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DEVELOPMENT AND CURRENT TRENDS IN THE USE OF MOBILE DEVICES

Abstract. The paper deals with the analysis of the development of mobile devices and current trends in their use and development. The relevance of the article is in its linking history and present. The article points to milestones in historical development and future trends and development of mobile devices. Today, mobile devices affect all areas of human life, whether private or business. Mobile devices are now able to replace computers and laptops, so the user has the information they always have with them. The development of mobile devices inherently includes systems supporting their functioning, which the article also discusses.
Keywords: the mobile device, historical development, actual trends, the components of mobile devices

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Introduction

The current stage of the company's development is most often characterized by an exponential increase in new information, even an exponential increase in new scientific information. Technological production and societal processes are now based on in-depth scientific results, which is reflected in economic performance and competitiveness in a particular area. In this context, information and communication technologies have an irreplaceable role.

The following sections will analyze the development of mobile devices in a historical context, developments in development as well as current trends in the use of these devices.

1. The definition of the mobile device

The mobile device is a computing device small enough to be held and operated in one hand. The definition of a mobile device says it is a small electronic wireless device with its own power supply and various applications. Typically, each mobile device has a flat LCD interface that includes a touch interface with digital keys and a keyboard or physical keys together with a physical keyboard. The power source for the proper functioning of such a device is usually provided by a lithium battery. Figure 1 shows an example of lithium batteries used in mobile devices.

Fig. 1 Lithium batteries used in mobile devices

Mobile devices can be triggers for mobile operating systems that allow you to install and run third-party applications that specialize in these features (schedules, internet banking, maps, etc.). The current mobile devices are equipped with several functional accessories that create a compact unit for complex communication with the environment using multiple communication channels.

Mobile devices are most commonly equipped with the following accessories:

- integrated camera,
- digital media player
- phone calls
- video calling,
- GPS functions.

Mobile devices are also used in various areas of the work environment.

For the use of applications related to individual requirements of the transport market segments, the following mobile devices can be used:

- mobile phone - especially smartphone,
- Laptop or smartbook
- PDA.
- tablets.

The mobile phone is a portable electronic device designed for voice, text, image and data communication. The device is radio-connected to the telephone network and therefore the phone is only usable for communication in an area that is covered by the mobile network (it cannot be used in tunnels or in dense wooded areas). Mobile phones have different functions (Dlugoš, 2017, p. 14).

In addition to telephony, the following devices are available:

- connect to the Internet,
- browse websites,
- send and receive text and multimedia messages
- organize meetings and create timetables.

They can be connected to other devices via infrared, bluetooth, NGC, Wi-fi or data cable. These connectivity options vary depending on the type and age of mobile phones. The operation and functioning of mobile phones is also different depending on the operating system, manufacturer and type (Chvostál, 2016, p. 22).

2. Historical development of mobile devices

The first mobile multifunction devices began to enter the European market at the end of the 20th century, but great progress in sales and normal use began in the early 21st century. They were operated with a closed operating system or other specific solution.

Mobile releases have caused a huge boom in the trading market around the world in recent decades. Over the years, the luxury convenience, which was designed for the few chosen, has become a common tool for all ages, making life and work easier and better in many ways. The ability to connect with your loved ones at any time and anywhere has become a reality that has in many ways influenced and continues to have a significant impact on people's lives.

2.1. The origins and development of analog networks 0. Generation

One of the first pioneers of wireless transmission was D. E. Hughes, who in 1879 was able to generate and capture signals transmitted by radio waves (Developer Library, 2012).

Almost ten years later, in 1888, German scientist Heinrich Hertz confirmed Maxwell's theory and experimentally demonstrated that some kind of wireless transmission between two remote devices using air as a transmission medium could be considered (Allen, 2013).

Using these principles, the Italian Guglielmo Marconi designed and operated the first radio system and obtained a patent for it in 1897. In fact, however, Nikola Tesla patented the same invention several years earlier. In 1901, Guglielmo Marconi transmitted the signal across the Atlantic Ocean and the radio was successfully used in shipping (Application Developers, 2011).

Marconi's radio only allowed transmission of telegraph sequences, but not voice. R. Fesseden, who designed a complete system for wireless transmission and reception of radio signals using the then revolutionary amplitude modulation (Developer Library, 2012), contributed to the voice transmission.

Mobile networks of the 0 th generation were unable to use the allocated spectrum efficiently, and as a rule one city was served by only one broadcasting antenna with 25 channels, which allowed a maximum of 25 participants to suddenly serve (Developer Library, 2012).

The following generation networks fall into the 0th generation of mobile networks (BlackBerry 10 Platform Choise, 2013):

- Mobile Telephone Service (MTS)
- Improved Mobile Telephone Service (IMTS)
- Advanced Mobile Telephone (AMTSO)

These networks were not very popular, but served as an important basis for next generation networks. The main problem was the infrastructure of these networks itself, which did not allow any roaming and also the possible number of subscribers, which was very small (BlackBerry 10 Platform Choise, 2013).

During the 1950s and 1960s, all companies in the telecommunications market focused exclusively on the development and research of the cellular network. Bell was headed by a patent application in December 1971 for patenting a mobile telecommunications network, which was recognized the following year, but the Federal Communications Commission (FCC) was only five years later in 1977 (Developer Library, 2012).

Mobile phones belonging to the 0 th generation were predominantly mounted in cars due to their use and size. One of the first public telephones capable of connecting to the public network was launched in America in early 1946 (IOS Developer Library, 2012). Figure 2 is a diagram of a car in which a mobile phone has been installed.

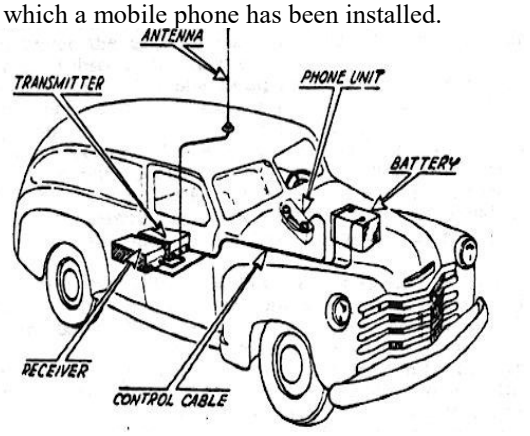

Fig. 2 The mobile phone in the car *(IOS Developer Library, 2012)*

The entire mobile device consisted of a transmit and receive block, which were connected by a data conductor to a control block containing a handset and a microphone. These devices weighed tens of kilograms (IOS Developer Library, 2012).

By far the most revolutionary novelty was launched just before 1960 and was called "Duplexer". It was the device that allowed the first full duplex transmission. It contained a frequency filter that made it possible to transmit and receive a signal using one antenna at the same time (IOS Developer Library, 2012).

The second novelty introduced in 1960 was the implementation of a dial pad in the control panel. This device enabled the user to directly dial the called number, so there was no need to notify the called number to the operator (Čamaj & Gašparík, 2011).

With the advent of the new IMTS mobile network after 1960, manufacturers have gradually introduced their new car systems with full IMTS support. They were labeled "MJ" and one of the first was again from Motorola. It became the most typical and most used control block between 1964 and 1980 (Červinka, 2007). Figure 3 shows a 1963 Motorola mobile control block.

Fig 3 Mobile control block

The development of a transistor, which fully replaced the mechanical relay, brought the first wave of miniaturization to mobile phone manufacturers. By the end of the 1960s, the first "attaché case telephones", also referred to as briefcase mobile phones, came to the market. Most of the first briefcases only supported the MTS network. These mobile phones were very heavy and were equipped with nickel-cadmium (NiMh) batteries that had a capacity of only a few hours. The transmit, receive, and control blocks, along with the battery, were placed in a briefcase. The antenna was realized by foil tapes glued between the inner leather layer and the outer lining of the trunk case (Červinka, 2007).

One of the first briefcase phones was introduced by Livermore, the LAP1000, which was a virtually conventional MTS phone placed in the briefcase. The following LAP-2000 model fully supported the MTS network as well as the IMTS network, thanks to the switch that determined which of the two networks would be used for the call. With the network selected, the dial-up telephone number length was changed to 5 digits for MTS and 7 digits for IMTS. These briefcases were manufactured in small quantities and cost about $ 3,000 on average (Dlugoš, 2017, p. 14). Figure 4 shows an example of a briefcase mobile phone.

Fig. 4 The briefcase mobile phone

The market for automobile and briefcase phones began to stagnate slowly in the 1970s, and manufacturers were only innovating the looks and small technical details of their devices. Indeed, it was clear that 0-generation networks could not meet the demand for mobile connectivity due to the inefficient use of the available spectrum. At that time, a cellular network prototype had already been developed in AT&T and mobile phone manufacturers were developing their devices in this direction (Gilbert & Stoll, 2014).

2.2. First generation analog mobile devices and networks

The first generation of mobile networks is typically characterized by analogue networks that support voice services. First-generation networks such as AMPS, NMT450, and TACS use FDMA access technology in which one radio channel is reserved for each user. The main disadvantage of these networks is in the use of the analog signal itself, which cannot cover as much area as the digital signal, furthermore it does not allow higher transmission rates and is susceptible to various types of interference.

Analog mobile phones of the first generation were fitted with a rod antenna, most often a half or quarter wave dipole. The mobile phone antenna for the AMPS US network operating at 850 MHz had to be long for the 176 mm half-dipole and 88 mm for the quarter-wave dipole. Such a long rod antenna was impractical and very prone to manual damage, so it had to be replaced later by a spiral antenna. On the other hand, obtaining a half-polar dipole is better than obtaining with spiral or integrated antennas. Another common type of antenna used in analog mobile phones was the sliding antenna, which was a compromise between spiral and rod antennas. In the retracted position, it had a comparable gain to the spiral, and if the signal quality was insufficient for the users, it had the possibility to extend the antenna and obtain parameters comparable to that of a whip antenna. The retractable, also telescopic antenna, was very mechanically stressed and was therefore a frequent source of disturbances (Krásenský & Klapka, 2010).

DynaTAC a ďalšie mobilné zariadenia vyrobené v 80. a 90. rokoch boli vybavené nikel-kadmiovými batériami, ktoré mali hlavnú nevýhodu v ich hmotnosti a veľkosti. Výhody tohto typu článku boli hlavne schopnosť nabíjať

sa pri vyššom prúde, čo skrátilo čas, počas ktorého sa batéria nabila, a odolnosť voči nízkym teplotám, pri ktorých nestratila svoju kapacitu kvôli teplote. Jednou z hlavných nevýhod tejto batérie je jej pamäťový efekt, ktorý postupom času znižuje plnú kapacitu batérie, až kým nie je potrebné ju vymeniť. Nikel-kadmiové batérie nainštalované v prvých mobilných telefónoch mali problém s prehrievaním starších batérií počas nabíjania, takže počas životnosti mobilného telefónu bolo bežné batériu niekoľkokrát vymeniť (Krásenský & Skopal, 2008).

In 1973, Martin Cooper led Motorola's engineer team to create the first mobile phone prototype. It was not officially introduced until 1984 due to the ongoing construction of the AMPS network infrastructure. The DynaTAC series was the first series of mobile phones capable of working on the AMPS network. DynaTAC 8000X was the first phone in this series with a height of 25 centimeters and a weight of less than 800 g, was fitted with the same type of battery as those used in briefcases, but thanks to more advanced and less energy-intensive circuits, this battery was several times smaller. The charging time was 10 hours and it was possible to call for 30 minutes. It was fitted with a one-line seven-digit LED display that displayed the dialed number. At the time of its entry into the market, the purchase price was $ 3,995, which is about $ 10,000 compared to today's prices, so this device was a symbol of luxury and wealth. Figure 5 shows a 1st generation mobile phone.

Fig. 5 The first generation of mobile phone DybaTAC 8000x

The DynaTAC 8000X allows you to store up to 30 numbers on internal ROM memory. As one of the first phones to have a device lock feature, it ensured that it was only after entering a three-digit code to receive a call or dial a number (Lacko, 2014).

If Motorola dominated the US mobile phone market, in Europe it was MOBIRO, later known as Nokia. The company introduced several analog mobile devices working on the NMT450 network, such as the MOBIRO Senator, which has been on sale since 1982. In 1985, the company introduced the device as MOBIRO Talkman. This phone, weighing 4.5 kilograms, was not quite pocket-sized, but featured a very advanced technology. In 1987, the MOBIRO Cityman 900 was introduced, reminiscent of the Motorola MicroTAC 9800X, in terms of functionality and functionality in all aspects, just in adapting to the NMT900 network (IOS Developer Library, 2012).

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2.3. Second generation network (2G) and GSM

2G stands for 2nd Generation Wireless Phone Technology. 2G services are often referred to as Personal Communications Service (PCS) in the US.

Examples of standards that use 2G networks are:

- GSM – A European system that is used almost worldwide,
- IS-136 or D-AMPS – used in America
- IS-95 or cdmaOne – used in America and some Asian countries.

Second generation networks differ from their predecessors primarily in their full support for digital communications. Initially, these systems carried exclusively voice, but subsequently data services were added. Compared to the first-generation system, the second-generation networks have, in particular, higher network capacity, digital modulation, which has dramatically improved call quality and, last but not least, the implementation of digital coding and improved eavesdropping resistance. Second-generation systems already use the FDMA/TDMA access technique, which allows multiple users to share a single channel, with each subscriber being separated by a so-called "single channel" approach „timeslots". As the first GSM network was established in 1992 German D2. The result of this development is a safer system, allowing automatic localization, automatic call transfer. A new option was also the transfer of data with a basic rate of 9.6 kbps. The dimensions of infrastructure and terminal equipment have been several times smaller than in the previous generation, and the weight and energy consumption of terminal equipment has also been reduced (Meier, 2012).

2.4. Global System for Mobile Communication - GSM

The development of GSM, which belongs to the second generation of mobile networks, began in 1982, when the Conference of European Post and Telecommunications Administration - CEPT (Group of European Posts and Telegraphs) formed a research group Groupe Special Mobile (the first name for GSM). The Group conducted a study and subsequent development of the trans-European public cellular system in the 900 MHz

frequency band. The criteria for the required system were: good subjective speech quality, low end-user and service pricing, international roaming support, mini-handheld end-user capability, enhanced service support (SMS, regional news, etc.). The chronological sequence of GSM development is shown in Table 1

Table 1. The chronological development of GSM

Year	Event
1986	The GSM Development Group was established
1987	basic proposals were set for a separate network
1989	the GSM system was introduced at the conference of the European Telecommunications Standardization Institute ETSI
1991	the first GSM test network called Telekom 91 started operation

Therefore, European mobile phone manufacturers have redirected their evolution towards digital GSM mobile phones. (IOS Developer Library, 2012).

According to the initial specifications, the GSM network should support the following specifications:

- quality transmission of human speech,
- Digital ISDN compatible network
- maximizing network capacity in the frequency band,
- international compatibility and roaming support,
- support of modern services - ISDN,
- low cost of mobile stations and services
- the possibility of minimizing mobile devices,
- minimizing power consumption - battery power.

The cooperation of 26 European telecommunications companies has slowed this development considerably. The demand for GSM-based operating resources has become urgent, and the solution was to divide the standardization process into stages that leave us a legacy today in the form of the three phases of GSM development. These are phases 1, 2 and 2+.

In the first phase, the GSM system provided basic services such as voice transmission, related call barring and call forwarding, voicemail and international roaming. An entirely new feature was the introduction of the SMS service, which was originally intended to transmit messages along signaling routes for the purpose of managing telephone traffic. Therefore, it was necessary to limit the message length to 128 bytes in order to seal the message into a dedicated signaling message space. Later, the size of the SMS was increased to 160 7-bit characters. In 1991, the addition of new services was stopped to allow operators to adapt the space of their existing network to requirements.

In early 1994, the second phase of GSM was introduced, in which the main and key data transfer service was added. This was limited to 9.6 kbps. This phase also brought in particular ancillary services, such as holding a call or informing the user of the next waiting on the line. These specifications were suspended in 1995.

The last phase 2+ was introduced in 1996 and brought a doubling of the number of phone calls on one channel. However, the main improvements were in core services. With the increasing number of GSM network options such as Internet browsing, it became clear that a 9.6 kbps bandwidth limitation would not be sufficient for the data channel. Therefore, the HSCSD (High Speed Circuit Switched Data) method was introduced, which allowed the combination of up to eight time slots. That is, the transfer rate can be increased to 76.8 kbps for a single channel, but in practice the transfer rate is limited to 64 kbps, which is the maximum ISDN channel rate. SIM card services have also recently been expanded (Meier, 2012).

2.5. Generation 2,5 (2,5G)

The 2.5 generation is not a symbol of major breakthroughs, as was the case with 2G. The existing network was primarily focused on voice transmission and related voice services. Circuit switching technology has proven to be an insufficient standard for data transmission in practice, and development has therefore focused on the implementation of packet switching technologies.

The two most important networks are:

- General Packet Radio Service - GPRS
- Enhanced data rates for GSM Evolitation – EDGE.

These networks allow faster data transfer and serve as an intermediate stage for 3rd generation.

Until the advent of GPRS technology, mobile data was transmitted similarly to voice data, either with CSD technology or with a newer HSCSD. Mobile operators usually charged the cost of data services by connection time instead of by the amount of data transferred. This changed in 1998, when a new GPRS technology appeared on the market. It now uses packet interconnection to transmit data that can be unconnected or linked. During a linked data transfer, a communication session or temporary connection must be established, and the data is checked to see if it came in the same order as it was transmitted. The opposite is unconnected transmission, which does not check the correctness of the data. The bit rate is not constant, but depends on the signal quality and the number of services used. In total, up to 8 timeslots can be used. In practice, a maximum of 4 timeslots are used for data transmission, so the real data rate is limited to 85.6 kbps (Meier, 2012).

Since its inception, GSM technology has been improved several times with new systems and standards, the number of subscribers has increased and the transmission speed has increased. However, the existing specifications no longer allowed further development towards faster data transfer. The number of timeslots per frame could no longer be increased to match the effort. HSCSD already uses the method of merging individual timeslots, and efficient use of free channels is implemented in GPRS technology. Progress has therefore moved in a different direction, towards a change in modulation (Meier, 2012).

Although the official launch of the GSM network was in Finland in 1991, the first commercially available

GSM mobile phone was manufactured in workshops by the English company Orbitel and was called Orbitel 901. Although this model would be fully digital, its dimensions have increased again compared to analog predecessors. This was due to the size of the newly used digital components such as modulators and digital converters. This model is not only the first GSM mobile phone, but also the first device to receive an SMS message. It was sent in December 1992 (European Commission, 2006). Figure 6 shows the first commercially available GSM phone from Motorola.

Fig. 6 The first commercially available GSM phone

The first GSM phone that could already be stored in the pocket of the trousers was manufactured by Nokia in November 1992, bearing the designation Nokia 1011, thus beginning the era of dominance of the mobile phone market by Nokia. This model had a black and white two-line display and a sliding antenna. With more advanced, less energy-intensive digital chips and a 900mAh battery, this model has an operating time of up to 12 hours (Pittner, 2015). Figure 7 shows the first handheld mobile phone from NOKIA.

Fig. 7 The first handled phone

After the transition to the new millennium, the whole world already knew how strong and prosperous the mobile phone market was. Only the Nokia 3210 and 3310 models, which were in demand due to their practical design, have sold over 300 million units. With increasing competitors, there was nothing else left for the manufacturers but to force the customer to buy with brand new technologies. Table 2 shows the most significant advances in the 2.5 generation of mobile devices after 2000.

Table 2. Functionalities of mobile phone after 2000

Company	Model	Functionalities
IBM	IBM Simon	touchscreen
NOKIA	NOKIA 9000 Comunicator	reading and sending e-mails and faxes; the Internet
Ericsson	Ericsson T36	Bluetooth
Sharp	Sharp J-SH04	integrated camera
Samsung	Samsung SPH-M100	mp3 player
Sharp	Sharp SH251iS	LCD 3D display
Motorola	Motorola Razer V3	tilting display
Nokia	Nokia N92	DVB-H broadcasting

The development of mobile devices after 2000 has progressed by leaps and bounds.

2.6. Third generation devices and networks

Services related to this generation means the ability to transmit voice (phone call) as well as data (downloaded data, e-mails, messages). Japan was the first country to introduce a third generation of mobile phones. In 2005, 40% of mobile phone users in Japan used third-generation mobile phones. The main service used is not video calls, as expected, but music downloads. Third-generation mobile networks are designed for devices such as PDAs and mobile phones.

Unlike the 2nd generation systems, which used the TDMA method for the vast majority, UMTS uses CDMA multiple code multiplexing. It enables voice and data transmission in parallel, supports VoIP, and redefines Quality of Service (QoS) to optimize network utilization. It defines four QoS service quality classes, which are characterized in terms of transmission rate, packet size, transmission priority or transmission delay (Meier, 2012).

The UMTS standard is based on Wideband CDMA (CDMA) broadband system technology, used mainly in countries with developed GSM networks. The transfer rate of this technology can reach 384 kbps. This standard can provide services that require the so-called always connected apps. UMTS is managed by 3GPP, which is also responsible for GSM, GPRS and EDGE standards (Hordějčuk, 2011).

2.7. The origins of applications in mobile phones

The opportunities brought by mobile phones capable of using the UMTS data network, and thus playing online multimedia and efficient use of WWW services, were reflected mainly in the increasing size of displays. While the phone's hardware keypad capable of sliding beneath the display allowed manufacturers to install several inch displays on their devices, these mobile devices were

generally wider. The second option was to place the keyboard under the display, which meant an uncompressed width and height of such a device.

In 2007, the Apple iPhone was introduced at Macworld, the first modern phone to completely remove the hardware keyboard and replace it with a 3.5-inch capacitive display. Although this phone worked on the iOS operating system, it did not fully meet the specifications of the "smartphone" because at the time of introducing this device, the user had no opportunity to install third-party applications. However, thanks to Apple's marketing genius, this model has become a very successful device despite GPRS Internet access, limiting the data rate to 56 kbps. Thanks to Iphone, for the first time the user had the opportunity to operate the system with an intuitive graphical interface only by touch.

Competing devices like the Nokia N95 offered better specification, but simplicity seemed more desirable among users than performance (Štalmach, 2013). Figure 8 shows Apple's first iPhone.

Fig. 8 iPhone by Apple

The development of applications for mobile platforms was still very limited at the time of iOS. Neither BlackBerry OS nor Symbian OS had their own platform for distributing third-party applications. In the case of Symbian OS, the development of GUI (Graphic User Interface) platforms for devices of different manufacturers was an obstacle for developers. Symbian was only the core of the operating system, with each phone manufacturer using its graphical superstructure. Sony Ericsson and Motorola used the UIQ platform, while Nokia used the S60 platform and NTT DoCoMo had its MOAP. This inconsistent solution resulted in the application developed for the Nokia phone not being compatible with a Motorola device, although both phones had the same version of Symbian. With the advent of iOS and the introduction of a new opensource development platform for Apple devices, the number of developers has grown sharply, and Apple introduced its 2008 Appstore, the application distribution platform. The first device to install from a database of more than hundreds of applications was the iPhone 3G (Varga, 2014).

Google immediately responded to this new trend, working with other 33 companies like Samsung and HTC to introduce the Android operating system. It was designed as an open source multiplatform for use on devices from several manufacturers. One week after Android was released, the SDK 1.0 for developers was released. Today, Android is the market leader in operating systems with more than 65% market share, the second is iOS with 30% market share. (Štalmach 2013)

2.8. The fourth generation of mobile networks

This generation focuses primarily on multimedia, ensuring fast data rates for the most demanding multimedia applications, HD mobile TV or online gaming. However, the high-speed bit rate of hundreds of Mbps carries one major drawback, namely the large power consumption, which can be up to ten times greater than HSPA +. Representatives of the 4th generation networks are for example LTE-A, 802.16 or WiMAX mobile.

3. News and current trends in mobile devices

At present, the visual pages of individual mobile devices are very similar, and the ordinary user is not even able to detect technological differences between several manufacturers at the first moment. For a certain amount of money in a specified price range, the user can obtain virtually the same performance device with minor differences caused by different manufacturers. The decisive factor for the user is the workmanship, appearance and operating system. Figure 9 shows a prototype of a first wearable phone.

Fig 9 The first warable phone

In the near future, new and mobile devices will promote larger and larger display areas compared to the phone body. In many types of phones, the hardware button has even been removed, increasing the ratio.

The future trent in imaging technology will undoubtedly be the installation of flexible OLED displays either on conventional phone bodies or on highly bendable platforms that will make it possible to bend to form a bracelet (Tengler, 2018).

Operating systems in mobile phones, be it Android or iOS, still offer only a fraction of the functionality of computer operating systems. This is due to the superfluous implementation of these functions in devices where, due to the small display and the lack of a full keyboard and mouse, it is not possible to carry out a classic office administrative activity. Manufacturers respond to this by supplying special docking stations that, when connected to

a phone, redirect the image to a connected monitor, and the user can use a mobile phone as a desktop computer via a graphical interface (Pittner, 2015).

Conclusions

The world of mobile technology is now at a very high level. Thanks to the ingenuity and hard work of mobile phone companies, they are now affecting every sector of the company. Mobile phones have undergone a long and demanding development, the knowledge of which enables us to learn from mistakes and face the new challenges that the mobile phone and device market faces every day.

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