SMACS (Social, Mobile, Analytics, Cloud and Security) Technologies for Business

Block

2

MOBILE TECHNOLOGIES FOR BUSINESS

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Ref. No. SMACS-IFHE – 092022B2

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BLOCK 2: MOBILE TECHNOLOGIES FOR BUSINESS

Block – 2 Mobile Technologies for Business - focuses on the mobile environment and discusses various devices and platforms, current operating systems which help build solutions for access of applications through mobiles, all mobile applications for business organizations and use of mobile in various task areas of business process management. There are four units in this block.

Unit 5: *Mobile Devices and Platforms* - Presents the characteristics of mobile platforms and gives a detailed study of the Android market, mobile application development framework, and software development kit. It discusses 15th version of Android mobile operating system**.** It gives a brief on the iPhone platform, Nokia/OVI, Blackberry, Symbian, WebOS etc. This unit concludes with a study on the future of mobile platforms.

Unit 6: *Mobile Operating Systems* - Narrates about the mobile OS architectural trends, OS design for user experience and optimizing the user experience. It discusses power management and cross-platform capabilities.

Unit 7: *Mobile Apps for Business Organizations* - details various benefits and approaches of mobile application development. It focuses on the mobile market, Indian mobile subscriber base, connecting to the cloud, adoption of mobile cloud applications, mobile cloud computing architecture, working with mobile web services, and performing service discovery-context-aware services. After a discussion on mobile device platform selection, the HTML5/Mobile web approach is detailed. It moves on to mobile application testing followed by API applications for mobile security and mobile application distribution.

Unit 8: *Mobile BPM* - Orients you to business process management through SMACS. Mobile service oriented architecture for business process design, automating mobile business processes, web methods platform for mobile BPM, including innovative solutions for integrating with enterprise BPM, Oracle suite for integration of mobile BPM with enterprise BPM are highlights of this unit.

Unit 5

Mobile Devices and Platforms

Structure

"The future is mobile computing – smartphones and tablets are just elements of it. The industry is on the verge of a whole new paradigm."

- Thorsten Heins, former CEO, Blackberry

5.1 Introduction

With mobile computing gradually taking over the use of personal computer, more innovative trends are being witnessed on mobile platforms. The small, portable nature of mobile devices makes it fit for many practical applications, leading to development of mobile applications that can run on multiple platforms.

A mobile phone is a basic communication tool and with the emergence of the latest technology, it has transformed from a communication tool to a powerful multipurpose gadget. Mobile phones support the different needs of the society such as business, finance, education and healthcare areas to name a few. These phones have become indispensable of late due to their integration with social media and cloud services. Current mobile platforms include: Android OS (Google Inc.), Bada (Samsung Electronics), BlackBerry OS (Research in Motion), iPhone OS / iOS (Apple), MeeGo OS (Nokia and Intel), Palm OS (Garnet OS), Symbian OS (Nokia), webOS (Palm/HP).

In the earlier units, we have seen the basics of SMACS technology comprising social networking and platforms, their roles in creating social networks, social

media and customer relationships. In the current unit, we will discuss applications of mobile phones and platforms and their role in networking for useful social services.

Two mobile platforms Google Android and Apple iPhone are covered in detail in this unit. It also covers software development platforms and the future of mobile platforms.

When mobile phones are integrated with social media, the paradigm of communication will change significantly with real-time data made available to the user at the fingertips.

5.2 Objectives

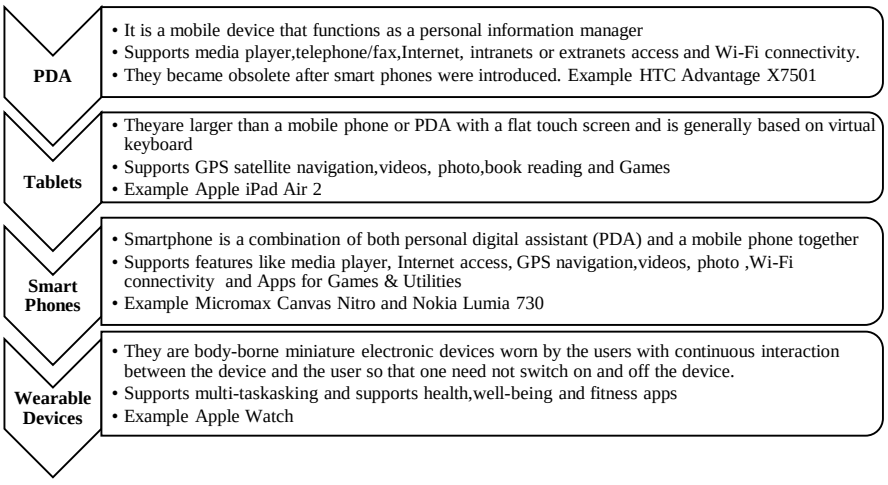
After going through this unit, you will be able to:

- Define various characteristics of mobile platforms.
- Discuss the framework, the Software Development Kit (SDK) and market presence of Google Android.
- Describe the features of Apple iPhone and other mobile platforms.
- Discuss the basic application development environment, tools, and utilities used in mobile application development.
- Define the features of emerging trends in the mobile platform.

5.3 Characteristics of Mobile Platforms

Mobile phone technologies saw rapid development during the 1990s with the introduction of Personal Digital Assistant (PDA), smartphones, tablets, and wearable handheld devices (See Figure 5.1). Despite all these advanced devices with various features with limited input-output interfaces, their performance is purely governed by the operating system on which they are running.

Figure 5.1: Trends in Mobile Devices Development



Source: ICFAI Research Center

The mobile OS (Operating System) is also called the platform; it administers, monitors, and controls the software and hardware. The operating system is also known as the resource manager which manages all the software and hardware resources of the mobile (or a computer) system (See Table 5.1). It integrates the device to make use of features like media players, digital cameras, video cameras and GPS enabled navigation and touchscreens. It also supports web browsers, Wi-Fi connectivity and mobile broadband.

Table 5.1: Different Mobile Operating Systems

Mobile Operating System	Google Android	Apple iOS	RIM BlackBerry	Microsoft Windows Phone
Manufacturer	OEMs	OEMs (Foxconn Technology Group)	RIM	OEMs
Remote administration interface and method	Third party agents use Android Admin API	Native agent uses iOS MDM protocol	Native agent uses BES protocol	Native agent uses EAS protocol
Native products	None	None	Blackberry Enterprise Server, Blackberry Mobile Fusion	Exchange server, Office 365, System center, Windows Intune
Third party products	Many	Many	Limited	Many for Windows Mobile, Limited for Windows Phone
Single-OS management	×	×	✓	✓
Multi-OS management	✓	✓	✓	✓
EAS management	✓	✓	×	✓

Source: ICFAI Research Center

Example: Apple Makes Use of Light Detection and Ranging (LiDAR) Technology for Improving Photo Clarity

Mobile platforms were constantly evolving with introduction of new characteristics and technologies. For example, Apple used Light Detection and Ranging (LiDAR), a significant technology advancement in its iPad Pro, iPhone 12 Pro, and iPhone 12 Pro Max. With LiDAR, it became possible to capture superior quality photos in low light. One application of this technology was in the construction industry, wherein virtual walkthroughs were made available on iPhone and iPad that helped to keep construction crews up to speed and clients up to date. Instead of reams of blueprints and paper documents, superintendents now just carry an iPad around job sites and capture frames, walls, roofs and construction materials with the camera on iPhone and iPad.

Source: https://www.apple.com/in/business/success-stories/construction/, 2022, Accessed on 7th May, 2022.

5.4 Google Android: A Platform for Mobile Devices

An operating system provides the basic functions such as making a call, sending a message, managing settings, installing or removing apps as and when required. Android is the most popular Linux-based mobile Operating System (OS) developed by Google. It is designed for supporting touchscreen devices like smart phones and tablets.

5.4.1 Android Programming Framework

Android OS (Operating System) is built based on a multi-layered architecture with each layer providing a well-defined set of services to the layers above it. The software developed is used to support both middleware and applications. The Android architecture framework is made up of five layers

Let us understand these different layers and their functionality in detail:

- *Linux Kernel:* It is the core layer of the Android Operating System (AOS) (note that the Kernel is the core and controller of any operating system) containing all the essential drivers that are used to control and communicate with the hardware. For example, to connect to a Bluetooth device, a Bluetooth driver is required. Similarly, this layer has different drivers to handle display functions, camera, keypad, Wi-Fi and network devices.
- *Library:* This layer enables the device to handle inter-compatibility and conversion issues among different types of data in AOS. It is a collection of pre-defined programs to manage and address issues concerning recording and playback of different audio-video media formats (for example, AVI file format, MP4 file format, etc.), using media framework. This layer includes media framework, SQL Lite, and Web Kit libraries.

- *Android Runtime (ART):* Android Runtime consists of two main components, namely, Dalvik Virtual Machine (DVM) and core Java libraries in AOS. DVM is used for running apps in an optimized manner, providing security, isolation, memory management and threading support to improve background processing. Similarly, core Java libraries provide most of the functionalities defined in the Java libraries.
- *Application Framework:* This layer has different application frameworks, for example, resource manager to handle resource management function of the concerned device in AOS. Some of the other frameworks are:
    - Activity Manager: It manages the activity lifecycle of applications of AOS.
    - Content Providers: It manages the data sharing between applications of AOS.
    - Telephony Manager: This manages all inbound and outbound voice calls of AOS.
    - Location Manager: Manages location-dependent service like GPS (Global Positioning System) or cell tower detection to support AOS.
- *Applications:* This is the topmost layer with which the user directly interacts with the device and the underlying software in AOS. It includes several standard pre-installed applications available with the device for usage. Some of the commonly used tools are messaging apps, social media tools, games, audio/video players, utility apps, web browser and content manager

5.4.2 Android 6 Features

Android 6 Marshmallow, the sixth major version of the Android Operating System was released in 2015, with lots of additional features. Marshmallow primarily focuses on improving the overall user experience of its predecessor, Lollipop. Subsequently, Android 7 Nougat was also released.

Following are some of the Google Android 6 (Marshmallow) features:

i) *Lock screen:* The Marshmallow lock screen is almost identical to Lollipop's, complete with expandable notifications and app shortcuts. Marshmallow replaces the dialer shortcut with one to Google’s voice search. Response rates are dependent on internet speed and search terms. One can launch apps from even launch screen using voice.

ii) *Home screen:* Voice command functionality is available on the home screen.

iii) *App drawer:* It is a vertical scrolling list to scroll through or can use a new scrubber bar to jump to a letter or alphabet. It also has an app search bar accessible through keyboard/voice/scrubber bar.

iv) *System UI Tuner:* Provides simple UI Tweaks, customizable quick settings area, and menu for display of icons on the status bar, and thus avoids clustering.

v) *Animations:* It is possible to have transitions between apps, pages, and settings through animations.

vi) *Internal storage and file manager:* It has a stock file manager called explorer, and provides at-a-glance information on internal and external usage.

vii) *RAM manager:* Its dedicated setting menu area called Memory facilitates viewing memory usage by the system along with individual apps logged.

viii) *Fingerprint API:* Has a system level fingerprint support and thus are made independent than depending on manufacturer's add-ons. Its accuracy standards are very high.

ix) *Encryption:* Encryption is by default on Android Marshmallow with an improvement.

Encrypted devices will also be subject to Marshmallow's verified boot process to ensure the trustworthiness of their software during each boot sequence. If Android identifies or recognizes some changes have been made, the user will be notified to potential software corruption.

5.4.3 Android 7 - Features

Android Nougat operating system was rolled out with many useful and important features loaded. It was released in 2017 and had improved user features. Following are some of the features of Android 7 Nougat:

i) Multi-window multitasking

More than one "window" on your phone's screen is what multi-window means.

Google has built things in a way that any app will just work, independent of the developer — doing something special. The screen will be split 50/50 by default, and it's quick to pull up different apps between the top and bottom on a phone or left and right on a tablet.

Devices with larger screens are also equipped with a freeform mode that lets you change any window size and picture-in-picture mode is supported for apps running on Android TV.

ii) The phone will use less battery

Google's "Project Doze" is a way to have your phone use less battery. By only allowing things like ways to manage memory and when (and how) apps can run in the background (Google's "Project Svelte") which you really *need* to run, your phone will perform better and use less of battery power.

iii) Using less mobile data

When on a metered connection (one that's not unlimited) — cellular or Wi-Fi — the new Data Saver setting can block background random data usage and restrict things like checking for tweets or emails so that the phone uses less data.

iv) Improved security

New features in Android Nougat make things even more secure. Some apps can partially work before you sign in with your password or PIN. Other apps and allied data will remain unavailable and/or encrypted.

This feature helps keep your data safe if your phone gets lost or stolen, and synergizes well with the remote features of Android Device Manager.

v) Language and locale

An app can display text and numerical data for a defined specific region, instead of just using the default language settings. You can also select multiple languages (or regionalization of the same language) in an order of importance. If it is set up for one but not all of your languages, it'll pick the highest one it can.

vi) Android TV recording and Picture-in-Picture

Basic DVR functionality is provided on Android TV with 7.0. Besides basic controls like Play or Rewind, you'll be able to save multiple sessions. This facilitates you to schedule recordings or record items as you watch. With picture-in-picture support, you will also be able to go into the settings to schedule a recording without missing any of your shows. This is classified as a great feature for televisions that come with Android TV installed.

5.4.4 Android 8 (Oreo)

Android Oreo is the 15th version of Android mobile operating system. It was released to the public on 21st August, 2017. Its features are as follows:

i) Native picture-in-picture feature

Picture-in-picture is a special type of multi-window mode mostly used for video playback. It lets the user watch a video in a small window pinned to a corner of the screen while navigating between apps or browsing content on the main screen.

ii) Password Autofill

This facility allows to autofill the login details for the apps visited. It is same as chrome's auto fill feature.

iii) Notifications

Android Oreo brings a new feature called notification channels, which is meant for both developers and users. This lets the user decide how important

different types of notifications are. In addition, with apps updated for Android Oreo, the settings can be changed for different types of notifications within an app.

iv) Snooze Notifications

This application allows snoozing the notifications for a specific period. (It has the facility to pick a different time span from the dropdown box provided for that purpose).

v) Notification Dot

This feature will put a little dot in the bottom-right corner of the app to indicate any unread notifications. By pressing tap and holding on the app icon, a new popup can be seen, which will show all the notifications for the specific app. Unlike iOS, Android does not show the number of the unread messages in the dot.

vi) New Emoji Styling

Android Oreo's emojis have the same round shape as that of Apple's emojis but Oreo's emojis are more detailed in nature.

vii) Smart Text Selection

Smart Text works in several different scenarios, including navigating to specific apps based on selections (phone numbers, email address, street addresses, and names) from web pages, emails, recents, notifications, and some other screens that display text. For instance, if a text is selected that looks like an address, a shortcut is provided to directly open it in Google Maps.

viii) Auto-Enable Wi-Fi

This feature will automatically enable Wi-Fi when the user is near high quality saved networks. When user is nearing home or office or any other place user frequently visits, Android will automatically enable Wi-Fi for the user. This way the hassle of logging every time is avoided in addition to saving on cellular data allowance.

5.4.5 Android 9 (pie)

Android Pie is the 16th version of Android mobile operating system. It was released to the public on 6th August, 2018. The following are its features:

i) New Gesture Navigation

In Pie, the standard back, home, and recent buttons are dropped in favour of a new gesture-based navigation system.

ii) Adaptive battery and brightness

Adaptive battery goes further by learning about the apps and services that are mostly used and then adjusting the power to give more to these apps and less to apps that are not used as much.

iii) App Actions

Google's launcher already predicts the apps the user is most likely to use based on the time of the day. Now, App Actions let the user quickly start tasks by predicting what he or she wants to do.

iv) Slices

Similar to App Actions, Slices let user jump right to certain actions in apps. For instance, Google says that if the user is searching for Lyft on his phone, he or she will see a shortcut to hail a ride to work, complete with price and ETA (Expected Time of Arrival).

v) Improved Security Features

Mainly two security features were improved in Android Pie.

The first is that this version of Android restricts access to mic, camera, and all sensor manager sensors from apps that are idle. This means that even if user granted permission for an app to access the microphone, it cannot do so unless user is actively using it.

Second, a new lockdown mode fortifies the smart phone in emergency situations. This instantly locks the phone, disables fingerprint unlocking and smart lock, and hides notifications on lock screen. The user has to use PIN, password, or pattern to unlock it again.

vi) New Accessibility Menu

Android has plenty of accessibility features, but they aren't always easy to access. A new menu in Android Pie makes it simple to access common functions for users who need assistance.

vii) New Screenshot Shortcut

In Android Pie, screenshot can be taken from the Power menu any time. What's more, by tapping on Edit command in the notification that appears to make adjustments to screen shot right away.

viii) Easier Screen Rotation

Android automatically switches the screen orientation based on how it's situated. User can lock the orientation to portrait or landscape.

ix) Volume and Sound Improvements

By pressing Volume button, the slider appears on the right side instead of the top. Pressing volume buttons now changes the media volume instead of the Ringer volume.

x) Selectable Dark Mode

Android Oreo included a dark mode, but the system automatically decides whether to enable it or not based on the wallpaper.

xi) Easier Text Selection

Copy and paste facility is enhanced in Android Pie. When the user long-presses to select text and grabs the handles, a little magnifier lets the user see exactly what is being selected.

5.4.6 Android 10

Android 10 is the latest version of Android mobile OS. It was released on 3rd September, 2019 with a preliminary name of "Android Q".

i) Automatic caption media playing

With a single tap, Live Caption automatically captions videos, podcasts and audio messages, without ever-needing Wi-Fi or cell phone data.

ii) Sound Amplifier

With Sound Amplifier provided in Android Pie, the phone can boost sound, filter background noise and fine tune to how user hears the best.

iii) Gesture Navigation

Gestures are now quicker and more intuitive than ever. Go backwards and forwards, pull up the home screen and swipe up to see all open apps. All can be done smoothly.

iv) Dark Theme

Android's new Dark theme uses true black to keep the battery alive longer.

v) Data Privacy

Here, the user is in control of privacy. Because this version of android provides smarter controls that lets user decide how and when data on the device is to be shared.

vi) Focus Mode

Focus mode lets smart phone user select apps to pause temporarily. So if user wants to turn off a distracting app to get something done, all he or she has to do is tap.

vii) Family Link

The user can set screen time limits in this version. User can view app activity, manage apps and content restrictions, and see where they are.

5.4.7 Android 11

Android 11 is the upcoming eleventh major release and the 18th version of the Android mobile operating system.

Expecting features to be included in Android 11 are:

i) Mute notifications during recording

ii) Improved touch sensitivity

iii) Native screen recording
iv) Scrolling screenshots
v) Back gesture tweaking
vi) Improved support for curved displays
vii) Air plane mode won't turn off Bluetooth
viii) Share menu app pinning
ix) Improved notification shade conversations
x) Chat bubbles
xi) Dark mode scheduling
xii) One time permissions
xiii) Scoped storage

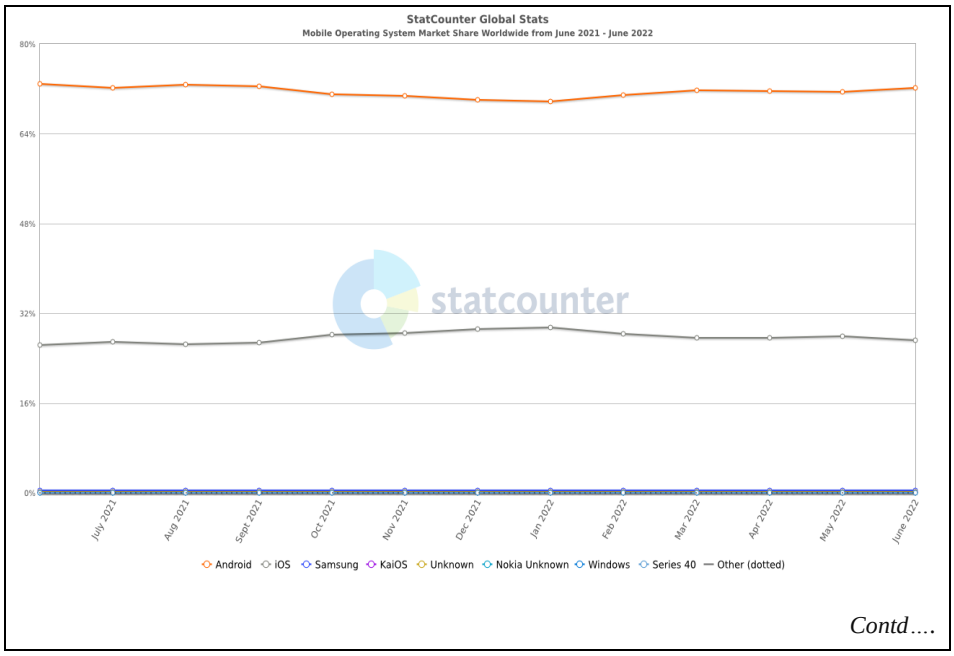
5.4.8 Android Software Development Kit

A software development kit allows developers to create Android applications. The Android Software Development Kit (SDK), also called the Android SDK, consists of development and deployment tools, an emulator, and libraries to develop applications. Generally, the mobile phone has a minimal resource environment because they have limited memory, input/output capabilities and processing power when compared to a normal personal computer.

5.4.9 Android Market Analysis

Apart from Android, there are other operating systems like Apple's iOS, Microsoft's Windows phone, and Blackberry OS in the market with a significant market share of sales. (See Table 5.2).

Table 5.2: Mobile Operating Systems Market Share (Worldwide)



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Date	Android	iOS	Samsung	KaiOS	Unknown	Nokia Unknown	Windows	Series 40	Linux	Other
2021-06	72.83	26.35	0.41	0.18	0.14	0.03	0.02	0.02	0.02	0.02
2021-07	72.21	26.92	0.43	0.19	0.14	0.03	0.02	0.01	0.02	0.02
2021-08	72.74	26.42	0.42	0.19	0.14	0.02	0.02	0.01	0.02	0.02
2021-09	72.44	26.75	0.41	0.17	0.14	0.02	0.02	0.01	0.01	0.02
2021-10	71.09	28.21	0.38	0.11	0.13	0.02	0.01	0.01	0.01	0.02
2021-11	70.74	28.54	0.38	0.14	0.13	0.02	0.01	0.01	0.01	0.02
2021-12	70.01	29.24	0.43	0.13	0.12	0.02	0.01	0.01	0.01	0.02
2022-01	69.74	29.49	0.45	0.14	0.11	0.02	0.01	0.01	0.01	0.02
2022-02	70.94	28.29	0.43	0.17	0.1	0.01	0.01	0.01	0.01	0.02
2022-03	71.7	27.57	0.42	0.14	0.1	0.01	0.01	0.01	0.01	0.02
2022-04	71.59	27.68	0.39	0.12	0.15	0.02	0.01	0.01	0.01	0.01
2022-05	71.45	27.83	0.41	0.12	0.12	0.01	0.01	0.01	0.01	0.01
2022-06	72.12	27.22	0.42	0.08	0.11	0.01	0.01	0.01	0.01	0.01

Source: https://gs.statcounter.com/os-market-share/mobile/worldwide, 2022 (Accessed on July 11, 2022)

Based on the past sales, Android O/S is going to maintain its market dominance.

5.5 Apple iPhone Platform

Ever since Apple's iPhone was introduced in the year 2007, its operating system iOS had many improvements over time by releasing different versions. Similarly, the introduction of iPad and iPod Touch redefined mobile computing. iOS had different versions with each version supporting new features and improving its performance. For example, iOS 7 version offers an easy-to-use smartphone operating system and a platform for app developers.

The operating system X and iOS 1.0 introduced Google Maps, Visual voicemail, iTunes Sync and virtual keyboard features. Similarly, later versions iOS 2.0 and 3.0 saw new features like App store, cut, copy, and paste along with push notifications for third-party apps.

Lastly, the latest iOS 4.0, 5.0, 6.0, 7.0, and 10.0 versions supported a wide range of utilities like the front-facing camera, home screen folders, notification center, iTunes Wi-Fi Sync, iCloud, camera, photos, and audio.

Some salient features of iOS 10 / i10 OS (some are added on need basis) include:

- Facial recognition that's not creepy
- Customizable widgets from your favorite apps
- Visual link-sharing in messages
- Apple music gets personalized playlists

- Voicemail transcription and spam-detection
- Phone support for VoIP services
- Bye-bye native apps
- Multilingual keyboard support
- Live photos editing and stabilization
- Proactive navigation in maps
- Safari gets Split View (iPad only)
- New bedtime feature in the Clock app
- Health app makes it easier to be an organ donor
- Unsubscribe link at the top in the mail

Example: Hästens iPhone based Point of Sale System Enhanced its Ordering Efficiency

Swedish bed manufacturer Hästens was known for its luxurious, handmade beds. Previously, when a customer made a purchase at Hastens, a sales associate had to input the order into a personal computer in the back of the store, which took up to 30 minutes. Now the company adopted Apple's iPhone for their Point of Sale data capture, which allowed Hästens sleep experts to configure everything from the size and firmness of the mattress to the style and color of the legs, and finalized it in under two minutes with a custom app that was developed using a mobile software development kit for Apple's iOS. Hastens was using more than 1000 iPhone devices and has achieved 95% faster ordering.

Source: https://www.apple.com/business/success-stories/retail/hastens/ 2022 Accessed on 2nd May, 2022

Activity 5.1

Android vs. iOS

Considering the popularity of Apple iPhone and Android smartphones in the market, compare the features of the latest Android version and latest iOS operating system in the market. What is so unique about Android? Find out the reasons for its dominance in the mobile OS market.

Answer:

Check Your Progress - 1

1. Which of the following layers has all the drivers in an Android architecture?
   a. Linux Kernel
   b. Library
   c. Android Runtime
   d. Application Framework
   e. Unix
2. Which of the following operating systems is acquired and developed by HP (Hewlett Packard)?
   a. Web OS
   b. BlackBerry OS
   c. Symbian
   d. iOS
   e. Android
3. What does ART stand for?
   a. Android Runtime Technology
   b. Android Runtime
   c. Adaptive Resonance Theory
   d. Advanced Reporting Toolkit
   e. Audio Response Time
4. Pick the odd option out.
   a. Microsoft
   b. IBM
   c. Google
   d. HP
   e. RIM
5. In Android programming framework, who will manage the data sharing between applications?
   a. Content provider
   b. Service provider
   c. Telephone provider
   d. Mobile tracer
   e. Data manager

5.6 Other Mobile Platforms

There are a number of other mobile operating systems and tools which are popular like Nokia/OVI, Blackberry, Windows Mobile, Symbian, and WebOS.

- **Nokia/OVI:** Nokia Suite is an integrated tool to synchronize different contents between a mobile and a PC (Personal Computer). The information stored on the mobile using different interfaces like contacts, calendar, messages, photos, videos, and music can be synchronized. The Nokia suite also supports backup or restore and software upgrade utilities.
- **BlackBerry:** BlackBerry smartphones and tablets are manufactured by Research in Motion Limited (RIM), a Canadian telecommunication company. It is a worldwide provider of secure & high-reliability software for mobile phones. The BlackBerry operating system had many variants such as BlackBerry OS (Java) which supports running mobiles in low powered, narrow bandwidth and high-security environment. This platform found it difficult to incorporate features like mobile web browsing, multimedia, and touchscreen interfaces. BlackBerry Tablet OS (QNX) has PlayBook feature built on QNX as an alternative to the Apple iPad. It has native email, calendaring and contact facilities. The BlackBerry 10 is an updated version of BlackBerry tablet OS to support latest smartphones. Blackberry 10 is an updated version of BlackBerry tablet OS.
- **Windows Mobile:** Windows Mobile supports common features, such as multitasking, navigating a file system, internet explorer mobile, a default web browser and windows media player. This platform has seen multiple versions emerge over time, starting with Windows CE up to Windows Mobile 6.5. With stiff competition from other platforms like iOS and Android, Windows Mobile could not grab a huge market share.
- **Symbian:** It was a worldwide popular smartphone operating system. Symbian rose to fame from its use with the S60 Nokia platform in 2002 and was used in most of the Nokia smartphones and portable display adaptors.
- **WebOS:** WebOS was initially developed by Palm running on Linux and was later acquired by HP (Hewlett Packard). HP released WebOS as open source with a plan to enhance it with additional features. Some of its features include multitasking interface, over-the-air updates, notifications, and third-party applications.

Example: Continuum - a Feature of Microsoft's Stint - An App that allows a Smartphone to be used like a PC

Windows is traditionally recognized as an operating system for standard x86_64 personal computers (PCs). Microsoft's stint into the mobile operating system market in the form of Windows Phone was short-lived; but one of its

Contd….

features known as Continuum, first introduced by Microsoft in 2015, is an app that allows a smartphone to be used like a PC. Since then, Microsoft as well as a lot of software developers have been trying to get around the firmware of existing devices and manage the device-specific drivers, to port Windows to smartphones. Project Renegade is a collaborative project in this direction which has been able to bring Windows 11 to a small but growing list of smartphones, including ASUS Zenphone 5Z, Google Pixel 3, Samsung Galaxy S9 plus, Motorola Z2 force and many others.

Source: Antony Terence (6th February, 2022). The Renegade Project Brings Full-Blown Windows 11 To Smartphones. www.medium.com. Accessed on 2nd May, 2022.

5.7 Software Development Platforms

A Software Development Platform/Kit (SDK) is a development environment which consists of programming interface and set of tools to build, deploy, and run user-developed applications that can run on mobile phones. Some of the popular development platforms are:

- ***Java 2 Micro Edition***

  Java 2 platforms, Micro Edition (J2ME) is a Java programming language based technology for programming PDA (Personal Digital Assistant) and mobile applications. J2ME consists of the programming environment, a mobile-enabled virtual machine, also called the K Virtual Machine and tools, to build and deploy applications.

- ***Python Mobile***

  Kivy, a Python framework, was designed to address natural interface like 'Touch', and to take advantage of modern Graphics Processing Unit (GPU) a specialized electronic circuit was designed to accelerate the creation of images for output display. GPUs are used in mobile phones, personal computers, workstations, and game consoles.

- ***Qt***

  Qt is a cross-platform application framework that is widely used for developing application software which is compatible to run on various platforms with little or no change in code. Qt is currently being developed by the Qt Company under open-source governance, involving individual developers and firms. Qt is available in both commercial and open source license versions.

Example: Finland Based Bus Operator Choses Qt Framework for Application Development to Enhance Customer Experience

Savonlinja, a bus company in southern Finland, decided to completely renew their web store's functionalities as well as mobile applications for drivers and

Contd…..

passengers for iOS and Android. Qt was chosen as the application development framework for this purpose, primarily because it was a complete cross-platform framework that was used for creating connected devices, UIs, and applications. This resulted into a consistent user experience across all platforms, both from a user interface and experience point of view.

Source: https://www.qt.io/bitfactor/savonlinja-built-with-qt, 2022. Accessed on 2nd May, 2022.

5.8 Mobile Platform Wars

The market for smartphone is very competitive as different OSs have their own set of features to outsmart the other competitors in the field. There are three main contenders in this segment, namely, iPhone, Android phone and Windows phone. Some of the major features among these phones which are of value to the users are affordability, interface, Apps & App store, OS updates, power management, security, and backup along with utilities like maps, camera, and cloud services.

Example: Mobile OS Market Share

Statista was a German company specializing in market and consumer data. The company published data regarding the mobile operating systems' market share worldwide from January 2012 to January 2022 on its platform. According to this report, the market share of Android, iOS and Symbian were 23.21%, 24.04% and 31.89% respectively in January 2012. As on January 2022, the market share was 70%, 25.4% and almost negligible for Android, iOS and Symbian respectively. Android was maintaining its position as the winner of the mobile platform war worldwide since past several years.

Source: https://www.statista.com/statistics/272698/global-market-share-held-by-mobile-operating-systems-since-2009/., 2022. Accessed on 2nd May, 2022.

5.9 Future of Mobile Platforms

Google's Android and Apple's iOS are the most dominant players in the smartphone segment with significant market share. Users prefer better accessibility to use apps and better user experience when compared to basic mobile OS performance. Based on the user's preference, upcoming mobile OS developers are planning strategies for improving product competitiveness.

Some of the future trends are:

- Android OS is the market leader in the market. The main reason for this growth is the fact that most mobile handset manufacturers don't have their own OS.
- Web Platforms will be the next upcoming feature in mobile OS. Firefox, Tizen and Ubuntu are the mobile OSs compatible with web content that supports HTML 5.0.
- Google's Android and Apple's iOS are environment-specific, making them non-compatible with various web platforms.

- Firefox developed a low cost ($25) smartphone. The Firefox OS smartphone is not very different from the existing phones, but it has superior execution speeds. It is based on HTML5.
- Tizen is a new mobile operating system developed jointly by Samsung and Intel. This mobile OS enables mobile phones to integrate and control electronic gadgets in cars and TVs (Televisions).
- The UK based Canonical Company released the Ubuntu OS for smartphones, and developed 'Ubuntu Touch' for tablets.

Example: Metaverse, a Disruptive Technology in Virtual Reality

Metaverse was one example of a technological trend that was considered to bring the most extensive technological disruption yet and was expected to have a big impact on the future of mobile platforms and app development. The Metaverse was a virtual world in which people connected and entertained themselves via avatars. Some instances of metaverse mobile applications were in the areas of gaming, virtual meeting, education and shopping. For example, fitness apps in metaverse transported users to a gym where a personal trainer corrected their form, analysed their heart rate, and encouraged them to work harder. Car dealers provided virtual test drives through their mobile apps, and virtual tours were made available from realtors. Users utilized retail apps to simulate being in a store and tried on clothes on an avatar that was based on their own body dimensions and weight.

Source: Adam (January 2022). Metaverse and Future of App Development Companies. https://techresh.com/metaverse-and-future-of-app-development-companies/. Accessed on 2nd May, 2022.

Activity 5.2

Smartphones at a Courier Company

A Chandigarh based courier and package delivery company is struggling to sustain the business with the competition. They would like to reduce the time of delivery of each consignment, and provide routes and needed advice remotely to delivery executives who are on the field. The CEO asked the CTO to find out a way to reduce delivery times, costs, and on-field support to delivery executives. According to him, the delivery executives should locate the address easily in seconds on the field and get route directions remotely. Advise a cost-effective solution to the CEO and suggest the features that would be helpful in the technology that you are going to advise them.

Answer:

Check Your Progress - 2

6. Which of the following developed Tizen mobile OS along with Intel?
   a. Google
   b. Apple
   c. Nokia
   d. Web OS
   e. Samsung
7. What does J2ME stand for?
   a. Java 2Platform, Micro Edition
   b. Java 2Platform, Mobile Edition
   c. Java 2Platform, Macro Edition
   d. Java 2Platform, Mobility Edition
   e. Java 2Platform, Middleware Edition
8. Which of the following are the features that are expected to be on priority for the next generation upcoming mobile OS?
   a. Widgets
   b. Accessibility
   c. Interface experience
   d. OS performance
   e. Accessibility and Interface Experience
9. Identify the number of layers in Android architecture.
   a. Three
   b. Two
   c. Seven
   d. Four
   e. Five
10. Some of the major features, among the smartphones which are of value to the users, are affordability, interface, Apps & App store, OS updates, power management, security, and backup along with utilities like maps, camera, etc. What is the missing characteristic?
    a. Cost
    b. Cloud services
    c. Interoperability
    d. Auto upgrades
    e. Internet

5.10 Summary

- The mobile OS is the key to the success of a mobile phone as the former administers, monitors, and controls the software and hardware of a mobile. Some of the characteristics of mobile OS are - facilitating the use of media players, digital cameras, video cameras, and GPS enabled navigation, touchscreens and communication. Also, it supports web browsers, Wi-Fi connectivity, and mobile broadband.
- Google's Android is a Linux-based mobile Operating System (OS), designed to support touchscreen devices like smartphones and tablets. Its five-layered architecture consists of Linux Kernel, library, Android runtime, application Framework and applications layers.
- Apple's iPhone was introduced in the year 2007, beginning with OS X and iOS 1.0 version. Later visual voicemail, followed by App Store, cut, copy and paste along with Push notifications features were incorporated in iOS 2.0 and 3.0 versions.
- The front-facing camera, home screen folders, Notification Center, iTunes Wi-Fi Sync, iCloud, Camera, features were introduced in later versions.

5.11 Glossary

Android: Android is the most popular Linux-based mobile Operating System (OS) developed by Google. It is designed for supporting touchscreen devices like smartphones and tablets.

Android Runtime (ART): Android Runtime consists of two main components, namely, Dalvik Virtual Machine (DVM) and core Java libraries. Mobile apps are run using DVM in an optimized manner. This layer also provides security, isolation, memory management and threading support to improve background processing.

J2ME: Java 2 Platform Micro Edition (J2ME) is a Java programming language based technology for programming PDA and mobile applications. J2ME consists of programming environment, a mobile-enabled virtual machine, called the K Virtual Machine and tools to build and deploy applications.

Nokia/OVI: This is an integrating tool to synchronize heterogeneous contents between a mobile and a PC. The information stored on the mobile using different utilities like contacts, calendar, messages, photos, videos, and music can be synchronized. Backup and restore services are also provided.

Software Development Platform/Kit: Software Development Platform/Kit (SDK) is a development environment which has a programming interface and a set of tools to build, deploy, and run user-developed applications that can be executed on the mobile device.

5.12 Self-Assessment Test

1. Briefly discuss the purpose of different layers in android architecture.
2. Explain any three mobile software platforms known to you.
3. Highlight the unique features supported by your android smartphone.
4. Define the terms PDA, SDK and Windows mobile.
5. Write a short note on Apple's iOS and its versions.

5.13 Suggested Readings / Reference Material

1. Rodney Heisterberg and Alakh Verma (April 2022). "Creating Business Agility: How Convergence of Cloud, Social, Mobile, Video and Big Data Enables Competitive Advantage," Narrated by Stephen Graybill.
2. Jonathan S Walker (2021). Social Media Marketing For Beginners - How To Make Money Online: Guaranteed Strategies To Monetizing, Mastering, & Dominating Any Platform For Your Brand, JW Choices.
3. Barry Connolly (2020). Digital Trust: Social Media Strategies to Increase Trust and Engage Customers, Bloomsbury Business.
4. Seema Gupta (6 August 2020). Digital Marketing McGraw Hill; Second edition.
5. Tracy L. Tuten, Michael R (15 June 2020). Solomon et al, Social Media Marketing, SAGE Publications Pvt. Ltd; Third edition.
6. Paul Martin Thomas Erickson (2019). Social Media: Usage and Impact, Global Vision Publishing House, 2 edition.
7. Steve Randazzo (2019). Brand Experiences: Building Connections in a Digitally Cluttered World, Paipen publishing.

5.14 Answers to Check Your Progress Questions

1. (a) Linux Kernel

Linux kernel is the core layer of the Android operating system containing all the essential drivers that are used to control and communicate with the hardware.

2. (a) WebOS

WebOS initially was developed by Palm running on the Linux and was later acquired by HP.

3. (b) Android Runtime

Google has introduced a virtual machine in Lollipop OS named Android Runtime (ART).

4. (b) IBM

IBM is a data management service provider, whereas all others have their own mobile OS in the market.

5. (a) Content provider

Content providers usually manage the data sharing between applications.

6. (e) Samsung

Tizen is a new Linux-based mobile operating system, developed by electronic consumer durables giant Samsung and semiconductor major Intel, and was launched in the market in 2016.

7. (a) Java 2 Platform Micro Edition

J2ME stands for Java 2Platform Micro Edition.

8. (e) Accessibility and Interface experience

Accessibility and Interface experience are the features that are expected to be on priority for the next generation mobile OS.

9. (e) Five

There are five layers in Android architecture. They are Applications, Application Framework, Libraries, Android Run Time and Linux Kernel.

10. (b) Cloud services

Some of the major features among these phones which are of value to the users are affordability, interface, Apps & App store, OS updates, power management, security, and backup along with utilities like maps, camera and cloud services.

Unit 6

Mobile Operating Systems

Structure

"The future of mobile means a more intricately connected ecosystem of applications. The "walled gardens" will be torn down and roads and bridges between apps will be constructed."

- Nate Smith, Co-founder of URX (acquired by Pinterest)

6.1 Introduction

Both consumers as well as businesses today require the mobile operating systems to allow exchange of information among various apps that users install on their phones. A well connected ecosystem of applications, combined with seamless user experience, security and cloud integration are some of the features that will shape the development of mobile technologies in future.

In the previous unit, we discussed mobile devices and platforms which provided us a good basic introduction to mobile operating systems and its applications in mobile devices. Now we will focus on operating systems in a little more detail to get a better understanding.

The origin of mobile operating systems dates back to 1996 with the release of Palm OS by Canada based RIM (Research In Motion) (currently known as BlackBerry Ltd). Different versions of Palm OS came into the market such as Palm OS 5.0 in 2002 and Palm OS Cobalt in 2004. Microsoft released Windows Mobile in 2003. In 2005, mobile OS such as Windows Mobile 5, BlackBerry OS 4.1 and Android with the acquisition of Android Inc. by Google have entered the market. In 2007, Apple introduced the first version of the iPhone with iOS. Other mobile operating systems which entered the market include EPOC and Symbian in the early 2000s.

In this unit, we will compare different mobile operating systems and also throw some light on important mobile OS features such as open development, user experience, security and cloud integration, which are some of the latest areas that are being focused for the upcoming versions of mobile technologies.

6.2 Objectives

After going through this unit, you will be able to:

- Compare different mobile operating systems and discuss their architectures.
- Express the issues pertaining to user experience and how best they can be optimized.
- Discuss power management and inter-platform compatibilities.
- Describe cloud integration aspects across different mobile operating systems.

6.3 A Comparative Study of Mobile Operating Systems

A mobile operating system (OS) is similar to any standard OS (like Windows, Linux and Mac) but needs to be relatively simple and light (in total load weight) and primarily be able to manage the wireless variations of local and broadband connections, mobile multimedia and various input methods. A mobile operating system (OS) is software that allows smartphones, tablet PCs and other devices to run applications and programs. A mobile OS typically starts up when a device powers on, presenting a screen with icons or tiles that present information and provide application access. Mobile operating systems also manage cellular and wireless network connectivity, as well as phone access.[1] Thus, the major features need to be built into the mobile OS cover:

- Assured user experience
- Battery and power management as minimum features.

[1] *http://searchmobilecomputing.techtarget.com/definition/mobile-operating-system*

Latest mobile operating systems, especially, the most popular ones have a few characteristics like

- Security
- Openness and
- Cloud readiness as latest technology updates.

A mobile OS is responsible for identifying and defining mobile device features and functions, including keypads, application synchronization, email, thumbwheel and text messaging. The market has many players in the development of mobile technologies, each competing with their latest features to capture maximum market visibility and share.

Nine Popular Mobile Operating Systems are:

- Android OS (Google Inc.)
- Bada (Samsung Electronics)
- BlackBerry OS (Research In Motion)
- iPhone OS / iOS (Apple)
- MeeGo OS (Nokia and Intel)
- Microsoft Windows
- Palm OS (Garnet OS)
- Symbian OS (Nokia)
- WebOS (Palm/HP)

Let us study features of the three popular mobile OS: Apple's iOS, Google's Android and Microsoft's Windows phone platforms.

6.3.1 Apple iOS

With the introduction of iPhone and iPad devices, Apple was a major contributor to the mobile OS design which ruled the market. Apple iOS features are:

- **User Experience (UX):** iOS has given good performance to the user and was a role model for other mobile operating systems. Apple provides regular updates to enhance the UX performance. The iPhone 4S has given a better performance than its previous version mobiles regarding Internet and browser capabilities.
- **Power Management:** Operating System Power Management (OSPM) is an operating system technology for managing the power of the underlying platform and switching it between different power states. OSPM enables a platform or system to implement the most efficient power mode and is applicable across all devices and components within a platform/system. OSPM is also known as Operating System-directed configuration and Power

Management. OSPM is primarily designed to work on handheld or portable devices such as laptops and tablets. For OSPM, the entire system is divided into different categories such as the core system and subsystem, each with its own unique power requirements. OSPM works with the System Controller Unit (SCU), a power management unit that directly interfaces with the all the hardware components. OSPM provides different power-operational modes for a system. When implemented with an Advanced Configuration and Power Interface (ACPI), it can switch a system in between power state, performance state and processor state. iOS power optimization is not as expected, due to the introduction of new features in mobile devices. As per iOS developer's estimates, iPhone 4S users consume two times more data compared to the earlier models due to the introduction of virtual personal assistant feature which consumes more power.

- **Cloud Readiness:** iOS 5.0 with HTML5 support and subsequent versions of iOS make it a good cloud-enabled client and the iCloud has been integrated by default as its storage.
- **Security:** Apple watches security on its devices closely. For example, when the first zero-day exploit aimed at iOS was identified in 2016, Apple issued a security update to patch the problem within a few days. Installing the latest iOS upgrades helps in enhanced security. Passcode, which is a single most important security protection, needs to be adopted in every device.
- **Openness:** After years of keeping much of its technology close to the vest, Apple is creating an environment where its own platforms deliver a level of continuity that binds the Mac and iOS devices together and enables them to interact and work together seamlessly.

The best example of Apple's willingness to be more open is allowing third-party keyboards on iOS. Opening up to third-party keyboards is potentially risky, as most of these outside keyboards record keystrokes, but Apple has specified that they cannot record keystrokes by default. If they have to record keystrokes for some internal reason, these vendors must obtain the user's permission.

Apple, meanwhile, added predictive technology to its own keyboard that can make suggestions based on the person with whom you are chatting.

6.3.2 Google Android

Android is a popular mobile operating system, developed by the Open Handset Alliance led by Google. Android open source project's goal and motto provide the best mobile user experience.

- **User experience:** The Android user experience is based on a set of design principles with a purpose. The principal goals to be achieved, as far as user experience is concerned, include "Enchant me", "Simplify my Life," and "Make me amazing".

- **Power management:** Android makes use of wake lock thread mechanism to suspend and activate devices as and when required to save power. Despite this mechanism, Android allows third-party applications to run in the background which consume power.
- **Security:** Each application runs in an independent, isolated environment with a unique user ID. To enforce security in this environment, the unique ID is used to monitor each application as an independent process.
- **Openness:** Google updates the Android code under Apache license as part of the Android open source project, in which Android development and maintenance takes place. Google has partnered with a few device manufacturers for each new version of OS released and makes it openly available after that device has been launched in the market. Android maintains a compatibility program which supports inter compatibility of its versions among all its mobile devices.
- **Cloud readiness:** Google has made major developments in the cloud computing domain. For example, in Google docs, there are significant developments in cloud-integrated mobile solutions when compared to its competitor Apple.

6.3.3 Microsoft Windows Phone

Microsoft has developed the latest mobile OS called Windows phone which is better than its earlier versions such as Windows Mobile 6.5 and Windows Phone 7. Some of its features are:

- **User experience:** It transformed itself from stylus input to the touchscreen mode of user interaction. Like Android's Widget concept, Windows Phone introduced "Live Tiles" on the home screen.
- **Power management:** Windows phone's design to enhance battery life chooses black as the main default theme. This is because black pixels do not emit any light, saving power on the LED screen.
- **Security:** Windows phone's design has a shift from enterprise-oriented design to an end-user–oriented design. The earlier security aspects that existed for the enterprise product were being used without much change.
- **Openness:** Earlier Microsoft released its SDK to provide an open platform to developers to contribute to the new OS updates required. Windows phone marketplace as a platform was introduced enabling its services to be available for development across different countries using programming languages such as C# and Visual Basic.
- **Cloud readiness:** Windows Phone has made its efforts towards cloud readiness. For example, the Windows Phone 8 version is integrated with

Internet Explorer 10 which supports HTML5 and parallel page loading. Similarly, Skype is integrated into Operating Systems which greatly improve phone's user experience with cloud services. The software framework of Windows Phone is made of two components, Screen and Cloud, with the cloud segment supporting "Developer Portal Services" and "Cloud Service" development.

Example: UX Design for Inito

Inito was a provider of women health and fertility monitor software that needed iOS and Android Mobile Apps for its users, with user friendly design that could present easily understandable insights and reports allowing users to track their health data. Nickel Fox, a company specializing in UX development, successfully completed the project for Inito by building mobile apps that utilized the key strengths and capabilities of iOS and Android mobile environments. The key technologies that were used by the company were Java (for Android applications) and Swift (for native Apple iOS apps).

User experience (UX) was a very important characteristic of both Android and iOS mobile operating systems.

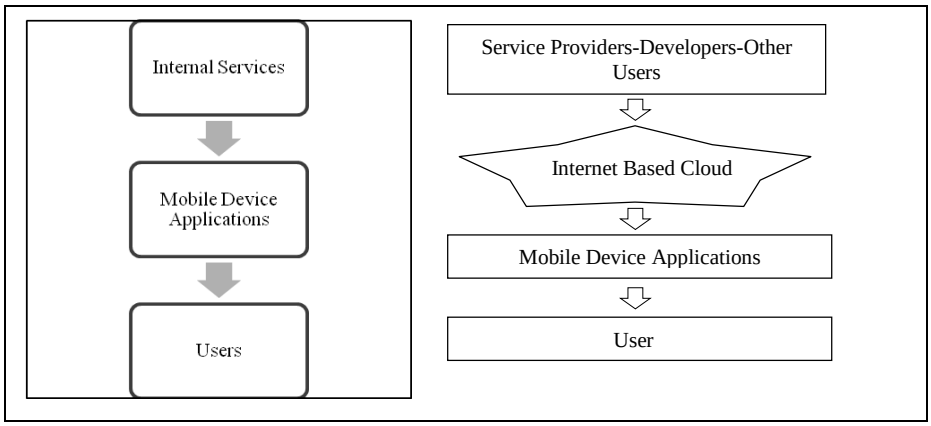
Source: https://www.nickelfox.com/success-stories/inito, 01-Jun-2020, Accessed on 18th May, 2022.

6.4 Mobile OS Architectural Trends

In recent times people have become increasingly mobile communication-oriented, using its most useful services like Short Message Service (SMS), Multimedia Message Service (MMS), and social media tools (WhatsApp and Facebook), with instant connectivity over a secure network. Mobile devices allow portable mobility of network and services to closely communicate with family and friends. Mobile OS is the key to all the changes in technology and over a decade had a phased development starting with PC based OS, embedded systems to present day smartphone OS (See Figure 6.1, Figure 6.2).

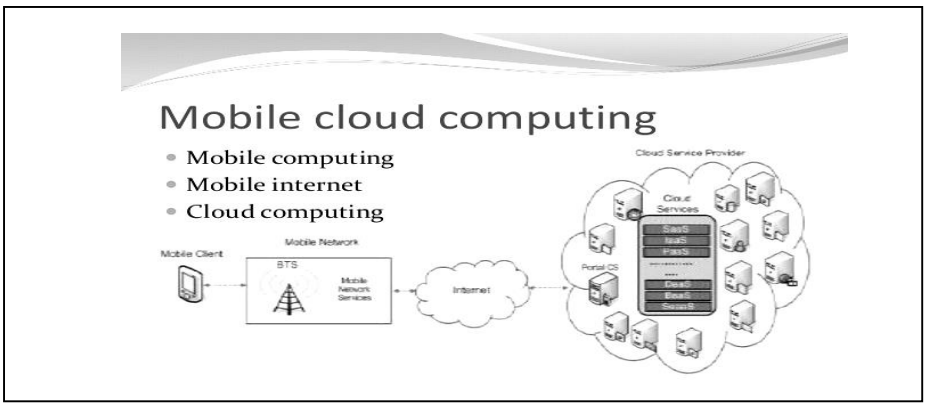
This development of the improvised mobile OS was mainly due to technological improvement in hardware, software, and the internet. Hardware improved in size and capability like PDA instead of PC (Personal Computer) in size. Similarly, the software was more oriented towards user's productivity with features like rich user interface and touchscreens. Lastly, the internet adopted Web 2.0 framework standard for better web compatibility. In the past, the extent of its usage was limited due to the availability of pre-installed applications and browsing of static web pages. Comparatively, the present mobile technology involves service providers, application developers, and other device users to participate and interact with the device on the requirement.

Figure 6.1: Comparison between the Past and Current Mobile Devices and Usage Models



Source: ICFAI Research Center

Figure 6.2: Mobile Cloud Computing



Source: https://www.google.co.in/search?q=mobile+internet+based+cloud&safe= strict&rlz

Future mobile OS architectures also need to mainly revolve around factors like user experience, power management, security, cloud integration and open system development support. User experience includes the easy understanding ability of the features of OS without much help, for example, stylus and touchscreen.

Similarly, the power management and security deal with how best to optimize power consumption without affecting the functioning of the mobile and the level of security restrictions possible on various services as per the user's requirement respectively. For example, Android environment isolates user's app data and code execution from other apps.

Lastly, cloud integration and open system development implies to what extent the third-party tools can be integrated with the operating system and what support tools the operating system developer provides publicly for development and enhancement of services respectively like Google docs and Play store.

Example: Xcode Cloud for iOS App Development

Xcode Cloud released by Apple in 2021 was one example of mobile OS architectural trends, that was considered as a welcome move by the iOS app developers. Xcode Cloud integrated the multiple tasks and tools required to build, test, and deliver apps using powerful cloud services. It accelerated the development and delivery of high-quality apps, allowed running automated tests in parallel, delivered apps to testers & viewing and managing user feedback. The developers using the Xcode development tool built, tested and deployed applications for any of iOS versions via an Apple-managed cloud service that ran on its infrastructure, rather than on their own devices or in a data center.

Sources: https://developer.apple.com/xcode-cloud/, (2021), Accessed on 21st May, 2022

6.5 Mobile OS Design for User Experience

GUI - Graphical User Interface - is a very critical element in ensuring the highest user experience with the instruments (desktop, Laptop, iPad, Mobile, etc.). The term user experience is the overall experience of a user/buyer using a product/ service such as a mobile device or an app, especially in terms of its efficacy. Its self-explanatory nature is considered as a measure of user satisfaction. Apart from this the look and feel, uniformity of interface across navigation screens, adaptability of new features and apps also contribute to the user experience.

All the three major players, namely, Apple's iOS, Google's Android and Microsoft's Windows phone operating system compete aggressively providing the best user experience capabilities in their respective operating systems. User experience is one major factor that plays an important role in achieving maximum acceptability of a mobile technology. This is because what is visible has the maximum impact on a buyer when compared to its internal performance. Because of its market presence and popularity, let us study Apple's iOS user experience features.

The Apple's User Interface (UI) elements provided by the UI kit consist of four categories, namely - bars, content views, controls, and temporary views. Bars provide contextual information, help users navigate and initiate actions while content views give app-specific content, enables operations like scrolling, insertion, deletion, and rearrangement of icons. Similarly, controls and temporary views are used to perform actions and display important information or additional functionality (if any). These components are commonly used across different screens of the mobile device.

Apart from this, there are other common elements which are taken care to provide uniformity in UI design and inter-compatibility across different iOS versions. The following content details you about the requirements/features to be built into the mobile OS.

Some of them are:

Adaptivity and Layout

The Auto Layout of iOS defines how the layout of screens, view controllers, and views should adapt when the display environment changes. iOS supports automatic layout changes when the size of a display environment changes. For example, navigation bars and toolbars automatically become taller when the screen orientation is changed from vertical to horizontal mode.

Layout involves much more than how UI elements look and position themselves on screen. Layout communicates with the users what is most important, what are his choices and how things are positioned. Some aspects like 'make items' are to focus on elevating important content, for example, placement of items in the upper half of the screen. Similarly, large items are catchy and appear more important than smaller ones. For example, 'End Call Button' appears in red.

Navigation

Navigation experience in an app should be well defined, structured, and self-explanatory in nature for its success. There are three types of navigation supported by Apple's iOS environment such as hierarchical, flat and content or experience-driven models. Irrespective of the type of navigation being used, users should always know their current location and understand how to move further or backward as and when required.

Modality Contexts

Modality is a standard pre-defined mode of alert mechanism which informs the users how to complete a task or get information without distractions from the rest of the app. Examples are providing alerts about important information like 'Shutting down' or 'File does not exist'. Keep modal tasks always simple, short, focused, and provide a safe way to exit a modal task, if required.

Interactivity Using Standard Gestures

Many of us are used to the standard gestures like tapping the screen, drag and pinch while interacting with applications and mobile devices. Understanding these gestures gives users a personal experience and allows us to directly manipulate onscreen objects. Users depend on these gestures enormously to perform tasks. Uniformity of these gestures across applications should be maintained.

Example: Mobile Banking App Design at Bank of Jordan

The Bank of Jordan's (BOJ) mobile banking app was receiving lot of poor ratings on Google Play Store. The app offered too many functions that confused BOJ's users, and they ended up experiencing difficulty to perform even simple frequently used actions like reviewing their checking account balances.

Contd….

The bank decided to redesign their mobile app's User Experience (UX) and made significant changes in the user interface, layout, navigation and interactivity. For this purpose, extensive research, engineering and redesigning of the app was carried out, while keeping in mind the pain points and needs of the target customer. After the UX transformation, the app's Google Play and App Store rating rose from 2.8 to 4.7 stars.

Sources: https://www.theuxda.com/blog/mobile-banking-ux-case-study-hated-loved., 2020, Accessed on 21st May, 2022.

Activity 6.1

Advanced Mobile OS Features

Conduct a study using the internet. Identify which operating system versions of Google Android and Apple iOS support video calls, WhatsApp, bar code detection, nearby restaurant, hospital detection etc.

Answer:

Check Your Progress - 1

1. Which of the following is/are the new service layer/s added to mobile OS architecture?
   a. Apps
   b. User Interface
   c. Widgets
   d. Cloud
   e. Notifications
2. Which of the following is the alert mechanism used in mobile devices?
   a. Modality Contexts
   b. Layout
   c. Navigation
   d. Standard gestures
   e. Notifications
3. Which option among the following enhances the longevity of battery life?
   a. Power management
   b. Security
   c. Apps

d. Airplane mode
e. Notifications

4. Which among the following is/are not an Apple's User Interface element?
   a. Bars
   b. Content views
   c. Temporary views
   d. Controls
   e. Messages
5. Which of the following is known as Google's open source App collection tool?
   a. Google Play
   b. Google+
   c. Play Newsstand
   d. Hike
   e. Map

6.6 Optimizing User Experience

It is also necessary to optimize the features of user experience while providing all basic features for enhanced user experience. Google Android has several built-in features and supporting apps to manage and optimize the user experience to enhance the performance of the mobile device. Some of the key points in Android are:

- **Bloatware:** Bloatware is a software that has unnecessary features that use large amounts of memory and RAM. Software comes to be known as bloatware when it becomes so unwieldy that its functionality is drowned out by its useless features. This is also known as software bloat. Most of the device manufacturers supply devices with some preinstalled apps known as bloatware. Some of them may not be required. The user can uninstall some of the apps to enhance the phone's user experience.
- **Use browser efficiently:** Lesser the bandwidth requirements for browsing, faster and better becomes the mobile browsing. In the Google Chrome app, the user can choose "Bandwidth management" option to improve browsing efficiency.
- **Control home screen:** Launcher is the name given to the part of the Android user interface that lets users customize the home screen (e.g. the phone's desktop), launch mobile apps, make phone calls, and perform other tasks on Android devices (devices that use the Android mobile operating system). Launcher is built into Android; however, there are a number of

Launchers available for download in the Android Market. A custom Android launcher makes the device more flexible and productive. It allows customizing the home screen. There are many launchers. For example, Action Launcher 3, ADW launcher 2, APEX launcher, Arrow launcher, Evie launcher, Launcher 8, Lightning launcher, Nova launcher, etc.

- **Better task switching:** When you want to frequently switch between apps with ease, you can use Android's 'Recent Apps' feature or a third-party task manager like 'Switcher'. User can also customize the look of the apps list using this tool.
- **Improve display:** On an Android phone, one can control the display to be in active mode or passive mode depending on usage. An application called 'Screebl' makes use of the phone's accelerometer to save power. Android 5.0 Lollipop, Android KitKat are well-known power saving options.
- **Set auto brightness feature:** An Android app called 'Lux' regulates screen's brightness which is good for the eyes and increases battery life. As screen brightness consumes maximum power, this tool helps save power and allows setting personal preferences for different lighting levels.
- **Install better virtual keyboard:** The Google Play Store has a number of excellent third-party keyboard apps. For example, 'SwiftKey' supports personalized next-word prediction and customization.
- **Lock screen Management:** Android allows widgets not only on home screen but also on lock screen, i.e., the screen that appears on pressing the mobile's power button. Some important information like weather updates, important appointments and the latest news can be viewed without unlocking the device.
- **Minimize Notifications:** Android's notification system is very useful, but if not managed properly the panel will be filled with unwanted information. Android has a built-in mechanism to disable apps' notifications as per the user's preference.

Example: Avast's Bloatware Removal Tool

Avast Cleanup was a bloatware removal tool that was used by users to identify and get rid of bloatware from their mobile devices. One of the lab tests of this tool revealed that use of this tool led to 30% faster work performance, 79% quicker startup and 71 GB space cleaned up by removing bloatware as well as additional junk from browser, disk, and registry.

Bloatware are the programs that were installed on mobile devices, but not used, and still take up plenty of space, memory and battery life and affect user experience.

Source: https://www.avast.com/c-what-is-bloatware, 29-Oct-2020, Accessed on 2nd May, 2022.

6.7 Mobile Security

As mobile became a day to day communication as well as payment device, the highest amount of security needs to be built in the pay apps, messages sent, while equally controlling the spurious messages and access. Over a period, it is being observed that attacks on mobile device's apps and mobile operating systems came into the mobile world. Following is the discussion on attacks based on the communication and SMSes.

Attacks on Mobile Applications (Mobi Apps): Attacks are based on flaws in the OS or applications on the phone. In today's world, mobile-based web browsers are used very often and these browsers may not even be aware of any breaches. These OS may be showing the user in safe mode. But it is not the real situation. With the recent advances in hacking, when the user accesses the websites on the browser some of the browsers' information is also taken by websites. The attackers always wait eagerly to test the security loopholes from the information collected by the websites and inject their own malicious code into the websites' responses. Such malicious codes hosted on the browser applications run the processes in unintended ways to gain privileged access. As such, the browsers with new plug-ins, ActiveX add-ons and flashes which claim for better-optimized services are the actual applications which are exposing vulnerabilities.

Jailbreaking (is to hack it so that you have unrestricted access to the entire file system on the mobile) the iPhone with firmware 1.1.1 and exposing the iPhone vulnerabilities, like those affecting the browser process due to an obsolete and vulnerable library, are common features. Next, the phishing attacks (The first couple of hours in a phishing attack are critical. After that, many attacks are blocked by phishing filters or taken down. Hence, mobile users are more likely to be hit by phishing just because they are always on") are also the classic piracy concerns related to browsers. All such attacks are verified to be majorly due to the limitations of anti-virus.

Since OS files are embedded on ROM, it was assumed that these files cannot be tampered with. But gradually with time, it was also known to be unsafe or attacked when an attacker overwrites the original file with his/her file of the same name. And when this application is installed, it is verified by a series of certificates; but an attacker can create a valid signature without using a valid certificate and adds it to the list. Such a case is seen in Symbian OS, wherein by modifying the firmware, the attacker could easily insert not only valid but malicious certificate.

Mobile security or the mobile phone security is growing to be more complex and critical in the mobile world. Mobile malware is the most common security threat.

Such threats have come by means of communication like Short Message Service (SMS), Multimedia Messaging Service (MMS), Wi-Fi networks, Bluetooth,

GSM which can disturb the function and may even modify user data. That's why the applications installed must guarantee the privacy and integrity of the information they collect and store. In addition, some apps are malicious software (malware) whose functionality must be limited by some tools in OS.

Mostly, attacks are done on the basis of:

i) **Data:** Sensitive data like credit card numbers, authentication information, private information, activity logs.

ii) **Identity:** Every mobile device transmits information related to the owner of the mobile phone (This is vital data which may be stolen to commit allied offenses).

iii) **Availability:** Limiting the access and deny the services.

6.7.1 Attacks based on Communication

With advances in technology, mobile phones are also used for storing addresses, maintaining a calendar, accessing e-mails, drafting purposes, etc. These devices are getting smaller and portable day by day and the user can be in contact anytime and anywhere. Recent advances in mobile technology make the mobile highly functional, with the improved applications useful for business professionals as well as the casual user.

Mobiles are frequently used for sending and receiving messages. Such devices send text messages using Short Message Service (SMS) and enhanced messages using Multimedia Messaging Service (MMS). But unfortunately, nowadays, such mentioned services become viable to propagate new malware vectors with services as SMS/MMS messaging and file transfers. Some of the viruses, worms and Trojans used in propagation are Mabir 2004, Commwarrior 2005, Skulls 2005, Redbrowser 2006, and Trojan-SMS.

Attacks based on SMS/MMS

Since mobile phone devices are man-made, they are vulnerable and are prone to attacks. As such, some models which have trouble through binary SMS, send ill-formed SMSes to restart the phone, leading to denial of service attacks. One such good example is Siemens S55, which on receiving a Chinese character in the message leads to denial of service (Dos). Another case is seen in Nokia mail address which accepts 32 characters, but some models accept more than 32 characters which would lead to dysfunction of the e-mail handler. Such an attack is "curse of silence".

An additional way to attack is with vibrated MMS. Most of the users in inquisitiveness suddenly open their attachment to see and become a victim of infected attachment which propagates to all devices and due to which user devices send all the personal information to the attackers unknowingly to the user. Some attackers send a new apps link to install which also does the same.

MS A, B: Mobile station A, B;

BSS: Base Station System;

MSC: Mobile Station Center;

IWMSC: Interworking MSC;

GSM: Global System for Mobile Communication

SMS spoofing: Sometimes the identity of the sender is taken over by a hacker. For example, the recipient may be charged for getting SMS. This can be accomplished if a mobile switching center emulator sends the message to the victim's home SMSC (Short Message Service Center) while pretending as if the receiver is roaming in a foreign network.

SMS faking: SMS fake is a fraud in the mobile terminated (delivery) path. Let's understand how a regular genuine message is delivered. Normal SMS delivery has two phases - Location query and the message delivery to the handset. The originating subscriber's (X Party) message center queries the recipient (Y Party). Home Location Register (HLR) determines the address of the Mobile Switching Centre (MSC) to identify the current location where the Y Party is currently connected. Then, the message is directly sent to the Y Party's phone from the X Party's network.

Faking: A fraudster with access to the SS7 network first sends an SRI-SM to the attacked network's HLR, looking for the location of one or more subscribers, which the HLR will return to him. This is the same as a normal signaling flow. However, in the second part of the attack, the fraudster sends a message in the MT part of the message flow; but like SMS spoofing, the low-level signaling parameters of the MT message are manipulated so that it appears to be coming from a different X-party and/or network. In this scenario, the fraudster has faked the X-party's identity – in fact, the X-party may not even exist – in order to send a message to a subscriber.

SMS flooding: It occurs when the unsolicited SMSes are sent to a user, leading to a denial-of-service in both the core network and radio access networks.

6.8 Power Management: Processor, Device and Mobile OS

All mobile users realize the importance of the life of battery while using mobile instruments. Power management is an operating system facility for optimizing power utilization by switching between different power states. It enables the OS to implement the most efficient power mode across all devices and components. The power management is primarily designed for handheld or portable devices such as laptops and tablets. It is divided into different categories such as the core system and subsystem, each with its own unique power requirements. A power management unit that directly interfaces with the hardware components is known as the System Controller Unit (SCU). When implemented with an Advanced

Configuration and Power Interface (ACPI), it can switch a system between different power states, performance states and processor states. Google's Android is the best mobile OS regarding power management services as it offers services which are either inbuilt or supported through third-party application. Discussed below are certain manual settings to save battery power on Android phones:

- **Lower Screen Brightness:** The screen is the largest power consumer in smartphones. By lowering the display brightness, setting display brightness to automatic, the battery lasts longer. By setting this option, the display brightness will change accordingly as required.
- **Switch off Wi-Fi, GPS, Bluetooth, and Mobile data options:** Both Wi-Fi and mobile data are not required at the same time unless a mobile hotspot is running. Activating Bluetooth for long durations consumes more power, and can be a security risk and a health hazard. So, Wi-Fi, GPS, Bluetooth, and mobile data options can be switched off if they are not in use.
- **Turn off Auto-Sync:** Android Auto-sync is a background process which keeps on consuming phone's battery. Turning sync off will not update the user with e-mail and Facebook notifications as they arrive. They need to be refreshed manually on the requirement.
- **Kill unused background processes:** Kill unused applications which run in the background and which consume power. One should be cautious while doing this as the phone may become unstable. So, do not venture into it unless you are sure of which is being stopped.
- **Set screen sleep time to a minimum:** Set the phone's display to the minimum possible time to save power. This setting may cause hindrance to the user, especially while reading, browsing, or watching movies on the mobile device.
- **Switch on Airplane mode:** Airplane mode switches off Wi-Fi, GPS, Bluetooth, and mobile data and blocks all incoming and outgoing calls and messages. In this mode, the user can still read, listen to music, and play games with minimum power consumption.

Along with these manual settings, Android supports a few good third-party easy to use power management tools.

- **DU Battery Saver:** DU Battery Saver tool claims that its use saves up to 50% power with the free version and up to 70% with its Pro version. Its main feature includes a one-click 'Optimize' button which supports different battery 'Profiles' such as 'Long', 'Sleep' and 'General'. It also allows customizing battery profile and is available on Google play store.
- **Battery Doctor:** Battery Doctor is a free app which provides a task killer that kills all running processes with a click even when the phone screen is turned

off. It provides a widget allowing toggling Wi-Fi, mobile data, and Bluetooth features.

Example: Battery Optimization Issues in OxygenOS

The users of OnePlus smartphones running the Android based OxygenOS, were facing an issue that resulted in delayed notifications. Main reason for this issue was the battery optimization setting enabled in the phones that could get overly aggressive and kill certain apps/services that were running in the background. For example, a 'sleep standby optimization' setting was an option that was enabled by default and it disabled the network connection when the phone was 'sleeping'. This setting was provided by the phone manufacturer for the purpose of power management and saving battery life but was leading to delayed notifications in the phone. The issue was then resolved by the company by releasing security patches in the subsequent updates of the operating system.

Sources: https://piunikaweb.com/2021/03/25/oneplus-nord-users-on-stable-oxygenos-11-facing-delayed-notifications/ (Mar 2021), Accessed on 27nd May, 2022.

6.9 Cross-Platform Capabilities

Mobile Apps are the most useful tools used by heterogeneous mobile users. Cross-platform capability is the ability of an app that successfully runs on different OS platforms with minimum or no change in code or features. In this section, we will consider a few examples of applications with such capabilities.

- 'Knocking Live Photo' sharing app for iPhone, which allows user's friends and family viewing photos. It was initially rejected by Apple but later it got accepted and has become a very popular tool. Recently, a cross-platform "Knocking Live Video" Android version is made available on 3G and 4G network. The app is free for downloading on Apple App Store and Android market.
- 'Mxit', a mobile messaging app, has been launched in India, which supports images sharing and group chatting among 50 users across different platforms. It is useful for small businesses and NGOs. The App can run on Java, Nokia, iOS, Android, Blackberry, and Windows phone platforms. It is compatible to run on different devices and supports many Indian language formats.
- Microsoft has been upgrading its OS features and apps to support cross-platform capability since long. For example, by purchasing 'Accompli', MS Outlook became compatible with Android and iOS devices.
- Microsoft has also acquired 'Sunrise', a calendar app for Android and iOS mobile which allows users to connect to Google calendar, and iCloud calendar.

All these initiatives are taken to prevent users from switching between different platforms and protect company's respective market presence.

Example: Flutter for Cross Platform Development

Flutter was a framework for cross-platform mobile app development. BMW, the automobile giant, decided to adopt Flutter in 2018 to solve the difficult issue of discrepancies between their iOS and Android offerings. Idea was to design apps that give the same experience and functionality to their consumers irrespective of the mobile operating system they were using. In July 2020, the company launched My BMW App. The app was a universal interface for consumers spread across 47 countries in five continents. The cross platform capability of the app provided its users a seamless experience across all mobile phones and platforms.

Source: https://www.bacancytechnology.com/blog/build-scalable-app-using-flutter (December 13, 2021.) Accessed on 27nd May, 2022

Activity 6.2

Market Survey

An agency, which is conducting a survey on the customer's preference in purchasing mobile devices, started collecting data from the segment of youngsters. What would be your list of preferences (features, functions, apps, etc.) in the order of priority to look at the time of purchase decision for buying a mobile?

Answer:

6.10 Cloud Integration

Cloud storage is a data storage model in which the digital data is stored in logical pools. The physical storage may span multiple servers (and often locations), and the physical environment is owned and managed by any hosting company. The cloud storage and service providers are responsible for making the data available and accessible when needed. They also ensure that the physical environment is protected and is running. People and organizations can buy or lease storage capacity from the storage/service providers to store individual, organizational, or application data. Cloud storage services may be accessed through a co-located cloud computing service, a web service application programing interface (API) or by its applications such as cloud desktop storage, a cloud storage gateway or web-based content management systems.

With the Apple's iCloud, a cloud storage and cloud computing service launched in the year 2011, integrating cloud services and mobile has become imminent. It is a subscription service that facilitates user to manage documents and other types of files across iPhone, iPad, and Mac platforms. It allows the users to synchronize, save, manage, access, import, and edit saved content using compatible devices and apps. The iCloud service enables its users to store data in the form of documents, photos, and music on remote servers which can directly be downloaded to iOS, Macintosh, or Windows devices.

iCloud functions include:

- **Backup and restore:** iCloud allows users to backup the settings and data on iOS devices which include photos, videos, device settings, app data, messages, ringtones, and visual voicemails. For any malfunction during the restoration process, iCloud restores all data along with App data when the device is coordinated with iCloud.
- **Email, Contacts, and Calendars:** iCloud implements a push-enabled email, calendaring, and contact services to its user to keep them updated whenever there is a change or/and update to their respective devices. It means, whenever a user gets an email, changes an appointment or adds/changes contact, it is immediately updated on the device. It also provides sync of users' bookmarks, notes, and reminders.
- **Find My Friends & My iPhone features:** 'Find My Friends' was introduced to iCloud in iOS 5.0 version so that users can share their location with friends or family who are using the similar feature. 'Find My iPhone' is another feature. Using this feature, a user can view the device's approximate location on a map, display a message, change the device password, and erase its contents.
- **iCloud Keychain:** iCloud Keychain was proposed during 2013 along with iOS 7.0 and iOS 10.9 versions. It is a secure database to store and retrieve information regarding a user's login credentials, Wi-Fi network passwords, credit card information which does not include CVV (Card Verification Value) details, and other details. The data is encrypted and stored for auto-fill on web pages when required with ease.
- **iWork:** This feature includes pages, numbers, and keynote for collaboratively working in groups. Pages allow sharing document links and facilitate real-time editing with other users. Similarly, numbers feature is like spreadsheet tool with a lot of built-in formulas for data analysis. The keynote is a visual aid for preparing presentations.
- **iCloud Photo Stream & Photo Library:** iCloud photo library allows to store unlimited photos compared to "Photo Stream" which allows up to 1000 recent

photos till 30 days. These photos on Photo Stream are compatible with iPhone, iPad, Mac, and PC; however, the iCloud storage is not allotted for this purpose. While for photos on iCloud and Photo Library multiple formats are supported, the videos can also be uploaded.

- **Apple ID:** Introduced in 2011, each Apple customer is given an account with 5 GB of free storage. An Apple ID is the unique login ID to access Apple support services and iCloud features such as storing user content, downloading apps and access to paid songs, movies, and TV shows from the iTunes Store.
- **iCloud Drive:** iCloud Drive is a file hosting service for devices on iOS 8.0, OS X (version 10.10), or Windows 7.0, which allows users to save photos, videos, documents, music and apps on iCloud. This allows users to work on different devices as and when required with 5 GB free storage available on the cloud.

Check Your Progress - 2

6. Which of the following is a cloud storage and cloud computing service launched by Apple?
   a. iCloud
   b. iOS Cloud
   c. Photo Library
   d. Key Chain
   e. Apple Cloud
7. Which of the following Apple service provides spreadsheet-like features?
   a. Pages
   b. Numbers
   c. Key Note
   d. Drive
   e. Apple ID
8. Which of the following is called software supplied with preinstalled default apps on mobile device?
   a. Malware
   b. Middleware
   c. Firmware
   d. Bloatware
   e. Appware

9. ‘Lux’ is an Android app used for which of the following?
    a. Regulating screen's brightness
    b. Controlling Notifications
    c. Managing mobile data
    d. Sharing Messages
    e. Blogging
10. Which mobile services does Airplane mode not block?
    a. Bluetooth
    b. Calls
    c. Games and Music
    d. Wi-Fi
    e. SBike mode

6.11 Summary

- Mobile operating systems like Apple’s iOS, Google’s Android and Microsoft’s Windows phone platforms have a few characteristics like transparency, security, and cloud integration as some of the latest updates in their OS development.
- Cloud integration and open system development refer to third-party tools which can be integrated with the operating system and the support tools for the OS developer. It is available publicly for development and enhancement of services respectively.
- Apple’s User Interface (UI) elements provided by the UI Kit consist of four categories, namely, bars, content views, controls, and temporary views. Standard user interaction mechanisms like tapping the screen, drag, and pinch, bars give users a personal experience and allow them to directly manipulate on-screen objects.
- Google Android has several built-in features to optimize the user experience and to enhance the performance of the mobile device. Some of them are using browser efficiently, home screen setting, task switching, display, auto brightness and lock screen management.
- In this unit, we studied the comparisons among different mobile operating systems and threw some light on important mobile OS features such as user experience, power management and the latest inclusion, the cloud integration in this domain.

6.12 Glossary

ACPI (Advanced Configuration and Power Interface): ACPI is an industry specification for the efficient handling of power consumption in desktop and mobile computers. ACPI specifies how a computer's basic input/output system, operating system, and peripheral devices communicate with each other about power usage.

Bloatware: Most of the device manufacturers supply devices with preinstalled apps known as bloatware. Some of them may not be required. The user can uninstall some of the apps to enhance the phone's user experience.

Cloud Integration: Cloud integration is the process of enabling multiple application programs to share data on the cloud. A network that incorporates cloud integration implies diverse applications communicate directly or through third-party software which can be downloaded on a mobile.

Cross-Platform: Cross-platform capability is the ability of an app to successfully run on different platforms with minimum or no change in code or features.

Jailbreaking: Modify (a smartphone or other electronic device) to remove restrictions imposed by the manufacturer or operator, e.g. to allow the installation of unauthorized software

MT part of message flow: MT refers to a message being sent to a mobile handset.

Openness: Openness means software and its original source code is freely available for the public which may be redistributed and modified if required.

Phishing: Phishing is the fraudulent attempt to obtain sensitive information such as usernames, passwords, and credit card details (and money), often for malicious reasons, by disguising as a trustworthy entity in an electronic communication.

Power Management: Power management is an operating system facility for optimizing power utilization by switching between different power states. It enables the OS to implement the most efficient power mode and across all devices and components.

SRI-SM: Send routing info for short message.

SS7 Network: Signaling System 7 (SS7) is an international telecommunications standard that defines how network elements in a public switched telephone network (PSTN) exchange information over a digital signaling network. Nodes in an SS7 network are called signaling points.

User Experience: The term user experience is the overall experience of a user/buyer using a product/service such as a mobile device or an app, especially in terms of how easy to handle or its self-explanatory nature and is considered as a measure of user satisfaction.

6.13 Self-Assessment Test

1. Briefly, discuss any five techniques to optimize the user experience in mobile devices.
2. Explain the following features of the Google Android operating system - user experience, cloud readiness and third-party apps.
3. Highlight Apple's cloud integration feature.
4. Tabulate general user interface features of iOS.
5. Write a short note on cross-platform capabilities in mobile devices.

6.14 Suggested Readings / Reference Material

1. Rodney Heisterberg and Alakh Verma (April 2022). "Creating Business Agility: How Convergence of Cloud, Social, Mobile, Video and Big Data Enables Competitive Advantage," Narrated by Stephen Graybill.
2. Jonathan S Walker (2021). Social Media Marketing For Beginners - How To Make Money Online: Guaranteed Strategies To Monetizing, Mastering, & Dominating Any Platform For Your Brand, JW Choices.
3. Barry Connolly (2020). Digital Trust: Social Media Strategies to Increase Trust and Engage Customers, Bloomsbury Business.
4. Seema Gupta (6 August 2020). Digital Marketing McGraw Hill; Second edition.
5. Tracy L. Tuten, Michael R (15 June 2020). Solomon et al, Social Media Marketing, SAGE Publications Pvt. Ltd; Third edition.
6. Paul Martin Thomas Erickson (2019). Social Media: Usage and Impact, Global Vision Publishing House, 2 edition.
7. Steve Randazzo (2019). Brand Experiences: Building Connections in a Digitally Cluttered World, Paipen publishing.

6.15 Answers to Check Your Progress Questions

1. (d) Cloud

Cloud integration implies - to what extent third party web-enabled applications can be integrated with the operating system.

2. (a) Modality Contexts

Modality is a standard pre-defined mode of alert mechanism which informs the users how to complete a task or get information without distractions from the rest of the app.

3. (a) Power management

Power management is an operating system facility for optimizing power utilization by switching between different power states. It ensures the long life for the battery.

4. (e) Messages

The Apple's User Interface (UI) consists of four categories, namely, bars, content views, controls, and temporary views. Message is a service.

5. (a) Google Play

Google's open source App collection tool is called Google Play, a store with thousands of third-party tools compatible on the Android platform.

6. (a) iCloud

iCloud is a cloud storage and cloud computing service launched in the year 2011 by Apple with a number of innovative features to use and share over the virtual network storage.

7. (b) Numbers

Numbers is an iCloud feature, like a spreadsheet tool, with a lot of built-in formulas for data analysis.

8. (d) Bloatware

Most of the device manufacturers supply devices with the preinstalled apps known as bloatware in which most of the applications are not used frequently.

9. (a) Regulating screen's Brightness

An Android app called 'Lux' regulates screen's brightness which is good for the eyes and increases battery life.

10. (d) Games and Music

Airplane mode feature is used for security reasons while traveling by air, to avoid unwanted communication by users and it does not block the use of games and music.

Unit 7

Mobile Apps for Business Organizations

Structure

"Our lives will be facilitated by a myriad of adaptive applications running on different devices, with different sensors, all of them collecting titbits about everything we do, and feeding big digital brains that can adapt applications to our needs simply because they get to know us."

– Márcio Cyrillo, Executive Director at CI&T

7.1 Introduction

The future of mobile application development is adaptive applications which can bring rich personal experiences to the users.

The previous unit has detailed the comparative aspects of various mobile operating systems. Most of the mobile operating systems also provide various important components, including various applications (Apps). In continuation to the previous unit, we will concentrate on mobile applications and their uses in the current unit.

Mobile Applications are popularly known as Apps in short, and are very popular and easy to use. There are many Apps used for various activities like weather updates, business, education, finance, entertainment and healthcare. Most of these Apps are easy to access through a number of App stores like the Android Play Store, Nokia's Ovi store, App store from Apple and Microsoft's Windows phone marketplace. These Apps are developed using different approaches to support platform-specific and web-enabled features depending on various requirements.

In this unit, apart from different development approaches, various App development environments are discussed. It deals with details of the Application Programing Interface gateway and various methods to distribute mobile apps, along with a discussion on programmer's productivity.

7.2 Objectives

After going through this unit, you will be able to:

- Explain different mobile application development approaches and their benefits.
- Explain various mobile application development environments.
- Discuss the importance of web mobile development.
- Explain the factors that influence mobile app testing and the types of testing.
- Describe APIs management and mobile app distribution.

7.3 Benefits and Approaches of Mobile Application Development

There are different mobile application development approaches available which are based on the requirements of the proposed application to be developed. Some of the approaches are:

- **Native Approach:** A native mobile application is an application program that has been developed for use on a target (mobile) platform or a device. As these native applications are platform specific, these can access all OS services (Operating System) and other software installed on the device. It can make optimal use of device's installed hardware and software capacities, including other features like Global Positioning System (GPS), camera and other features. This is one of the advantages of native applications over the other web-based and cloud-based mobile applications. A native app is a separate version built for each mobile device which can be downloaded from a public or private app store and installed on the mobile device. Major advantages of this approach are best performance, better user experience, consistency multi-touch (double taps), fast graphics (better refresh rates), fluid animation (games), built-in components (camera, GPS, location detection) and ease of use. Two important drawbacks with this kind of

applications are: 1) Knowledge gained is specific to the mobile OS and device only, and 2) The developer will specialize in a specific environment without any scope to easily migrate to other environments. Based on version changes in OS, change in devices, and platforms, there will be need to develop and maintain different versions of the same app for integrating it to the present OS features, devices, and platforms.

- **HTML5 / Mobile Web Approach:** An HTML5 mobile app is a collection of web pages that are designed to work on a handheld device's small screen. Mobile web apps are coded either in CSS (Cascading Style Sheet), JavaScript, or HTML5 (Hypertext Markup Language)[1],[2]. The apps are not device specific and can be opened with any modern mobile browser. HTML5 concept of 'write-once-run-anywhere' allows easy distribution utilize minimal memory space and support to mobile app services compared to native apps. In this approach, users can access data from any device as long as the internet is available as all the databases are saved on the internet servers. The major drawback of these apps are, don't work in poor internet connection as data is saved in servers and don't have access to so many APIs. Mobile web HTML5 apps are easier to develop, but have their own limitations regarding enterprise mobile application issues like offline storage and security[1].
- **Hybrid Approach**: A hybrid application is a mix of native and web applications put together, which can be installed on a device and it runs using a web browser. These apps are built using multi-platform web a language such as called HTML5, JavaScript, CSS. While native applications are platform and device specific, web applications are generalized with cross-platform compatibility its maintenance is very cheap. The development of these apps are very easy which is its principal advantage. Web applications are accessed using a browser on the internet by using a mix of native approach for front-end development, and a web service implemented for back-end processing. Facebook, LinkedIn, and Xerox have many apps developed using this approach. 'PhoneGap' is an open source development framework for building cross-platform mobile apps using HTML (Hypertext Markup Language), CSS (Cascading Style Sheet) and JavaScript for creating hybrid mobile apps[2]. However, it has its limitations too. In comparison to native mobile apps, hybrid apps lack performance, less speed, and overall optimization. Hybrid apps have some design specific issues too.

[1] HTML is a markup language for describing web documents (web pages).

[2] CSS describes how HTML elements are to be displayed on the screen.

[1] HTML is a markup language for describing web documents (web pages).

[2] CSS describes how HTML elements are to be displayed on the screen.

Example: Delasport Develops an App for both Android and iOS which Offers Enhanced Personalization and Elevate Customer Engagement

Delasport, an international iGaming software company, set to deliver modern cutting-edge software and turnkey solutions to gaming operators. The company developed a new app based on Native Approach both for the most popular Android and IOS platforms. Since they were built as native apps, they utilized all the facilities offered by the native operating system so that the customer experience can be elevated with faster response and more personalization elements.

Source: https://igamingbusiness.com/company-news/delasport-launch-new-android-and-ios-native-app/, (June 2022). Accessed on 21/06/2022.

7.4 Mobile Device and Platform Selection

Different mobile application development environments are available from various companies. Most of these environments have different support tools and services to integrate different technologies like cloud and Service Oriented Architecture (SOA). Some of the popular platforms are:

- **SAP Mobile Platform:** Version 3.0 of SAP Mobile Platform helps build cross-platform enterprise apps from a single HTML5 codebase. It provides the application development environment compatible with Eclipse and Visual Studio. It supports web services and databases along with compatibility of multiple devices. Formerly, it was named as "Sybase unwired platform". To connect business data to mobile devices, SAP mobile platform is the simplified application. It helps in managing workflow as well as backend integration.
- **Syclo:** Syclo specializes in providing enterprise asset management applications, but later extended its base to all mobile OSs (Operating Systems). Its Agentry platform is an excellent choice for B2E (Business to Employee) and B2C (Business to Customer) application support. Agentry supports hybrid applications that behave like native applications and web-oriented implementations. Syclo's Agentry minimizes application maintenance costs, less app development duration, and provides support for varying mobile standards. It also maximizes value and provides persistent return on investment. (Syclo is acquired by SAP recently.) Syclo offers development, deployment, and management of wireless business application architecture.
- **Adobe:** Adobe's cross-platform development offerings have PhoneGap Build, based in the cloud. PhoneGap is an open source solution. PhoneGap is based on Apache Cordova. Nitobi, software maker of the PhoneGap framework, was acquired in 2011 by Adobe Systems. It is a strong choice for

enterprises with requirements for mobile clients that want to wrap mobile web applications developed with other platforms like Sencha, Dojo mobile, jQuery mobile and others. It is available for Windows, Linux, and Mac OS platforms. It is a single code based environment with a rich set of libraries and IDEs (Integrated Development Environment) available in its framework.

- **Sencha Touch:** Sencha is a web-based mobile application development approach, suitable for clients who seek expertise in web application and JavaScript development. Sencha touch application development framework is based on HTML 5. It is tied up with SAP to allow SAP customers to use Sencha Touch to build and integrate with SUP (Sybase Unwired Platform).
- **jQuery Mobile:** jQuery mobile is an open source project, suitable for organizations that need an open source mobile web framework which allows using HTML, JavaScript, and CSS technologies to build interactive mobile web pages. It supports several smartphone devices and can build hybrid mobile applications with PhoneGap.
- **Appcelerator:** Appcelerator focuses on enhancing the time-to-market feature for cross-platform apps. It uses a single JavaScript codebase for its apps. It supports real-time mobile analytics. The Appcelerator is open and extensible. It can produce apps for Android, iOS, and BlackBerry, as well as HTML5 and hybrid apps. It includes an open-source SDK and supports more than 5,000 devices and (1) OS APIs, (2) Eclipse-based IDE Studio and (3) MVC framework Alloy. Eclipse-based Appcelerator's Titanium mobile platform comes with pre-integrated cloud services and an extensive library of application extensions. It is used in organizations that require implementing multi-OS application development involving web technology skills. Appcelerator is in partnership with SAP, for its customers to use Titanium to build and integrate features with SUP.
- **Xamarin:** Xamarin is a cross-platform development tool that helps developers build native iOS, Android, and Windows apps, by using a single shared C# codebase. Apps developed with this platform can be tested on a number of devices through the company's cloud service. Xamarin offers own interface development tool and online classes are held through its Xamarin University program. Features of Xamarin's offerings include forms interfaces for sharing code, native API access, add components directly from an interface, and integration with back-ends such as Microsoft Azure, Parse, and SAP.
- **iFactr:** iFactr has a speedy delivery of apps. The solution can be learned easily. Prototypes can be easily and rapidly created for quick feedback from employees. iFactr uses Xamarin to create apps, and the solution supports Adobe PhoneGap. It is the only platform that supports both traditional and modern computing operating system.

- **Kony:** Kony's products can be delivered through an on-premise solution, in a hosted private/public cloud, and these services are scalable and can be adjusted on demand. Allied testing tools and analytics are also embedded in the platform.
- **Kony Visualizer:** It integrates design capabilities into the development environment. By enabling designing and development, line of business can quickly build apps across channels (web, mobile).
- **Kony Studio:** It is a set of visual development tools for developers to add cross-platform JavaScript code. It connects to back-end APIs and Kony Management. Through this, it deploys and administers mobile device apps. Kony studio provides robust and powerful integration tool to enable a platform that can mobilize their systems across various industries. These include manufacturing, pharmaceuticals, consumer packaged goods, utilities and many others. Kony studio also offers a complete solution that supports sophisticated integration of mobile applications.
- Kony can be a good fit for organizations needing apps that integrate with SAP, Oracle. It deals with a large number of diverse devices.
- Decision makers need to focus on the platform, supporting programing languages, debuggers available, and emulators available while choosing the tool.

Example: Windfinder Provides Weather Forecasting for Surfers on the Mobile App Using WAP Technology

Windfinder was a weather forecasting service provider for surfers. The company began with SMS-based service. The service was the e world's first mobile phone-based weather forecasting service for surfers.

The platform incorporated the facility to get the forecasts through WAP based browsing feature. They later adopted high resolution rendering using other tools. Forecasts for around 45,000 locations were provided. The service got real time measurements from around 2000 weather stations.

Source: https://www.surfertoday.com/surfing/the-best-surf-forecasting-websites-and-apps,(January 2022). Accessed on 21/06/22.

Check Your Progress - 1

1. Which of the following is known as a mobile app developed specifically to suit an operating system or a device?
   a. Native app
   b. Web app
   c. Hybrid app
   d. Stand-alone app
   e. Independent app

2. Which of the following is an open source web framework which allows using HTML, JavaScript, and CSS technologies to build interactive mobile web pages?
   a. Syclo
   b. Adobe
   c. Sencha
   d. jQuery
   e. Appcelerator
3. Which of the following is an eclipse-based platform integrated with cloud services and supports multi-OS application development?
   a. Syclo
   b. Adobe
   c. Sencha
   d. jQuery
   e. Appcelerator
4. Which of the following is a mobile development approach which supports both native features and web enabled tool?
   a. Native APP
   b. Web app
   c. Hybrid app
   d. Stand-alone app
   e. Independent app

7.5 State-of-the-art in Mobile Apps, Services and Technologies

Mobile technology is changing rapidly focusing more on easy user applications, location-based and context-aware services, analytics, adaptive, power backup, and storage, etc. We will focus on the mobile market, Indian mobile subscriber base, connecting to the cloud, adoption of mobile cloud applications, mobile cloud computing architecture, working with mobile web services, and performing service discovery-context-aware services.

7.5.1 Defining the Mobile Market

Communication between the people is made easy after the invention of devices like cell phones, telephones, pagers and more. Mobile users keep increasing due to various factors. Based on the number of mobile users in the world, India is ranked at number-2 and China is in the first position.

Indian Mobile Subscriber Base

According to TRAI (Telecom Regulatory Authority of India) report, the mobile users in India reached 1.16 billion in April 2019 as compared to 1190 million in December 2017[3].

The number of telephone users increases every year as telecommunication is always a growing field in India. This strength increased from 970.97 million to 972.21 million in 2015 including landline and mobile. Based on a TRAI report, this growth is nearly 0.85% every month. This increase in usage is both in urban and rural areas. Similarly, the mobile users also increased every year; it increased from 943.97 million to 952.37 million to compare with the previous year 2014.

7.5.2 Adoption of Mobile Cloud Applications

Mobile Cloud Computing (MCC) can be realized as the combination of cloud computing, mobile computing, and wireless networks. MCC is software which when installed in various portable computing devices can be accessed with the help of internet. The applications of mobile cloud are of two types, viz. mobile cloud apps and mobile web apps. These apps run on external server of the computing devices for both apps. The storage of data is performed externally as well as it can be accessed through web browser over the internet. This facilitates rich computational resources to mobile users, and in the process, business to network operators, as well as cloud computing providers. Today, most of the mobile operations are performed with the help of cloud. In these operations, processing and storage functions are performed with the help of cloud using the mobile device.

Today, most of our computer applications and operations are performed with the help of mobile using cloud computing technology, examples being banking operations, online transactions, ticket booking, hotel booking, movies, food delivery apps, essential items, and more. All these operations are run with smartphones like iPhone, BlackBerry and windows mobiles. People also have started using a tablet and computer as devices in addition to mobile for cloud computing. Today, most of the mobile operations are performed with the help of cloud. In these operations, processing and storage functions are performed with the help of cloud using the mobile device. Today, most of our computer applications and operations are performed with the help of mobile using cloud computing technology, examples being banking operations, online transactions, ticket booking, hotel booking and more. All these operations are run with smartphones like iPhone, BlackBerry and windows mobiles. People also have started using a tablet and computer as devices in addition to mobile for cloud computing.

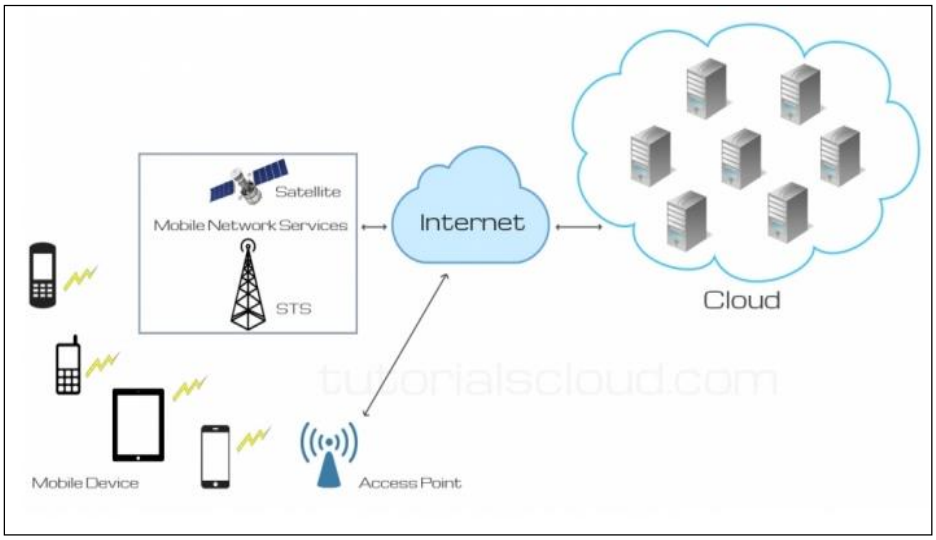
[3] http://www.livemint.com/Industry/0z0LWFhHNhj6pHP32lQJEJ/Telecom-subscribers-in-India-reach-119-billion-in-December.html

Today, most of our day-to-day operations like reading the newspaper, knowing the weather forecast, current stock value can be done with the help of our mobile device. When we buy a smartphone or a feature phone, all these apps and facilities are inbuilt by the providers. User needs to select only the network service provider. Presently the mobile phone is not only used for communication, but also as an information sharing and data processing device.

Mobile Cloud Computing Architecture

Let's understand what are "mobile cloud" and its architecture. The technology of mobile cloud can be modeled as a framework in which processing and storage are done in cloud whereas mobile device acts as a display unit. Earlier, in this architecture, the network connectivity and its internet connection of the computing device plays an important role. The internet connection has to be reliable to run it in a browser. Nowadays, applications are processed locally on the mobile devices such as iPhone, Android, Blackberry, Windows mobile, etc. Essentially, these smartphone acts as a minimized form of computers.

Figure 3.5: Mobile Cloud Computing Architecture



Source: https://www.w3schools.in/mobile-cloud-service/

7.5.3 Working with Mobile Web Services

Due to the popularity of the mobile phones, every year the usage of mobile phones is increasing, leading to a lot of network traffic congestion. In addition to this, the popularity of mobile phones faces some difficulties and challenges in relation to using the web services. One of the main reasons is that the screen resolution of most of the web services does not match with that of mobile resolutions as most of them are PC-based applications only. To overcome this mismatch, developers are developing a number of protocols and interfaces to convert existing functionalities applicable from PCs to mobile platforms. To make this process of

compatibility effective, we must first identify the type of applications and services a mobile user wants through web services like those based on PC or laptop type of devices.

Most of the mobile users use both the pull and push type of service. Pull services are like email, Facebook, Twitter and more. The push content via mobile is similar to traditional marketing and advertising strategies. Mobile push happens without the request of the recipient. Therefore, web-based service should effectively support those functions. The SMS is one of the best examples of push-based service being used by most of the mobile users around the world today.

7.5.4 Performing Service Discovery - Context-aware Services

We can derive full benefits of web services in mobile platform only when appropriate protocols and relevant supporting resources are made available. Protocols are used here to perform various functions; some of them are used for the communication purpose and some for publication purpose. Most of the web services use Service Oriented Architecture as their publishing protocol described by web service description language. The WSDL-Discovery service providers perform advertizing service on small network applications using multicast protocols.

With the development of mobile technology number of users also increased and every user exchanges large data using their mobile phones due to which the transmission of data and information through mobile phones increased. This technology popularized the position-based services and they play a very important role in mobile applications now and efforts are made to provide information from the nearest source to the mobile as the position of mobile is a known factor. With the help of GPS technology, the requests of mobiles are routed to the nearest service points for authentication and for further processing of the requested service. The user requests are managed through two frameworks called physical framework and logical framework.

In mobile communication, the exchange of information is through the medium of Radio Frequency. This medium is effectively multiplexed using techniques like TDMA (Time Division Multiple Access), FDMA (Frequency Division Multiple Access) and CDMA (Code Division Multiple Access). The medium is again classified based on applications. Sometimes the same medium is used for transferring information regarding mobile set and its capabilities, called signaling information, whereas during effective communication it may be used to transfer digital data, be it speech or data, called traffic information. This also helps service providers to identify and authenticate the mobile subscribers to provide the required service effectively.

7.5.5 MEMS, Location Awareness

Micro-Electro-Mechanical Systems, or MEMS, is a technology that in its most general form can be defined as miniaturized mechanical and electro-mechanical

elements (i.e., devices and structures) that are made using the techniques of microfabrication. The advantage of the small size of these devices is made use of in manufacturing mobile devices. With a size as small as a micrometer, these devices can be used as sensors, memory devices and even as microprocessors to be fitted in mobile devices saving space, weight and power consumption. Today, most of the GPS services are offered as user location, identity-based services and are referred to as location-based services. They included other features as below:

- Identify the motion
- Ambient Light Sensor
- Sound Antenna
- Compasses
- Pressure Sensor etc.

Another needed element for better and clear communications is antenna.

Gyros/Accelerometers antenna offers a number of service operations and they are installed in the smartphone and iPhones. For example, the proximity antenna is the one that works whenever the user keeps the mobile phone near to his face to turn off the screen light to avoid over radiation to his face. Most of the iPhones today are installed with the dual microphones to avoid or reduce the noise.

Location Awareness

Today, almost all cell phones have location-based services functionality. Every mobile phone updates its location frequently called location update by sending the signals to register its location with the service provider. Because cell phone offers service during mobility, it is necessary to identify the location of mobile effectively. The desktop also offers some of the services like this. For example, when we type a certain comment on Google, it returns your postal code. Cab booking, food delivery, groceries, weather, news are quite popular location-based services on mobile. Few such providers' home screens are displayed below.

Skyhook works based on Wi-Fi positioning system. The app has a number of points globally, so any user is identified very easily and quickly by the nearest service provider points. For that purpose, the system maintains large size database systems and the company maintains different types of mechanisms to locate the service operations effectively.

7.5.6 Push Services

Normally in client/server technology, server responds the client query. Communication takes place based on the client request. But in PUSH service, the server initiates some service and that information is communicated to the client. The notification from push services are in the form of alert messages that slide on a mobile device. The other set of operations is called PULL service and is

opposite to that of push service. Here, the service is initiated by the client and this request is transferred to the server. Pull services are the information which is requested by user, for example news service subscription, booking a cab, etc. Some of the examples of push service are:

- Most of the operating systems and apps are updated automatically. IM is one of the best examples.
- Email communication
- RSS services
- Software installation and even updating is done effectively
- Teleconferencing service

It is important to note that not all push services are offered by the server, and the same way all push services are not performed on mobile phones and some of them are performed on the desktop also. A number of protocols are used for this service. For example, Post Office Protocol-POP3, Internet Message Access Protocol-IMAP, Simple Mail Transfer Protocol-SMTP, etc.

The polling technology offers its service on an interval basis. During intervals, services are offered by push operation and the time interval is utilized to push operations effectively. These polling operations are defined based on the intervals like long polling. Here, suppose a client sends a request to service some operations, and those operations are not allowed by the server or those services are not available with the server to respond to the client, but the client waits until the response comes from the server. Meanwhile, the client sends one more request to the same server, the operations enter a queue. In the cell phone, these kinds of services are offered by antenna and cell phone battery.

7.5.7 The BlackBerry Push Services

BlackBerry users use the blackberry widgets to perform the push services effectively. During the manufacturing, various applications like text, image, audio, video, email service and other applications are loaded by using this push services. In that way, the system is designed to perform these operations effectively. But like other devices, BlackBerry also avails this operation using up to 8 kb of information only. If we want to push an image or video file at that time, the size exceeds the limited size and system indicates to the users the excess of operations. To perform the push operation, we need to perform the following steps:

1. When the user decides to push any function, he first sends such request to a server.
2. Based on the request received, the server sends an acknowledgment to the requested user.

3. The server pushes the content requested by the user to the user's system.
4. After successfully receiving the message or content, the client sends an acknowledgment to the server.
5. Once again, the server sends the acknowledgment to the client.
6. Finally, the client sends read information to the server.
7. Operations get over from both client and server.

7.5.8 Using SMS

Today, most of the cell phone users use the text message communication to interact with one another called Short Message Service also called SMS. Because of its popularity, the internet email service users are reduced to select SMS as an alternative; it plays a central role between instant message and chat. Today, every cell phone user has this facility in the mobile. The messages have their own limitations. We can send only 140 bytes at a time, also referred to as words. The short message can be delivered to the user through a single communication channel. If the user sends a long message, the information is broken into small text and transferred in packets through the same channel. It also has a limitation such as 153 characters for 7-bit information.

Compared to email and chat, SMS occupies low traffic because of its size and type of flow of information. Whenever a user sends and receives information, the flow is controlled using handshake technique due to which information is transferred without any disturbance and in a correct sequence. Mobile communication also uses a technique called store-and-forward. Whenever we transfer any text messages, the flow is to control channel and from there to message controller and from there to Short Message Service Centre (SMSC). This SMSC service once again connects to the message controller to ensure that the appropriate user receives the correct message in the correct order. SMS service uses the recipient services capability available in mobile, so both controller and users get identified regarding their message status. If the user is out of coverage area or receiver is not interested to receive the message, during that period, messages are available at the SMSC until the message gets delivered to the user. For that, the message can be stored for a number of days. It is one of the secured methods for communicating with each other.

Because of its popularity, today most of the developers provide a number of additional services along with SMS such as Enhanced Message Service (EMS) which offers service of sound, images along with text and it also allows the user to format the text. Multimedia Text Message (MMS) enables sending multimedia content without any restriction. This SMS initially is available on GSM mobile service. The later development of technology made it available with different methods and functionalities.

7.5.9 Defining WAP and Other Protocols

The Wireless Application Protocol, also called WAP, is an application layer network type protocol used on mobile devices to perform the WAP type of browsing operations. The Wireless Markup Language (WML) used in the mobile phone helps to convert the information and to fit into the mobile platform. It started functioning from 1997 onwards as developed by the WAP Forum, but today it is owned by Open Mobile Alliance (OMA). Because of its popularity today it is used worldwide, especially in Asian countries compared to Europe and US. It has certain restrictions based on the WML and certain developer's tools. It has different techniques and methods to suit various mobile standards. Some of them are:

i. *Wireless Application Environment (WAE)*: It performs various applications, based on WML. It forms the foremost layer in WAP that provides an environment for a wide range of applications which can be used on mobile devices.

ii. *Wireless Session Protocol (WSP):* It works with every function of HTTP. The session of the web browser starts with the user connected to any URL (Uniform Resource Locator) and ends when user leaves that URL. But certain operations are restricted and available in compressed version. It also offers WAP push which allows to push data in the network to those mobile devices which has push enable applications.

iii. *Wireless Transaction Protocol (WTP):* This layer of WAP intends to provide internet access to mobile devices. When communication takes place between the user and service, the request and response operations are monitored by this protocol. It works similarly as TCP (Transaction Control Protocol) in an optimized way for wireless devices. The major advantages are less processing and memory cost as compared to TCP.

iv. *Wireless Transport Layer Security (WTLS):* This works for the security purpose. Here operations are controlled by encryption technique. Specifically, they use public key encryption technique. WTLS was designed to provide solutions related to mobile network devices, such as low bandwidth, limited memory capacity, low processing power, authentication issues, privacy protection concerns, and data integrity.

v. *Wireless Datagram Protocol (WDP):* It allows the user to perform unreliable data communication functions and also supports the user for data formatting operations. It covers the TCP and other upper layers in internet models and creates an invisible interface for data communication.

7.5.10 Performing Synchronization

In mobile, most of the web service operations are performed by data synchronization. Most of the mobile operations like contact, the time management function are synchronized effectively. For this, a number of standard techniques and methods are available; the most trusted standard being SyncML also called Synchronization Markup Language. Some of the functions supported by this are mobile operations like Mail service, Chat, SMS, Book Marks, Contact operations, Music, Images, Video, MMS, Talks, and more.

Most of the SyncML operations are performed with the help of SyncML server or host service. Here this service is offered by client and server communication. Most of the client machines have browser plug-in or client connector software. Depending on the type of operations, we use different data types and different servers. This SyncML protocol today performs most of the mobile hardware and software operations effectively. If we want to synchronize our mobile to desktop, we use windows mobile device center. It synchronizes all operations effectively.

7.6 HTML5 / Mobile Web Approach

Web 2.0 changed the nature of web content by enabling community-based input, interaction, content-sharing and collaboration through the internet. To achieve this objective, different social media channels, forums, micro-blogging and social networking were used. With increased importance of Software as a Service (SaaS), web apps and cloud computing enabled the use of smartphones, tablets, and Wi-Fi networks. As web 2.0 supports these technologies, the use of mobile technology, the mobile app development and HTML5 became very popular.

In a mobile web app development approach, the application is developed to run over the internet from a central server, accessed by any device with a web browser. The web technologies required for development are HTML5, Sencha, jQuery using technologies like JavaScript, HTML, and CSS. A mobile web app supports the functionality of touch-enabled devices and works across browsers and a wide range of devices. It also supports features like rich look and feel, offline browsing, location-based services and video capabilities like native apps approach.

HTML5 is one of the most powerful and feature-rich tools used for the development of mobile and web applications. It is a most common technology used for cross-platform web application utilizing development tools such as Apache Cordova, Rhodes, and others. Robust features of HTML5 are easy for deployment. Ability of skilled professionals is the key to its wide usage and success. On the technical side, HTML5 supports a number of features like Geolocation API, video and audio streaming and canvas drawing, etc., making it the best choice for web application development.

Activity 7.1

Using Mobile App

Consider Flipkart's mobile app for online shopping which is popular and widely used. Draw the steps for shopping process cycle followed by this app. At each step list different features, you liked the most.

At each stage, describe the role of technology like SMS and email, if used.

(Hint: The shopping process means: 1. User registration 2. Product selection 3. Cart management and Check out)

Answer:

Check Your Progress - 2

5. What does WTP stand for?
    a. Wireless Transaction Protocol
    b. Wireless Transfer Protocol
    c. Wireless Transmission Protocol
    d. Wired Transmission Protocol
    e. Wired Transaction Protocol

7.7 Mobile Application Testing: Integrations, Security, Network and Performance Testing

Mobile application testing involves many complexities and a challenging task when compared to a conventional desktop application. The reason being a mobile app involves different devices with different capabilities and works in a restricted environment. A mobile device has limited memory, input/output limitations along with smaller processing power when compared to a PC (Personal Computer). With many mobile OS (Operating Systems) and handheld devices available, testing mobile apps is a challenging job because it has many inter-compatibility issues to be checked to satisfy the requirements of the product.

Given below are the preparatory steps for mobile application testing:

- **Hardware/Software Variations:** Good mobile app testing tools and quality assurance standards for testing are the need of the time. As a number of devices and OS are available in the market with many supporting tools as plug-ins, the app testing should be able to address all these inter-compatibility issues. For example, operating systems like iOS, Windows Phone, Blackberry, and Android with their various versions are available in the market running on different devices. Similarly, various device manufacturers like HTC, Samsung, Nokia, and Micromax are very popular with different handset models. Keeping all these factors in mind, an app tested in one environment should work exactly in a similar fashion across other environments.
- **Skilled QA Staff and Testing Strategy:** Availability of specialists in testing and those who are having exposure to automated testing tools are required to get the best results. Apart from tools availability, a strategy of how to test is also important. Strategy involves three aspects, namely - emulator, cloud/web testing and device. An emulator is a tool on which all apps can be deployed and tested. Emulators are free tools used for interface and performance testing. Generally, all apps are browser-enabled which can be deployed, tested, and managed most on a private cloud for security reasons. Device specific testing gives a hundred percent correct and reliable results.

Types of Testing:

Explained below are the various testing types:

- **Usability Testing:** Usability testing is also known as user experience testing. It involves different language selection, inter-screen navigation, online-offline functionality like download and upload issues. This testing mainly takes its inputs from customer feedback and recommendations, for its improvement and identifying bugs in the apps.
- **Compatibility Testing:** It is a type of non-functional testing. Different screen sizes, different devices, and application isolation issues are tested. Apart from these, it also ensures that the app runs on various operating systems, network environment along with specific internal hardware specifications.
- **Interface Testing**: It necessitates screen, button, and text input along with the navigation flow to be tested.
- **Low-level resource testing:** It comprises memory management, temporary file clearance, garbage collection, local database size and process release issues.
- **Stress testing**: Stress testing is the process of determining the ability of a program or device to ensure a certain level of effectiveness under unfavorable conditions. Stress testing benefits organizations by revealing application

issues during the extreme conditions. Stress tests help uncover synchronization and timing bugs, priority problems, interlock problems, memory leaks, resource loss bugs, data loss & corruption.

- **Performance testing:** This testing technique is used to evaluate the performance of the mobile application given heavy workload. To ensure that the mobile app isn't malfunctioning, this test is important. It is the change over time lapse between 2G/3G and Wi-Fi services, response time, CPU optimization, power management, services like GPS, camera, and video players. All these come under performance testing.
- **Operational Testing:** Operational testing is carried out on following: save, backup and recovery issues, data loss due to upgrades, accessibility during calls, messages, alarms, and reminders. It is also known as functional testing and it ensures proper functioning of apps and its flow.
- **Security Testing:** Security testing comprises encryption / decryption of sensitive information, multi-user support, virus, and malicious content issues. It is imperative to test an app for its security features. Usually users uninstall an app due to security reasons.

Example: N26 Achieved a 200 Percent Increase of Monthly App.

N26 (The Mobile Bank) is able to achieve a 200 percent increase of monthly app. releases by adopting mobile testing platform from bitrise. It was a mobile bank with over seven million customers. In partnership with bitrise, N26 decreased the mobile app testing time by over 80%. It was able to release once a week from earlier three weeks. The bank also automated its app's security testing.

Source: https://www.businesswire.com/news/home/20220510005953/en/N26-Teams-Up-With-Bitrise-To-Scale-Mobile-Banking-App%C2%A0And-Achieve-200-Increase-in-Monthly-App-Store-Releases, (May 2022). Accessed on 21/06/22

7.8 APIs Management for Mobile Applications Security

API Gateway allows managing, deploying and operating APIs (Application Program Interfaces). It provides security by employing authentication, authorization and audit procedures. It provides a central control to implement security, routing, mediation, auditing, threat protection and other operational issues. The gateway enables enterprises to standardize API and service delivery with high security, performance, and availability. Gateway is a third-party filter which filters API traffic and allows authenticated/authorized traffic only. It also does rate limiting, i.e., how much traffic each client of the API can send, security filtering (means checking the incoming message content for attacks), and implements redirection/traffic routing.

There are different types of gateway implementations suitable for different requirements of the client. Some of them are:

- **On-premise proprietary gateways:** These are generally installed locally in the organization's data center. It acts as a connector and provides fast and secure data transfer. The various technologies used are Power BI, Power automate, Power apps, Azure logic apps, and Azure analysis services. Examples: Apigee and Layer7.
- **Cloud-hosted gateways:** Cloud-hosted gateways are those which have their API traffic redirected through their servers to function. It is also known as "cloud access security brokers" (CASB). CASB enforces policies between the organization and cloud servers for gateways security. Examples are Mashery and Apigee.
- **Plug-in/Agent architectures:** The concept of plug-in is very simple i.e., being proficient enough to add features to the existing applications. These types of implementations provide software modules that can be deployed on-premise within the application.
- **Open source solutions:** It is the one which can be deployed on-premise or in the cloud. Example gateways are APIAXLE and WSO2.
- **Mobile SDK:** For enterprise app developers with built-in API, it ensures trouble-free back-end data access for authorized users in a secured manner. It treats back-end application services and data as external resources. Example: Restful mobile APIs.

An API gateway protects REST, SOAP, and OData APIs against Denial-of-Service (DoS) and API attacks by enforcing mutual SSL (Secure Sockets Layer) based security for API consumption. It allows centralized connectivity between social networks, cloud services, and notification services. Using an API gateway, one can improve app development acceleration and provide back-end protection along with maximum performance optimization.

Example: Berkshire Banks goes for Salt Security Solution for API Security

Berkshire bank had over 100 branches in New England and New York to provide banking services to individuals and businesses. The services included mortgage, investment, and wealth management. The bank used more and more APIs to share information online. APIs allowed the bank to roll out new services. But with increased usage of APIs, more security issues surfaced and addressing these security challenges was critical to smooth operation of business. The top three issues for API security are API Inventory, API design Security and Runtime protection. The bank worked with Salt Security to achieve this.

Source: https://content.salt.security/rs/352-UXR-417/images/SaltSecurity-CaseStudy-BerkshireBank.pdf, May 2020. Accessed on 21/06/2022

Activity 7.2

Testing Mobile Apps

HDFC bank launched mobile app specific for Stock Trading purposes. The slogan for the mobile app is "Watch your wealth while your wife is shopping". You are assigned with the job of testing this Mobile App.

Please describe the needed test plans for various test scenarios for this mobile app. Please list out the prerequisites and the types of tests those are required for testing the app.

Answer:

7.9 Mobile Apps Distribution

Mobile app distribution is a competitive market and therefore, easy availability of mobile apps is important for their success.

Some of the popular mobile app distribution methods are:

- **App Stores:** The most popular distribution mode among users is 'app stores' based download of mobile apps. There are many app stores from different platforms like Android market, Nokia's Ovi store, Microsoft's Windows phone marketplace and others. Some are free for download while other app creator charges for download or sometimes for the services after download.
- **Pre-Loads:** Pre-loaded apps are the very effective channel for application distribution. Apps are pre-installed on a handset. Generally, pre-loaded apps are demo versions. The paid mobile apps are available but their rates are high. This is one of the ways for effective marketing for products or brand promotion. It also removes the mediator between a customer and a marketer.
- **Search-based App Download:** Websites should be optimized by developers for traditional searches and convert website visitors to application download. For example, GetJar provides a web-based widget which is posted on websites or Facebook pages to attract visitors to download the app.
- **Pay-Per-Installation:** This is a recommendation-driven promotion approach to attract users to install an app. It rewards users with virtual goods using a promo code and other means. For example, 'Paytm' promotes itself to new users by offering Rs.200 worth virtual money, which can be used for mobile recharge and other purchases. Similarly, Uber cabs use promo code to new users, offering free cab rides to first-time app users.

- **Free Time Bound App Usage:** In this approach, a certain number of free downloads are allowed for a limited time. It can be an effective method for distributing apps. For example, a music app 'Saavan' offers a free trial version of the app through which popular songs can be listened to or downloaded.

Example: Fortnite (A Popular Game from Epic Games) was removed from Apple App Store as Epic Games Introduced a Direct Payment Option to Customers by Passing Share with Apple

Apple removed the popular game Fortnite (from Epic Games) from its app store as the developer introduced its own in app payment option denying the 30% share to Apple. As per Apple, the developer violated the guidelines for hosting app on Apple Store. The game could be downloaded from third party sites by users, but it was fraughted with security issues. The Android version was removed from Play store but was available through web on Epic Games website. Epic Games filed a monopoly lawsuit against Apple.

Source: https://www.theverge.com/2020/8/13/21366438/apple-fortnite-ios-app-store-violations-epic-payments, (August 2020). Accessed on 21/06/2022

7.10 Programmer Productivity

Most of the mobile apps use web-based technologies for content development which includes HTML, JavaScript, and CSS. Unlike the KLOC (Kilo Lines of Code) used for normal software productivity test, the Function Point (FP), used in case of mobile apps, is a measurement of the size of software based on interface developed and its implemented functionality. This method is independent of the technology used and is used to estimate business information systems. Estimates include calculating its size and cost regarding development and maintenance of software. However, the most crucial practice in any mobile app development is identifying your customers' requirement. A thorough research would help you in determining whether the capabilities required for the target customer is achievable or not. Web application development includes several components:

- Number of user interfaces required
- Internal and external database connectivity
- Business functionality
- Image optimization
- Code Compression
- Content delivery networks
- Auto resizing
- Security services
- Browsers support
- Email component

- Database transactions
- Deployment tools
- Build and execute the application
- Debug bridge support

Based on the application's functionality, the above stated components are determined for each project. Some of these components dynamically change over time depending on the requirement. Organizations fix value based on FP depending on the number of man-hours required to implement and integrate these elements in a working application. This is the basic method used to measure a programmer's productivity in mobile application development.

Example: Conquer Mobile (Enterprise Mobile App Development Company) uses Function Point Project Management Tool to Measure Programmer Productivity

Conquer Mobile was a major player in enterprise mobile app development for corporates. The company was unable to measure the productivity of coders. It was not able to review progress against targets for app development. Time sheet management was not accurate. The company deployed the Project Management Software of Function Point. The company's time-tracking was streamlined. The staff could easily enter time sheets. The company compared hours worked to the original estimates throughout the project life cycle.

Source: https://functionpoint.com/wp-content/uploads/2022/04/Conquer-CaseStudy.pdf, (Apr 2022). Accessed on 21/06/2022

Check Your Progress - 3

6. Which of the following is mobile testing, which considers issues such as different screen sizes, different devices?
   a. Usability Testing
   b. Compatibility Testing
   c. Interface Testing
   d. Performance Testing
   e. Operational Testing
7. Which of the following is an example of Pay-Per-Installation mobile app?
   a. Talking Tom2
   b. Paytm
   c. DU battery saver
   d. ICICI i mobile
   e. Google Play

8. Under which category of app distribution does Google play fall under?
    a. Pre-Loaded
    b. Pay-Per-Installation
    c. Free time bound App
    d. Search based App
    e. Paid App
9. Which of the following options helps in managing, deploying and authenticating APIs?
    a. API Gateway
    b. API Manager
    c. API Distribution
    d. API Integrator
    e. API Protector
10. Which of the following is the testing that deals with encryption/decryption, virus and malicious content issues?
    a. Usability Testing
    b. Compatibility Testing
    c. Interface Testing
    d. Performance Testing
    e. Security Testing

7.11 Summary

- Mobile application development approaches are used based on the requirements of the proposed application to be developed. Different approaches are the native approach, mobile web approach, and hybrid approach. Various mobile application development environments are available from various companies. Some of the popular platforms are jQuery mobile and Appcelerator which support services to integrate different technologies like cloud and SOA.
- Mobile web app development approach is developed to run on the internet from a central server, accessed by any device with the help of a web browser. The web technologies required for development are HTML5, Sencha, jQuery using technologies like JavaScript, HTML, and CSS.
- Mobile application testing involves many complexities and is a challenging task when compared to testing a conventional desktop application. The reason for this being, a mobile app involves different devices with different capabilities and works in a restricted environment. Different types of app

testing methods are usability testing, compatibility testing, interface testing, performance testing, and operational testing.

- API Gateway allows managing, deploying and operating APIs and enables enterprises to standardize API and service delivery with high security, performance, and availability. A gateway is a third-party filter which filters API traffic and allows authenticated/authorized traffic only.
- Mobile app distribution is a competitive market and easy accessibility of mobile apps is important for their success. Some of the popular mobile app distribution methods are Pre-Loaded, Pay-Per-Installation, Free time bound app search based app and time-bound app.
- Various app development environments and details of API gateway and various methods to distribute mobile apps are explored along with a discussion on programmer productivity.

7.12 Glossary

API Gateway: API Gateway allows managing, deploying and operating APIs. It provides security by employing authentication, authorization, and audit procedures. It provides a central control to implement security, routing, mediation, auditing and threat protection.

App Stores: It is a popular distribution mode of mobile apps. There are many app stores from different platforms like the Android market, Nokia's Ovi store, Microsoft's Windows phone marketplace and others.

Appcelerator: Eclipse-based Appcelerator's mobile app development platform comes with pre-integrated cloud services used for implementing multi-OS application development involving web technology skills.

CDMA (Code Division Multiple Access): A digital cellular technology that uses spread-spectrum techniques.

FDMA (Frequency Division Multiple Access): Frequency division multiple access is a channel access method used in multiple-access protocols as a channelization protocol. It gives users an individual allocation of one or several frequency bands, or channels and coordinates access between multiple users.

HTML5: HTML5 is one of the most powerful and feature-rich tools used for the development of mobile and web applications. It is the most common technology used for cross-platform web application development tools such as Apache Cordova, Rhodes, and others.

Hybrid Approach: A hybrid application is a mix of native and web applications put together, which can be installed on a device and it runs using a web browser. These apps are built using a language called HTML5. While native applications are platform and device specific, web applications support cross-platform compatibility.

jQuery Mobile: jQuery Mobile is an open source mobile web framework which allows the use of HTML, JavaScript, and CSS technologies to build interactive mobile web pages.

TDMA (Time Division Multiple Access): Technology divides a radio frequency into time slots and then allocates these time slots to multiple calls.

7.13 Self-Assessment Test

1. Explain the different types of mobile testing methods.
2. Write about any three mobile app distribution mechanisms. Support your answer with suitable examples.
3. Write a short note on API gateway.
4. Discuss the terms Mobile Web approach and HTML 5.0.
5. State different mobile application development approaches.

7.14 Suggested Readings / Reference Material

1. Rodney Heisterberg and Alakh Verma (April 2022). "Creating Business Agility: How Convergence of Cloud, Social, Mobile, Video and Big Data Enables Competitive Advantage," Narrated by Stephen Graybill.
2. Jonathan S Walker (2021). Social Media Marketing For Beginners - How To Make Money Online: Guaranteed Strategies To Monetizing, Mastering, & Dominating Any Platform For Your Brand, JW Choices.
3. Barry Connolly (2020). Digital Trust: Social Media Strategies to Increase Trust and Engage Customers, Bloomsbury Business.
4. Seema Gupta (6 August 2020). Digital Marketing McGraw Hill; Second edition.
5. Tracy L. Tuten, Michael R (15 June 2020). Solomon et al, Social Media Marketing, SAGE Publications Pvt. Ltd; Third edition.
6. Paul Martin Thomas Erickson (2019). Social Media: Usage and Impact, Global Vision Publishing House, 2 edition.
7. Steve Randazzo (2019). Brand Experiences: Building Connections in a Digitally Cluttered World, Paipen publishing.

7.15 Answers to Check Your Progress Questions

1. (a) Native app

A native mobile application is an application program that has been developed for use on a platform or a device.

2. (d) jQuery

jQuery Mobile is an open source mobile web framework which allows using HTML, JavaScript, and CSS technologies to build interactive mobile web pages.

3. (e) Appcelerator

Appcelerator is an eclipse based platform integrated with cloud services and supports multi-OS application development.

4. (c) Hybrid app

A hybrid application is a mix of native and web applications put together, which can be installed on a device and it runs using a web browser.

5. (a) Wireless Transaction Protocol

WTP stands for Wireless Transaction Protocol.

6. (b) Compatibility Testing

Mobile testing, which considers issues such as different screen sizes and different devices is known as compatibility testing.

7. (b) Paytm

'Paytm' promotes itself to new users by offering Rs. 200 worth of virtual money, which can be used for mobile recharge and other purchases.

8. (a) Pre-Loaded

Google Play Store falls under the preloaded app category and it is supplied on all Android-based mobile devices.

9. (a) API Gateway

API Gateway allows managing, deploying and operating APIs. It provides security by employing authentication, authorization, and audit procedures.

10. (e) Security Testing

The testing that deals with encryption/decryption, virus and malicious content issues is security testing.

Unit 8

Mobile Business Process Management

Structure

"Eventually everything connects - people, ideas, objects. The quality of the connections is the key to quality per se."

- Charles Eames, Designer

8.1 Introduction

When designing processes, designers may focus only on the task at hand and forget how things relate to one another. Businesses processes are connected to each other, and the key to designing great processes is in the connections.

In the previous unit, we discussed mobile apps for business organizations, which provide most of the processes and the process of using apps for business purpose. The current unit may be treated as a complementary unit of the previous one. This unit discusses the business process management, an important business process service, which is implemented on a mobile device.

The enormous growth of the internet combined with the development of mobile technologies has led companies to integrate multiple technologies on a single platform. These technologies include social media, mobility, analytics and cloud computing, which collectively bind customers and companies, leading to an increased collaboration. The reach of the internet and the growth of smartphones provide consumers with unmatched access to information.

The combination of Social Media, Mobility, Analytics, Cloud computing and Security technologies, known as SMACS in short, is the latest domain transforming technology. It is being used in marketing, healthcare and many more areas to collectively share information through mobiles for improving quality of service. This unit deals with some of the SMACS related aspects like the change of work/process flow, web technologies involved and improving customer experience with due adoption of SMACS based technologies in companies.

8.2 Objectives

After going through this unit, you will be able to:

- Explain the impact of SMACS implementation on business process management and its automation in an organization
- Describe the need for web technology and SOA implementation of mobile BPM in a company
- Discuss the technological change that is required to transform from traditional BPM to mobile BPM
- Describe how mobile BPM enhances customer experience
- Define the features of Oracle Business Process Management Suite

8.3 Business Process Management through SMACS

Today's technology and its users are posing challenges to companies and technology inventors to deliver more services, which can be used with minimum effort. User organization's perspective is based on the information collected which must be suitable for strategic planning and making operational decisions.

Business Process Management (BPM) is a systematic approach to evolve a better workflow in an organization to be effective, efficient, and capable of adapting to changing technological and business environment. The emergence of mobile, cloud, analytical and social age has transformed the way in which business operations and customer engagement are being handled. The changes required due to the adoption of SMACS technologies include changes in the workflow and processes, also known as BPM (Business Process Management). A traditional business process management is an integration of conventional resources like people, IT (Information Technology) systems, information, business rules and policies. This helps in operational process outcomes. With the growing

requirements for mobility, BPM approaches moved to one level higher, to be more proactive and intelligent towards processing capabilities.

Given below are the points where BPM processes need to be relooked in the wake of SMACS.

- **BPM and Social Media**: The virtual world of social media is making companies redefine their processes for better implementation, optimization and control. By infusing higher degrees of social quotient and involvement, companies are enriching processes and workflows to explore multi-channel revenues, real-time decision making and "crowdsourcing" avenues for the betterment of the business. BPM changes suitably for the use of social tools like blogs, Twitter, Facebook which are being considered as communication, is the key to success.
- **BPM and Mobile Technology**: Companies are seriously perusing changes in business processes to suit and integrate mobile technology through apps. This leads to improvisations in device architectures and software. But challenges remain regarding the security of data. IBM and Pega systems Inc. have made significant improvements in mobile apps and their capabilities for development of business process management solutions.
- **BPM and Analytics**: In companies, processes are being designed to support more real-time intelligence and analytics by implementing automated solutions to capture data from multiple sources like mobile, social and cloud. An organization takes measures to view trends, analyze data, decide on actions to be taken and measure the results through reports. Visibility of data across the hierarchy of a company in a BPM platform is the key to success of data analysis and its importance. For example, built-in dashboards are helpful to recognize performance issues in real-time and take corrective actions when required.
- **BPM and Cloud:** Business process management solutions implement Service-Oriented Architecture (SOA) and cloud computing integration to make the best use of web services. SOA technology allows developing reusable business service modules which are well defined using standardized interfaces. Due to the above, such architectures maximize reuse and improve business agility, enabling rapid business change. For example, companies like IBM and Cordys have developed cloud-based BPM architectures and web-based modeling tools.
- **BPM and Security:** Authentication, authorization, and protection of sensitive data are all critical topics while designing and implementing business processes. BPM teams need to consider these things and design services with an assurance to ensuring management that, individuals have access to information or functionality they are authorized to have access.

Generally, security is given to a third-party to secure processes appropriately. But the answer is building security management into the BPM systems directly. While defining and designing the processes, major focus needs to be on securing every important process from unauthorized access from within and outside.

Example: IGT Solutions Deploys Microsoft Security Platform to Strengthen the Company's Security Posture to Face New Challenges

IGT solutions provided Business Process Management (BPM) services to companies in travel and hospitality sectors. It employed around 20000 customer experience and technology professionals.

Lakhs of online bookings were facilitated by the company. Sensitive personal and financial data of the users was involved. The company needed to comply with privacy regulations and data protection laws of different nations. The company went for Microsoft security platform to address these issues. New employees were able to easily and securely onboard new devices and apps on their devices without IT team support. This led to cost reduction and faster employee onboarding.

Source: https://news.microsoft.com/en-in/features/microsoft-helped-us-extend-enterprise-security-to-employees-homes-roman-rafiq-igt-solutions/, 2022. Accessed on 21/06/22.

8.4 Automating Mobile Business Processes

Business Process Automation (BPA) is the technology based on the automation of processes/services that accomplish a specific function or workflow. Business processes can be determined for many different activities of an organization such as sales, management, operations, supply chain, human resources, and information technology. If it is web-integrated and mobile-enabled, then the scope and reach of information will be round the clock. There are many IT service providers who have developed architectures and mobile tools like IBM BPM 8.0, Citiustech M-Verge Mobile and PEGA Smart BPM Suite. Well-defined standardized mobile business process management procedures are conceived and implemented, which give multiple benefits to the organization in enhancing its decision-making and analytical capabilities. Automation of mobile BPM has many advantages, namely, quality and consistency, time-saving, analysis and better operational efficiency with reduced cost.

Some of the key impact areas due to the adoption of automated mobile BPM solutions are:

- **Interoperability:** Interoperability among diverse technologies like mobile devices, apps, and healthcare tools - like Apple Health, Google Fit, can be achieved.

- **Communication:** Multichannel communication can be maintained between healthcare providers and mobile devices for sending health alerts, medication reminders and lab results. Automated emails, SMS and notifications may be used for this purpose.
- **Privacy and Security:** Advanced privacy and security features required for accessing and sharing healthcare data can be integrated using encryption techniques. Another area where privacy is important is location-based services.
- **Interactive communication:** Provision of interactive secure communication between providers and patients can be established. Auto-generated push-based mobile communication to promote the latest healthcare products and services can be enabled. For example, e-visits, remote monitoring, video conferencing and notifications.

Example: Blessing Health System, Illinois, Plans to Deliver Hospital-At-Home Care through Sensors Attached to a Mobile App

Blessing Health System was Illinois based rural healthcare centre trying to offer at home critical medical services. The company was partnering with Biofourmis, a healthcare technology company. The idea was to develop a mobile app which was connected to sensors to collect vital data of critical patients at home. This data was analysed with AI tool developed by Biofourmis. The doctors in the hospital got real time data to monitor and recommend medical actions.

Source: https://mhealthintelligence.com/news/illinois-health-system-to-offer-hospital-at-home-care, (March 2022). Accessed on 22/06/22.

8.5 WebMethods Platform for Mobile BPM

A business process is a collection of business activities that are executed in a pre-decided order, involving a large number of applications, systems, employees and external partners as required by an organization. For example, an activity in a hospital can be considered as a complete set of processes between a patient's admissions for treatment, until his discharge.

WebMethods Business Process Management Suite facilitates to automate business processes within an organization and is developed by Software AG USA, Inc. Business processes may involve many dynamically changing constraints and conditions. For example, to admit a patient, the hospital may run out of empty beds or certain medical equipment required for treatment may not be available. Business process management allows the user to have early alerts and planning to handle such situations accordingly. For example, the patient admission may be put on hold until vacant beds are available depending on his condition. Number of users with different roles interact with the suite.

Some of them are administrators. They install and configure the BPMS (Business Process Management Suite).

WebMethods suite includes Designer, WebMethods Broker, Integration Server with Process Engine and My WebMethods Server with Task Engine.

- **Designer:** It is an eclipse-based graphical development application for developing and designing services and business processes along with tasks. A service entity is built and deployed to an integration server while a business process is published to integration server. A task is not available at runtime until it is published to My WebMethods servers. Integration Server and My WebMethods Server authenticate designer users during runtime.
- **Integration Server and Process Engine:** It provides web services defined through Web Service Description Language (WSDL), including encrypted messages. Integration Server is configured to authenticate the user requesting a service and it maintains details like username and password. Process Engine controls the run-time execution of business processes on Integration Server.
- **WebMethods Broker**: It is a message router for handling publish-subscribe messaging and point-to-point messaging. In case of publish-subscribe messaging, a messaging service user connects to WebMethods Broker and publishes a document. Broker sends the document in a first-in, first-out fashion to all the subscribers.
- **My WebMethods Server with Task Engine:** WebMethods BPMS components contain web applications for using and managing the components. These applications are called WebMethods applications. My WebMethods Server is a run-time container used to provide the functions required by WebMethods applications. Task Engine controls the run-time execution of tasks on my WebMethods Server.

Example: Colruyt Group (A Belgian Family Business Group) Deploys WebMethods BPM to Push Real Time Product Data to Smartphones of Staff in Stores to Answer Customer Queries

Colruyt group was a Belgian retailer with 4.5 million customers. It developed an app for customers ordering on their mobile phones. The company wanted to automate the entire business process management so that data can smoothly flow across channels. It partnered with Software AG, a leader in BPM especially mobile BPM. The business processes were automated and life cycle of services was managed efficiently. The new system handles around ten million transactions every day during business hours. The workflow ensured the staff in the store get real time product data to handle client queries. The compliance issue was also addressed.

Source: https://blog.softwareag.com/colruyt-integration-retail (March 2021). Accessed on 22/06/22.

8.6 Innovative Solutions and Integrating with Enterprise BPM

Most of the major IT service providers have developed their own BPM frameworks which can be customized to suit the business requirements of clients. Some of the popular BPM frameworks are listed below:

i) Cognizant's Enterprise Architecture Integration

It is a platform which provides interactive and real-time activity monitoring. It has dashboards and proactive alert features to monitor business processes and services. The platform's BPM is process driven and is efficient, which supports analysis and optimization of resources.

ii) Oracle BPM Suite 12.1.3

Oracle Business Process Management is a complete set of tools used to create, execute and to optimize business processes. The suite enables collaboration between business and IT services to automate and optimize business processes.

iii) Software AG WebMethods Business Process Management Suite 8.2

A business process is a collection of business activities that are executed in a pre-defined order, involving several applications, systems, employees, and external partners as required by an organization. The WebMethods BPMS provides business process management to automate business processes within an organization. The WebMethods BPMS includes Designer, Integration Server with Process Engine, WebMethods Broker and My WebMethods Server with Task Engine.

Example: PHOENIX Group (A Leading Healthcare Company in Europe) Deploys WebMethods BPM to Streamline its Business Processes to grow Business While Complying with Regulations Across Countries

Europe based healthcare company, Phoenix Group, provided healthcare products to clients across Europe. It was operating in more than one country. The compliance requirements varied from country to country. The volume of business was rapidly growing. Most of the business processes in the company were manual and paper based. There was a lot of duplication, inconsistency of data across processes. No one had a transparent view of the workflows. The group implemented WebMethods BPM solution to integrate processes. The net result was streamlined processes, automated workflows, visibility through dashboards, consistent data. Security, compliance and agility of operations improved dramatically.

Source: https://www.softwareag.com/en_corporate/customers/customer-stories/phoenix-group.html, 2020. Accessed on 22/06/22.

Activity 8.1

BPM Suite for a Network Service Provider

You are picked up by ABC Consultants Company for helping the procurement of a BPM suite for a network service providing company based in Mumbai. Please list the advantages of having the suite and parameters or features, which the company should look for during procurement.

Answer:

Check Your Progress-1

1. Which of the following is a systematic approach to improve workflow in an organization?
   a. Business Process Management
   b. SOA
   c. SMACS technology
   d. Flowchart
   e. Business Continuity
2. The impact of mobile BPM is on interoperability, communication and which of the following?
   a. Reliability
   b. Customization
   c. Security and privacy
   d. Cost
   e. Time
3. Which of the following developed WebMethods Business Process Management suite?
   a. Oracle
   b. Pega Systems
   c. IBM
   d. Infosys
   e. Software AG

4. Name the message router used in WebMethods Business Process Management suite.
   a. Integration Server
   b. Process Engine
   c. WebMethods Broker
   d. My WebMethods Server
   e. Task Engine
5. What does WSDL stand for?
   a. Web Service Description Language
   b. Web Server Development Log
   c. Web Security Deployment Layout
   d. Web Service Design Language
   e. Web Security Description Language

8.7 Mobile SOA (Service Oriented Architecture) for Business Process Design

Organizing distributed IT resources into an integrated solution provides information which is consistent and maximizes business agility. Service orientation integrates IT (Information Technology) resources as loosely coupled business processes across the organization. A well-designed service-oriented architecture generates business process solutions that are free from IT infrastructure constraints. Service Oriented Architecture (SOA) delivers a collection of dynamic applications which provide more accurate information and processes, to be accessed through the web or a mobile device.

A service has four properties according to one of many definitions of SOA:

- It logically represents a business activity with a specified outcome
- It is self-contained
- It is a black box for its consumers
- It may consist of other underlying services

Service orientation is a mechanism for integrating an application, systems, and trading partners, which can be accessed as a service. Service orientation uses standard protocols and well-defined interfaces and web services to facilitate access to business logic and information. SOA-based solutions facilitate automation of old manual information, connecting existing systems and transfer processes to evolve new applications. SOA benefits are first based on the IT organization perspective and then followed by the perspective of the business user. Regarding IT perspective, the SOA-based solution requires less hardware,

more reliable, standardized solution and it is cheaper too. On the other hand, in business users' view, it enables development of new dynamic applications addressing business concerns.

Microservices are the next step in the evolution of Service Oriented Architectures. Basically, this type of architecture is a particular way of developing software, web, or mobile applications as suites of independent services. These services are created to serve only one specific business function, such as User Management, User Roles, E-commerce Cart, Search Engine, Social Media Logins, etc. Furthermore, they are completely independent of each other, meaning they can be written in different programing languages and use different databases. Hence, "microservices must be independently deployable, whereas SOA services are often implemented in deployment monoliths. Classic SOA is more platform-driven, so microservices offer more choices in all dimensions." - Torsten Winterberg.

Technologists need to ensure that any microservice is well-defined, well-documented, and standardized. Such best practice for creating the definition and standardization is an API. APIs define the mechanism for accessing any particular component of the systems.

API needs to have

- Confidentiality
- Integrity
- Availability
- Reliability

to provide a secure and well-defined access point to a microservice.

A secure API can guarantee the confidentiality of the information it processes. It makes the information visible only to the users, apps, and servers who are authorized to consume it. It must guarantee the integrity of the information it receives from the clients and servers. It shall only process the information which it knows that has not been modified by a third party. The ability to identify the calling systems and their end-users is a prerequisite to guarantee those security qualities.

The four principles of API management for security are:

- Publish your APIs so that developers of consuming software have everything they need to self-serve their needs and understand clearly the purpose, scope and interface of your microservice.
- Adapt your APIs through injectable policies of logic covering security, quality-of-service, auditing, dynamic data filtering, etc.

- Watch your APIs so that you can strategize scalability according to traffic levels and take a temperature gauge of the impact on your assets.
- Tailor your APIs to the specific needs of different lines of business so that API management becomes a decentralized or federated exercise in collaboration between LOBs and central IT.

Therefore, mobile BPM (m-Business Process Management) can empower organizations with better reach and flexibility to the organization's IT infrastructure. The roles of services in SOA solution architectures are:

i) Expose: They focus on exposing existing IT investments to a set of standards-based services and make available to a broader set of consumers. Service architecture describes the development, deployment, and management of services.

ii) Compose: They focus on integrating services into applications or business processes. Service architecture describes a set of capabilities to compose services into business processes.

iii) Consume: They concentrate on the delivery of new applications with increased productivity and enhanced business performance. An SOA architecture describes how integrated services are made available to new services and end users for usage through business processes.

Mobile SOA implementation allows reusability or recurring capabilities like the use of messaging services between senders and receivers, workflow and process changes among teams and data management among diverse sources of data stores. It allows customized user view to enhance user experience and provides secure access with a unique identity.

8.8 Need for Technology Convergence in Enterprise from Mobile to Traditional Desktop / Server based BPMs

Collaboration and managing information flow that is generated within the business and by external sources is a complex and difficult task to handle. To complete a required task, knowledge workers must access and discover information from various sources. For many organizational processes, the number of people involved to handle such complexities has increased, leading to an undefined chain of events. As such, activities are not a part of the pre-defined process, rather it depends upon the total span of time required to complete an activity.

Another area of concern for decision-making is apart from discovering information, employees create new information with the help of many tools and resources, both within and outside the company.

The term "Social BPM" describes the use of social tools such as Facebook, YouTube in improving business process efforts. Social BPM mitigates the communication gap between decision makers and the affected people. These tools help in communication on which the companies depend in favor of improving the business processes.

Both SOA and Social BPM increase business value by extracting information from enterprise systems and using it within social networks. Social technologies allow employees to utilize feedback from social networks to improve business processes.

BPM will strategize process change to improve performance by continuously optimizing business processes. BPM technology helps organizations to create and modify business processes easily involving many departments and IT systems in an organization. SOA is a platform to interlink and integrate diverse applications. It uses web technologies to improve process efficiency. The SOA, when combined with social BPM, gives the maximum leverage to companies to innovate and help in decision-making and to measure/analyze its products.

Example: Australian ME Bank Uses Customer Feedback from Social Media to Improve Processes

Australian Bank ME bank offered a low frills credit card named Frank Card with no annual fee and one of the lowest interest rates. It did not believe in insurances, reward programs. But the card was a modern card with security features. Customers reported unauthorized purchases and get reversals. The reporting could be on mobile phone or web site.

The company got inputs from its customers through social media platforms asking for new features. The company incorporated them into business processes. This was an example of Social BPM.

Source: https://www.cardrates.com/news/me-bank-recognized-for-its-no-frills-low-rate-frank-credit-card/, (Oct 2020). Accessed on 22/06/22.

8.9 Enhancing Customer Experience

Customer delight is the most attended business function area. Social media, networks, crowdsourcing, engaging through mobile technologies are the common tools for enhancing customer experience. Discussed below are the details.

Social computing: Social computing is a mix of social media usage and analysis for decision-making systems. It includes the collective use of tools for social engagement, social media monitoring and analytics. Information, helping in the analysis, consists of customers' past experiences, interactions, and social conversations. This is of immense value to the organization to improve products, enhance customer care, and help improve customer experience.

Feedback through social networks: Companies are compiling consumer's feedback and experiences on social networking sites like Twitter, Facebook, and LinkedIn to understand them in a much better way. Analyzing that data helps a company to identify what customers want along with their preferences. Social computing tools can also be used to identify key trends and evolve new ideas for upcoming products and services.

Analysis and crowdsourcing: This may lead to open innovation techniques like crowdsourcing. Latest mobile applications enable the user to make use of advanced features like GPS-driven location services, contextual search results and allow easy interaction. Smartphones and tablets support drawing information from enterprise information systems. Consumer apps run on different operating systems. Companies are taking advantage of this high-end mobile technology to connect and collaborate with employees, partners, and customers.

Customer engagement: With the social networks and mobile technology usage on the rise, the companies need to focus on the process efficiency and customer engagement with high priority. Of late, with new technologies in place there is an increase in customers' demands to interact with companies through social and mobile channels like, placing orders using mobile phones and tweeting their issues. Companies need to develop a new strategy to meet these expectations. Most companies have departments such as Marketing, Sales, and Service where order information is on an Enterprise Resource Planning (ERP) system, and similarly, customer issues are handled through a CRM system. To serve customers better, the organizations must integrate information across such systems and include information from social networks and create a unified customer view. BPM helps to design and integrate customer experiences across multiple channels, systems, and applications to deliver the right information to the right people at the right time.

Example: United Airlines Engages with Customers with a Two-Way Communication Campaign on Various Social Media Platforms

United Airlines conducted a customer survey on social media and other channels during pandemic and realized how customers associated Airline travel negatively during the covid pandemic. As a responsive corporate, the airlines just did not ignore. The customer feedback was taken seriously, and a campaign named Rising was launched. Rising stressed the Airline brand's improvements and accountability. This was to demonstrate that the airline was doing everything for customer safety during air travel.

Source: https://www.forbes.com/sites/rhettpower/2022/05/22/how-to-create-brand-touchpoints-that-engage-both-customers-and-employees/?sh=2406828f381e, (May 2022). Accessed on 21/06/22

8.10 Oracle Business Process Management Suite for Integration of Mobile BPM with Enterprise BPM

Oracle Business Process Management (BPM) Suite is an easy to use tool for managers, analysts, and developers to create new business processes. It also allows bringing improvements in existing ones. It is an ideal mechanism for modeling, executing and optimizing business processes across different departments and applications. It has two components namely - Oracle Web Center and Oracle SOA Suite.

- **Oracle Web Center**: It includes several services like portal, tools for web experience management and content management - technologies to manage social collaboration in a single package. Oracle Web Center facilitates organizations to deliver contextual and targeted web experiences to users and enables employees to access information and applications using a designated portal.
- **Oracle SOA Suite**: It enables unified customer experiences over the cloud, on-premise, and business-to-business applications. SOA components include a platform for event processing, proactive pattern detection and business activity monitoring to delivery of role-based business visibility. It allows rapidly designing, assembling, deploying, and managing adaptable business applications.

Example: Herballife Nutrition Deploys Oracle BPM Suite to Stream its Project Management Process

Herballife nutrition was a global company selling health supplements in over 90 countries. Currently the company was not able to track the projects and utilization of resources in the company. It was not able to ensure all managers follow the process. The company worked with a vendor to develop a business process using Oracle Primavera. The automated process captured all communications between groups in the organization. A new set of reports for project tracking were developed by the vendor. The projects started following process without exceptions.

Source: https://www.projectp.com/customers/Herbalife.php, July 29, 2022. Accessed on 22/06/22

Activity 8.2

Integration of Mobile BPM with Enterprise Systems

Eureka Forbes is a joint venture between Aushim Gupta of Sharpoorji Pallonji group from India and Electrolux of Sweden. The current objective of the organization is to increase field sales. They would like to enable field sales executives with mobile devices so that they get the needed details remotely at any time on the field. They also would like to place product orders from mobile

devices of sales executives, integrate and further process with organizational system towards product shipment. As a technology strategy expert, advise Eureka Forbes with required procedures and groundwork needed to integrate their enterprise systems with mobile devices of sales executives. **Answer:**

Check Your Progress - 2

6. Which of the following is a mechanism for the integration of an application, systems and trading partners, which can be accessed as a service?
   a. Service Orientation
   b. Process Reengineering
   c. Product Definition
   d. Application Integration
   e. Service Management
7. In SMACS environment, which of the following is/are not considered for improving customer experience?
   a. Feedback
   b. Social media responses
   c. Analysis
   d. Phone calls
   e. Physical appearance
8. Which of the following is the way services are developed, deployed and managed in SOA architecture?
   a. Expose
   b. Develop
   c. Compare
   d. Consume
   e. Communicate

9. The way services are developed, deployed and managed in SOA architecture, helps in:
   a. Integration
   b. Ease of use
   c. Innovation
   d. Interlinking
   e. All (a), (b), (c) and (d) above
10. Which of the following does Oracle Business Process Management Suite have?
   a. Oracle Web Center only
   b. Oracle SOA suite only
   c. Both (a) and (b) above
   d. Oracle Report writer only
   e. Oracle Analytics only

8.11 Summary

- Business Process Management (BPM) is a systematic approach to evolve a better workflow in an organization to be effective, efficient and capable of adapting to changing technologies and business environment.
- Business Process Automation (BPA) is the technology-enabled automation of activities or services that accomplishes a specific function or workflow. BPA addresses interoperability, privacy and security, and interactive communication issues for process flow improvement.
- WebMethods suite consists of Designer, Integration Server with Process Engine, WebMethods Broker, and My WebMethods Server with Task Engine components.
- Information consisting of customers' experiences, interactions, and social conversations is of immense value to the organization. It is used to improve products, enhance customer care, and help improve customer experience.
- Analyzing the data helps the company to identify what customers want and their preferences. Social computing tools can also be used to identify key trends and evolve new ideas for upcoming products and services.

8.12 Glossary

Business Process Automation (BPA): It is the technology-enabled automation of activities or services that accomplish a specific function or workflow. Business processes can be determined for many different functions of a company such as

sales, finance, marketing, operations, supply chain, human resources, and information technology. If it is web integrated and mobile-enabled, then the scope and reach of information will be round the clock.

Business Process Management (BPM): It is a systematic approach to evolve a better workflow in an organization to be effective, efficient, and capable of adapting to changing technologies and business environment.

Customer Experience: It is information collected during the interaction between the customer and the company during the process of buying a product. Information consisting of customers' past experiences, interactions, and social conversations is of immense value to the organization.

Service Oriented Architecture (SOA): It delivers a collection of dynamic applications which provide more accurate information and processes. They are to be accessed through the web or a mobile device.

8.13 Self-Assessment Test

1. Briefly describe the difference between traditional and social media enabled BPM.
2. Explain the role of SMAC technology for adopting a BPM in an organization.
3. Describe any two BPM suites.
4. Highlight the role of SOA in the enterprise integration process.
5. State how customer experience can be improved with Mobile BPM.

8.14 Suggested Readings / Reference Material

1. Rodney Heisterberg and Alakh Verma (April 2022). "Creating Business Agility: How Convergence of Cloud, Social, Mobile, Video and Big Data Enables Competitive Advantage," Narrated by Stephen Graybill.
2. Jonathan S Walker (2021). Social Media Marketing For Beginners - How To Make Money Online: Guaranteed Strategies To Monetizing, Mastering, & Dominating Any Platform For Your Brand, JW Choices.
3. Barry Connolly (2020). Digital Trust: Social Media Strategies to Increase Trust and Engage Customers, Bloomsbury Business.
4. Seema Gupta (6 August 2020). Digital Marketing McGraw Hill; Second edition.
5. Tracy L. Tuten, Michael R (15 June 2020). Solomon et al, Social Media Marketing, SAGE Publications Pvt. Ltd; Third edition.
6. Paul Martin Thomas Erickson (2019). Social Media: Usage and Impact, Global Vision Publishing House, 2 edition.
7. Steve Randazzo (2019). Brand Experiences: Building Connections in a Digitally Cluttered World, Paipen publishing.

8.15 Answers to Check Your Progress Questions

1. (a) Business Process Management

Business Process Management is a systematic approach to evolve a better workflow in an organization to be effective, efficient, and capable of adapting to changing technologies.

2. (c) Security and Privacy

Automated BPM includes implementation of privacy and security features needed for using and sharing data using encryption techniques.

3. (e) Software AG

WebMethods Business Process Management Suite provides business process management to automate business processes within an organization developed by Software AG.

4. (c) WebMethods Broker

WebMethods broker is a message router for handling publishes-subscribe messaging in which a messaging client connects to WebMethods Broker and publishes a document.

5. (a) Web Service Description Language

Web Service Description Language (WSDL) is an XML based standard used for giving functionality details of a web service.

6. (a) Service Orientation

Service orientation is a mechanism for integration of an application, systems, and trading partners, which can be accessed as a device.

7. (e) Physical Appearance

Companies use user's feedback and previous experiences on social media like Twitter, Facebook, and LinkedIn for enhancing the experience but never use his/her appearance and race as attributes.

8. (a) Expose

Expose aspect of SOA describes how services are developed, deployed and managed, while "consume" deals with who are the users and who use these services.

9. (e) Integration, Innovation, Interlinking and Ease of use

With the use of SOA architecture, the analysts can integrate and interlink all the applications and lead to innovation and ease of use.

10. (c) Both Oracle Web Center and Oracle SOA Suite

Oracle Business Process Management Suite for Integration of Mobile BPM with Enterprise BPM includes both Oracle web Center and Oracle SOA Suite.

SMACS (Social, Mobile, Analytics, Cloud, and Security) Technologies for Business

Course Structure

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