A Brief History of Mobile Computing

TOPIC 1

Topic Outline

1. Wireless Technology

2. Telephony and Messaging concept

3. Mobile Computing Concept

1. Wireless Technology

In the Beginning

▸ The telephone is one of the greatest inventions of mankind

▸ It revolutionized communications, enabling us to communicate across great distances.

▸ Telephone was used only to carry out analog voice communication over electrical wire

▸ The invention of wireless communication enables phone communication over electromagnetic signal subsequently leading to the development of cellular/mobile phones

In the Beginning

- The advancement in digital signal processing (DSP) enables digital information to be carried out over communication

- This gave birth to 2nd Generation wireless telephony technology (2G), which enables the sending of SMS text, picture messages, multimedia messages (MMS) and internet communication

- The mobile phone no longer being used solely for the purpose of analog voice communication

Evolution of Devices

Figure 1-1. The traditional telephone
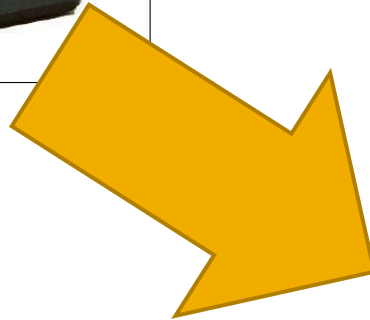

Figure 1-2. A modern mobile phone

Evolution of Devices

▸ However the modern mobile phone is no longer used solely for '**communication purposes**'

▸ Modern mobile phones have been imbued **with processing power** and **high resolution** screen which can rival even the classic desktop computers.

▸ In fact, modern mobile phone is capable of doing nearly everything that can be done with a desktop computer – **with the potential** for more meaningful relevance to our daily activity

Evolution of Mobile Devices

▶ Brick Era

▶ Candy Bar Era

▶ Feature Phone Era

▶ Smartphone Era

▶ Touch Era

Evolution of Mobile Devices: Brick Era

- First generation of mobile device (circa 1975-1988)

- Bulky, has chord. Also known as suitcase phone, has large battery pack.

- This is because Brick Era phone require enormous transmission power to reach the nearest cell tower site, in which in that era were few and far between.

- Only provide analog voice communication and only useful to those who require constant communication or those who work on the field

- It was very expensive and only used by specific group of people

Evolution of Mobile Devices: Brick Era

Suitcase Phone

Evolution of Mobile Devices: Candy Bar Era

- Candy Bar is a term to describe the long, thin, rectangu form factor of the majority of mobile devices used durin the era (1988-1998)

- Mark the shift towards second-generation **2G technology and SMS**

- Number of cell towers exploded by increased demand, has reduced the device power requirements. Thus candy bar era phones are **significantly smaller**.

- Devices in this era are getting progressively more affordable to the masses

Evolution of Mobile Devices: Candy Bar Era

Evolution of Mobile Devices: Feature Phone Era

▶ The Feature Phone (1998-2008) marks the incorporation of **computing power** to mobile phone

▶ This opened the floodgates to variety of use and services on the phone such as listening to music, taking photos and introduces internet (post-WAP) on a phone.

▶ Feature Phone Era introduces the concept of **customizable content** (custom ringtones, applications, games)

Evolution of Mobile Devices: Feature Phone Era

Evolution of Mobile Devices: Smartphone Era

▸ The Smart Phone Era occurred at the same time as the Feature Phone and Touch Era (2005-now?)

▸ Smartphone have almost the same capabilities as Feature Phone, except Smartphone **incorporate multi-tasking operating system.**

▸ Most Smartphone also **shares common operating system** and applications developed for smartphone often can be shared across devices that share common operating system

▸ Example: Symbian application can be shared across several mobile phones which runs Symbian OS

▸ 3G technology is prevalent within Smartphone era (video-call and HSDPA offering high speed data and network capacity)

Evolution of Mobile Devices: Smartphone Era

Evolution of Mobile Devices: Touch Era

▸ The Touch Era beginnings is marked by the launch of the first iPhone back in 2008.

▸ The Touch Era phone distinct itself from Smartphone era devices on the virtue of its input which uses multi-touch touchscreen.

▸ Touch Era phone also includes a **standard set of sensors** (as defined by its operating systems: accelerometer, magnetometer, gyroscope, Location-aware, GPS)

Evolution of Mobile Devices: Touch Era

Exercise

▸ Differentiate between feature phone and smartphone

▸ Briefly explain the importance having wireless communication device

▸ Differentiate between touch era phone and smartphone

▸

2. Telephony and Messaging

Telephony History

- First wireless experiments
  - 1888: Heinrich Hertz – spark generator
  - 1894: Guglielmo Marconi – Ring a bell 30 ft away
- Broadcast radio – 1920
- Photographs transmitted by radio – 1924
- Mobile Radio to Police Cars – 1926
- Satellite Systems for Telephony – 1962
- Cordless Telephones – 1980
- Brick Era Phone – 1975-88

- Pagers (widely used) – 1985
- Candy Bar Era Phone – 1988-1998
- Feature Phone – 1998-2008
- Smartphone Era – 2005
- Touch Era - 2008

1G, 2G, 3G Networks

- 1G
  - Circuit-switched, analog signals, Voice only

- 2G
  - Circuit-switched, digital signals, voice or data overlay, 9 kbps or 19 kbps

- 2.5G - GPRS, why it is called 2.5G?

- 3G
  - Packet-switched, Transparent roaming, 2Mbps, Identification of caller location

1G - First Generation

▸ This was the first generation of mobile technology.

▸ 1G is an analog technology and the phones generally had poor battery life and voice quality was large without much security and would sometimes experience dropped calls

▸ The maximum speed of 1G is 2.4 Kbps .

▸

2G - Second Generation

▸ Unlike 1G network which are analog, the 2G networks are digital .

▸ Main motive of this generation was to provide secure and reliable communication channel. It implemented the concept of CDMA and GSM.

▸ 2G capabilities are achieved by allowing multiple users on a single channel via multiplexing. During 2G Cellular phones are used for data also along with voice.

▸ The advance in technology from 1G to 2G introduced many of the fundamental services that we still use today, such as SMS, internal roaming , conference calls, call hold and billing based on services e.g. charges based on long distance calls and real time billing.

▸ The max speed of 2G with General Packet Radio Service (GPRS) is 50 Kbps or 1 Mbps with Enhanced Data Rates for GSM Evolution (EDGE).

▸ Before making the major leap from 2G to 3G wireless networks, the lesser-known 2.5G and 2.75G was an interim standard that bridged the gap.

3G - Third Generation

- The goals set out for 3rd generation mobile communication were to facilitate greater voice and data capacity, support a wider range of applications, and increase data transmission at a **lower cost** .

- The 3G standard utilises a new technology called **UMTS** as its core network architecture - Universal Mobile Telecommunications System.

- 3G has Multimedia services support along with **streaming** are more popular. In 3G, Universal access and portability across different device types are made possible.

3G – Third Generation

▶ 3G increased the efficiency of frequency spectrum improving how audio is **compressed** during a call, so more simultaneous calls can happen in the same frequency range.

▶ The UN's International Telecommunications Union **IMT-2000** standard requires stationary speeds of 2Mbps and mobile speeds of 384kbps for a "true" 3G. The theoretical max speed for **HSPA+** is 21.6 Mbps.

4G – Fourth Generation

▸ 4G is a very different technology as compared to **3G** and was made possible practically only because of the advancements in the technology in the last 10 years.

▸ Its purpose is to provide **high speed** , high quality and high capacity to users while improving security and lower the cost of voice and data services, multimedia and internet over IP.

▸ Potential and current applications include amended mobile web access, **IP telephony** , gaming services, high-definition mobile TV, video conferencing, 3D television, and cloud computing.

4G – Fourth Generation

▸ The max speed of a 4G network when the device is moving is 100 Mbps or **1 Gbps** for low mobility communication like when stationary or walking, latency reduced from around 300ms to less than 100ms, and significantly lower congestion.

5G – Fifth Generation

▸ **5G** promises significantly faster data rates, higher connection density, much lower latency, among other improvements.

▸ Some of the plans for 5G include **device-to-device** communication, better battery consumption, and improved overall wireless coverage. The max speed of 5G is aimed at being as fast as **35.46 Gbps** , which is over 35 times faster than 4G.

SMS: Short Message Service

▸ A messaging service supported by cell phones that allows s
text messages to be sent between mobile devices.

▸ All GSM phones support SMS, but not all CDMA or TDMA
support SMS.

▸ SMS train consumers to use mobile phone for non-voice
communication

▸ SMS messages are handled via a **short message service
center that the cellular** provider maintains for the end
devices

▸ The SMSC sends SMS with a maximum payload of 140 octets,
limiting the SMS to 160 characters using 7-bit encoding.

SMS: Short Message Service

▸ SMS can also be used to send binary data over the air

▸ Customized Ringtones and wireless bitmap graphic are typically exchanged over binary SMS during the Feature Phone Era

▸ Most modern mobile phone has the ability to combine two or more SMSes in one message, thus a message can exceed the 160 character technical limit. However, the sender will be charged two (or more) units of SMS for a combined message

SMS: Short Message Service

The SMS Protocol Stack comprises of **FOUR (4) layers**:

- **Application layer**

- **Transfer layer**

- **Relay layer**

- **Link Layer**

Adapted from: Brown, J., Shipman, B., & Vetter, R. (2007). SMS: The short message service. Computer, 40(12).

Typical SMS Applications

CONSUMERS

1. Person to person messaging (chat with friends)

2. Interactive Information services (getting weather forecast)

3. Entertainment services (download a ringtone)

CORPORATE

1. Notification & alert services: (Emergency broadcast messages)

2. Managing contacts & Appointments (Outlook Integration)

3. Content Push – pushing information or content to subscribers

Adapted from: Brown, J., Shipman, B., & Vetter, R. (2007). SMS: The short message service. Computer, 40(12).

Factors which makes text-messaging attractive to mobile users

▶ Ability to communicate in noisy environment or in situation where voice call is undesirable

▶ Text messages can be sent even when the receiver is temporarily out of mobile network coverage

▶ Ability to sent brief messages without the unnecessary overhead of voice communication

▶ Modern text-messaging technology even enables user to sent images and documents which facilitates meaningful discussion compared to voice communication.

Risk Associated with Text-Messaging

‣ Impersonation and identity theft –compared to voice communication, text messaging is vulnerable to identity theft or impersonation.

‣ Spam – text messaging is also exposed to spamming activity

‣ Privacy issues – compared to voice communication, most text messaging application keeps a history in the mobile device which makes past communication accessible if the mobile devices fall into the wrong hand.

‣ Malicious black hat crackers / hackers often use text-messaging as a medium to for malware delivery

‣ Language pollution – overuse of text-messaging slang can affect language skill, particularly for younger users.

3. Mobile Computing Concept

Mobile Computing Concepts

Divided into **Device Characteristics** and **User Characteristics**:

Mobile Device Characteristic

- Portable

- Connected

- Limited Storage

- Limited Power

- Limited Resource

Mobile User Characteristic

- Mobile

- Interruptible, Easily Distracted

- Available

- Socialible

- Identifiable

•Barbara Ballard.(2007)."Designing the Mobile User Experience", John Wiley and Sons. ISBN 978-0470033616 (Page: 10-16)

Mobile Devices Characteristics

▸ Mobile Device Characteristic

    1. Portable

    2. Connected

    3. Limited Storage

    4. Limited Power

    5. Limited Resource

▸ Barbara Ballard.(2007)."Designing the Mobile User Experience", John Wiley and Sons. ISBN 978-0470033616 (Page: 10-16)

Portable

▸ Mobile device are designed to be movable and portable

▸ It is meant to be carried by its user and kept close by

▸ This also means that the data stored inside mobile device should be portable too

▸ Mobile devices are also expected to be used at a moment notice (user don't plan-ahead before using mobile device)

▸ Ad-hoc uses due to its portability must be reflected in the device usability and user interface. Information presented should be concise and UI must be clear and less verbose.

Connected

▶ Mobile devices are meant to be connected and are expected be connected to any form of network

▶ Even the most primitive form of mobile device is connected to a GSM network

▶ A mobile device without connection is useless

▶ Users expect to use mobile device to connect with other users.

▶ This very concept is also extended to modern smart phones where most users expect mobile applications to be connected (i.e: Calendar application that can be syncronized, Dropbox application, Google Drive, Facebook mobile)

Limited Storage

▸ Due to its nature, mobile device will always have relative limited storage. This trend will continue in the foreseeable future.

▸ Early phones only have limited space to store contact names and phone numbers (typically limited to 256-512 'slots')

▸ Later candy-bar era phones allows users to store notes and reminders in a built in memory (usually not more than 1024k)

Limited Storage

▸ Even by current standards, mobile phones still in need 'extra' storage.

▸ Storage space is still one the deciding factor in buying phones. Whether it supports external memory card or if the phone comes with complimentary cloud storage facility.

▸ Application designed for mobile device should always minimize the use of storage or at least offload the storage to a remote location (by using cloud storage facility)

Limited Power

- One can argue that there is no 'unlimited' power

- However, in mobile device – power is significantly limited by its battery capacity

- Factor that affects battery drains:

    - Weak cell tower signal

    - Extensive processing cycles

    - Extensive use of sensors (GPS, NFC, Magnetometer, light sensor etc)

    - Connectivity (Mobile data, WiFi, Bluetooth)

    - Screen activity

    - Background process activity

- A good application should keep battery drains to a minimum level

Limited Resource

▸ Resource in mobile device refers to its memory, processing capabilities and connectivity.

▸ Memory (or RAM) is limited in mobile device. Applications should reuse objects and discard objects that are out of scope to conserve memory.

▸ Devices will often stalled when it runs out of memory during use.

▸ Processing power in mobile devices is usually constrained to conserve battery and to reduce heat. Application that uses extensive and prolong computation usually offloads them to remote server.

Limited Resource

▸ Mobile device has limited connectivity

▸ This is due to:

  ▸ Unreliable network coverage

  ▸ Limited network cell capacity (overcrowding)

  ▸ Subject to interference (signal bounces off barrier, noise)

▸ Mobile device also suffers from frequent disconnection.

▸ Application designed for mobile device should be tolerant to unreliable speed and connectivity

▸

Mobile User Characteristics

1. Mobile

2. Interruptible, Easily Distracted

3. Available

4. Socialable

5. Identifiable

▸ Barbara Ballard.(2007)."Designing the Mobile User Experience", John Wiley and Sons. ISBN 978-0470033616 (Page: 10-16)

Mobile

▸ Mobile users are mobile. They may move while using the application or between instances of application

▸ Physical location and social context may change while mobile user are travelling

▸ Users may be in rush hour traffic, in a meeting, in class, on a bus or train, at the library, in the restroom.

▸ Some resources may not expected to be available while mobile: Internet connectivity, storage, notes, familiar locations, etc.

▸ Information stored on a remote computer may not be available while users are mobile

Interruptible, Easily distracted

- Mobile users are easily distracted

- Users attention may be distracted by his environment or social cues.

- Example: a user in a bus station writing an SMS may be distracted by bus departure announcement.

- Tasks performed on mobile device should always be expected to be interruptible.

- Writing SMS or watching videos on mobile can always be interrupted by a phone call.

Available

▸ Converse side to interruptible is that mobile users are always available to remote friends and contacts.

▸ The purpose of mobile devices is to make its users 'available'. (why own one if you don't want to make yourself available? ☺☺)

▸ Mobile devices are likely to be close to users wherever the user goes (restroom, bedroom, in the class, etc)

▸ In fact, Many people feel uncomfortable when separated from their devices

1. Lasen, Amparo (2002). A Comparative Study of Mobile phone use in Public Places in London. University of Surrey Digital World Research Center.

2.Cumiskey, Kathleen M. ""Surprisingly, Nobody Tried to Caution Her": Perceptions of Intentionality and the Role of Social Responsibility in the Public Use of Mobile Phones." *Mobile Communications*. Springer London, 2005. 225-236.

Socialable

- A voice call is socially and technologically assumed between two or more people

- Sociability is a key metaphor in mobile app design.

- Sociability in mobile phone is a means to reach others around you, to be able to communicate whether verbally or in written form or to immerse in other form of digital social interactions (giving digital gifts, receiving invitations, playing games together, sharing memorable photos)

- Users may not be interested to use applications without the element of sociability,

Identifiable

▸ Because devices are personal, they are usually unique t single users, exception to this rule is RARE.

▸ This identification includes – unique phone numbers, user account, SIM card, email addresses, contact lists.

▸ Mobile devices are usually tied to a single user. People sharing mobile device is <u>extremely RARE</u>

▸ Therefore, application designed for mobile devices <u>SHOULD NOT</u> ask for users for login credential each time when accessing the app.

Exercise

1. List THREE(3) Mobile Device Characteristics

2. List THREE(3) Mobile User Characteristics

3. Mobile application needs to take account into Mobile Device Characteristic and Mobile User Characteristic.

   Briefly explain the concept of "portable" and "Limited Storage" device characteristic in relation to mobile application.

Platform Proliferation

Platform Proliferation

- Platform proliferation and device fragmentation is prevalent in mobile devices

- Unlike desktop computer market which commonly use Intel x86 based machine, mobile devices comes in many different machine architecture (Armv7, x86-32bit, BCM/Broadcom)

- This lead to different operating system and different machine code binaries produced for each machine architecture

- Additionally, different manufacturers championed their own operating system and set of system libraries for their own devices.

- Some manufacturers supported several different OS for their devices. (eg: Samsung uses Tizen, Bada, Windows Mobile and Android on their devices)

Platform Proliferation

▸ Platform proliferation is unavoidable due to nature of mobile devices market and the nature of mobile device architecture.

▸ However, platform proliferation poses problem to application developer and service providers.

▸ This is because developers have to support different devices, operating system and device features for the same application.

Platform Proliferation

Examples of Mobile Device OS Platform

- Android - mainly uses Java and Kotlin

- iOS (iPhone and iPad) – mainly uses Swift and Objective-C

- Windows Mobile – mainly uses C# and Visual Basic.net

- Bada – mainly uses C

- Tizen - mainly uses C

Platform Proliferation

▸ Different platforms available to users means users are divided when buying their device

▸ Application developers may have to choose which platform to support

▸ Some users will not be able to use certain applications which are available on another platform.

▸ Complexity of maintaining software increases.

▸ There is also issues in maintaining compatibility between platform and interoperability. Certain platform has restrictions which are not present on another platform.

Device Fragmentation

- Device Fragmentation is a situation where devices for a platform has vastly different specification, features or capabilities.

- Device Fragmentation also refers to device that has different OS and API

- Device Fragmentation can occur within the same platform and is more common in Android and Windows Mobile.

- iOS avoids this problem by tightly coupling their OS with their device (iOS only available to iPhones, iPods and iPads)

- Android and Windows Mobile on the other hands is used in devices produced by different manufacturers.

Examples of Device Fragmentation

▸ **Example 1**

  ▸ Samsung Galaxy 5 and Samsung Galaxy Note II both are Android smartphones produced by Samsung.

  ▸ Samsung Galaxy Note II has 5.3" screen size, has front and back camera , supports NFC

  ▸ Samsung Galaxy 5 has 2.8" screen size and has a back camera

  ▸ An application developer who releases a "Self-Portrait" camera application must not assume all phones have front an back camera, because doing so may crashes the application on devices like Samsung Galaxy 5.

  ▸ An NFC or RFID application will crash on Samsung Galaxy 5, because it will try to access a non-existence NFC sensor

Examples of Device Fragmentation

‣ **Example 2**

  ‣ Ahmad and Abu both use Samsung Galaxy 2 phones, initially the device sold with Android 2.3.7 operating system. However Ahmad decided to upgrade the device OS to Android 4.0.4.

  ‣ One day, Ahmad decides to use a download application which uses WiFi P2P features available in Android 4.0.4

  ‣ Abu saw what Ahmad did and try to load the same application

  ‣ The application does not work on Abu's phone, leading him to speculate that his device might be broken.

‣

Device Fragmentation

▸ Further reading on Device Fragmentation

  ▸ http://www.comp.nus.edu.sg/~damithch/df/device-fragmentation.htm

  ▸ http://curioustester.blogspot.com/2015/01/device-fragmentation-how-to-tame-bull.html

  ▸ http://mashable.com/2012/05/16/android-fragmentation-graphic/

Exercise

a) Define Platform Proliferation in Mobile Device

b) Describe problem poses by Platform Proliferation in Mobile Device

c) Describe Mobile Device Fragmentation

d) Differentiate between Device Fragmentation and Platform Proliferation

e) Give TWO(2) examples of Device Fragmentation.

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End of Lecture