welcome.jsp?name=<script>alert("Attacked")</script>

Possible Impact of XSS-Attacks: Some Examples

Access to authentication credentials for Web application (such as cookies, username, password)
- Regular (normal) users
  - Access to personal and/or sensitive data (for ex.: credit card, bank account, SSN)
  - Access to business and confidential data (for ex.: medical records, financial data, etc.)
  - Misuse account (for ex.: order of expensive goods)
- Privileged users (admins)
  - Control over Web applications
  - Control/Access: Web servers
  - Control/Access: Back-end / Database systems

Impact on Web site or university/ corporate network
- Denial-of-Service (DoS)
  - Crash of user’s browsers
  - Pop-up flooding
  - Redirection
- Access to user computers
  - Use ActiveX objects to control machine
  - Upload local data to attacker’s machine
- Spoil public image of an university, organization, company or business
  - Load main frame content from „other“ locations
  - Redirect to dialer download

An example of June-2010 XSS-related attack
* Cross Site Scripting (XSS) Vulnerability on Twitter exploited by Turkish Hacker – June, 2010
- A persistent XSS vulnerability was exploited by Turkish hacker to post sensitive data harvested by Turkish Hacker.

Preventing from common XSS attacks
(those recommendations are based on applied research and multiple tests)

• Validate all inputs
  – Validate all inputs. Inspect all inputs, and allow only valid data to be entered into your Web application.
  – Remove from user input
    1) All characters that are meaningful in scripting languages: =<>*();
    2) Quotes of all kinds (",", and ");
    3) Semicolons (;), Asterisks (*), Percents (%), Underscores (_);
    4) Other shell/scripting meta characters ( = & | ^ * ? ~ < > ^ ( ) { } $ \ n \ r )

• Validate all outputs
  – Escape all outputs. For data that is meant to be displayed as raw data and not interpreted as HTML, it must be escaped for the context of HTML.

• Use mature and well-tested solutions
  – When possible, use mature, existing solutions instead of trying to create your own. Functions like strip_tags() and htmlentities() are good choices.

• Allow only safe content
  – Instead of trying to predict what malicious data you want to reject, define your criteria for valid data, and force all input to abide by your guidelines.

• Choose and use proper naming convention
  – There are many naming conventions that you can use to identify whether a particular variable is tainted. Choose whichever convention is most intuitive to you, and use it consistently in all of your development.

Advanced XSS Attacks
(this is a serious threat these days)
The examples of advanced XSS attacks include but are not limited to:

• DNS pinning, anti-DNS pinning, anti-anti-DNS pinning
  – May affect Google Desktop, firewalls, Flash, XMLHTTPRequest.
  – Anti-DNS pinning, although difficult for the average attacker, represents a very real risk towards applications like Google Desktop that are otherwise safe from an attacker.

• Hacking JSON (JavaScript Object Notation)
  – May affect objects through CSRF (Cross Site Request Forgery).
  – JSON also represents a real risk to consumers, since more of their personal information being stored in a way that is easy for remote Web sites to call and read from. Although not widely used at the moment, with advances in dynamic Web design, this type of vulnerability is sure to become more widespread and dangerous.

• Header based "EXPECT" Vulnerability
  – May affect some versions of Apache server

• Cross-Site Request Forgery (XSRF)
  – May affect almost any web browser

• Cross-Site Script Inclusion (XSSI)
  – May affect almost any web browser

• Attacks through Multipurpose Internet Mail Extensions HTML (MHTML) protocol in IE. (MIME HTML)
  – May affect some versions of IE, Outlook
  – MHTML provides a great conduit for exploiting IE to read from across domains.
  – The Expect vulnerability allows for attackers to exploit older Web servers quickly, without needing to find vulnerable applications on the site.

Conclusion:
Further applied research on XSS-related vulnerabilities (especially, advanced XSS) is needed.
The Bottom Line

Be involved into Mobile Software Systems (Mobile Apps)
- research,
- design,
- development,
- testing,
- management,
- etc.

This area will definitely dominate in Computing in upcoming 5...10....20 years.