The History of Mobile Phones

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Abstract

This paper examines the evolution of mobile phones over the past three decades, roughly 1990-2020. It begins by distinguishing between three different stages of mobile phone evolution, and how each stage contributed to the next transition. The first stage consists of basic phones, followed by feature phones, and finally smartphones. In addition, the paper examines how innovations in cellular technology (1G to 5G) influenced the form factors, operating systems, and applications and security of the mobile phones at each of the three stages of evolution. This examination may provide clues as to what the mobile phone of the future looks like, as the world rolls out the 5th generation of cellular technology.

The History of Mobile Phones

The evolution of mobile phones over the course of the last 3 decades has been remarkable, moving from basic voice communication to mobile broadband and eventually handheld computing and media. When looking at the history of mobile phones, one can establish three distinct eras in their evolution—the basic phone, the feature phone, and the smartphone. Basic phones are just that, basic, offering analog voice or digital text/voice communication between cellular devices on 1st and 2nd generation cellular networks, respectively. Of note, the first commercial mobile phone, the DynaTAC 8000x, was manufactured by Motorola in 1983 (Ruckno, 2017). It was large and bulky, earning itself the nickname "Brick" as a result of its form factor. Basic phones continued to evolve in the early to mid-1990s, shrinking in size and adding both black/white and colored displays, though still very basic in capability and functionality. Basic phones persisted until the late 1990s, when feature phones began to emerge and grab our attention.

This paper will focus mainly on feature phones and smartphones. Feature phones are the predecessors of smartphones which thrived during the early days of mobile communication, before the advent of high-speed broadband. Through 2G, 3G, and eventually 4G, feature phones paved the way for the smartphones we enjoy today. I want to emphasize some of the greater leaps in mobile technology that led to the creation and further development of smartphones from their humble beginnings.

Feature Phones

Feature phones began to emerge in the latter half of the 1990s, when cellular networks were becoming capable of offering more services beyond traditional talk and text, which included very limited amounts of data (Mobile Phone, 2021). In the early 2000s, the 3rd generation of cellular technology—the emergence of mobile broadband—further helped push the feature phone to the fore. "The 2000s saw dramatic increases in memory storage capabilities, battery life, available features, and design options; as a result, cell-phone use by consumers also increased markedly" (Accettola, 2019). Cameras, Liquid Crystal Displays (including touchscreens), and Qwerty Keyboards became commonplace features. Feature phones also offered more robust operating systems, unlike their predecessors, which allowed for baked in applications such as alarms, browsers, calculators, cameras, email, and media, all of which we take for granted today. Today, feature phones are considered mid-tier phones compared to their top-tier smartphone counterparts.

Smartphones

The modern mobile phone is the smartphone. Smartphones began to emerge during the 3rd generation of cellular technology; however, it was not until the 4th generation—advent of high-speed mobile broadband—that smartphones made great technological leaps to become the phones of the future. The arrival of faster networking capabilities allowed smartphones to harness the power of mobile computing. A smartphone is "a mobile phone that performs many of the functions of a computer, typically having a touchscreen interface, internet access, and an operating system capable of running and downloading applications" (Oxford, 2015). High-

definition cameras, large light-emitting diode (LED) display, ultra-responsive capacitive

touchscreens, and advanced operating systems give smartphones the capacity to become

multimedia powerhouses. Smartphones are capable of multitasking between email, gaming,

multimedia streaming, web browsing, word processing, and so much more. Users are also able

to download an endless variety of applications to make their smartphone uniquely theirs.

Welcome to the world of mobile computing.

Form Factors and Hardware

Mobile phones, put one way, are input/output devices. As a result, many different form

factors have contributed to the evolution of mobile phones. Size, shape, and orientation

matter. Clamshells, for instance, were popular early on and were equipped with some of the

first cameras. Like many feature phones, they were small and had only a number pad. The

advent of both the sliding and the larger candy bar form factor allowed for more surface area to

accommodate physical qwerty keyboards for faster input. As phones and screens continued to

become bigger and more colorful, physical qwerty keyboards gave way to resistive and

capacitive touch screens. "Smartphones and feature phones alike came in all many different

shapes and sizes, and moving parts were in – displays that pivoted, swiveled, and twisted

around, or keyboards that clumsily tucked under the display" (Martin, 2013). These new

hardware designs, along with mobile broadband, were beginning to change the way mobile

phones were being used. Exploring these design trends will allow for a better understanding of

how feature phones evolved into the robust smartphones we use today.

Displays and Keyboards

The first mobile phones were phones first. So, one could expect to find a number pad to input numbers along with some type of basic display. Because phones were phones first, mobile phones got smaller and smaller over the course of the 1990s, eventually fitting into the palm of our hands (Accettolo, 2019). However, as we approached the 21st century, cellular technology was rapidly advancing, causing us to rethink phone design in order to use these new technologies. SMS text messages, for example, emerged towards the end of the 2nd generation which prompted the advent of predictive text, such as T9 for number pads, and even larger phone form factors to support physical QWERTY keyboards. The era of feature phones included the most diverse set of form factors, most of which are dead, an indication of how fast the industry was moving during that time.

Mobile broadband in the 3rd and 4th generations, too, played a huge role in the development of displays particularly. "Samsung, introduced cellphones with color LCDs to the American and European markets in 2002 and they sold well, despite the added cost" (Klemens, 2010, p.181). High-speed mobile broadband and colored displays gave us unparalleled access to content and media in the palm of our hands. As a result, the size of mobile displays grew in size and resolution as a response to consuming content and media (TigerMobiles, n.d.). Liquid crystal displays (LCD) gave way to light-emitting diodes (LED) to save on power consumption. Physical keyboards, and resistive touchscreens gave way to ultra-responsive capacitive touchscreens with virtual keyboards and number pads. In the end, manufacturers seemed to settle on an ideal form factor for smartphones, the candy bar—i.e., a huge square screen.

Clamshell

The clamshell, or flip-phone, is arguably one of the most popular phone designs of all time. The clamshell reigned supreme during the 1990s and early 2000s and is marked by its small design and simplicity of use, featuring a screen and number pad on the inside of a folding shell. As clamshells increased in size, following the advent of mobile broadband, their displays increased in both size and resolution. In addition, displays were often added to the outside face of clamshells for receiving quick notifications. Interestingly, the first camera phone released in the United States in 2002 was on a clamshell form factor. Few clamshells, on the other hand, ever received a QWERTY keyboard due to limited physical space.

One of the most recognizable and iconic clamshells was released by Motorola in 2004, the Moto Razr. The Razr series began as clamshell feature phones that eventually evolved into smartphones. However, it was at the expense of their clamshell form factor. Though clamshells have never been favored as the dominant design for smartphones, Motorola recently re-released a new version of their iconic clamshell in 2020. The Moto Razr 5G is Motorola's newest clamshell smartphone running on Android. As more companies experiment with folding screens, perhaps the clamshell will finally join the smartphone era for good.

Slider

It is probably safe to say that the sliding form factor for mobile phones is a thing of the past. These relics of yesteryear were likely the attempt to address the fast-paced evolution of cellular technology that beckoned for QWERTY keyboards. During the early to mid-2000s, mobile manufacturers attempted to give us physical QWERTY keyboards while keeping device

size manageable. Enter the slider. There were numerous variations of the slider, many of which did not stay on the market long, including the both vertical and swivel sliders. The premise was to hide a physical keyboard under the display, sliding the display away when the keyboard was needed. The horizontal slider was the only one that really caught on for any length of time. "They were particularly high in demand just before and after the big modern smartphone boom" (Martin, 2013). The most notable horizontal sliders came from HTC's Touch Pro series that ran on Windows Mobile. As Martin (2013) echoes, though, ultra-responsive capacitive touchscreens may have hastened the demise of physical keyboards. Even so, Blackberry taught us that we can have QWERTY without sliders.

Candy Bar

The candy bar, or bar, is the most popular form factor for mobile phones in general, and smartphones specifically (Martin, 2013). Bar phones are just that; they have a cubelike chassis in which the keypad and/or the display are mounted on the same rectangular plane. The advantage to this type of form factor is that it allows for the largest displays which take advantage of today's mobile gaming, multimedia, and streaming. Early candy bar phones in the 1990s and 2000s were smaller and resembled candy bars more so than today's smartphones. Moreover, the early feature phones generally used half of the rectangular plane for the display and the other half for the keypad. With the advent of touchscreens, most smartphones today eliminate the keypad altogether (except in some cases a home button) and use the whole plane to maximize the color display. The Apple iPhone and Samsung Galaxy are great examples of candy bar smartphones. Although today they are looking more like Hershey's Bars than Snickers Bars, the candy bar form factor is not going away anytime soon.

Operating Systems

Operating systems (OS) also played a pivotal role in mobile phone evolution. Early operating systems had little functionality outside of the programs that were baked into the OS. Application stores did not exist at the time. Symbian, however, was a major player in OS design and was found on many early feature phones at the turn of the century. As mobile computing power continued to increase and mobile broadband was coming of age, companies began to create more powerful operating systems with increased functionality and ability to download applications. Competition was fierce for market dominance and eventually Apple's proprietary iOS and Google's open-source Linux kernel, Android, dominated the market. Symbian, WebOS, and Windows, among others would eventually be discontinued as mobile operating systems.

Early Operating Systems

During the early evolution of mobile phones, manufacturers had to rely on themselves for the operating systems that would run their devices. Most of these operating systems were embedded, meaning that they were designed for very specific tasks such as making phone calls and sending text messages. In other words, the operating systems ran a single, non-customizable code in order for the mobile phones to function as they were intended (Posey, 2019). So, when sending a text message, for example, end users did not have the option to change the font or the color of the text; the code simply executes that which is built into the code, font and color included. As one can surmise, these early phones lacked the degree of customization and functionality that we enjoy with operating systems of today.

Symbian & Windows

There were many competing operating systems vying for market dominance at the turn

of the 21st century. Mobile phone technology was transitioning into its 3rd generation and

smartphones capable of emailing, gaming and web browsing were on the rise (Ruckno, 2017).

As a result, companies began to develop more powerful operating systems that could handle

these new tasks. Symbian and Microsoft were two companies that led the way in developing

these new operating systems in the early 2000s.

Beginning in 1998, the predecessor to the Symbian operating system was used by

manufacturers such as Motorola and Nokia for use on their feature phones (Mobile Operating

System, 2021). The platform was continually developed and improved, and eventually Symbian

Series 60 found its way onto its first smartphone in 2002. Symbian continued to grow and

"[w]ith no major competition in the smartphone OS then (Palm OS and Windows Mobile were

comparatively small players), Symbian reached as high as 67% of the global smartphone market

share in 2006" (Symbian, 2021). Unfortunately, due to increasing market competition later in

the decade, the Symbian OS lost its appeal with consumers and was discontinued in 2014.

Similar to Symbian, Microsoft launched the predecessor to its Windows Mobile

operating system in 2000. As Windows Mobile began to develop over the decade, its user

interface began to resemble that of its desktop counterpart, Windows for the personal

computer. This was perhaps an attempt to levy market advantage over consumers familiar

with desktop versions of Windows. However, Windows Mobile never came close to Symbian's

market share—e.g., in 2007, Symbian held 63% compared to Window's 12% (O'Dea, 2020)—

and windows mobile was eventually discontinued. In the 2010s, however, Microsoft tried

subsequent reboots of its mobile platform with both Windows Phone and Windows Mobile 10.

However, both shared a similar fate with Windows Mobile and were later discontinued.

Android & iOS

Today, only two operating systems truly dominate the mobile OS landscape—Android

and iOS. "Android maintained its position as the leading mobile operating system worldwide in

January 2021, controlling the mobile OS market with a 71.93 percent share. Google Android

and Apple iOS jointly possess over 99 percent of the global market share" (O'Dea, 2021).

Android is an open source, Linux based operating system developed largely by Google. It can

be found on a host of smartphones developed by numerous manufactures, including Motorola,

HTC, Nokia and Samsung. Though the base Linux kernel is open source, these manufactures will

often make proprietary changes to the operating system or graphical user interface (GUI),

giving each company its own Android look, flavor and style. Furthermore, Android

smartphones come packed with proprietary software, for example, Google Play and Google

Maps (Amadeo, 2018). Apple's iOS, on the other hand, is completely propriety and the OS and

GUI will look much the same across all of their smartphones.

So, why were these two mobile operating systems so successful? Enter the mobile

ecosystem. Apple and Google were both successful in creating an ecosystem of products and

services that interact seamlessly with each other, creating an uncanny ease of use for the

consumer. For example, an Apple ID gives an iOS user access to a host of Apple products and

services including the App Store, iCloud, Apple Music and TV, all working together, on all the

user's devices, under one Apple ID. Similarly, Android's ecosystem is centered around Gmail

which connects all of Google's products and services together, including Drive, Maps, Photos,

Play, and YouTube. Given the success of these platforms, it is hard to tell whether a third

company could vie for dominance in the mobile OS market. What we do know is that

applications are at the heart of the mobile market. Thus, it would likely be a company that

could successfully use the open-source license to fork Android into a version better than

Google's, while taking advantage of the already tons of android apps on the market (Amadeo,

2018).

Applications & Security

Application stores have played a pivotal role in turning our communications devices into

computing and multimedia powerhouses. No longer are we hindered by older operating

systems with limited application functionality. App stores today offer an overabundance of

applications that one can install on their smartphones to increase functionality, including word

processing, social networking, mobile banking, streaming, and gaming. However, with

increased functionality comes the increased risk of security threats. Simple pins and out-of-

date applications account for many smartphone breaches. Unlike feature phones with simple

pins and manufacturer-initiated security updates, smartphones require us to take ownership in

our digital security by creating difficult passwords and updating applications with the latest

security patches. Our digital lives and wallets, after all, are increasingly becoming a part of our

smartphones and mobile applications.

Application Stores

User-installed applications are one of the defining characteristics of smartphones, allowing developers and users to change the way they use and experience their mobile devices. As a result, it is no surprise that application stores (app stores) have had a direct influence on the evolution of smartphones. One can imagine video streaming apps that call for larger screens on smartphones. There are camera apps, for example, that beckon for high resolution HD cameras, or mobile banking apps that call for enhanced security and encryption. And on top of all that, app stores may even play a role in the extinction or survival of smartphone operating systems.

App stores started to appear during the mid-2000s when operating systems were competing for market dominance. Apple (App Store) was the first to launch an app store in 2008, swiftly followed by Google (Android Market, later Google Play) in the same year (Zolotareva, 2017). These releases gave Apple and Google a marked advantage amongst competitors vying for space in the OS market—i.e., developers could develop apps for these operating systems first. It is no doubt that the selection of apps available is proportional to the success of a smartphone OS; running apps is at the heart of smartphones after all.

Recall the discontinued operating systems mentioned in the previous section—Symbian, Windows, and to a lesser degree WebOS. All of these platforms released app stores (Nokia Ovi Store, Windows Marketplace, and Palm App Catalog, respectively) that were only marginally successful compared to Apple and Google. Perhaps this was due to the lack of success in garnering developers to build for their platforms, which ultimately led to a lack of app selection,

comparatively (Tung, 2019). Or, perhaps customer loyalty to exclusive software suites and services played a role. Google services such as Gmail, Maps, and Drive, for example, were not available on competitors' app stores. In any case, Microsoft made the largest inroads into the market, but were ultimately unsuccessful. Do mobile operating systems make or break app stores, or vice versa? Whatever the case, app stores are incredibly important to the evolution of the smartphone.

Authentication

As mobile phones become more and more an extension of our personal lives, security becomes increasingly important. In the early days of mobile communication, one's phone may have had a 4-digit pin to protect contact information and the contents of SMS text messages. However, as mobile phones became more technologically sophisticated, they became places to store email, photos, calendars, and other more personal information making the need for security more important. Enter the era of smartphones where business, mobile banking, and social media is conducted in the palm of one's hand; security on mobile phones is now paramount.

With mobile security in mind, Smith (2017) contends that "[t]he weak link in many personal data breaches can be traced back to an overly simple password, an out-of-date smartphone app with missing security patches or the use of an unfamiliar Wi-Fi network." So how do we solve this? The first step in securing one's information is to set up authentication on their mobile device. "More than a quarter (28%) of smartphone owners say they do not use a screen lock or other security features to access their phone" (Anderson, 2017). Perhaps users

do not secure their devices, for example, because of the hassle it creates given the amount of

time they spend on their device. But authentication could be as simple as setting a 4-digit pen,

one may contend. However, Parson (2018) notes that 4-digit pins are not as secure as one

might think—i.e., 4-digit pins can be easily brute forced with the right software given that there

are only 10,000 possible combinations. A more secure option would be to use an alpha-

numeric-symbol password using upper and lower case, which offers over 6 quadrillion

possibilities. That said, most smartphones today will erase, or at least have the option to erase,

one's data and reset their phone if a pin or password is entered incorrectly for a specified

number of times. One may lose some of his or her own data if not backed up, but at least it is

secure.

In addition to authentication, keeping a mobile phone up to date can prevent security

breaches in both the operating system and installed applications. Operating systems will

prompt one to install updates, and those are best not ignored too long for security's sake.

Applications on the other hand, can be completely ignored, posing a potential security risk. It is

good practice to turn on automatic updates, even if they are only updated when connected to

Wi-Fi. Lastly, be wary of unsecured public Wi-Fi. Any logins to banking or social media, for

example, could be potentially intercepted. Keeping mobile phones secure can prevent huge

headaches.

Future of Mobile Phones

It is hard to predict where the future of smartphones is headed. We are in the initial

rollout of the 5th generation of cellular technology. So, if history is any indication, one can

expect to see some evolution in the mobile phones that have access to 5G. One trend that is

emerging is that of the folding screen, which can lead to innovations in form factor. Or,

perhaps glasses with a virtual display. Innovations in augmented and virtual reality could bring

these types of phones to life. Whatever the case may be, let us hope it is exciting.

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