

## Technologies Shaping the Digital Transformation

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### Introduction

Anything that can be expressed in a binary number system can be called digital. In this system, the operations that can be done through 0 and 1 are expanded and the borders are removed. By expanding the scope, the data can be easily reproduced and transferred at a cost close to zero without any distance limit (Acungil, 2018). The process of transferring a job, resources, or service to the digital environment is defined as digitalization. With digitalization, the speed of access to information has been significantly increased by compacting information into small spaces and making it portable (Aksu, 2018). Music, books, photos, money, etc. in various fields. The concept of digitalization, which emerges with the change of different components, brings with it various technologies.

The concept of “digitalization” has been explained above. Digital literacy, on the other hand, can be defined as the ability to use digital technologies in the digitalizing world, to access information with the help of digital technologies, to test the accuracy of the accessed information, and to use the accessed information correctly. These aforementioned capabilities enable users to communicate in different ways while facilitating learning. Digital literacy enables users to access information quickly, regardless of time and place.

With the introduction of the concept of digitalization into our lives, various concepts in the social context have been developed and brought to the literature. In recent years, with the development of technology, there have been differences between generations, and concepts such as digital natives, digital immigrants, and digital hybrids have been developed to reveal these differences.

Individuals who can easily use information and communication technologies and adapt to new technologies are called digital natives (Prensky, 2001 as cited in Karabulut, 2015). Five different aims of digital natives in using technology are mentioned (Waycott et al., 2010). These purposes were conveyed as personal interest, social communication, daily use, professional work, and course homework. Individuals who try to adapt to in-

formation and communication technologies are called digital immigrants, unlike digital natives, whose tools, technology, and speed of access to information have developed and gained an advantage. The study of Prensky (2005) can be given as an example to reveal the difference in the use of resources between digital natives and digital immigrants. As reported by Prensky (2005), while digital immigrants refer to the user manual before starting to use a new tool device digital natives prefer to discover and learn on their own (Bilgic et al., 2011). Similarly, while digital immigrants use physical libraries to access information, it is emphasized that digital natives receive support from social media applications and forum sites where information is shared rather than physical libraries (Tonta, 2009).

Digital transformation, which includes the concepts of digitalization and digital literacy, is a holistic transformation in people, technology, and business processes to increase service quality, reduce workload and ensure customer satisfaction in organizations in line with technology and needs (Aksu, 2019). With the invention of the Internet, in addition to money, music, books, and newspapers that affect our daily life, the digitalization process has begun in organizations and businesses. This digitalization process has made the digital transformation of people, technology, and business processes inevitable with the development of information technologies.

## Technologies

### Virtual Reality and Augmented Reality

Virtual Reality (VR), which is transferred as a simulation model, is the platform where the feeling of reality is created with the dynamic communication environment created through various devices (Primental & Teixeira, 1993). These platforms, which first emerged in the game and entertainment sector, are used in various simulations in the field of education, in virtual markets in the field of marketing, and in various applications where the field of view is controlled in the manufacturing sector (Bayraktar & Kaleli, 2007). In applications based on VR technology, users are cut off from real life and an abstract environment is presented. Unlike this abstract environment, virtual objects and images are added to real-life images in augmented reality applications (Icten & Gungor, 2017).

In 1995, VR glasses called Virtual Boy were started to be used in the entertainment industry by Nintendo Company. It is stated that this product developed by Nintendo Company for its game consoles is the pioneer of the studies. In the following years, the scope of personal experiences was expanded with the development of Head Mounted Displays. Smartphone users are offered different experiences with the Gear glasses developed by the Samsung Company. With the various sensors used in these glasses, the ambient sounds change along with the images. An abstract environment is presented with images and sounds that vary depending on the user's head movements (Ferhat, 2016).

It is stated that the idea of augmented reality, which consists of components included in real life, unlike virtual reality applications, dates back hundreds of years. (Ozarlan, 2015). However, the term VR was first coined by Thomas Caudell and David Mizell. (Altinpulluk & Kesim, 2015). It is aimed to guide the workers in the cable connections with the digital imager developed for the Boeing Company. This image, which is used in production and engineering processes, has also been used in the training of workers (Thomas & David, 1992). One of the areas where augmented reality technology is first

used in the military field. The flight data was displayed with transparent screens integrated into the pilots' helmets (Livingston et al., 2011).

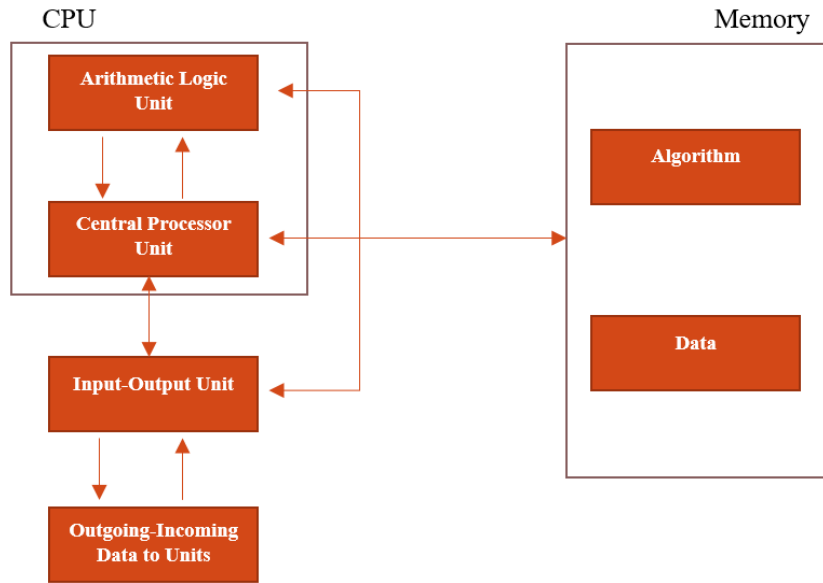
Wearable technologies, simulations, computers, and cameras form the basis of augmented reality applications. In the following years, augmented reality applications have differentiated with the development of mobile devices and software with the internet (Altınpulluk & Kesim, 2015). Today, in addition to military applications, it is used in various fields such as education, entertainment, and marketing. Within the scope of Digital Transformation, the effectiveness and efficiency of augmented reality applications are increased with the studies carried out in the field of Human-Computer Interaction, especially with the transformations in processes and technologies.

### Artificial Intelligence

Artificial Intelligence (AI), a branch of computer science, deals with transferring the characteristics of intelligent living things to systems and devices. The characteristics of intelligent creatures are generally based on their thinking and behavior. Studies based on transferring rational behavior and thoughts to systems can be called AI (Winston, 1991).

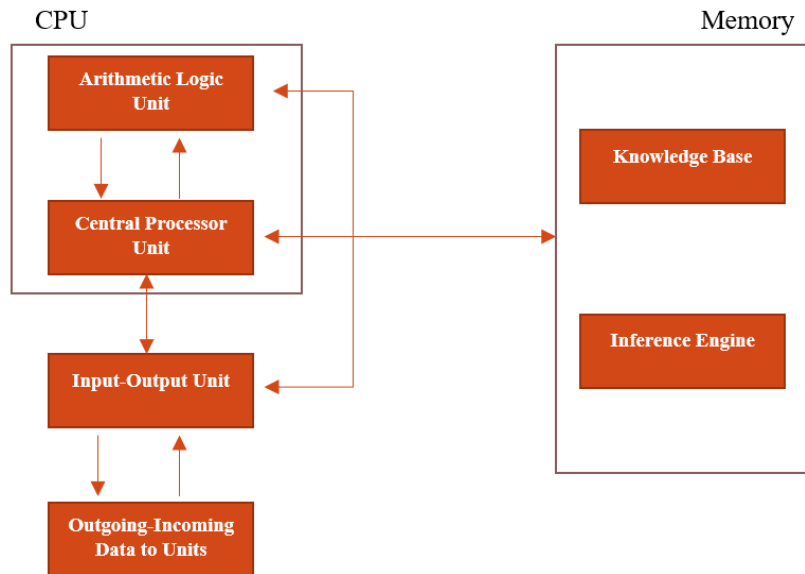
It is stated that AI studies started with the Turing test developed by Alan Turing in 1950 (Tas & Mert, 2019). In the Turing test, various questions were asked and the answerer's state of being a machine or a human being was mentioned (Turing, 1950). The Turing method is based on data storage, unlike the first computers produced to solve a specific problem. This process has become the basic approach of computers in the following process. This situation, which offers the opportunity to store and change data, unlike the function of the first computers, can be considered the beginning of learning or thinking in the computer world (Yavuz, 2019).

Differences can be seen in evaluating research or system within the scope of AI. In this context, deciding whether a system is intelligent or not is based on humane-rational thoughts and behaviors. In addition, adaptability to unexpected situations is the indicator that distinguishes intelligent systems from classical approaches. This difference can be better demonstrated by considering the Classical Computing approach and the Artificial Intelligence-Based Computing approach. In the classical approach, the software has an algorithmic structure and quantitative solutions are produced. In addition, solutions cannot be produced for situations that are not included in the algorithm using a numerically addressed database (Firebought, 1989). The classical information processing of a general-purpose computer is given in Figure 1.



**Figure 1.** Classical Information Processing

Different from the classical computing approach shown in the figure, the way the systems based on the artificial intelligence approach work is given in Figure 2.



**Figure 2.** Artificial Intelligence-Based Computing Approach

As seen in the figure, the main difference between the Artificial Intelligence-Based Approaches from the classical computing approach is the knowledge base and inference engine. Spatial information, which is the basis of the artificial intelligence approach, is presented symbolically. These symbols that represent motion, action, object, or anything are made up of character sets. These character sets also form the knowledge base. A method is also needed to analyze the knowledge base obtained depending on the problem. This method, which is designed to make decisions in line with the information in the knowledge base, refers to the inference engine. It is aimed to reach the result by evaluating by including the external data together with the information in the knowledge base (Frost, 1986).

To solve problems with a certain algorithmic structure, data with certain properties are needed. For this reason, algorithmic techniques may be lacking in solving unpredictable and uncertain problems. The artificial intelligence approach, which has a wide application area, provides benefits in solving problems that are not suitable for a certain algorithmic structure. Today, artificial intelligence techniques are used to solve problems that are encountered in different fields and require adaptation. It is among the technologies that make a great contribution to digital transformation in the context of business processes, commercial activities, and technological developments.

### Data Mining

In order for the data to be processed and converted into information and then information, it must be rendered operable (Davenport & Prusak, *Working Knowledge: How Organizations Manage What They Know*, 1998). These data are especially digital data. Digital data are collections of data that are transmitted, stored, and processed with software in an electronic format. Digital data is stored in the computer environment by converting it to a binary number system (1-0), which is the computer language so that it can be stored on HDD, SSD storage devices. Digital data is produced by a variety of devices such as desktop computers, laptops, tablets, mobile phones, and electronic sensors (Berksoy, 2019).

Big data consists of digital data. However, traditional databases and traditional analysis methods are not enough to manage big data and make it useful and accessible to users (Zikopoulos, 2012). And, as in the characteristics of big data, the data obtained must go through Data Mining applications in order to add value to an organization and provide a benefit to the organization. Today, every job and every action can be the subject of data mining (Toptas, 2021). Data mining is defined by Büncher, Anand, and Hughes as follows; “The discovery of previously unknown, understandable and useful patterns of particular importance in large data sets”. Data mining has the ability to analyze billions of data. The main purpose of data mining is to make predictions for the future by analyzing the change from past to present with the available data (Bastos et al., 2014). For this purpose, different purposes are used in different fields such as education, health services, marketing, banking, production, retail, and insurance (Isik, 2022; Dincoglu, 2022). It has 5 characteristics: size, speed, variety, accuracy, and value.

Knowledge discovery in data mining refers to the discovery of previously unknown useful knowledge. The stage of reaching new information indicates that there are different numbers of steps in each source. As a result of the literature research, it was concluded that knowledge discovery was carried out in 8 steps, namely “Data Selection”, “Data Cleaning”, “Data Integration”, “Data Selection”, “Data Transformation”, “Data Mining”, “Pattern Evaluation” and “Information Presentation”. The result can be deduced. In the knowledge discovery process, 60-80% of the time is spent bringing the data into a format to be used, while the rest is used for data mining.

One of the most important steps of data mining is data preprocessing, which is also involved in knowledge discovery. At this stage, the available data are prepared in a way that is suitable for use, meaningful, and of high quality (Gemici, 2012). As a result of processing with quality data, the error rate decreases, and quality outputs are obtained. Data preprocessing consists of 4 steps.

1. Data Cleaning; It is the phase of minimizing the noise in the data, correcting the inconsistencies in the data set, and detecting and removing the missing data.

2. Data Merge; It is combining data from different sources into a single source.
3. Data Transformation; It is the selection of the data mining model to be used and the conversion of the data set to that model format. Correction, generalization, merging, and normalization operations can be used in the transformation phase.
4. Data Reduction; It is the reduction of the data set in order to obtain effective outputs with data merging, data compression, size reduction, and discrete rendering methods.

In addition to these, certain common methodological steps must be followed before using one of the selected applications in data mining (Isik, 2022);

1. Determining the type of learning
2. Data mining algorithm selection
3. Selection of target variable
4. Data preprocessing
5. Data mining application
6. Analysis of outputs

Models in data mining are divided into predictive (supervised) and descriptive (unsupervised) models. With models, learning can be done with classification according to their functions, association rules, and sorting algorithms. Regression analysis and classification can be given as examples of predictive (supervised) learning, and clustering and association rules can be given as examples of descriptive (unsupervised) learning (Braha, 2001; Savas, et al., 2012).

1. Descriptive Models are the definition of the relationships between the data that affect the decision stage, and clustering and relationship analysis are the basic components (Yildirim, 2019).

1.1. Clustering is the process of breaking up data into different groups and clusters. As a result of fragmentation, subsets or groups that are similar in themselves are formed.

1.2. Association Rule; If there is a secret rule other than the predicted associations between two or more variables, this is the data mining method used to reveal potential relationships (Anane, 2001). The Apriori algorithm is “a method in which many iterative are performed to find frequently occurring item sets” (Isik, 2022).

2. Predictive Models, “is aimed to make predictions of datasets with unknown results by developing models from previously known data ‘’ (Dincoglu, 2022).

2.1. Regression Analysis; reveals the relationship between the dependent variable and the independent variables in a fixed data set (Freedman, 2009).

2.2. Linear Regression: It is a linear approach that shows the relationship between a dependent output variable and one or more independent input variables. It is the most basic algorithm used for estimation (Freedman, 2009).

2.3. Decision Trees; It is used to predict output variables based on different input variables. It can also match nonlinear models very well (Beser, 2018).

2.4. Regression trees; It was formed by incorporating decision tree algorithms into regression models. It is designed to estimate functions that always have values instead of using classification methods on data (Isik, 2022).

2.5. CHAID and the Comprehensive CHAID Algorithm; this algorithm is based on the chi-square statistic and gives a probability value between 0-1. When two classes with a chi-square value close to 0 are compared, it is concluded that there is a significant difference, while it will be concluded that there is no significant difference between two classes with a value of close to 1 (Ramzai, 2020).

2.6. CART Algorithm; there are two important factors when the tree is branching; Purity and balance. While purity is determined by the Gini index.

## Big Data

The Internet of Things (IoT), which has entered our lives with the development of sensor technology, was first mentioned in 1999. It is defined as the set of devices that communicate with each other using a specific protocol. Today, it is used in many areas, from smart city construction to small household appliances in our homes, from bracelets on our arms to military equipment. Smart devices that collect data in their environment, process it themselves when needed, and transfer it to another device are called Things. Most Things do not require human interaction to perform their functions. They communicate with other Things and exchange data with the information they receive from each other. In the advanced technology world, we exist in, change is progressing at a speed that cannot be kept up. While taking this speed on the path of technological change, it leaves behind collections of real crumbs that will contribute to the change of the whole world (Berksoy, 2019). A collection of real scraps is data, which is simply the rawest form of information. Data are facts in different forms that do not make sense on their own (Krishnan, 2013); facts in an individual's mind, photographs, drawings, and a table of survey results collected for a study, a printout of results (Pala, 2021). These data, which do not make any sense on their own, are extremely important to ensure the survival of an organization. Data traffic has grown at an unprecedented rate globally over the last 10 years as organizations become dependent on data in the 21st century (Deepa, et al., 2022).

The most basic data is structured and unstructured data, and there is also semi-structured data. Structured data is relatively more organized, readable, predictable, combinable, and can be analyzed with simple methods, queried, transformed into information using algorithms, and visualized data compared to unstructured data (Inmon & Linstedh, 2015). Structured data are data types that have multidimensional matrices but have regular forms, unlike unstructured data. Experts think that structured data covers 10% to 20% of the world's data (Hurwitz, et al., 2013). Unstructured data represents the opposite of structured data properties. They are irregular, unpredictable, unreadable, large, messy, and unrelated data types that cannot be represented by traditional table forms. And unstructured data have very different properties from each other (Pala, 2021). Considering the estimations in the literature, it grows 10-50 times faster than structured data (Simon, 2014). Semi-structured data, on the other hand, are some regular and some irregular data. An example of this is the survey data, the demographic part of the survey, namely date of birth, education level, etc. While the data is organized, the address or qualitative question data in the questionnaire are examples of unstructured data.

Unstructured data also represents a large part of what is called Big Data in the literature. 80% and 90% of big data consist of unstructured or semi-structured data (Gantz & Reinsel, 2011). Today, businesses direct their organizations by analyzing high-volume data in petabytes, exabytes, or zettabytes, not with data that would fit in a spreadsheet, database table, Gigabyte, or Terabyte. These data are called Big Data in the literature.

According to one source, the concept of big data was first used in the literature by John Mashey – Chief Scientist at Silicon Graphics in the early 1990s to reference the analysis and processing of large data sets (Ohlhorst, 2013). According to another source, the term Big data was named “Application-Controlled Demand Paging for Out-of-Core Visualization” presented by Michael Cox and David Ellsworth at the 8th IEEE Imaging Conference (Proceedings of the 8th Conference on Visualization) in 1997. There are rumors that it was used in the study (Cox & Ellsworth, 1997). Based on these sources and data, it is not possible to say in what time period big data emerged in real terms. While the data was at a size that could be entered manually at first, with the development of technology, these data, which needed petabytes, exabytes, and zettabytes for storage, began to be collected by various tools and ways. While big data was first collected by smart factories, smart cities, and smartphones, each individual has become a data source with the widespread use of social media.

However, the data sources that make up big data also vary. If we summarize them; In structured data, created by machines; human-generated data while sensor data, Web (Log) log data, point-of-sale data, and Financial Data; input data, Clickstream data, and game-related data. In unstructured data, machine-generated; human-generated data, while apparition images, scientific data, digital surveillance and sensor data; text files, email, social media, website, mobile data, communication, media, and business applications (Tykheev, 2018; Mohieldin, 2022). Providing data from various tools and sources has led to the formation of irregular and diverse data stacks.

Based on the diversity of data sources, it is seen that big data is data in extremely different forms and it is not possible to define this technology with a single accepted definition. Because big data itself is irregular and messy in terms of structure and features, big data could not be fully expressed in definitions. Therefore, there are many different definitions in the literature. Some of them are as follows; According to Manyika et al. (2011), big data dimensions are data sets beyond the ability of standard database software tools to acquire, store, parse and analyze information. Havens et al. (2012) briefly defined it as data of a size that we cannot load into the working memory of our computer. According to Wash (2013), it is the process of applying heavy computing power and the latest machine learning techniques to extremely large and often complex information sets. According to Kaur and Sood (2017), it is defined as a large variety of structured or unstructured data stacks with a volume too high for even state-of-the-art data processing platforms to handle. According to Davis (2014), big data consists of large data collections (large volumes) that are updated rapidly and frequently (high speed) and display many different formats and content (wide variety). Based on these definitions, big data can be defined as follows; Big Data is data stacks that cannot fit in traditional databases and spreadsheets, are in different forms that cannot be analyzed with traditional analysis methods, have an extremely fast refresh rate, and extremely diverse data sources.

Considering the definitions of big data, it is determined that these three features, namely Speed, Volume, and Diversity, are frequently emphasized. In the literature, these three features that make big data different from other data draw attention. The first three dimensions used in the literature to characterize big data were named 3V (Speed, Volume, Diversity), and it was claimed that they became the basic dimensions of big data and were first presented by Laney in 2001 and by Ylijoki and Porras (2016). Later, these three dimensions were insufficient to characterize and describe the complex and dispersed structure of big data, and the number of new dimensions increased rapidly. Later, the Accuracy dimension was added by D. Snow (2012), the Value dimension was added



by Gamble and Goble (2011), the Variability and Visualization dimensions were added by Seldon and Currie (2017) and the dimensions were considered as 7 Dimensions (7V). These dimensions mean:

**Volume;** It refers to the size of the data collected from various sources and converged at a single point.

**Speed;** It refers to the speed of data collection, transmission, and analysis.

**Variation;** It expresses the richness and diversity in the data structure (Gupta & George, 2016). That is, it consists of various unstructured and semi-structured data such as text, audio, video, geolocation, and internet data (clicks and log files) (Minelli et al., 2012; Mohanty, et al., 2015).

**Truth;** It is about big data being reliable, valid, accessible, consistent, meaningful, and transparent.

**Value;** It expresses the benefit that the big data set adds to the organization as a result of data analysis processes (Kusat, 2020). It can also be called obtaining the expected competitive advantage of the information obtained as a result of the analysis of the large data set (Pala, 2021).

**Variability;** It means the change of the information/meaning extracted from the data according to the purpose and limit of the analysis. In other words, it refers to constantly changing data (Mohieldin, 2022).

**Visualization;** It turns the result obtained as a result of large data set analysis into representative images that the end user will understand and deals with insights (Kusat, 2020).

The data with these 7 characteristics allows organizations to obtain future inferences and information about their operations, customers, and suppliers (Ebner, Buhnen, & Urbach, 2014), course suggestions to students by the analysis of their data, and suggestions for which courses to be opened for the next semesters (Ebner, et al., 2014). Desai, (2018) is used in various fields because it provides contributions. These areas can be listed as follows; Healthcare, Finance, Education, Telecom Sector, Food Industry, Retail Sector, Government Sector, Manufacturing, Business, and Marketing (Mohieldin, 2022; Mukherjee & Shaw, 2016; Desai, 2018; Manyika, et al., 2011).

Like every new technology, it offers advantages and disadvantages to big data usage areas. Before starting to benefit from this technology, the purpose and the expected benefit from the outputs obtained at the end of the use of this technology should be determined. Because, like every infrastructure technology, this technology has positive and negative sides (Davenport, Big Data at Work, 2014). If we list the advantages and disadvantages that the organization will provide in the use of big data, it can be summarized as follows (Toptas, 2021);

**Table 1.** Advantages and Disadvantages that the Organization will provide in the use of Big Data

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Cost savings</li> <li>• Time-saving</li> <li>• Developing new service/product tactics, offers</li> <li>• Supporting business decisions</li> <li>• To accelerate the decision processes.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of “data analysts” who can keep up with technology “real-time”, the need for rapid analysis of data</li> <li>• Data synchronization and lack of models, Rapid data refresh, and fast data flow</li> <li>• The security dimension of Big Data</li> <li>• Data privacy</li> <li>• Privacy of data</li> </ul>

It can be listed up to this part of the article, data, structured data, unstructured data, semi-structured data, big data, big data sources, big data definitions, big data features, big data usage areas, advantages, and disadvantages are explained. After this section, how to store and analyze these stored data will be mentioned.

### Digital Media

With the emergence of internet technology and the rapid development of communication technology in the 21st century, unimaginable new communication and interaction environments have entered the lives of individuals. Many concepts such as social media, digital media, and social networking have been included in the literature. These concepts have become an indispensable part of the lives of individuals in today’s century and have caused changes in sociological, economic, and cultural fields.

LevManovich traces the emergence of the concept of new media to the 19th century. This process continues from the invention of Louis Daguerre's “daguerreotype” and Charles Babbage’s “analytical machine” to the development of modern digital computers (Baslar, 2013). While the development in computer technology started with the invention of the analytical machine, it has been witnessed that moving images, text, and sound are stored using different formats in media technologies with “daguerreotype”. With the combination of the development of these two inventions and the transformation of existing media into data, new media has emerged. At the same time, it has developed and brought concepts such as digital media and social media.

The concept of digital media is used to indicate that traditional media is a digital form. Digital media has high speed, interaction, and simultaneous communication features. Digital media, which has these features, offers individuals the opportunity to access, disseminate and communicate interactively, regardless of place and time (Demirel, 2018). In this case, digital media, as a large-scale communication revolution, introduced individuals to communication environments and communication types that they could not imagine. There have been many studies that distinguish digital media from traditional media. The common features extracted from these studies are as follows (Demirel, 2018; Van Dijk, 2016);

- Modularity
- Hypertext
- Interactivity
- Digitality

In summary, digital media has strengths such as sharpness, geographic reach, selectivity, storage capacity, and speed. Violation of privacy is the weakest feature of digital media (Van Dijk, 2016). Digital media has become indispensable for the societies we live in and is divided into platforms with different features under the concept of social media. The distribution of users in the social media platform generally determines the age and which platform the peers choose (Tas, 2019). With the development of digital media, the social media platforms developed are as follows;

Facebook; It is a platform that offers individuals the opportunity to share resources in different structures such as emotions, thoughts, memories, videos, and pictures (Tas, 2019).

Twitter; It is an application that allows individuals to share their feelings and thoughts by limiting them to 140 characters. Picture, video, etc. It can be shared in data, but the purpose of its emergence is text sharing.

Instagram; It is a social media platform founded on photo and video sharing of individuals.

Snapchat; It is an instant photo and video sharing platform. It disappears after the specified time or the specified number of views in the sent contacts. And it is stated by snapchat that these videos and photos are not stored.

YouTube; It is a social media platform founded on video sharing.

Websites; The first websites emerged 20 years ago (Erden Uzun, 2022). Web sites have recently been used frequently by organizations. It can be seen that almost every brand on any platform has a website. The reason for this is that the website offers the user the opportunity to express himself, express his corporate identity, vision, and mission more. In general, the websites of the institutions; It has been observed that it is used for purposes such as “presenting elements containing corporate identity, establishing two-way communication, making announcements, giving information, providing the opportunity to apply for a job, posting job advertisements, announcing human resources policies” (Oksuz, 2011).

These developments in the field of digital media have attracted individuals' communication channels to social media platforms. The intention of each individual to continue social media has caused them to keep active on social media and has made social media an indispensable field. However, it causes changes in marketing strategies for organizations. It offered the organization owners the opportunity to observe their customers more closely through social media. It offers customers a wide variety of options for shopping. Therefore, with the concept of fashion, individuals are affected by each other and cause uniformity in clothing. Along with this, new occupational groups have emerged with digital media. Social media, which affects every field, can be said to be one of the most important factors that trigger the changes we experience today.

### [The Internet of Things \(IoT\)](#)

The Internet of Things (IoT), which has entered our lives with the development of sensor technology, was first mentioned in 1999. It is defined as the set of devices that communicate with each other using a specific protocol. Today, it is used in many areas, from smart city construction to small household appliances in our homes, from bracelets on our arms to military equipment. Smart devices that collect data in their environment, process it themselves when needed, and transfer it to another device are called Things. Most

Things do not require human interaction to perform their functions. They communicate with other Things and exchange data with the information they receive from each other.

The Internet of Things ecosystem consists of four components. The Things Component, which refers to devices that are connected to the Internet, has sensors that provide data from the environment and a controller that sends the data to another device in the environment or to the cloud. The second component is called the Data Component. The data component is divided into two categories: Raw data and structured data. Raw data is unstructured data. In order to be used in the analysis and decision-making phase, it must be processed and displayed in a computer environment. The data that goes through all these processes is called structured data. The component that enables the transfer of data between devices or to the cloud is the Communication Component. Large amounts of data collected by things need to be processed to make it usable by humans. The fourth component, called the Human Component, enables data to be made meaningful through M2M (machine-to-machine), M2P (machine-to-human), or P2P (human-to-human) interactions.

The Internet of Things makes it possible to run ordinary processes automatically. It helps control processes that require more than one operation due to the connection of things (inventory management, transportation tracking, parts management, etc.). Processing the large amount of data collected helps companies develop business strategies, marketing, and promotional activities, and set pricing policies. It increases energy efficiency and reduces costs by making machines work more efficiently. Real-time data can also be used to predict faults in machines. The Internet of Things, used in the supply chain, ensures that products are tracked accurately, that action is taken quickly if a product is at risk, and that action is taken. Processing data on product usage will help the manufacturer and designer set the roadmap for new products with user experience in mind.

In today's world, where more than 70 billion devices are expected to be connected to the Internet by 2025, it is important to ensure the security of the Internet of Things, which has a widespread usage environment. Various types of attacks on things and network security threaten the IoT ecosystem. In addition to attacks on things during the maintenance phase, there are also physical attacks that target the software of things or the chip inside them. Communication attacks are carried out in the network environment to intercept the data transmitted by the things. The vulnerabilities in the APIs that things use to communicate with each other can be exploited for attacks. In 2016, passengers traveled without paying because 2000 ticket vending machines were shut down in the attack on San Francisco's transit system. The wide range of uses for the Internet of Things means that a variety of systems can be affected by attacks. The 2003 power outage, for example, caused more than \$6 billion in damage.

Some of the measures that can be taken to protect the Internet of Things from cyber attacks can be listed as follows;

- Device policies must be established. With these policies, the security of the data contained in the device will be ensured by creating the device password security level or device locking methods.
- Although the passwords used are difficult to guess, two-factor authentication should be used.
- By using next-generation firewalls as hardware or software-based network security systems, unauthorized access to the IoT network can be detected and prevented.

- By performing network segmentation, a possible threat that may occur in the network will be kept in a certain section. IoT devices and other IT devices should be separated from each other in the network environment.
- Security measures must be taken at the chip level.
- It is necessary to keep the software contained in Things up to date.
- Data to be transmitted between Things and to the cloud must be secured by cryptographic methods.
- Isolation measures should be implemented to prevent attacks on the software contained in the Things.

### Cybersecurity

Cybersecurity is a discipline that encompasses methods to protect computers, servers, electronic systems, and data from malicious cyber threats. It aims to reduce the risk of cyberattacks on software, computers, and networks. It includes tools for infiltration detection, virus and malicious access defense, mandatory scanning, and encrypted communications (Amoroso, 2006). It is a collection of tools, decisions, security concepts, security measures, policies, risk management approaches, learning processes, and best practices whose goal is to protect the cyber environment and institutional/legal interests (ITU, 2009). It is the state of protection against unauthorized or illegal use of electronic data or a method of taking action to ensure this (Oxford University, 2014). Looking at the definitions, it can be said that the main goal of cybersecurity is to protect against threats that may occur in cyberspace.

With the rise of digital transformation, more and more services are being used by governments, businesses, and legal entities through cyberspace. Any service that is accessible via the Internet is vulnerable to cyberattacks that may come from the outside. This applies not only to corporate servers but also to end-user computers and mobile devices. In the digital environment where all these types of devices are connected, it is important to ensure the reliability of devices and information at the institutional and personal levels.

As a result of the increasing use of information tools, ensuring the security of information and information processing/producing devices is becoming more important every day. In addition to defining cybersecurity, it is important to know the common and different aspects of cybersecurity and information security. Information security ensures the protection of data generated by services and systems from unauthorized access, unauthorized modification, and loss of validity. Cybersecurity and information security both seek to protect data. While cybersecurity provides this protection with its security mechanisms in cyber environments, the environment, and type of access are not important to information security. Moreover, cybersecurity provides protection for data in digital environments, while information security works to protect data in both physical and digital environments.

Actions that damage systems in the cyber environment, disrupt the service process, and affect the reliability of data are perceived as threats. To protect against threats, they must first be identified. While some threats are caused by intentional acts, there may also be threats caused by user error. For example, if the system administrator inadvertently grants access to an unauthorized user, the security of the system and the information it contains is compromised. Cyber threats can be categorized into five levels as their impact

is examined. Hacktivism, the least effective cyber threat, can be defined as the misuse of a system for social or political reasons. Although individuals generally pose a threat, there are also groups that have banded together for the same purpose. Cybercrime, which is a more common threat type than hacktivism, can be defined as murder in a digital environment. Cybercriminals use computers for crimes such as obtaining personal data and malicious information. The use of computer networks by hackers to obtain secret information against countries or specific organizations is referred to as cyber sabotage. Cyber terrorism, another type of cyber threat, is an attack on computer systems, computer programs, and important data that relies on infrastructure and is politically motivated (FBI, 2012). Cyber warfare is the most common attack against a country to disrupt critical systems, including public services, to disrupt services, challenge reliability, and damage the country's reputation.

To appreciate the importance of cybersecurity, one must look at global cyberattacks and the losses they have caused. There were 4,145 publicly disclosed breaches that exposed over 22 billion records in 2021. It was reported that 3 billion Yahoo user accounts were hacked in 2016. In the same year, it was revealed that over 57 million drivers' information stored in UBER company's systems were captured by cyber hackers. In 2017, it was found that 412 million Friendfinder website membership accounts were stolen. At the same time, it was reported that 31% of companies worldwide were affected by cyberattacks at least once in 2017. In the same year, nearly 148 million consumers were affected by a security vulnerability called Equifax. According to Symantec's report, nearly 2400 mobile malware were blocked every day in 2017 (Ulutas, 2018). In 2021 March, 533.000.000 records (phone numbers, full names, locations, email addresses) were lost on Facebook. In 2021 September, 500.000.000 records were lost on Syniverse which is a company that is a critical part of the global telecommunications infrastructure used by AT&T, T-Mobile, Verizon, and several others around the world (McCandless et al., 2022).

Rank	Entity	Sector	Records Compromised
1	Yahoo	Web	3.0B
2	River City Media	Web	1.4B
3	Aadhaar	Government	1.1B
4	First American Corporation	Finance	885M
5	Spambot	Web	711M
6	Linkedin	Web	700M
7	Facebook	Tech	533M
8	Yahoo	Web	500M
9	Marriott International	Retail	500M

**Figure 3.** 10 largest data breaches by the amount of user records stolen from 2004–2021 (Nwosu, 2022)

In today's world, where digital transformation is taking place at the state and corporate level, the processes that are being moved to the cyber environment are increasing day by day. Considering that every service opened in cyberspace contains information that must be protected, it is inevitable to ensure the security of the cyber environment. In recent years, the importance that companies and states attach to cybersecurity and the measures they have taken have become apparent. If you examine job posting websites, you will see that the need for cybersecurity specialists has increased significantly. States, in turn, are making radical policy changes to strengthen their cyber armies and meet the need for cybersecurity experts.

## Blockchain

In relation to the increasing data transfer in the Internet environment, the need for a database to store data is increasing day by day. Controls such as updating data, ensuring its integrity, and access permissions are provided by the database management system. The centrality of the database brings new challenges (maintenance, load balancing, uptime, etc.). The term blockchain was first introduced in 1991 with the use of timestamps to prevent the date of digital documents from being changed. Blockchain technology, for which there were no widespread use cases until 2008, came onto the world's agenda with the cryptocurrency Bitcoin, developed by the user nicknamed Satoshi Nakamoto in 2008. In the most general sense, blockchain can be defined as a protocol that enables the sharing of data in a decentralized, distributed network environment without the need for a central authority.

Blockchain is a distributed database structure consisting of the concatenation of blocks without a central point of control. Blocks are boxes that can store limited data. All data has a timestamp. Users in the distributed network have the task of verifying the data contained in the blocks. The chain structure is created by adding the hash value of the data contained in the block whose capacity is full to the next block. This ensures that the data in the blocks contained in the chain does not change. Since changing the data contained in the block or adding new data changes the hash value of the block, tampering with the data can be easily detected. The data contained in the blocks can differ depending on the type of blockchain. While this information may be money transfers for virtual currencies, it may be customer data or product information, depending on the design.

When building the blockchain network, it can be designed as public/permissionless or private/permissioned. The best example of general networks is Bitcoin and other alt-coins. There are no restrictions or permissions to access such networks. Anyone can track or process the data contained in the blocks of the blockchain network. In private networks, a node of the blockchain must be approved by the authorized organization that owns the network. Such networks are usually controlled by banks, financial institutions, corporations, or the government.

The most important feature of the blockchain network is its transparency. The fact that there is no central database, that the data is accessible to everyone, and that a certain amount of unverified data is not recorded in the ledger (database) maintains the transparency of the blockchain network. In this way, the system cannot be controlled or shut down by a central authority. In addition to the elimination of intermediary institutions, features such as the encryption of data and the use of digital signatures increase the reliability of the system.

Like any new idea, blockchain has its downsides. With a history of 14 years, a relatively new approach, limited areas of use, vulnerabilities, and cases of theft in bitcoin clearing-houses, confidence in the idea of blockchain is being questioned. The lengthy approval procedures for the data contained in the blocks limit the use of blockchain networks in certain areas (finance, trade). The cryptographic algorithms used in the validation of block data consume a lot of energy due to the computational processes required. Another problem is that due to anonymity, the owner of the data contained in the blocks cannot be precisely determined. The fact that the information pointing to the owner of the data consists only of the user name and the real name and identity information cannot be accessed means that the data in the blockchain network cannot be matched with real people.

## Cloud Computing

The 1960s were when the idea of cloud computing first emerged. This idea is a computing paradigm in computing that has evolved to offer computer services. The internet, virtualization, grid computing, web services, etc. all employ this method of computing extensively. It is based on several current technologies, including internet technology adds a new dimension to this service (Mathew, 2012). Numerous studies have been conducted to update the current information infrastructure, especially in the sphere of education, in recent years as educational institutions, universities, and companies have completely contributed to the transformation of society and the global economy.

Despite the increasing importance of cloud computing, several establishments struggle with financing. The ability of cloud computing to update at any time and the instantaneous transmission of transactions to numerous users has given rise to the notion that more money should be spent on web-based cloud systems in information technology. Information technology, as well as many other areas, is particularly damaged by natural disasters, fires, and epidemics. Sectors may not be impacted by such calamities because they use the cloud to conduct their business. But the acquisition of non-public knowledge by hostile actors can lead to a collapse of that company. In this situation, it is necessary to invest in security services, which could result in additional costs. But when you consider everything together, using the cloud to do the work is more favorable in terms of sharing and efficient functioning. In the education sector, as in every other, cloud computing offers a number of benefits. The corporate sector, the public sector, and academics have all decided to work remotely for a period in response to the COVID-19 epidemic, which is a widespread pandemic around the world. Although it was first difficult to offer training on this topic, the issue was quickly resolved with the help of cloud-based tools.

Cloud computing providers offer their services according to four models. Infrastructure service (IaaS) is the most basic, and each rising model leaves fewer jobs for organizations receiving cloud services.

### ***Software as a Service (SaaS)***

Users that utilize Software as a Service (SaaS) have access to apps through any platform connected to the Internet without the need for any installation. Examples of SaaS include Google Docs, Yahoo Mail, ERP, BPM, and CRM software. Because service providers may host applications and data, the end-user can use the service from any location (Bhardwaj et al., 2010).

Key features (IBM, 2021);

- SaaS suppliers provide software and applications to users through a subscription model.
- Users do not need to manage, install, or upgrade software; they are managed by SaaS providers.
- Data is safe in the cloud; equipment failures do not cause data loss.
- The use of resources can be scaled according to service requirements.
- Applications can be accessed from almost anywhere in the world from any internet-connected device.

### ***Infrastructure as a Service (IaaS)***

The operating system layer is where the company's management obligation begins, and



the provider is in charge of ensuring the dependability and availability of the infrastructure it offers. This paradigm could be useful in some usage circumstances. The Infrastructure-as-a-Service concept appeals to businesses without their own data center as a quick and affordable infrastructure alternative for projects that may be expanded or canceled as necessary (Barabba, 2021). Examples of traditional businesses that use infrastructure as a service well include those that require IT power to manage varied workloads with reduced capital expenses. Companies only pay for the services they utilize in both situations (Barabba, 2021).

Key features (IBM, 2021):

- Users pay for the Infrastructure Offered as a Service to their needs rather than buying hardware.
- The infrastructure may be built up to meet the needs for processing and storage.
- Saves businesses from having to pay for and maintain their own equipment.
- There is not a single point of mistake because the data is on the cloud.
- Management activities can be virtualized to free up time for other jobs.

#### ***Platform as a Service (PaaS)***

The platform of IAAS is what is intended for more sophisticated and feature-rich targets. PaaS, or platform as a service, is a type of cloud computing service model that gives hardware and software resources to application developers online so they may work on their projects. Servers, storage, network, and PaaS infrastructure (along with development tools, business intelligence services, database administration, system administration, and security solutions) are all examples of the latter. Users that utilize PaaS have access to a cloud environment where they may create, maintain, and distribute applications. Databases, operating systems, and programming languages, among others. It is the top illustration of a PaaS system (Mysoft, 2021).

Key features (IBM, 2021):

- Users pay for the Infrastructure Offered as a Service to their needs rather than acquiring hardware;
- The infrastructure may be scaled up by processing and storage needs.
- Saves businesses from having to pay for and maintain their own equipment.
- There isn't a single point of mistake because the data is on the cloud.
- Management activities can be virtualized to free up time for other jobs.

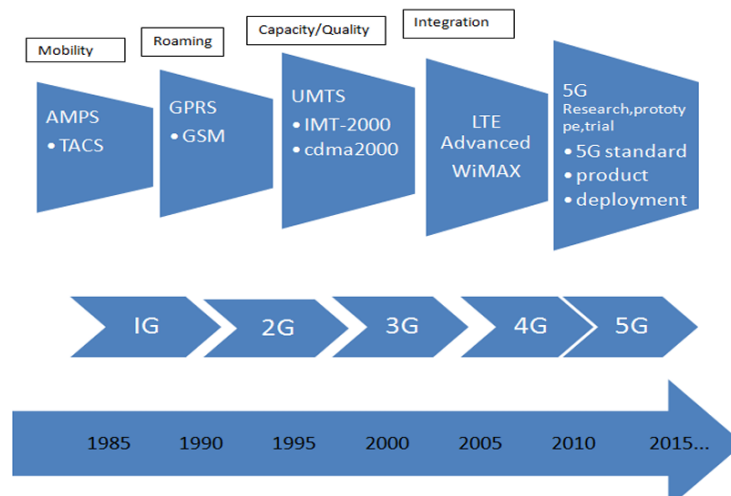
#### **Mobile**

Mobile technologies used in mobile devices include Wi-Fi, Bluetooth, Wi-Max (Worldwide Interoperability for Microwave Access), LTE (Long Term Evaluation), GSM (Global System for Mobile Communication), GPRS (General Packet Response Service), and 1G, 2G, 3G, 4G, 5G.

The first wireless mobile network generation was established in the 1980s as the first generation, mobile (1G), utilizing analog transmission for speech services by Nippon Telephone and Telegraph (NTT) in Tokyo, Japan, to power the first cell phones, but the technology was limited to delivering speech services between devices, and the transmission functioned analogically and utilized radio signals to encode the audio and this

resulted in communication service difficulties (Patel, et al., 2018).

When the first generation of digital connection debuted, it was promptly dubbed “2G,” and the word “1G” was rendered obsolete. 2G is based on GSM (Global System for Mobile Communication) technology and uses GSM and GPRS technologies.



**Figure 4.** Mobile Cellular Network Evolution Timeline (Sood& Garg, 2014)

Afterward, with 2.75G technology, EDGE (Enhanced Data Rates for Global Evaluation) and EGPRS (Enhanced GPRS) technologies were used. With EDGE, the data transfer rate increases to 236.8 Kbps. EDGE technology may be used in any network that supports GPRS technology and does not require any additional software or hardware. (Ekren & Kesim, 2016). In comparison to EDGE, GPRS can send data in two seconds, but EDGE transmits data in six seconds (Rayan and Krishna, 2014). Then NTT DoCoMo launched 3G in Japan in October 2001. In comparison to previous generations, 3G provided mobile consumers with an exceptional experience by providing high-speed connections (Emmanuel & Marvis, 2014).

3G is made up of a core network and a radio access network. Voice call switching and general packet radio service were the core network functionality systems (GPRS) because 3G RAN deviates from basic functionality, mobile devices, and network terminals can access the network independently (Ezhilarasan & Dinakaran, 2017). The smartphone had achieved its pinnacle by the time 3G was released because of connection, internet-ready apps were being developed at a rapid pace, and phones were transformed into portable minicomputers with the debut of 4G technology, the first phones with backward compatibility were created (Burkhalter, 2021). 4G, or fourth-generation wireless communication technology, seeks to provide faster speeds and a better user experience than 3G, the previous generation wireless connection technology. 4G internet speeds may reach up to 100 Mbps, allowing users to experience high-speed applications such as online gaming, high-definition video streaming, and interactive TV (Patel, Shah, and Kansara, 2018). IEEE's LTE/LTE-A and mobile WiMAX 2.0 (802.16m) technologies are considered 4G technologies (<https://www.btk.gov.tr/4-5g-nedir>, 18.12.2017) 5G aims to do more than just increase speed; it will also establish a wireless link to other devices. The outcomes are expected for home usage, with the growth of the notion of connected dwellings, and for industrial services, with new automation and Internet of Things possibilities (IoT) (Brockway, 2021). Many nations are still in the testing phase of 5G adoption, which entails a series of phases, and Apple's first compatible model, the iPhone 12, will be introduced in 2020. In addition, compatible phones have been released in recent

years by Samsung, Motorola, Realme, and Huawei (Brockway, 2021).

**Table 2.** Comparative Study of various Wireless Generations (Sood & Garg, 2014)

1G	2G/2.5G	3G	4G	5G
<b>Start/Deployment</b>				
1970/1984	1980/1999	1990/2002	2000/2010	2000/2015-2020
<b>Features</b>				
-Make use of analog radio signals <b>Services:</b> Analog voice service. No data service	-Used Digital radio signals -Voice encoded to digital signals <b>GSM:</b> Supported digital voice service, SMS messaging, improved voice clarity. Comparatively secure <b>GPRS:</b> Supported MMS, Internet Comm.	Fast data transfer rate, Improved spectral efficiency, and greater network capacity. <b>Services:</b> Enhanced audio video streaming video conferencing support, Web browsing at higher speeds, IPTV support	-Converged data and voice over IP -Entirely packet-switched network, -Higher bandwidth to provide multi-media services at a lower cost (up to 1000Mbps) <b>Services:</b> Enhanced audio, video streaming, IP telephony, HD mobile TV	-Simultaneous access to different wireless technologies -complete wireless communication (Wireless world wide web, WWW) <b>Services</b> -Dynamic information access -Wearable devices with AI capabilities
<b>Data rates</b>				
2kbps	14.4-6.4kbps	2Mbps	200 Mbps to 1 Gps	1Gbps and higher
<b>Standards</b>				
MTS, AMTS,IMTS	2G: GSM 2.5: GPRS 2.75: EDGE	IMT-2000 3.5G-HSDPA 3.75G: HSUPA	Single unified standard LTE, LTE adv Mobile WiMAX	Single unified standard
<b>WEB Standard</b>				
-----	www	www (IPv4)	www (IPv4)	www (IPv6)
<b>Technology</b>				
Analog cellular technology <b>Throughput</b> 14.4 Kbps	Digital narrow band circuit data, Packet data <b>Throughput</b> 20-20Kbps	Digital Broadband Packet data <b>Throughput</b> 3G:200Kbps 3.5g: 1-3 Mbps	Digital Broadband Packet All, Very high throughput <b>Throughput</b> 100-300Mbps	Proposed: Unified IP and seamless combination of broadband, Local area networks, Wide area networks, personal area networks, Wireless LAN
<b>Service</b>				
Mobile telephony (voice)	2G: Digital voice, SMS 2.5: Higher capacity packetized	Integrated high quality audio, video, and data	Dynamic informations access, wearable devices with AI capabilities	
<b>Technology</b>				
Analog wireless cellular technology used	Digital wireless network used	Digital broadband network	Digital broadband packet	Proposed: unified IP and seamless
<b>Switching</b>				

Circuit	2G: Circuit 2.5G: Circuit for access network & air interface; Packet for core network	Packet except circuit for air interface	Packet switching Message switching
<b>Handoff</b>			
Horizontal only	Horizontal only	Horizontal & Vertical	
<b>Shortfalls</b>			
Low capacity, Unreliable handoff Poor voice links, Less secure	Digital signals were reliant on locations & proximity, required strong digital signals to help mobile phones	Need to accommodate higher network capacity	Being deployed  Yet to be implemented

**Wi-Fi**

The technology is known as “wi-fi,” which stands for “wireless internet,” and is the sine qua non of modern existence. Wireless internet technology is not limited to “Wi-Fi.” When connecting to the wireless internet, you can utilize systems such as 3G, 4G, and LTE. However, in terms of speed, ease, safety, and ongoing usage, “wi-fi” outperforms these technologies.

Wi-fi is a wireless network technology that uses radio waves to accomplish two-way communication, and numerous devices may be linked to a single wireless network at the same time since devices that use this technology support the frequency range between 2.4GHz and 5GHz (Ekren & Kesim, 2016).

**Bluetooth**

Bluetooth is a technology that allows for the quick and easy communication of data and audio between devices without the use of cables or connecting equipment (Bisdikian, C,2001). The demand to transport data without using cables between personal devices, home, industrial devices, and business devices is growing by the day. Bluetooth, on the other hand, stands out as a technology that is quick, dependable, and affordable, and that all devices can interact with ease.

**Wi-Max**

WiMax, like wifi and LTE, is an IP-based wireless technology designed to offer a continuous connection between the user and the base station across a vast area at a radius of 3-10 km, regardless of the field of vision. LTE, on the other hand, is a high-speed wireless data transfer standard that employs GSM and GPRS technology.(Wikipedia-LTE). Speeds increased to 0.1 Mbps with 2G, and numerous users may connect to a single, secure channel. The introduction of 3G, which elevated mobile networks and data usage to unprecedented heights, was a true game-changer. Speeds increased to 2 Mbps, and the 3G network was expanded with towers that could serve 60–100 people simultaneously without experiencing any service disruption. Every moment a technological advancement was achieved, the first three tiers of connectivity needed new hardware.

**Discussion and Conclusion**

In today’s world, constantly developing technology makes the change and transformation of organizations inevitable. This development creates data piles all over the world. The processing and interpretation of data, which is the rawest form of information, is

of great importance for organizations. The information obtained by processing raw data with technological devices and in a rational way is seen as the raw material of transformation in the digital age. In organizations where competition and change come to the fore, future planning, rational decision-making and efficiency goals reveal the need for information systems and information technologies (Barnet & Cavanagh, 1995). Information systems that enable the processing, interpretation and reporting of data, and fixed and mobile technologies that provide remote access to information constitute the first wave of digitalization. Afterward, the second wave of digitization is connected to the internet and internet platforms. The third wave of digitization, which includes advanced technologies such as IoT, AI and Big Data, aims to process information and create an effective decision process (Katz, 2017). In the digital transformation process, which expresses holistic transformation far beyond digitalization with digitalization, everything can be measured and supported by various methods, techniques and technologies (Altuntas, 2018).

These technologies are used to increase the efficiency of decision processes, increase the speed of information processing, detect patterns, effectively manage customer relations, and determine needs and requirements. In this section, technologies that shape digital transformation are mentioned. Based on these technologies, it can be said that all technological developments started with digitalization and then each development triggered the next development. These developments have made change and transformation inevitable in different fields. Digital transformation consists of redesigning and transforming existing processes in the context of human, processes, and technology in line with new developments, taking into account new technologies. This process is of great importance for organizations to achieve their long-term goals. Digital transformation, implemented in line with the needs and requirements of individuals, businesses, and organizations, increases competitive advantage by ensuring success.

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