# A Comprehensive Guide to Enterprise Mobility

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AN AUERBACH BOOK

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# Contents

# Foreword

There is so much buzz around mobility with newer devices, platforms, solutions, and providers and with the entire enterprise ecosystem changing rapidly. Over the years, organizations have been leveraging technology to help their employees in multiple ways and have started using it as a key lever to engage with their end customers as well. It is almost a no-brainer as to the impact that mobile devices can have on an enterprise. Although it is absolutely critical to have a strategy in place before you start, the adoption or proliferation rate of the strategy has also to be understood for the strategy to yield the required benefits.

This book *A Comprehensive Guide to Enterprise Mobility* provides an excellent coverage of the basics of mobility from an enterprise usage perspective, from strategy definition to deployment. In this book, the authors introduce the basic principles of enterprise mobility and then go into the depth of implementation guidelines including the most common use cases and development and technology considerations. Thus, this book makes two important contributions. First, it shows the role that mobility can play in the enterprise ecosystem, targeting B2E (business to employee), B2B (business to business), and B2C (business to customer) scenarios. Second, it provides a very realistic view on the use cases and implementation examples, illustrating how the aspects covered in the initial sections are put into practice.

The authors Jithesh, Navin, Anoop, and Shibu have used their experience of delivering mobility projects to explain the concepts of enterprise mobility across industry verticals through concepts, functionality descriptions, applicable use cases, and implementation guidelines. Each section touches upon the definitions and use cases, explaining complex concepts without losing simplicity or introducing technical jargons, and finally directs the user to further reading materials to enable a better and detailed understanding of the introduced concepts, if desired.

I am honored to have had the opportunity to work directly with the authors in the architectural design efforts for various mobility programs, and I am sure that

this book is a valuable asset for academicians and professionals. I introduce this book with great pleasure, and I wish the authors success in this and their future endeavors.

**Manesh Sadasivan**
*Infosys Limited*
*India*

# Preface

With more than 250 million mobile subscribers in the United States and about three billion short message service (SMS) messages sent every month in the United Kingdom, there is no doubt about the level of penetration of mobiles in the consumer segment. Consumers no longer see a mobile handset as a device just for making calls and sending text messages. Mobile handsets are used to satisfy a wide variety of needs such as entertainment, business, commerce, and better life style and to improve productivity. The increase in the number of mobile commerce transactions year-on-year is a clear example of this changing trend. The number of enterprises adopting mobility to achieve higher operational efficiency and to boost profits is also increasing exponentially.

Enterprise mobility is the term broadly used to mean any mobility solution that is launched by an enterprise to increase profits or to reduce costs. This covers both customer-centric applications and internal enterprise applications for employees and partners in a supply chain. Enterprise mobility ecosystem has a wide coverage and is used in several mobility contexts. With acceptance across the industry that mobile is the next stage of digital revolution, enterprise mobility has emerged as a topic of great interest to both professionals and academicians.

There are currently limited books on enterprise mobility, as it is an emerging technology, and almost none that offers an end-to-end coverage of the topic. This is what triggered me to take up the initiative to write a guide on enterprise mobility, with three of my colleagues who are also experts in this topic. This book offers a complete coverage of the concepts, applications, and implementation of solutions under the realm of enterprise mobility in multiple industry domains.

The book has four sections. The first section is about mobility concepts. The chapters in this section provide a good foundation of enterprise mobility. All topics from strategy definition to deployment of enterprise mobility solution are covered in this section. This section was authored by me. The second section is about mobile solutions and case studies. The chapters in this section introduce the reader to the applications of enterprise mobility in various industry sectors. The section helps to bust the myth on enterprise mobility as confined to improving the operation efficiency of field service agents. This section was authored by Shibu. He is a talented

enterprise mobility architect who had the chance to work with various technology giants in the mobile industry.

The third section is about mobile application development. This section gives the reader an overview of the popular mobile platform and mobile programming languages. This section was authored by Navin. He is an enterprise mobility architect who has experience in developing applications on all popular smartphone platforms for a variety of clients. The fourth section covers the key topic "Technology Considerations in Mobility." Enterprise mobility has fused with other technologies such as cloud computing and digital signage to create new hybrid offerings, and adoption of enterprise mobility is not possible without considering supporting technologies such as security and device management. Hence, this section details the hybrid and supporting technologies in enterprise mobility and was authored by Anoop. He is a talented mobility researcher and developer.

This book was made possible not only due to the joint effort of the four authors but also due to the consistent support from our families, which has gone a long way in ensuring the timely completion of this book. I would like to thank all of them for their patience and support. I would also like to take this opportunity to thank the members of the Mobility Unit at Infosys for giving us numerous engagements in the enterprise mobility space with a variety of clients in multiple countries, which has helped us in acquiring the knowledge to write this book. Writing this book had been a very good experience, and I hope that you would enjoy reading it as much as I enjoyed writing it.

**Jithesh Sathyan**
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*India*

# MOBILITY CONCEPTS

# I

# *Chapter 1*

# Emergence of Enterprise Mobility

This chapter gives a brief background on the evolution of enterprise mobility and the factors that contributed to the growth of mobility. Initially, the mobile phone was considered as just a portable version of a land or fixed phone for satisfying the requirement of making calls while on the move. However, several technological advancements led to its emergence as a platform for improving office productivity and as an additional channel of marketing endeavors. This chapter will provide a good understanding of the factors that contributed toward the emergence of enterprise mobility.

## 1.1 Introduction

Mobiles have developed from being just a device that offers the ability to make calls to becoming a handheld instrument that has numerous applications that change a person's lifestyle. More and more enterprises are adopting enterprise mobility to enhance their marketing channels, improve office productivity, increase customer satisfaction, and offer shopping experience or sales through mobile. In order to stay ahead of the competition, some of the largest corporations are investing heavily in the development of m-commerce and mobile marketing. Technology is developing rapidly in the mobile industry, opening new unimaginable opportunities to enterprises.

The current enterprise mobile technology, as we know it today, did not emerge overnight. The ground-breaking revolution started with the wireless network and rapidly evolved first into simple handsets for making calls and later to feature-rich

smartphones as we know it today. Though mobility adoption is now quite common in most enterprises, it must be noted that enterprise mobility poses overheads to the enterprise in the form of additional infrastructure requirements to support new channels including cost of hardware, software, integration, service, and support. Security concerns, mobile device and infrastructure management, and performance issues due to traffic from mobiles on existing back-end enterprise systems are other issues associated with enterprise mobility enablement.

The emergence of enterprise mobility is attributed to advancements in three significant areas:

- The developments in web standards
- The advances in wireless networking technology
- The innovations in mobile device platforms

This chapter details the advancements in these three significant areas. Web standards have impacted mobile web presentation, while improvements in wireless networking have led to more innovative enterprise mobility applications, and finally innovations in mobile device platforms have led to the development of functionality-rich enterprise mobility applications. While enterprise mobility concepts will be discussed in Chapter 2, this chapter is intended to give the reader a background on how enterprise mobility reached its current level of maturity.

## 1.2 Developments in Web Standards

Web 1.0 treats Internet as an information portal, where information can be accessed through standard web protocols and browsers, with limited interaction in the form of chat. Web 2.0 and Web 3.0 are two major advancements in web technology, which have been significant from the mobile context. Web 2.0 is the second generation of web technology with a host of services that facilitate collaboration and sharing of data between web users. Social networking and web-based systems of knowledge-sharing evolved as a result of Web 2.0. Wiki and YouTube are representative information-sharing applications of Web 2.0, while MySpace, Twitter, and Facebook are examples of social networking sites. Web 2.0, in addition to the information portal offered in Web 1.0, provides features that allow users to participate.

Blogging that resulted from Web 2.0 can take one of the following forms:

- Personal blog: This is used to share personal details, similar to a diary, related to specific events or activities done and noted on an ongoing basis. Personal data is not private any more. With the sharing of personal details through blogs, people are becoming more transparent. Celebrity blogs are now being increasingly followed by fans, and the current trend is to first provide the information in the personal blog before providing details to the media.

- Microblog: This terminology is used for social networking through which thoughts and feeling are shared with a larger community. Microblogs, through Twitter, are being used to get opinions and advice from the user community and to share information. While sites such as MySpace are focused on friends- or family-based networking, LinkedIn offers a forum for professional networking, and sites such as Facebook are used from both the corporate and noncorporate perspective.
- Query blog: These sites are mostly discussion forums for posting queries and getting responses from multiple users around the globe. Based on site authentication and usage terms, any user with sufficient permissions can blog a response to the query posted by someone. The person who posted the query can also blog to the responses posted by others.
- Corporate blog: This can be either internal corporate blogging or external corporate blogging. Corporates have started internal blogging sites for employees to get inputs on new policies, understand employee issues, and use internal blogs to disseminate information. Thus, internal corporate blogs help to achieve higher transparency between corporates and their employees. External corporate blogs are targeted toward better interaction with partners and for running marketing initiatives including posts to improve brand image.

Wiki web page has been another innovative application of Web 2.0. It designated to enable team work and collaboration by creating a collective knowledge base where members can contribute and modify content. Although Wiki is the shortened form of What I Know Is, with the huge popularity of Wikipedia, which is an online database or encyclopedia of Wiki pages, most web users have started using the term Wiki to mean Wikipedia. Another major application is Really Simple Syndication (RSS), which offers a web-feed format to publish updates like news headlines. An RSS document, which is also known as web feed or channel, is a summarized text and metadata for subscribing to content. By using RSS, a web application can subscribe for updates from single or multiple web sites.

To summarize, Web 2.0 resulted in the following areas of advancement:

- Better content presentation: While WML was the prominent markup language in Web 1.0, the web standards in Web 2.0 focused on xHTML as markup language and CSS for style sheets.
- Better integration: There was an increased adoption of open and standard technology, with the opening up of web services in solutions for better integration with other components.
- Richer user experience: Web 2.0 solutions provided interactive experience to the user. User participation leads to web-based social networking.
- Content synchronization: Features offered from RSS feed helped users to get relevant content from a server based on a subscription model. The user in

this framework has the flexibility to select and filter data subscription from multiple areas.

- Innovative applications: Standardization of web syntax made data easily accessible and led to the development of innovative applications.

Web 3.0 is the next level of development in the web domain. There are five key areas of advancement in Web 3.0 that differentiate it from the previous generation. These areas are cloud, semantic web, artificial intelligence, personalization, and mobility. Web applications in Web 3.0 are more sophisticated and distributed. Use of autonomous agents for web mining and support for machine learning are the features of web artificial intelligence in Web 3.0.

Semantic web is the foundation of Web 3.0. Semantic web is centered at a resource description framework (RDF) together with the formal notations. The formal notations include RDF schema, web ontology language, and data exchange formats. The data exchange formats used are RDF/XML, N3, Turtle, and N-Triples. The underlying structure of any expression in RDF is a collection of triples, each consisting of a subject, a predicate, and an object. There is an explosive growth in the variety of information sources on the web. Web mining can be used to analyze and track the content and usage patterns on the web.

The advances in web from Web 2.0 and Web 3.0 had a major impact on enterprise mobility. xHTML:MP, the mark-up language for mobile web, ensured that web pages displayed on mobile handsets were lightweight, had an appealing look and feel, and were not limited to the features of WML. The recent developments with HTML5 have paved the way for mobile multiplatform development. The social networking and interactive capabilities in Web 2.0 had widespread applications in the mobile context. The mobile, being present with the user most of the time, served to be an instrument for use in social networking and to keep connected even on the move. Social networking sites such as Twitter and Facebook launched mobile web versions for displaying contents on small handset screens and offered intuitive interfaces to twitter and blog from the handsets.

Mobility is considered as a separate area of focus in Web 3.0 and has been given due importance. Enterprise mobility has spread fast with developments in web standards, and most enterprises have extended web site support for mobile devices. Although current enterprise mobile web implementations have a rendering platform to handle the display of web content of different types of handsets, it is hoped that with widespread adoption of HTML5, mobile web implementation would be less expensive and will require much less development effort. Web 2.0 and Web 3.0 has thus led to the development of several innovative mobile applications, and this has been a major contributor to the emergence of enterprise mobility. Advances in web space is seen to have a direct correlation with developments in enterprise mobility, as changes in web space, in general, will bring about changes in mobile web technology.

## 1.3 Advances in Wireless Networking Technology

Wireless networks made mobile communication possible and are the key contributor to the emergence of enterprise mobility. The improvements in speed, brought about by advances in the wireless network, resulted in various data services that form the backbone of enterprise mobility. Hence, wireless networking technology is given due importance in this chapter. The main operation of elements in a communication network is transmission of information (voice, data, media, etc.), where the information is transformed or evaluated to make communication between two equipments possible. Communication networks have evolved based on the need for "more information" transfer at a "higher speed." There are different kinds of communication networks based on the area of coverage, type of modulation used, speed of data transfer, type of switching, bandwidth, and type of interface used for data transfer between elements.

Wireless networking technology can be split into two phases:

- Traditional wireless technology: This phase comprises the second-generation (2G) mobile networks such as the Global System for Mobile Communication (GSM), the 2.5G network such as the General Packet Radio Service (GPRS), and the third-generation (3G) network such as the Universal Mobile Telecommunications System (UMTS). It should be noted that code division multiple access (CDMA) also had evolved based on telecom generations and captured the U.S. and Asian markets, while GSM and its successors were serving the European segment.
- Modern wireless technology: This phase comprises technologies such as Worldwide Interoperability for Microwave Access (WiMax), Wireless Fidelity (WiFi), Wireless Mesh, 3G network extensions such as Internet Protocol Multimedia Subsystem (IMS), and pre-4G and fourth-generation (4G) technologies such as Long-Term Evolution (LTE).

### *1.3.1 Traditional Wireless Technology*

Let us start with GSM. It is a cellular (user coverage area defined in the shape of cells) communication network. It was developed as an attempt to standardize the European mobile telephone network and is now one of the most popular standards for mobile phones in the world. GSM networks usually operate in the 900- or 1800-MHz bands, and in some countries the 850- and 1900-MHz bands are used. The modulation schema used in GSM is Gaussian minimum shift keying, and the bandwidth is distributed among many users using a combination of time and frequency division multiple access (TDMA/FDMA).

As shown in Figure 1.1, the GSM network consists of the following features:

- Mobile station: This is the user/mobile equipment that helps the user to make calls and receive subscribed services.

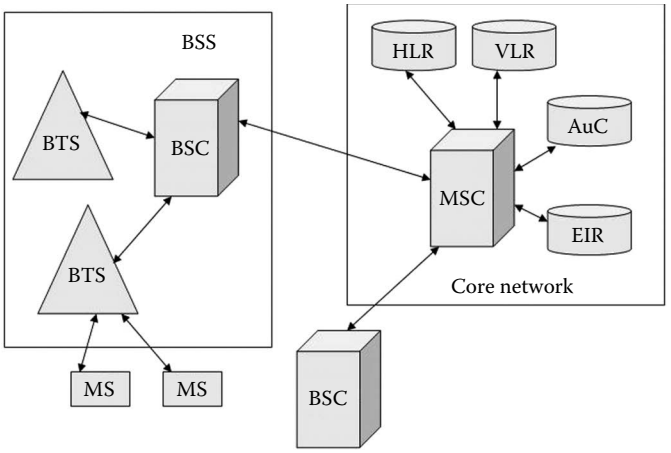


**Figure 1.1 GSM network simplified architecture.**

- Base station system (BSS): It is linked to the radio interface functions and has two components:
  - Base transceiver station (BTS): The BTS is the signal handling node between a mobile station and the base station controller (BSC). Its main function is transmitting or receiving radio signals and encrypting or decrypting communications with the BSC.
  - BSC: The BSC is the controller for multiple BTS, and its main function is to handle handover (user moving from one cell to another) and allocate channels.
- Switching system/network switching subsystem/core network: It does switching functions and is the main center for call processing. The core network is composed of the following components:
  - Home location register (HLR): HLR is a database for storing subscriber information. The information includes subscriber profile, location information, services subscribed to, and activity status. A subscriber is first registered with the HLR of the operator before he or she can start enjoying the services offered by the operator.
  - Mobile services switching center/mobile switching center (MSC)/call server: This is the main switching node of the GSM network and provides functionalities such as call switching to and from other telephones and data systems, call routing, subscriber registration and authentication, location updating, toll ticketing, common channel signaling, and handovers.
  - Visitor location register (VLR): It is a database for temporary storage of information about visiting subscribers. When a user moves to a location outside its MSC, the VLR in this new location queries the HLR and gets information about the subscriber to avoid querying the HLR each time

the user wants to access a service. The user in the new location is called a visiting subscriber.

- Additional functional elements in the GSM include the following components:
  - Authentication center (AuC): Handles security using authentication and encryption.
  - Equipment identity register (EIR): Database to store the identity of mobile equipments to prevent calls from unauthorized equipments.
  - Gateway mobile switching center (GMSC): A gateway integrated with MSC to interconnect two networks. It can be used for routing calls from a public-switched telephone network (PSTN) to a GSM user.

Many more components such as message center, mobile service node, and GSM-interworking unit can be seen in a GSM network. Some definitions specify operation and support system (OSS) as a part of GSM, although it is a more generic term that applies to operation and support for any kind of network.

The next entrant into the mobile communication network family is the GPRS network, which is more of an upgrade of the GSM network. The same components of the GSM network provide voice service, and the GPRS network handles data. Due to this reason, the GSM network providers do not have to start from scratch to deploy GPRS. GPRS triggered the transformation from the circuit-switched GSM network to the packet-switched network, and hence it is considered a technology between 2G and 3G, or commonly referred to as 2.5G.

Some of the benefits of GPRS over circuit-switched networks are as follows:

- Higher speed
- Instantaneous access to service ("always on")
- New services related to data communication
- Ease of upgrade and deployment on existing GSM network
- Can support applications that do not require dedicated connection

Compared with GSM, GPRS has three new components that are required, as shown in Figure 1.2:

- Terminal equipment: The existing GSM user equipments will not be capable of handling the enhanced air interface and packet data in GPRS. Hence, new terminal equipments that can handle packet data of GPRS and voice calls using GSM are required.
- Serving GPRS support node (SGSN): It handles mobility management functions including routing and handover. SGSN converts mobile data into Internet Protocol (IP) and is capable of IP address assignment.
- Gateway GPRS support node (GGSN): It acts as a gateway to connect with external networks such as public Internet (IP network) and other GPRS networks from a different service provider. It can be used to implement security or firewall in screening subscribers and to address mapping.

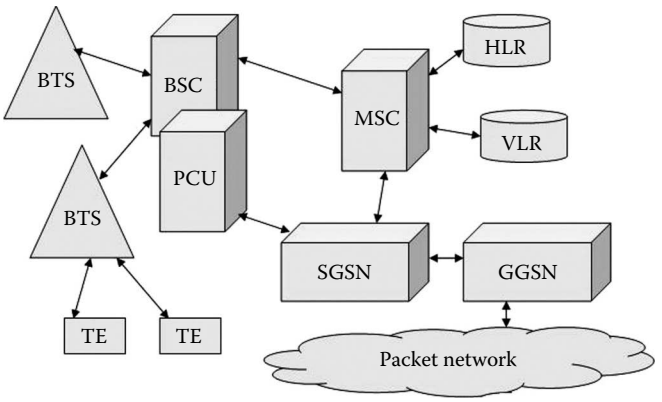


**Figure 1.2 GPRS network simplified architecture.**

The remaining components of GPRS are similar to GSM with minor software and hardware upgrades. The BSC in GPRS needs the installation of hardware components such as a packet control unit (PCU) to handle packet data traffic and some software upgrades, while components such as BTS, HLR, and VLR will only require software upgrades.

3G was a major leap in terms of communication network speed and has led to multiple services. UMTS is a 3G network that delivers voice, data, and media services. The media services that include pictures, video, and graphics are a new feature of 3G compared with the 2.5G networks such as GPRS. Some of the applications made possible with UMTS include video and music download, mobile commerce, messaging, conferencing, and location-based services. The air interface for communication in UMTS uses wideband CDMA (W-CDMA), and asynchronous transfer mode is the data transmission method used within the UMTS core network.

W-CDMA used for UMTS terrestrial radio access network (UTRAN) air interface is a modulation system where data is multiplied with quasi-random bits derived from W-CDMA spreading codes. These codes are used for canalization, synchronization, and scrambling. W-CDMA operates in both frequency division duplex and time division duplex.

UMTS has three major categories of network elements:

1. GSM elements: Core network (MSC, VLR, HLR, AuC, and EIR) and BSS (BTS and BSC)
2. GPRS elements: SGSN and GGSN
3. UMTS-specific elements: User equipment that can handle media and air interface and UTRAN consisting of radio network controller (RNC) and "Node B"

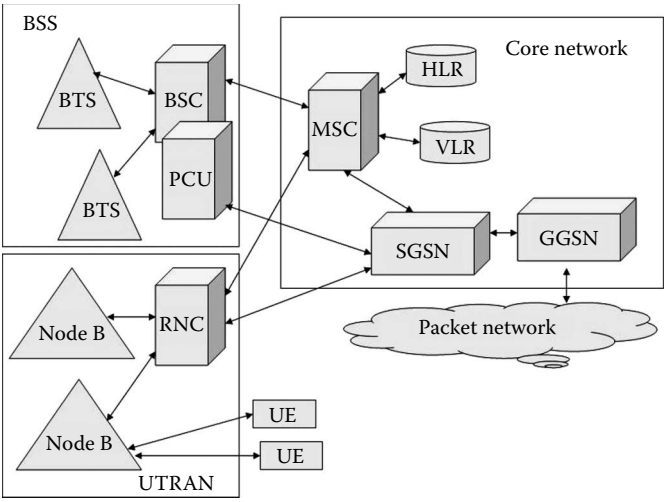


**Figure 1.3 UMTS network simplified architecture.**

"Node B" for the new air interface is the counterpart of BTS in GSM/GPRS (as shown in Figure 1.3). Based on the quality and strength of the connection, "Node B" calculates the frame error rate and transmits information to the RNC for processing. RNC for the W-CDMA air interface is the counterpart of BSC in GSM/GPRS. The main functions of the RNC include handover, security, broadcasting, and power control. The user equipment in the UMTS network should be compatible to work for the GSM/GPRS network.

During standardization activities for the 2G network, GSM was adopted in most parts of Europe, and CDMA evolved during the same time, capturing markets in the United States and Asia. The first major effort in the development of the CDMA network standard was from the Telecommunications Industry Association with an architecture named "cdmaOne" that could be used for commercial deployment of CDMA networks. While IS-95A of the Telecommunications Industry Association brought circuit-switched services using CDMA, the revised version (IS-95B) gave subscribers packet-switched data services. While networks based on IS-95B were considered 2.5G, the blueprint for CDMA-based 3G network came with CDMA2000 defined by International Telecommunication Union.

The following are the components in a CDMA2000 network (Figure 1.4):

- Mobile station: This is the client equipment or user equipment, like a subscriber handset, that provides interface for the user to access the services.
- Radio access network (RAN): It is the air interface component in CDMA for interacting with the core network. The RAN is similar to the BSS on GSM networks. The BSC and BTS are found in the GSM network. The RAN also

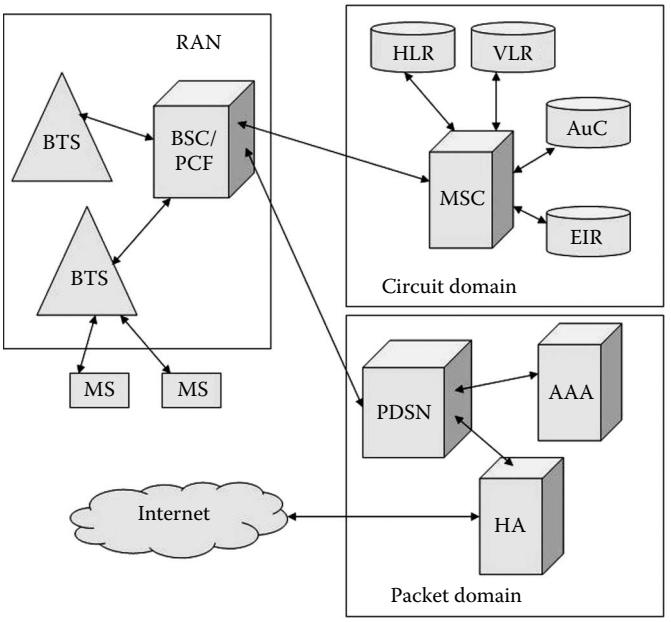


**Figure 1.4 CDMA network simplified architecture.**

contains a packet control function (PCF) that is used to route IP packets to a packet data serving node (PDSN).

- Packet domain: The packet domain in a CDMA network consists of the following components:
  - PDSN/foreign agent: It acts as a gateway for the RAN by routing packets to an external packet network such as the Internet. It can establish, maintain, and terminate a packet link.
  - Authentication, authorization, and accounting (AAA): These are servers used to authenticate and authorize users for access to the network and to store subscriber call details for accounting.
  - Home agent: The interface component to the external packet network provides an IP for mobile messages and forwards it to the appropriate network. A PDSN can be configured to work as a home agent.
- Circuit domain: The circuit domain is similar to the GSM network with components such as the MSC, GMSC, HLR, AuC, and EIR.

Third Generation Partnership Project 2 (3GPP2) is dedicated to the development of the next-generation standards for CDMA 2000. In addition to standardizing forums such as 3GPP2 that promote the evolution of CDMA, forums such as CDMA Development Group work on adoption and ease in the deployment of 3G CDMA wireless systems.

### *1.3.2 Modern Wireless Technology*

Let us start with WiMax. WiMAX is a wireless broadband technology based on the IEEE 802.16 standard. It is a wireless alternative to cable modems, digital subscriber line (DSL), and T1/E1 links. The IEEE standard was named WiMAX by the WiMAX Forum to promote the IEEE standard for interoperability and deployment. It can support voice, video, and Internet data.

The spectrum bands in which WiMAX usually operates include 2.3, 2.5, 3.5, and 5.8 GHz, with a speed of approximately 40 Mbps per wireless channel. Based on coverage, WiMAX is classified under the metropolitan area network. WiMAX can offer both non-line-of-sight and line-of-sight services. In the non-line-of-sight service, which operates at a lower frequency range, an antenna on the personal computer communicates with the WiMAX tower, and in the line-of-sight service, which operates at high frequencies, a dish antenna points directly at the WiMAX tower. It uses orthogonal frequency division multiple access (OFDM) as the modulation technique.

WiMAX architecture can be split into three parts, as shown in Figure 1.5:

- Mobile station: This is the user equipment or user terminal that the end user uses to access the WiMAX network.
- Access service network (ASN): This is the access network of WiMAX comprising base stations and one or more ASN gateways. While the base station is responsible for providing the air interface with a mobile station, the ASN gateways form the RAN at the edge.
- Connectivity service network (CSN): This is the core network that offers services and connectivity with other networks. It includes the AAA server, the mobile IP home agent (MIP-HA), the services offered using supporting networks such as IMS, an operation support system, or a billing system, which can be a part of the core or a stand-alone application, and the gateways for protocol conversion and connectivity with other networks.

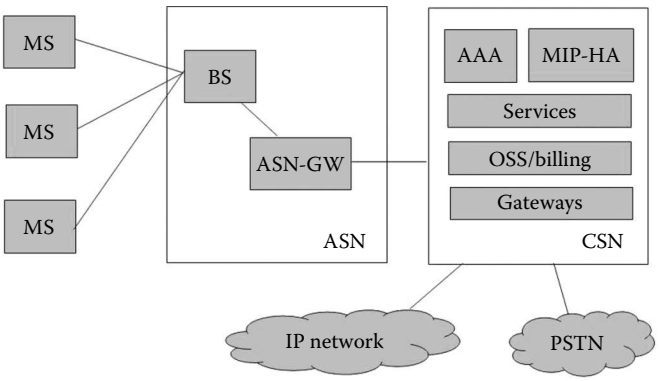


**Figure 1.5 WiMAX simplified architecture.**

WiFi refers to various IEEE 802.11 technologies used in mobile and video games. It is a packet-based network infrastructure and uses radio waves to communicate with handset devices. A wireless adapter on the end-user device translates data into a radio signal and transmits the same using an antenna on the device. The signals from the device are received by a WiFi router that decodes and sends the information to an external network, such as the Internet, or to an internal network. WiFi radios transmit at frequencies of 2.4 or 5 GHz.

WiFi has the following 802.11 networking standards:

- 802.11a: Transmits at 5 GHz and can handle up to 54 Mb of data per second.
- 802.11lb: Transmits at 2.4 GHz and can handle up to 11 Mb of data per second.
- 802.11g: Transmits at 2.4 GHz and can handle up to 54 Mb of data per second.
- 802.11n: Can provide a bandwidth of 140 Mb per second.

IMS is the next major development in mobile communication and is considered to be the backbone of "all-IP network." IMS was originally developed for mobile applications by the Third Generation Partnership Project (3GPP) and 3GPP2. With standards from the Telecommunications and Internet Converged Services and Protocols for Advanced Networking, fixed networks are also supported in IMS, leading to mobile and fixed convergence. Use of open standard IP, defined by the Internet Engineering Task Force, allows service providers to use IMS for introducing new services easily. With multiple standardizing organizations working on it, IMS will cross the frontiers of mobile, wireless, and fixed-line technologies.

IMS is based on open standard IP with session initiation protocol (SIP) used to establish, manage, and terminate connections. A multimedia session between two IMS users, between an IMS user and a user on the Internet, or between two users on the Internet is all established using the same protocol. Moreover, the interfaces for service developers are also based on IP. IMS merges the Internet with mobiles, using cellular technologies to provide ubiquitous access and Internet technologies to provide appealing services. The rapid spread of IP-based access technologies and the move toward core network convergence with IMS has led to an explosion in multimedia content delivery across packet networks. This transition has led to a much wider and richer service experience.

The IMS can be thought of as composed of three layers, as shown in Figure 1.6:

- The service or application layer: The end services reside in the application layer. It includes a host of application servers that execute services and communicate with the session control layer using SIP. It can be a part of the service provider home network or can reside in a third-party network. With open standards defined on interaction with the application server, it is easier to build applications on application servers. The power of IMS lies in easily

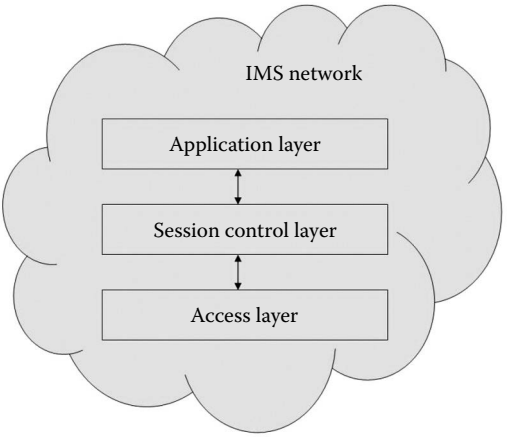


**Figure 1.6 Three-layered IMS network.**

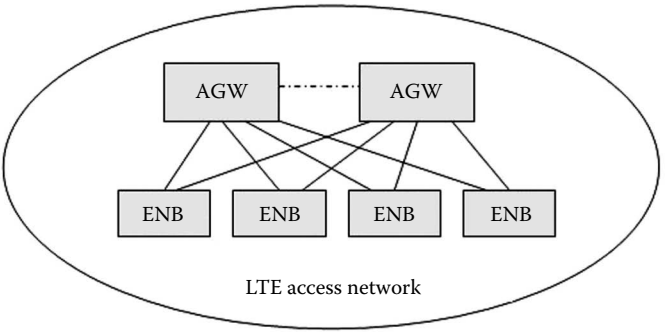


**Figure 1.7 LTE simplified architecture.**

rolling in or rolling out services on the fly in minimal time using application servers.

- The IMS core or session control layer: Session control and interactions between transport and the application layer happen through the session layer. These are the main components of the core or session control layer:
  - Call session control function (CSCF): It can establish, monitor, maintain, and release sessions. It also manages user service interactions, quality of service policy, and access to external domains. Based on the role performed, a CSCF can be a serving-CSCF (S-CSCF), a proxy-CSCF (P-CSCF), or an interrogating-CSCF (I-CSCF).
  - Home subscriber server: Database for storing subscriber and service information.

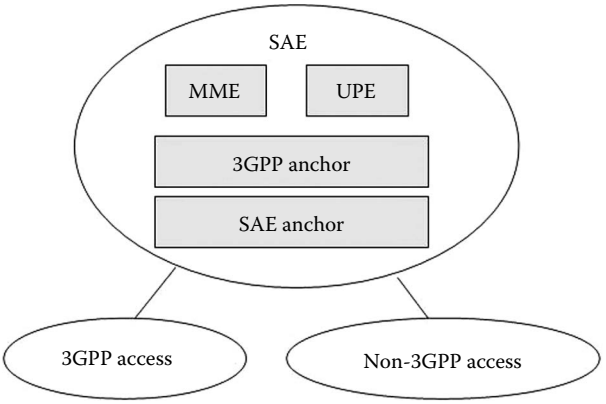


**Figure 1.8 SAE simplified architecture.**

  - Multimedia resource function plane (MRFP): It implements all media-related functions such as play media and mix media and provides announcements.
  - Multimedia resource function controller: It handles communications with the S-CSCF and controls the resources in the MRFP.
  - Breakout gateway control function: It mainly handles interactions with the PSTN.
  - Media gateway controller function: It is used to control a media gateway.
- The access/transport layer: This layer is used for different networks to connect to the IMS using IP. It initiates and terminates SIP signaling and includes elements such as gateways for conversion between formats. The connecting network can be fixed access like DSL or Ethernet, mobile access like GSM or CDMA, and wireless access like WiMAX.

Some other IMS components include signaling gateways, media gateway, and telephone number mapping (e.g., ENUM).

Another key technology in modern mobile communication is wireless mesh network. Instead of simple wireless point-to-point or broadcast networks, radio nodes can form wireless mesh networks via IEEE 802.11, 802.15, and 802.16 technologies. In a mesh network, traffic from one node has multiple paths to travel to another node in the topology, and so in case of a path or a node failure, the network still provides services to applications.

Wireless mesh network has two types of nodes: mesh routers and mesh clients. A mesh router is usually equipped with multiple wireless interfaces built on either the same or different wireless access technologies. Mesh routers are static and form

the backbone for mesh clients. Wireless mesh networks can be classified into three types:

- Infrastructure wireless mesh network: In this mesh network configuration, the mesh routers form a network infrastructure for mesh clients.
- Client wireless mesh network: In this mesh network configuration, the mesh clients provide peer-to-peer networks among mesh client devices.
- Hybrid wireless mesh network: This mesh network configuration involves a combination of infrastructure wireless mesh and the client wireless mesh networks.

Advanced LTE and mobile WiMax are two key drivers for 4G. So let us conclude the discussion with two initiatives that lead to 4G, which are LTE and system architecture evolution (SAE). The main difference between these two initiatives is that LTE is about enhancing the "access network" and SAE works on developing the "core network" architecture to support the high-throughput or low-latency LTE access system.

LTE is an effort to reduce the number of network elements, but it offers higher data rates and better quality of service on a packet-only network. It uses OFDM for uplink and SC-FDMA (single carrier-FDMA) for downlink. LTE access network has two types of components—the access gateways and Enhance Node B, as shown in Figure 1.7. While the access gateway does functionalities such as mode management, data compression, and ciphering, the Enhance Node B works on all radio-related issues and mobility management.

SAE is expected to provide an all-IP network solution with all services on the packet-switched domain and not on the circuit-switched domain. It will support mobility with multiple heterogeneous access systems both supported by 3GPP, such as LTE, and non-3GPP access systems, such as WiMAX. SAE consists of the following entities as shown in Figure 1.8:

- Mobility management entity (MME): It does functions such as user equipment authentication and mobility management.
- User plane entity (UPE): It manages and stores user equipment context, including ciphering, packet routing, and forwarding.
- 3GPP anchor: It is the mobility anchor between 2G or 3G and LTE.
- SAE anchor: It is the mobility anchor between 3GPP and non-3GPP.

Thus, it can be seen that there has been a tremendous improvement in bandwidth with the introduction of new technologies from different generations of communication. The upcoming generations are expected to offer even higher bandwidths, pushing user experience to high realms, with not just real-time media, but 3D holographic data transfer and projections similar to what is shown in *Star Wars* movies.

## 1.4 Innovations in Mobile Device Platforms

Mobile phones have turned out to be the fastest growing media device in terms of usage and sales. In 2007, the worldwide sale of mobile phones exceeded 1.5 billion. This is a huge number in comparison to 1.7 billion achieved by the television after years of deployment and approximately 1.3 billion units achieved by desktops.

Some of the key milestones in the mobile revolution are as follows:

1970s: Bell Labs started cellular revolution by developing the Advanced Mobile Phone Standard (AMPS).
1985: First transportable phone was developed.
1989: Personal cellular phone was launched in the market.
1992: First GSM mobile phone was launched.
1996: First personal digital assistant mobile phone was launched.
1999: First Wireless Application Protocol (WAP)-capable mobile phone arrives in the market.
2002: First smartphone was released.
2005: High-speed data access leading to features including 3G video calling was introduced.
2008: Apple iPhone 3G, App Store, and Android Market gave a new outlook to consumer mobility.
2009: Other platform vendors join the App Store race (BlackBerry App World, Nokia Ovi Store, Palm App Catalog, and Windows Marketplace for mobile), and enterprise mobility becomes part of enterprise strategy in most enterprises.
Present: Touch screens with qHD, iCloud, mobile payments, etc.
Future: Holographic mobile 3D displays, Unified Smartphone Platform standards, flawless speech and sensor-based mobiles, etc.

In developing countries, building wireline networking infrastructure is expensive and slow, making mobile technology a reliable and cost-efficient alternative option. In many Asian countries, there are more mobile phone users than the conventional wireline phone users. With the rise of smartphones having the capability of executing desktop or PC-like applications, there is an increased adoption of the mobile to satisfy personal and official needs. This change in perception has brought about a switch from the fixed-line phone to mobile phones as the main communication tool for users even in developed countries. The high processing power, extended memory, dedicated full-featured operating system, and the advances in wireless networks have ensured the development of innovative and appealing applications to meet the needs of mobile users.

The price of mobile phones has dropped considerably, making a handset easily affordable to all classes. Mobile devices have also become a part of a person's daily life. Even smartphones' prices have dropped significantly. Most executives in

developed countries now have handsets from iPhone, BlackBerry, Palm, or Android. The launch of App Stores by mobile platform vendors was a game changer in the mobile technology space. This opened up a forum for many to upload applications built for specific mobile platforms, allowing easy distribution of applications. The practice of having handset applications developed only by the handset vendor was thus replaced by development by any enthusiastic developer. There has been an explosion in the number of applications that are published in App Stores, and the result is the availability of innovative applications that have made way to rapid developments in enterprise mobility space.

Google and the Open Handset Alliance brought out the most popular open mobile platform named Android. Android is an open-source software stack for mobile devices, which includes an operating system, middleware, and a suite of applications. The Android Software Development Kit provides the tools and application programming interfaces (APIs) for developers to create applications on the Android platform using the Java programming language. The open source nature that leads to absence of developer license costs in getting the development environment and publishing application has resulted in quick adoption of Android by many mobile application developers, leading to rich applications. The market share of Android has significantly grown, and it is now a major competitor with commercial platforms such as iPhone, BlackBerry, and Windows Mobile in the smartphone industry. The increase in Android developers and users and the free nature of the operating system have led many device manufacturers to launch Android mobile handsets.

Customers who want the Apple brand and those who look for the best user experience prefer iPhone. Apple continues to define new innovations in mobile space and ensures that customers are offered unique features for being loyal to the brand. However, BlackBerry still dominates the enterprise employee handset segment. This dominance in enterprise employee handset segment is due to the BlackBerry Enterprise Server that offers the ability to push corporate e-mails, the BlackBerry Mobile Data Service that enables applications to be deployed to mobile users, including developer tools and administrative services, and most importantly provides a secure framework for interaction between the BlackBerry handset and the enterprise server.

One of the significant developments in the mobile multiplatform development came with Java 2 Micro Edition (J2ME). J2ME is an edition of the Java platform targeted at mobile handset and embedded devices. J2ME consists of a virtual machine and a set of Java APIs tailored for mobile and embedded devices. Configurations and profiles make up the two primary components in the J2ME platform. Thus, an application developed in J2ME without the use of any platform-specific APIs can be executed on multiple Java-based mobile platforms such as Android and BlackBerry without any code level changes. Mobile device manufacturers install and prepackage their devices with the Java virtual machine and associated APIs to ensure that Java applications developed for target devices can be

executed without further download of dependent libraries. These developments in mobile platform space have been a major factor for the current level of maturity in enterprise mobility.

## 1.5 Conclusion

Enterprise mobility is a topic of high significance in today's industry. Market research surveys suggest mobility adoption as top priority in the corporate strategy of most enterprises. The growth in sales of mobiles confirms that mobility will be a major channel for enterprises to reach customers. Mobiles provide instant access to information anytime and anywhere a user needs it. This has resulted in extensive use of mobile devices by customers for their daily information needs. The rise in mobile use has also resulted in multiple device vendors and tremendous reduction in the price of handsets. With multiplatform development tools, the lifecycle for mobile solution development has significantly shortened.

This chapter is intended to introduce the reader to the enabling technologies and major milestones in enterprise mobility. The chapter acts as an introduction to the complete book by explaining the history of enterprise mobility evolution. The three major factors that have made a significant impact on enterprise mobility (web standards, advances in mobile network, and handset technology) are discussed in this chapter. It is suggested to refer to the books listed under "Additional Reading" for a deep dive into the topics that are briefly covered in this chapter.

## Additional Reading

1. Jochen Schiller. *Mobile Communications*, 2nd edition. Boston: Addison Wesley; 2003.
2. Rich Ling and Jonathan Donner. *Mobile Phones and Mobile Communication (Digital Media and Society Series)*. United Kingdom: Polity Press; 2009.
3. Mischa Schwartz. *Mobile Wireless Communications,* 1st edition. Cambridge: Cambridge University Press; 2005.
4. Syed A. Ahson and Mohammad Ilyas. *Mobile Web 2.0: Developing and Delivering Services to Mobile Devices,* 1st edition. Florida: Auerbach Publications; 2010.
5. Andrew Pearson. *The Mobile Revolution,* 1st edition. North Carolina: Lulu Press; 2010.

# *Chapter 2*

# Enterprise Mobility Landscape

Before delving deep into mobility, it is essential to understand some of the common terms used in mobility and the basic building blocks of enterprise mobility. This chapter is a must-read for those who are new to enterprise mobility, as it builds on a solid foundation for understanding the rest of the chapters in this book, and even a person who is new to enterprise mobility can easily pick up the details after reading this chapter. This chapter provides a high-level overview on enterprise mobility.

## 2.1 Introduction

Enterprise mobility is the term broadly used to mean any mobility solution that is launched by an enterprise to increase profits or to reduce costs. This brings us to the discussion of the types of mobile applications that come under the scope of enterprise mobility. Broadly, the enterprise mobility paradigm is classified into two groups:

- Customer-centric mobility
- Internal enterprise mobility

Customer-centric mobility relates to mobile solutions developed for use by the end customer. Customer mobile applications can serve different purposes. For example, a retailer may create a mobile application for mobile shopping to increase sales and attract more customers. With easy access to mobiles, purchases over the mobile would become more frequent. Mobile-based business also lowers the cost of

serving the customer. The lowering of cost could be in the form of mobile customer support applications or reducing the visit of the customers to the physical store that needs support staff. For most enterprises, the fundamental purpose for launching mobile applications is to introduce a new channel for marketing and business. Internal enterprise mobility has several sublevels. The following are the different variations of internal enterprise mobility:

- Operational or field workforce mobility
- Partner or supply chain mobility
- Employee-centric mobility

Operational or field workforce mobility deals with mobile applications that are intended to bring down the operational expenditure of the enterprise. Bringing down the operational expenditure can mean different things to different enterprises based on the domain of operation. For example, for an enterprise that works on servicing equipments, reducing the operational expenditure can be achieved when the field service employee has a handset application that can help in collecting customer complaints, take images of faulty parts, connect to the office, check equipment manuals, take images of the bar code of the faulty part, check the availability of parts for replacement, place the order, and get service requests allocated to the location nearest to the current complaint's location. Similarly, for an enterprise in courier service, the operational expenditure can be reduced with a mobile application that reduces paper work and errors from manual entry, which is achieved using a handset application that can collect delivery details as well as get signature from the customer upon delivery and auto-update the details to the back-end server.

Partner or supply chain mobility deals with applications provided by the enterprise for channel partners. The intent is to increase sales and ensure better tracking. Let us discuss an example application under this category. An enterprise that specializes in car manufacturing could develop a mobile application for its suppliers who would use it to scan automobile parts that are sent with dates, which can be easily verified by the manufacturing unit on the arrival of the parts, and the production can be planned based on the shipment of parts. This makes it easier to keep track of the parts from different suppliers. It must be noted that a partner can also be a customer, for example, in scenarios where the enterprise creates a mobile application for its product service team to place orders for the end customer; although the application is for the partner, it is a means of getting business from the end customer.

Finally, we have employee-centric mobility that deals with mobile applications for employees at their work place. These can be simple applications that allow sharing of PC desktop data on the mobile device or applications that enable interaction with enterprise systems to generate critical reports for managers to make decisions even when they are on the move.

Through these different categories of mobile applications, it can be seen that enterprise mobility leads to higher productivity, improved data quality with less paper work, more business and satisfaction from customers, employee access to enterprise packages even when the employees are on the move, and a more productive workforce. Some of the overheads to the enterprise with enterprise mobility are additional infrastructure requirements to support a new channel, including the cost of hardware, software, integration, service and support, security concerns, mobile device and infrastructure management, and performance issues on back-end enterprise systems due to traffic from mobiles.

## 2.2 Mobile Solution Types

The mobile solution to a business problem can be of the following types:

- Short message service (SMS)
- Unstructured supplementary services data (USSD)
- Interactive voice response
- Thin application
- Thick application
- Hybrid application
- Subscriber identity module (SIM) application tool kit
- Combined package

The SMS is a popular method adopted for mobile-based customer support, mobile marketing, and multifactor authentication. An example of an SMS-based customer support is when we order an item from a retailer web site, and the retailer sends SMS messages to the customer to update the status of the order. Once the retailer has the customer's mobile number, this can be used to send SMS messages on promotions that might be of interest to the customer, leading to the use of the mobile as a marketing tool. Banks are increasingly using the SMS as an instrument for multifactor authentication, where the customer is sent an alphanumeric security code and asked to use the same, along with a web-based login or password for added security from hackers.

USSD is also a popular solution for customer support. Popular examples of USSD include dialing *123# to get the account balance message for a prepaid account with the telco service provider or *3445# to activate a service such as roaming or daily news. USSD is also being used to communicate promotional and advertising messages.

Interactive voice response is the traditional approach for customer support. Most enterprises provide a support number that can be called by the customer to get product information and customized responses to queries based on their product purchase or service subscription. The calls from a customer are first handled

by an automated response system, which provides the caller with a predefined set of options, such as "Press 1 to know your balance," "Press 2 for activating new services," etc., and then it provides a recorded response based on an input selected by the user in the mobile handset. These automated systems also give an option for the user to reach a customer support executive and thus switch from automated response to response from an actual person.

Thin application (Thin App) is the term used for browser-based applications. The device diversity and multiple platforms make mobile web application development more complex than normal web site development for the desktop. Different mobile devices have different screen sizes, platform versions, memory capabilities, etc., which result in multiple device profiles to be supported by the mobile web server. In a typical mobile thin application implementation, the server side will contain a rendering engine. Based on the device making the request and the web format supported (WML, HTML, and xHTML), the rendering engine will create an appropriate page for presentation to the browser in the mobile device. So accessing a web site that is not mobile enabled will result in the content being presented in an unformatted manner based on the profile of the mobile device. Offering browsing capability and mobile shopping through a mobile browser involves thin application development. Thin application development relates to changes on the server by providing the capability to browse the enterprise site from a mobile.

Thick applications are application packages that need to be downloaded to a mobile. Thick applications can offer a much better user experience compared with thin applications. These also help the user to work in an offline mode. Offline mode means that the user can work on the application in the absence of network connectivity, which is not possible in the case of mobile web sites. The disadvantage, however, is the requirement to download and install the application, which is not required in the case of browser-based applications.

A hybrid application, as the name suggests, is a combination of thick and thin applications. The hybrid application is similar to a normal thick application, which needs to be downloaded. However, some screens in the application will have a browser page embedding. So clicking or selecting an option such as "button click" will launch the browser or web page inside the thick application container. This is usually a requirement when handling payment transactions, such as credit card information, where regulatory compliance requires that no card information is on the device, and the best way to handle security in such a case is to delegate the responsibility to the server. So by using a mobile commerce retailer hybrid application, the customer views products and performs checkout, and finally when the step to enter payment processing is to be handled, an embedded mobile web page is loaded in the thick application container.

The SIM application tool kit has a memory card that has details of the subscriber and is used to place calls by identifying the subscriber with the telco call servers. As address details and other information are stored on the SIM, applications can also be made available on the SIM card. The important part of working

with applications for the SIM card is to understand that the storage capabilities of the SIM are limited. However, telco service providers who offer the SIM card can create value-added applications for the customer, which get loaded on starting up the mobile.

Combined packages are offered by most large enterprises, as a single mobile solution type will not satisfy the requirements of customers. The goal is usually to offer as many solution types as possible to address a business problem. For example, for mobile commerce, the retailer would provide the capability to browse mobile web pages (Thin App) and make a purchase; in the vendor App Stores, the retailer will launch a mobile thick application in which customers can save their favorite items and get customized promotions and other features leading to a purchase. To support the purchase, the retailer would complement an SMS service to provide delivery status and also provide interactive voice response support for handling queries. Also by offering an e-mail for support and providing the e-mail in the thick and thin solutions, the mobile mailing application can also be leveraged by the retailer.

## 2.3 Key Players in the Mobility Landscape

The mobile business landscape has the following players:

- Original equipment manufacturers (OEMs): Mobile handsets are manufactured by OEM vendors. There are both consumer handsets and handsets for enterprise requirements. Motorola and Panasonic are the two leaders in the enterprise handset manufacturing industry.
- Electronics manufacturing services (EMS) providers and original design manufacturing (ODM) companies: OEMs do not manufacture and design the electronic components that make up the mobile device. This is done by vendors who specialize in this space, which falls under the category of ODM/EMS. Compal and FlexMobile are the two popular players in the mobile ODM/EMS landscape.
- Mobile platform vendors: The operating system (OS) for a mobile is called the mobile platform. The inherent capabilities of a mobile handset depend on the OS in the mobile device. There are multiple mobile platforms, and Windows Mobile and Symbian are two examples of the mobile platform.
- Semiconductor vendors: The computational capability of the mobile handset depends on the processor chip. Market leaders in mobile chip technology, such as Intel, TexasInstruments, and Freescale, are coming up with smaller and more powerful processor chips that significantly improve the landscape of mobile applications that can be used in mobile handsets.
- Independent software vendors: Generic mobile applications for the mass market have been an area of key focus for independent software vendor giants

such as Google and Skype. However, Google has made a significant impact in the mobile space with its mobile OS named Android. Android is now eating up the market share of other mobile platform giants such as Research in Motion (RIM, BlackBerry) and Apple (iPhone).

- Content providers: Many content providers benefit from mobility. Media content providers such as Fonecta and MTV are just two examples of content providers from the media industry that benefit from mobility solutions. Enterprises that focus on consumer mobility use third-party content to provide value-added service to the customers.
- Operators: Telco operators play a key role in the enterprise mobility space. They come up with new service offerings for their enterprise customers. They are the leaders in innovation and change in the mobility industry by offering enhanced mobile middleware platform integrated with the telco service delivery platform, service application programming interfaces that can be used to create functionality-rich mobile apps, mobile cloud environment, etc. Vodafone, Orange, O2, and Telstra are some of the telco service providers who have made considerable contributions in the enterprise mobility space.
- Technology providers: Mobility client applications need to interact with mobile server components. The servers are supplied by technology providers such as HP, IBM, and Microsoft. Technology providers, such as Microsoft, are playing multiple roles with several mobility solutions: the Windows Mobile OS, the Windows CE for embedded systems including handsets, Azure as a hosting platform for mobile servers and middleware, and mobile synchronization solutions between the PC and the mobile.
- Enterprises: Enterprises require mobile applications for their customers and internal mobility needs. Enterprises interact with other players in the mobility space to meet their enterprise mobility needs.
- Mobile middleware providers: There are multiple mobile enterprise application platforms, mobile consumer application platforms, mobile web tools, and packaged tools for multiplatform application development. Some of the mobile middleware vendors are Netbiscuits, Volantis, Sybase, and Antenna Software. The use of middleware is not limited to multiplatform development. Mobile middleware also has capabilities of synchronization of data between the client and the server, built-in security, and quicker integration with back-end systems.
- Mobile application providers: The market leaders in back-end enterprise systems, such as Oracle and SAP, are effectively utilizing the opportunities coming up from mobility space, by introducing mobile applications that help enterprise users to connect with back-end systems. With the use of these mobile applications, enterprise users can get reports, alerts, and critical information and can work on enterprise applications even when they are on the move.

- Enterprise mobile open-source software providers: Several operation support applications are required for mobile enablement. For example, for managing the mobile devices of the enterprise, mobile device management solutions such as Sybase Afaria would be required; for ensuring security, several mobile security packages would be required; for over-the-air deployment, solutions such as BlackBerry Enterprise Server or iPhone Configuration Utility can be used; for test management, solutions from TestQuest are available; and for multiplatform test, services are provided by DeviceAnywhere. Hence, multiple solutions satisfy specific operation support requirements in the enterprise for mobility enablement.
- Cloud or managed mobility service providers: Enterprises are currently approaching managed mobility service providers to satisfy their mobile development, hosting, and maintenance requirements. Managed service providers give enterprises the ability to completely outsource their mobility activities. Cloud provider is a subset of the managed service provider and handles the hosting of the mobile solution. Mobiqa is a managed mobility service provider, and Kony Solutions is an example of a mobile cloud provider.
- Information technology (IT) service providers and system integrators: IT companies such as Infosys Technologies Limited take up mobile application development as well as integration with existing back-end solutions. They act as full-service agencies offering mobile design, development, build, quality testing, and maintenance. These service providers would, in turn, partner with different players to meet the end-to-end solution requirements of the enterprise.
- Consulting firms: Consulting service firms have added mobile strategy consulting to enterprises in their service portfolio to benefit from the immense opportunities in consulting. With multiple options on mobile platforms and vendors, most enterprises first introduce a consulting firm to define the mobility roadmap, before actually building the mobile solution in-house or outsourcing the development to an agency.
- Mobility research: Research firms, such as ABI Research, which have dedicated teams working on mobility research, constitute another group of the key players in the enterprise mobility space. The research publications in mobility from ABI Research, Gartner, and Forrester are some of the key references for enterprises, agencies, consulting firms, and all the major players in planning their business and technical roadmaps.
- Miscellaneous players: Apart from the major players discussed so far, several others are part of the mobility landscape. A few examples of other players include academic institutions, training centers, and certification centers that have started offering courses on mobility, considering its immense potential in today's industry. A mobile marketing firm is another example of a specialized firm that assists the enterprise to effectively use the mobile channel for marketing.