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The Rise of the Mobile Internet: Tracing the Evolution of Portable Devices

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Abstract. *The rapid advancement of technology in recent years has led to an increasing dependence on mobile devices for communication, entertainment and access to information. The rise of the mobile internet has fundamentally transformed the way we live, work, and interact with each other. This paper examines the evolution of portable devices, from the first mobile phones to modern smartphones and tablets, and explores the impact of these devices on the development of the mobile Internet. We trace the evolution of mobile technologies, from the early days of cellular networks to the emergence of 3G, 4G, and 5G networks, and the development of Wi-Fi and Bluetooth technologies. We also explore the impact of mobile devices on various industries, including advertising, entertainment, and e-commerce. Through this analysis, we aim to provide a comprehensive understanding of the rise of the mobile internet and the transformative effect it has had on society.*

Keywords: Mobile internet, portable devices, smartphones, mobile evolution.

Introduction

The emergence of mobile devices has revolutionized the way people interact with the Internet, making it possible for them to access information and communicate with others from anywhere and at any time. With the rapid growth of mobile devices, the mobile Internet has become an essential part of our daily lives. In recent years, mobile devices such as smartphones and tablets have become more sophisticated, offering advanced features and functions that were previously only available on desktop computers.

This paper aims to trace the evolution of portable devices and examine the rise of the mobile Internet. The paper will begin by providing an overview of the history of portable devices, from the first handheld calculators to the latest smartphones and tablets. We will then examine the development of wireless communication technologies, such as Bluetooth, Wi-Fi and cellular networks, which have enabled mobile devices to connect to the Internet and each other.

Next, we will explore the impact of mobile devices on the way people access and use the Internet, including changes in browsing behavior, online shopping, and social networking. We will

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also discuss the challenges associated with the mobile Internet, such as security and privacy concerns, and how they have been addressed.

The main results of the study will focus on the process of connecting a portable device to the Internet and its evolution.

Finally, we will look forward and consider the potential of emerging technologies, such as 5G networks, virtual and augmented reality and also artificial intelligence, to further transform the mobile Internet and the way we interact with it.

Overall, this paper seeks to provide a comprehensive understanding of the evolution of portable devices and the rise of the mobile Internet, highlighting the key technological and societal trends that have shaped this transformative phenomenon.

Literature review

The history of portable devices

The history of portable devices dates back to the 1960s when the first handheld calculator was introduced (Chiba et al., 2012). Since then, portable devices have evolved rapidly, becoming more powerful and versatile. One of the earliest portable devices that could access the Internet was the Personal Digital Assistant (PDA), which was introduced in the 1990s (Wiggins, 2014). PDAs were small, handheld devices that could be used to store and retrieve information, as well as connect to the internet via a wireless modem.

The next significant development in portable devices was the introduction of smartphones, which combined the functionality of a PDA with that of a mobile phone. The first smartphones, such as the Nokia 9000 Communicator and the Ericsson R380, were introduced in the late 1990s and early 2000s (West and Mace, 2010). These early smartphones were limited in their capabilities, but subsequent iterations, such as the iPhone and the Android devices, have become more powerful, offering advanced features such as high-quality cameras, voice assistants and biometric authentication.

The Rise of the Mobile Internet

The rise of the mobile Internet can be attributed to several factors, including the increasing availability of mobile devices, the development of wireless communication technologies and the growth of mobile applications. The widespread adoption of smartphones has been a key driver of the mobile Internet, with over 6.56 billion smartphone users worldwide as of 2021 (Statista, 2023a).

Wireless communication technologies have also played a significant role in enabling mobile devices to connect to the Internet. Wi-Fi and cellular networks, such as 3G, 4G and nowadays 5G, have become faster and more reliable, making it easier for users to access the Internet on the go.

The growth of mobile applications has also contributed to the rise of the mobile Internet. Mobile apps allow users to access a wide range of services, including social networking, online shopping, and mobile banking from their smartphones. As of 2021, there were over 3.3 million mobile apps available on the Google Play Store, and over 2.2 million on the Apple App Store (Dogtiev, 2022).

Impact of the Mobile Internet

The mobile Internet has had a significant impact on the way people access and use the Internet. One of the most significant changes has been the shift from desktop to mobile browsing (Chinie et

al., 2022. In 2022, over 59% of all website traffic worldwide came from mobile devices (Statista, 2023b). The mobile Internet has also transformed the way people shop online, with mobile commerce accounting for over 65% of all e-commerce sales in 2022 (Statista, 2023; Hoang and Nguyen 2022; Paraschiv et al., 2022).

The mobile Internet has also had a significant impact on social networking, with platforms such as Facebook, Instagram, and Twitter, all experiencing explosive growth on mobile devices (Matušínská and Stoklasa, 2022). In 2021, over 98% of Facebook's active users accessed the platform via mobile devices (Statista, 2023d).

Results and discussions

Evolution of smartphones

The evolution of smartphones has been a remarkable journey that has transformed the way we communicate and interact with technology. The Nokia 5120, released in 1998, was one of the earliest examples of a mobile phone with limited functionality. Today, smartphones have become an essential part of modern life, offering a multitude of features and capabilities that were once unimaginable. The Nokia 5120 was a simple mobile phone that allowed users to make calls and send text messages. It featured a monochrome display, a physical keypad, and a small form factor that made it easy to carry. Although it lacked the advanced features of modern smartphones, the Nokia 5120 was a revolutionary device that paved the way for future mobile phones. The first browser battle was being fought at the time between Microsoft and Netscape. The Internet was fresh and intriguing. On a phone, though, who could enter lengthy URLs? What would be the real purpose of that?

The BlackBerry, released in 2002, was one of the first smartphones that introduced email functionality. It featured a full QWERTY keyboard and a small screen that displayed email messages. The BlackBerry quickly became popular among business users, who appreciated the ability to access email on the go.

The iPhone, released in 2007, was a game-changer in the smartphone industry. It featured a touch screen display, a sleek design, and a wide range of features such as a camera, web browser, and music player. The iPhone was the first smartphone that offered a user-friendly interface and a wide range of applications. The world would change when a touchscreen took the place of a keyboard and mouse - this was Steve Jobs's concept. The first iPhone purchases were astounding. The initial version sold more than 6 million copies (Apple, 2007). The App Store, launched in 2008, allowed developers to create a wide range of applications that could be downloaded and installed on the iPhone. However, significant challenges remained:

- Cellular and Wi-Fi networks weren't very quick.
- Processors were unable to create 2D and 3D images with the same speed that PCs and notebooks could.
- Although smartphone displays have improved, they still didn’t have the appropriate resolution for easy reading.

Android, released in 2008, was a direct competitor to the iPhone. It offered a similar user interface and a wide range of features. Android was open-source, which allowed developers to customize and modify the operating system to suit their needs. Android quickly became popular among manufacturers such as Samsung, LG, and HTC, who developed their own smartphones based on the Android operating system. Android became the second most popular smartphone platform in the world after iOS in 2010, with a market share that increased from less than 5% in 2009 to 13.8% in the first half and 24.5% in the second half. Shipments of cellphones with Android

operating systems increased by 561% from 2009 to 2010, reaching over 55 million units (Computerworld, 2022). Around Android, developer groups emerged in 2010 and created what was called the Android Open Source Initiative (AOSP). A sustained era of development helped to solidify Android's dominance. From 2010 to 2017, the number of project submissions per month more than quadrupled.

Figure 1 presented below shows the global market share held by various mobile operating systems from the year 2009 to 2022. The market share is represented by percentages on the y-axis, while the x-axis displays the timeline.

In 2009, Symbian was the leading mobile operating system, holding a 46.9% market share. However, with the introduction of Android in 2010, the market share of Symbian started to decline, and Android began to dominate the market by 2012. As of 2022, Android holds the highest market share at 72.2%, followed by iOS with a 26.4% market share. Other operating systems such as Windows and Blackberry have a minimal market share.

The graphic shows that the mobile operating system market is highly competitive, with dominant players constantly changing over time. Additionally, it highlights the importance of innovation and adaptation in technology, as newer and more advanced operating systems continue to replace older ones.

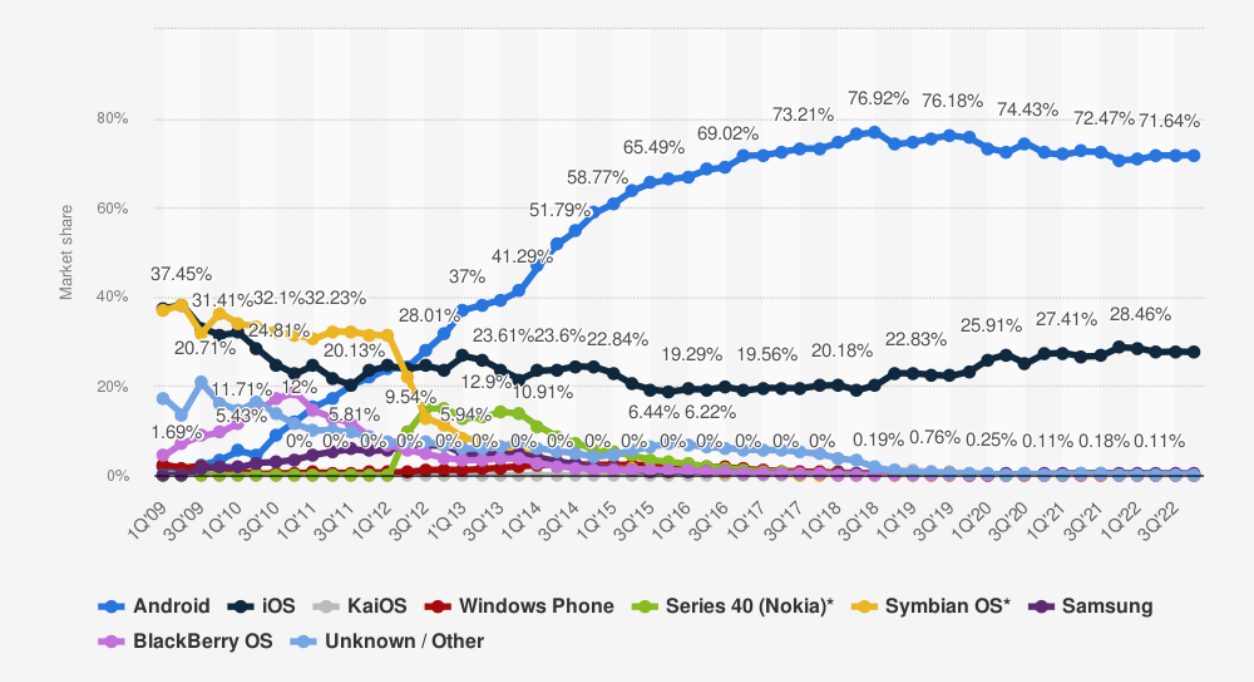

Figure 1. Mobile operating systems' market share worldwide from 1st quarter 2009 to 4th quarter 2022

Source: Statista, 2023e.

The Development of Wireless Communication Technologies

Wireless communication technologies have revolutionized the way we communicate and access information. From Bluetooth to Wi-Fi and cellular networks, these technologies have made it possible for mobile devices to connect to the Internet and each other without the need for physical cables.

The first wireless communication technology was the radio, invented by Guglielmo Marconi in the late 19th century (Bondyopadhyay, 1995). The radio was primarily used for point-

to-point communication over long distances. The first public radio broadcast took place in 1920 (Woodsmoke Productions and Vermont Historical Society, n.d.), and the radio became a popular form of entertainment and news dissemination in the following years.

In the 1980s, cellular networks were developed, allowing mobile devices to connect to a network of cell towers to make calls and send texts. The first cellular network was launched in Japan in 1979, and the first commercial cellular network was launched in the United States in 1983 (Kano, 2000; Gawas, 2015).

In the 1990s, wireless local area networks (WLANs) were developed, which allowed devices to connect to a local network without the need for cables. The first WLAN standard, IEEE 802.11, was released in 1997, and first commercial Wi-Fi products were launched in 1999 (Pahlavan and Krishnamurthy, 2021).

Bluetooth technology was developed in the mid-1990s by Ericsson and was first released in 1999. Bluetooth allows devices to connect to each other over short distances, typically up to 10 meters, and is commonly used for connecting devices such as smartphones, laptops, and headphones.

In the 2000s, the development of 3G cellular networks allowed mobile devices to connect to the internet at faster speeds. The first 3G network was launched in Japan in 2001 and 3G networks were later adopted worldwide.

The development of 4G cellular networks in the 2010s allowed for even faster Internet speeds and more reliable connections. 4G networks were first launched in Sweden and Norway in 2009 and were later adopted worldwide.

In recent years, the development of 5G cellular networks has been underway, which promises even faster speeds and lower latency. 5G networks have already been launched in some parts of the world.

Mobile Internet Evolution

The internet connection on a mobile phone has evolved significantly over time. Starting with the first models of mobile phones, the Internet connection was limited or absent, which made them useless for accessing online information.

Before the advent of 2G wireless communication technology, the Internet connection on a smartphone did not exist or was limited. First mobile phones were used only for voice calls and sending short messages (SMS), without access to the Internet or other online services.

However, some phone manufacturers have begun to offer models with limited Internet access capabilities through technologies such as integrated modems and cable or infrared connections. These were, however, early and expensive technologies, so their use was limited.

Therefore, before the advent of 2G technology, the internet connection on a smartphone was limited or absent, and these devices were only used for voice calls and short messages. This aspect has changed with the emerge of 2G wireless communication technology, which allowed data transmission and Internet access on the phone. However, speed was limited and costs were high, facts that limited the popularity of this technology.

Over time, technologies such as 3G and 4G were developed, allowing faster data transmission speeds and wider access to the Internet. This made it possible to use mobile phones to access online services, such as e-mail, social networks and others.

With the launch of 5G technology, a significant increase in data transmission speed and bandwidth is expected, so that it is possible to access a greater number of online services and reach new levels of efficiency and quality of the Internet connection. Therefore, the Internet connection on a mobile phone has evolved from the absence or limitation to modern technologies with high speeds and wide access to the Internet, so that it became an indispensable tool in the daily life of many people.

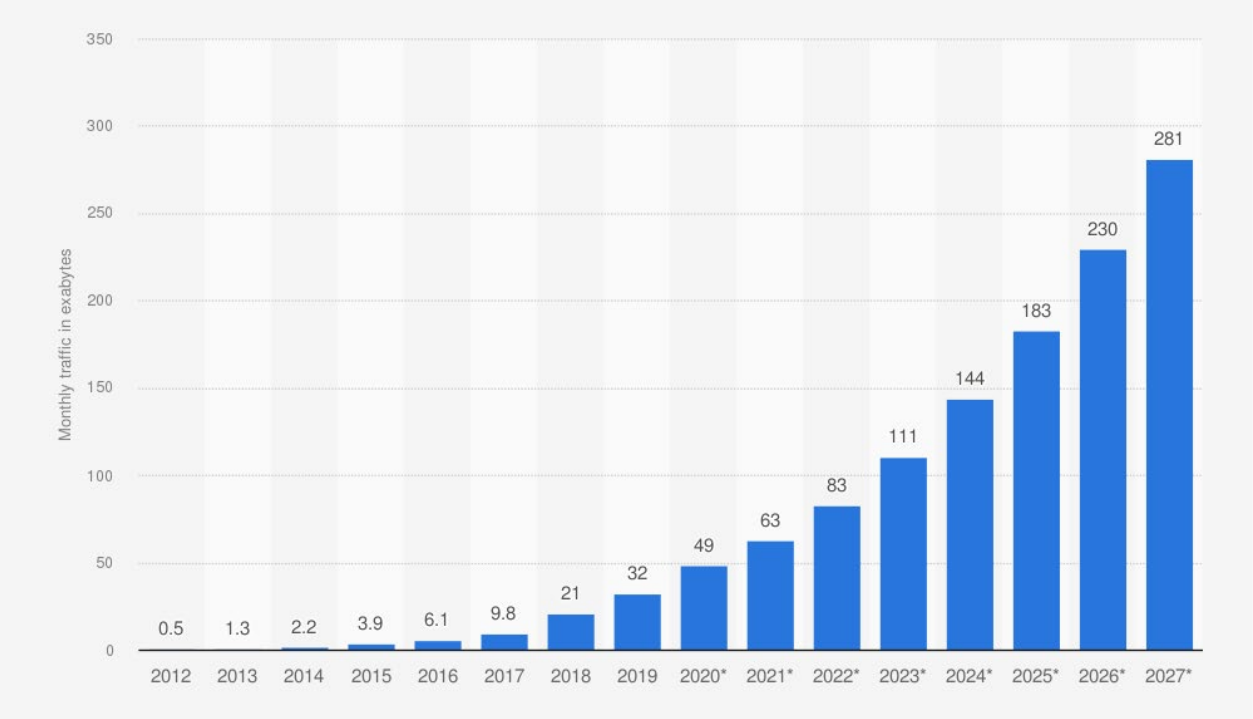

Figure 2. Average monthly smartphone traffic worldwide from 2015 to 2027 (in exabytes)
Source: Statista, 2023f.

Figure 2 presented above displays the worldwide monthly data traffic generated by smartphones from 2015 to an estimation until 2027. The y-axis represents the volume of data traffic in exabytes, and the x-axis represents the timeline. The graphic reveals that the monthly data traffic generated by smartphones has been consistently increasing since 2015, with a projected 169 exabytes of data traffic in 2025. This can be attributed to the increased use of smartphones for a variety of activities such as streaming video content, social media, and online gaming.

The graphic also shows that the COVID-19 pandemic in 2020 caused a sudden spike in data traffic, as people around the world were forced to work, study, and socialize from home. The pandemic accelerated the adoption of digital technology, leading to an increase in data traffic.

Overall, the graphic suggests that the demand for data traffic generated by smartphones will continue to increase in the coming years, presenting significant opportunities and challenges for mobile network operators, service providers, and policymakers. To meet the growing demand for data traffic, mobile network operators will need to invest in expanding their network capacity and infrastructure. Policymakers will also need to ensure that adequate regulatory frameworks are in place to promote consumer protection.

Impact of Wireless Communication Technologies

The development of wireless communication technologies has had a profound impact on modern communication. Mobile devices such as smartphones and tablets have become essential tools for communication and access to information, while wireless connectivity has made it possible to access the Internet and communicate with others from almost anywhere in the world.

Bluetooth technology has also enabled the development of wireless headphones, speakers, and other devices, making it easier to listen to music and other audio content without the need for cables.

Wi-Fi technology has revolutionized the way we access the Internet, allowing us to connect from almost anywhere, including our homes, workplaces and public spaces such as cafes and airports.

Cellular networks have also made it possible to communicate with others while on the go, and have enabled the development of mobile applications and services that would not have been possible without wireless connectivity.

Process of Connecting a Portable Device to the Internet

The development of cellular technology has made everything nearby and accessible with just a single touch. It transformed the way we communicate and interact with each other. Digital services have given people the ability to use them for a variety of socially beneficial purposes. A boom in linked digital gadgets, which in turn generate enormous amounts of data, is the downside of this extraordinary growth.

Over the past few decades, cellular technology has grown to become an essential part of our daily lives, allowing us to stay connected with friends, family, and colleagues, no matter where we are in the world. From the first generation of analog phones to the latest 5G networks, cellular technology has evolved rapidly, offering faster data speeds, clearer voice calls, and a more reliable connection.

The US phones overtook Europe as the global leader as mobile technology advanced into high-tech instruments, while Europe had pioneered mobiles and was formerly the international leader on the mobile markets. The story of cellular technology begins in the 1970s, when the first mobile phone was developed by Motorola. This first generation of mobile phones used analog technology, which was limited in its capacity and coverage. In the 1980s, the second generation of mobile phones was introduced, using digital technology, which allowed for greater capacity and coverage. With the introduction of 3G in the early 2000s, cellular technology began to offer Internet connectivity, paving the way for the era of smartphones.

Today, with the emergence of 5G, cellular technology is poised to transform the way we communicate and interact with the world around us. With faster data speeds and lower latency, 5G promises to enable new applications, such as virtual and augmented reality, autonomous vehicles and the Internet of Things. The development of cellular technology has been a remarkable journey, and its future promises to be even more exciting.

Internet on the phone works through wireless communication technology, such as 4G, 5G or Wi-Fi. These standards allow the phone to connect to an Internet network, so that it can access information and transmit data.

In essence, when a user accesses the Internet on the phone, his signal is transmitted through the telecommunications cells that make up the wireless network. This signal is decoded by the base station and then sent to a data center, where it is processed and transmitted via the Internet.

When a user requests a web page or an application, this information is transmitted via the Internet to the service provider's data center, which returns the requested information. Afterwards, this information is transmitted via the wireless network to the user's phone, where it can be displayed on the screen.

In addition, modern phones are equipped with browsers and applications that allow users to access various online services, such as e-mail, social networks, video and audio streaming services, and many others.

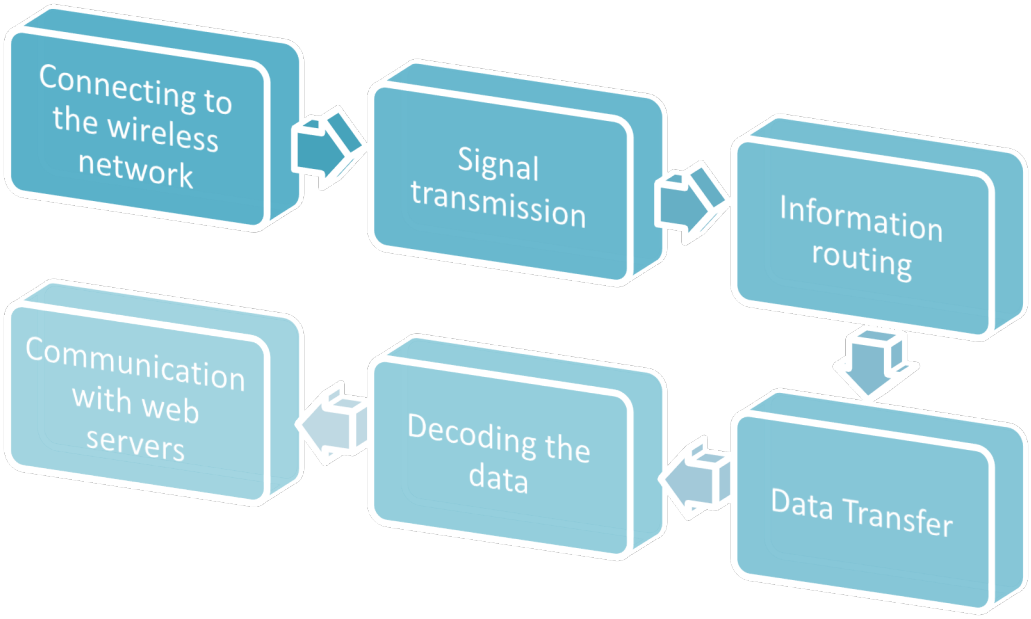

Figure 3. Steps for Internet connection on the smartphone

Source: Authors own research.

As presented in figure 3 above, the steps for connecting a smartphone to the Internet are:

1. Connecting to the wireless network: The phone connects to a wireless network through a wireless communication technology, such as 4G, 5G or Wi-Fi. When the phone connects to a network, it receives a unique IP address, which allows its identification in the network.
2. Signal transmission: When a user accesses the Internet on the phone, his signal is transmitted through the wireless network to the base station. This signal is then transmitted to the data center of the service provider, where it is processed.
3. Information routing: The data center of the service provider works as a router, which determines the optimal path through the Internet to deliver the requested information to the user.
4. Data transfer: The information requested by the user is transferred via the Internet to the data center of the service provider, which returns them via the wireless network to the phone.
5. Information decoding: The returned information is decoded by the phone, so that it can be displayed on the screen.
6. Communication with web servers: When a user accesses a web page or an application, his phone sends a request to the respective web server or application. The web server or application returns the requested information via the Internet.

This is a more detailed process that describes how the Internet can be accessed through a mobile phone. It is important to emphasize that this process takes place in milliseconds, so that the user can access the desired information without significant delay.

Conclusion

The development of wireless communication technologies has transformed the way we communicate and access information. From the radio to cellular networks, Wi-Fi, and Bluetooth, these technologies have made it possible to communicate and access information from almost anywhere in the world. As these technologies continue to evolve, we can expect even more advances in wireless connectivity and communication in the years to come.

Watching the evolution from analog phones to the current era of 5G networks, cellular technology has continued to evolve and push the boundaries of what is possible. With each new generation of technology, we have seen faster data speeds, clearer voice calls, and a more reliable connection.

The impact of cellular technology on our daily lives cannot be overstated. It has transformed the way we work, learn, and socialize, allowing us to stay connected with people and information from anywhere in the world. The future of cellular technology promises even more exciting advancements, as we continue to explore the possibilities of 5G and beyond.

All in all, the development of cellular technology has been a remarkable journey, and we can only imagine what the future holds. However, one thing is certain: cellular technology will continue to play a critical role in shaping our world and the way we interact with it.

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