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INTERNET OF THINGS IN SELF-DRIVING CARS ENVIRONMENT

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ABSTRACT

The development of Self-Driving cars has had two main approaches, the vehicle as an individual object, allowing it to perceive the environment and react to it, and seeing it as part of an autonomous system (smart city) where the environment is responsible for identifying all components and providing timely activation. Internet of Things technologies can drastically improve the capabilities of the autonomous vehicle to better understand its environment with the interconnection of the surrounding elements. The findings from the development of the Internet of Things in autonomous cars are more intelligent mobility with higher levels of safety (for passengers and pedestrians), efficiency (allowing drivers to avoid traffic congestion and facilitating their search for parking), and sustainability (through reduced fuel consumption.). This article reviews advances on the Internet of Things and how it has changed the industry. Aspects in the development of intelligent cities result from implementing the Internet of Things.

KEY WORDS

cloud computing, Internet of Things, safety, self-driving cars, smart city

CLASSIFICATION

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INTRODUCTION

The Internet of Things (IoT) is a system of interconnecting devices, which could be digital and mechanical devices, objects, animals, or people that are provided with unique identifiers [1]. The devices should have the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. An IoT ecosystem consists of web-enabled intelligent devices that use microprocessors, sensors, and technology to store, processing and act in their environments. The concept of Cloud Computing is used in IoT systems, consisting of computer programs for receiving Big Data, analysing, processing, and managing it; Big Data means all information can be transferred from any device to the cloud. In the last years, the development of wireless sensors, help to create the intelligent terminal for controlling remotely extensive systems. For example, security systems in airports, intelligent parking lots, intelligent homes, and more, the main goal is alerting and protecting people, giving users the confidence to use these systems [1]. IoT is also very present in the automotive world. Our cars are becoming more intelligent (Connected Car) thanks to intelligent sensors that go far beyond calculating a route: they save fuel, they notify emergency services, our geolocation in case of accident or breakdown, they receive and interpret incidents or safety notices that affect our trip and communicate it to us in real-time [2].

For smart cities, the role of IoT is essential. The benefits are addressing population growth in urban areas, reducing resources, cost savings, more accurate services to citizens and organizations, and more efficient transportation, all of which far outweigh the cons or risks of a connected city. In the same way, the security and protection of critical infrastructure, applications, identities, and sensitive data (personal information, medical details, vehicle routes, financial information, etc.) must be increased, maintaining the confidentiality of the data collected [3]. A single security vulnerability in one sensor could compromise the entire network segment where the sensor resides.

INTERNET OF THINGS

Refers to connecting everyday objects with the network, digitalizing the physical world, Figure 1. Some examples would be if the refrigerator notifies you of the expiration date of the products or the toothbrush alerts you to caries and asks for an appointment with the dentist [4].

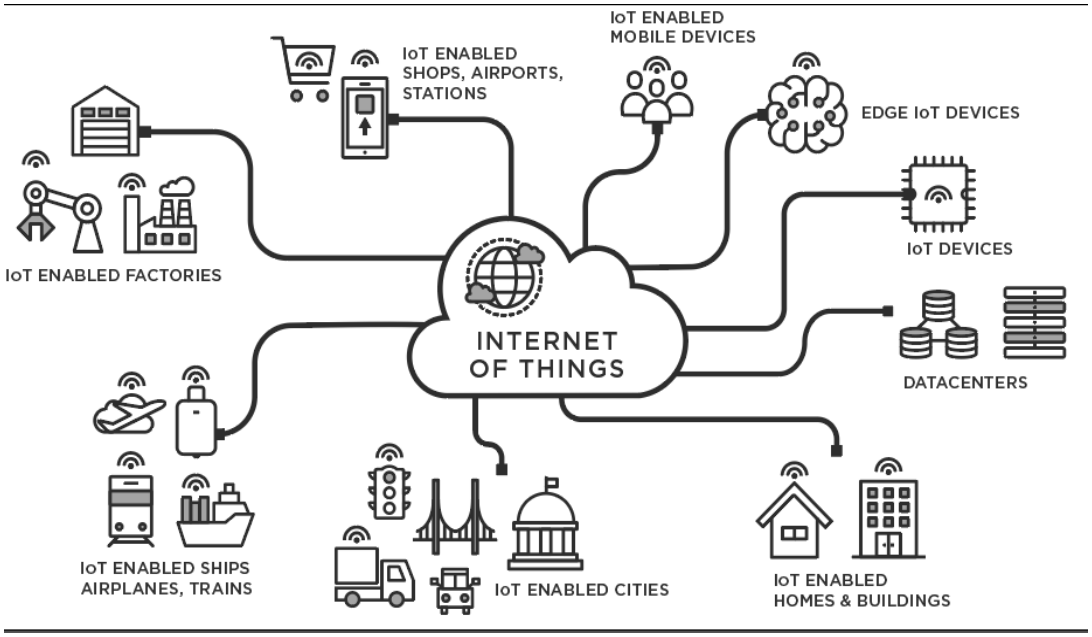


Figure 1. IoT.

To connect the devices to the Internet of Things, you need sensors, a Central Process Unit, and an Internet connection. IoT depends on an integrated set of technologies such as application programming interfaces connecting devices to the internet.

Connected objects and networks that, thanks to the information they receive from millions of sensors, store and interpret millions of data in seconds (Big Data) and launch orders that make it possible to streamline and automate processes that, until now, were based solely and exclusively on the human interaction.

The definition of the Internet of Things leads us to sensors or objects that, through interconnected networks, send, in real-time, millions of data to interpretation and analysis centers for study and decision making. Still, it is much easier to think about day to day and see examples of the Internet of Things that we already use daily that make our lives a little easier and have been integrated into our daily reality and that of our cities. In-home (Domotics), Figure 2, the intelligent refrigerators can order directly to the supermarket when there is a lack of food. Automotive systems allow saving electricity according to the real needs of the house, devices for irrigation and wise water consumption, intelligent garages, etc. Figure 3 [5].

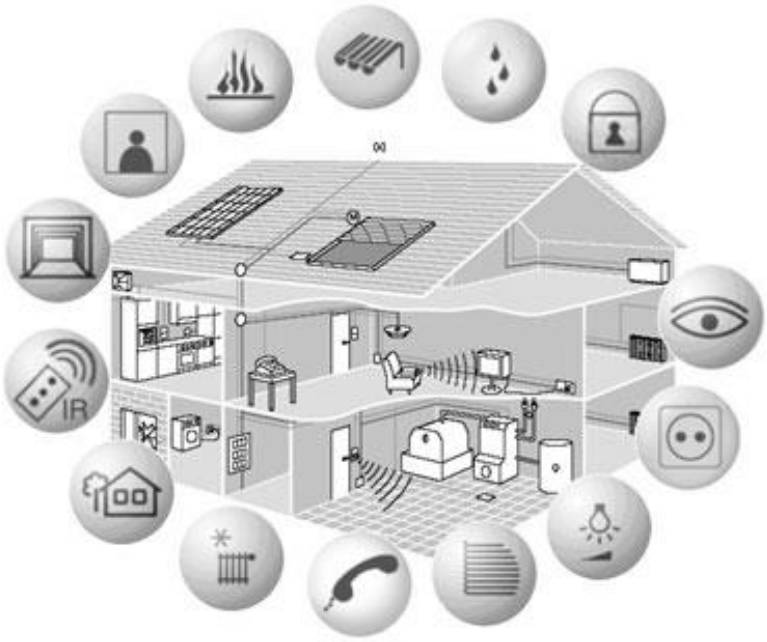


Figure 2. Example1 of IoT – Domotics [5].

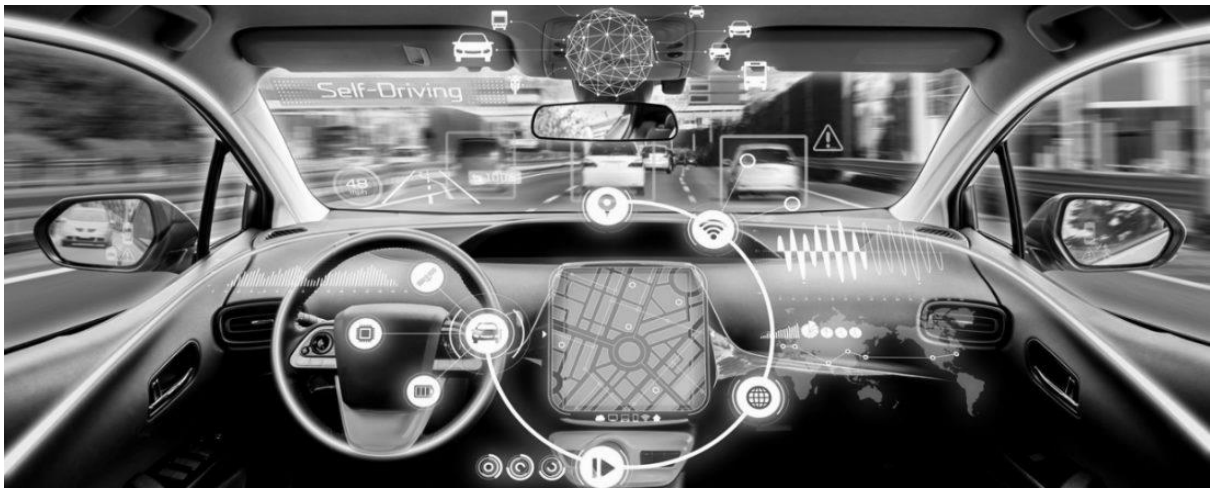


Figure 3. Example 2of IoT – Car Automation [6].

THE CLOUD AND CLOUD COMPUTING

Cloud computing is a technological and business model that allows ubiquitous, adapted. On-demand network access to shared configurable computing resources can provide information infrastructure, services, platforms, and applications that come from the cloud to users, as requested and through a network [6]. Clouds are groups of virtual resources coordinated by management and automation software. The users can access them as requested through self-service portals supported by automatic scaling and dynamic resource allocation. Cloud computing allows Information Technology departments not to waste time expanding custom implementations by giving business units the power to request and implement their resources, Figure 4.

Figure 4. Cloud Computing representation.

Clouds and cloud computing are not technologies in themselves. It would help if you had operating systems, virtualization software, and automation and management tools to use them. The operating systems configure the host user interfaces and networks; virtualization extracts resources and groups them in the clouds; the automation software allocates those resources, and the management tools provide new environments.

The basic idea is that all information is stored distributed in servers, being accessible at any time by the user without the worry of anything; the system of the "cloud" is responsible for always keeping the information available [1]. The system distributes the computing capacity and memory of the applications stored in the cloud; depending on its use, its capacity is delegated, and data processing is distributed to the servers.

ADVANTAGES OF CLOUD COMPUTING

- Change of capital expenses for variable expenses: Paying consumes computing resources and how long.
- Benefits from massive economies of scale: With Cloud Computing, hundreds of thousands of customers are registered.
- Stop guessing capacity: With Cloud Computing is not necessary to think in infrastructure, and this problem is eliminated. Additionally, the users can access as a need for the information.
- Increase speed and agility: The response in Cloud Computing is faster because the resources are available all the time.
- Save money in managing data centers: In Cloud Computing, the projects can focus on customers without infrastructure.
- Go global in minutes: This kind of system lets the developers build applications and distribute them worldwide without difficulty, which means global applications.

CLOUD COMPUTING DEPLOYMENT MODELS

PUBLIC CLOUDS

This model, Figure. 5, allows the entire public to access its services through free accounts.

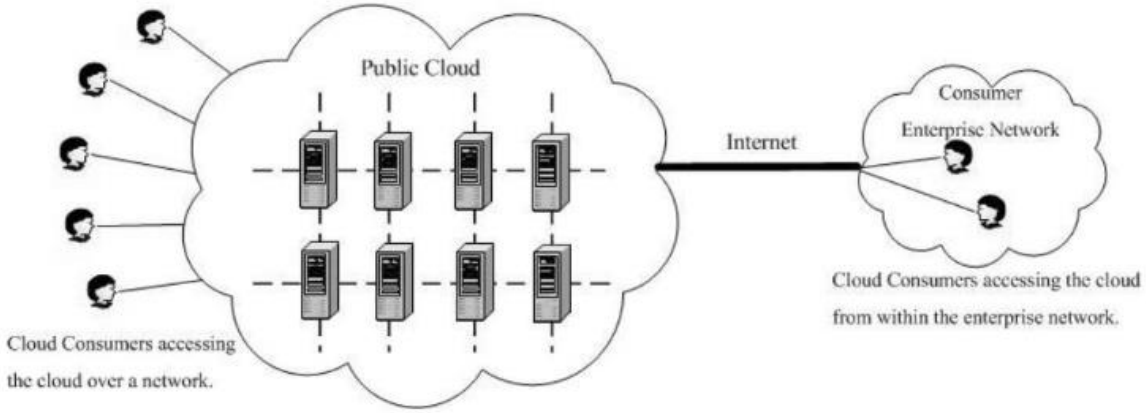


Figure 5. Public cloud structure [8].

Key aspects of public cloud:

- the access to innovative business apps for management and data analytics,
- flexible, scalable for storage and compute services,
- enables power for cloud-based application development and deployment environments.

PRIVATE CLOUDS

Usually is reserved for specific businesses and is provided on a private network, Figure 6.

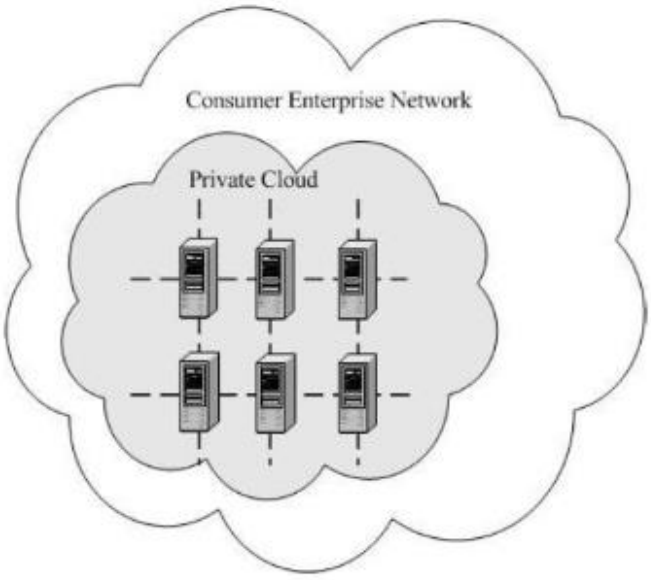


Figure 6. Private cloud Structure [8].

Key aspects of a private cloud:

- self-service interface controls services,
- automated management of resource pools,
- sophisticated security and governance.

HYBRID CLOUDS

A combination of public and private services is more flexible and helps optimize the user's infrastructure and security, Figure 7.

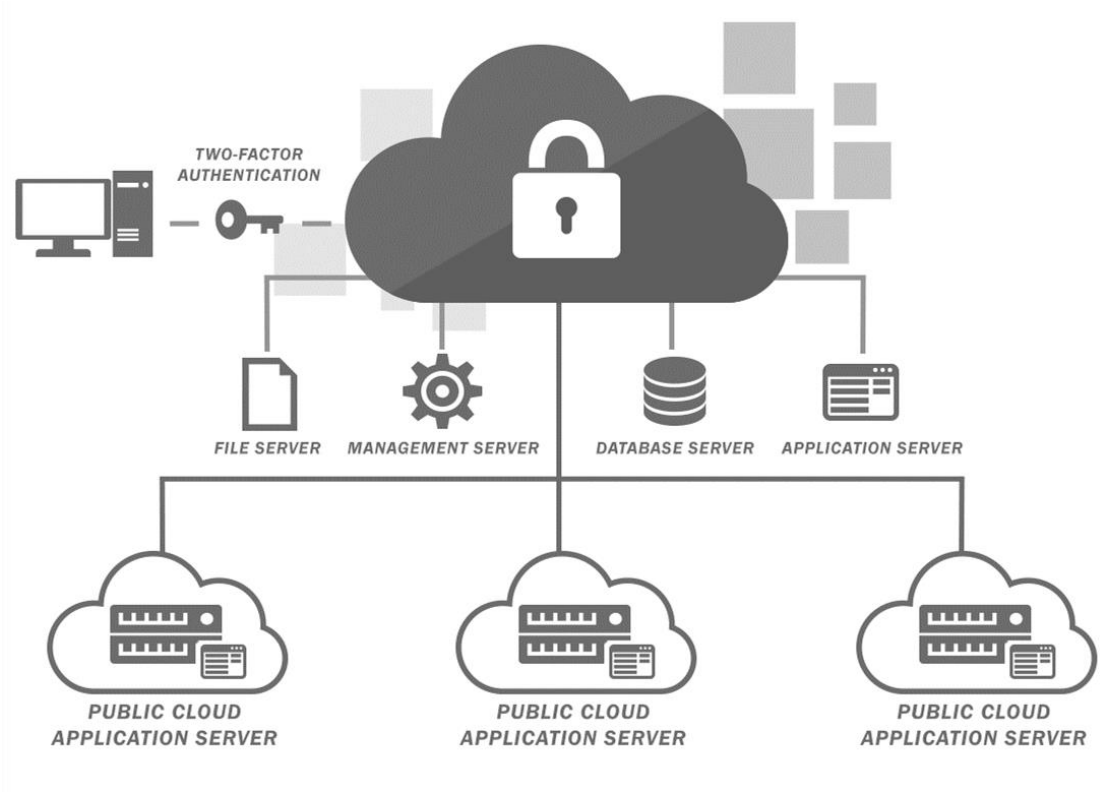


Figure 7. Hybrid Cloud Structure [8].

Key aspects of hybrid cloud:

- allows companies to save a critical application and sensitive data,
- the advantage in public cloud resources like Software as a Service (SaaS) for the latest applications and infrastructure as a Service (IaaS) for flexible virtual resources,
- facilitates portability of data, apps and services and more choices for deployment models.

VIRTUALIZATION

Virtualization is one of the technologies that allows cloud computing. However, virtualization is not cloud computing [8]. The main difference is that virtualization is an abstraction of computer resources, typically virtual machines. Virtualization is unnecessary to create a cloud environment, but it allows for rapid scalability of complex resources in non-virtualized environments.

A virtualized infrastructure is the basis for most high-performance clouds. Virtualization has been a successful strategy for consolidating data centers [9]. It is widely used to pool the resources of the infrastructure and can also provide the essential elements to improve the agility and flexibility of a cloud system. The servers continue to be the main focus of virtualization [10].

TYPES OF CLOUD COMPUTING

SOFTWARE AS A SERVICE

SaaS involves the licensure of a software application to customers, Figure 8 [8]. These applications are accessible from various client devices through client-light interfaces, such as a web browser.

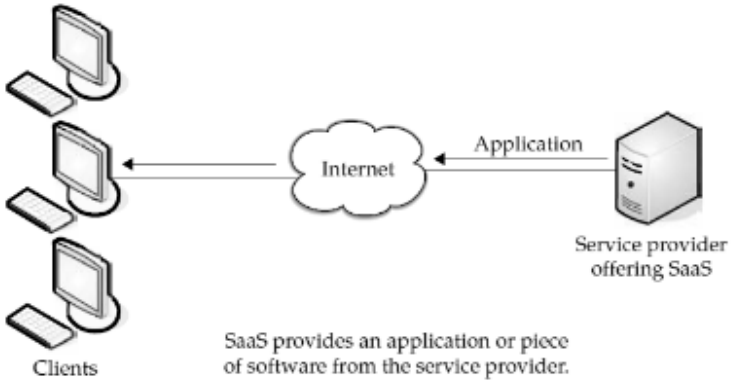


Figure 8. SaaS [8].

Benefits of SaaS:

- you can sign up and fastly start using innovative business apps,
- apps and data are accessible from any user,
- the data is never lost because all is in the cloud, dynamically scale to usage needs.

Some of these applications:

- customer resource management,
- video conference,
- administration of IT services,
- accounting,
- web analysis,
- web content management.

INFRASTRUCTURE AS A SERVICE (IAAS)

This method, through IP-based connectivity, is capable of distributing from operating systems to servers and storage, Figure 9 [8].

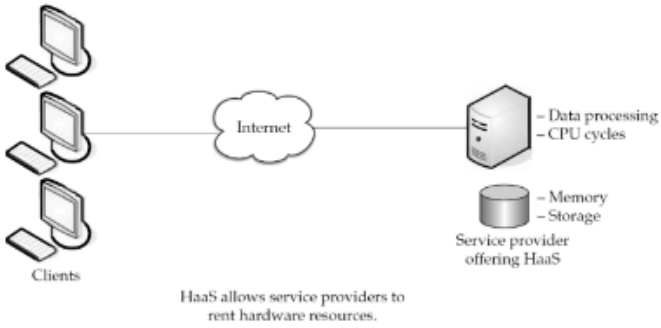


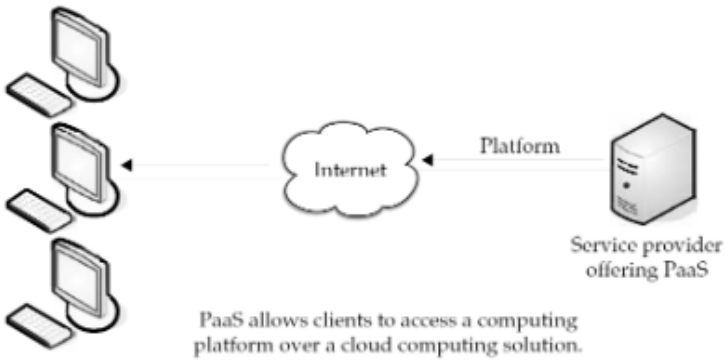
Figure 2. Infrastructure as a Service (IaaS) Structure [8].

Benefits of IaaS:

- no need to invest in your hardware,
- infrastructure scales on-demand to support dynamic workloads,
- flexible, innovative services available on demand.

PLATFORM AS A SERVICE

The main difference with SaaS is the delivering software online; the platform allows creating software delivered by Internet [8]. The consumer can deploy applications in the cloud infrastructure, developed by or acquired, programming languages, services, libraries, and tools supported by the provider.



aas

Figure 10. Platform as a Service (PaaS) structure [8].

Bepnefits of Platform as a Service (PaaS):

- develop application and get to market faster,
- upload new web applications to the cloud in minutes,
- reduce complexity with middleware as a service.

INTERNET OF THINGS – AREAS OF APPLICATION

The importance of IoT lies in the change that it will mean in our society since it is one of the fundamental elements of digital transformation whose presence is essential for sectors such as: Industry 4.0 or Connected Industry. The Internet of Things will automate processes and connect machines and production centers anywhere in the world to respond to a demand in real-time. There is talking about a new industrial revolution. Industry 4.0 refers to the introduction and application of digital technology to all production systems and processes in factories and customers, Figure 11.

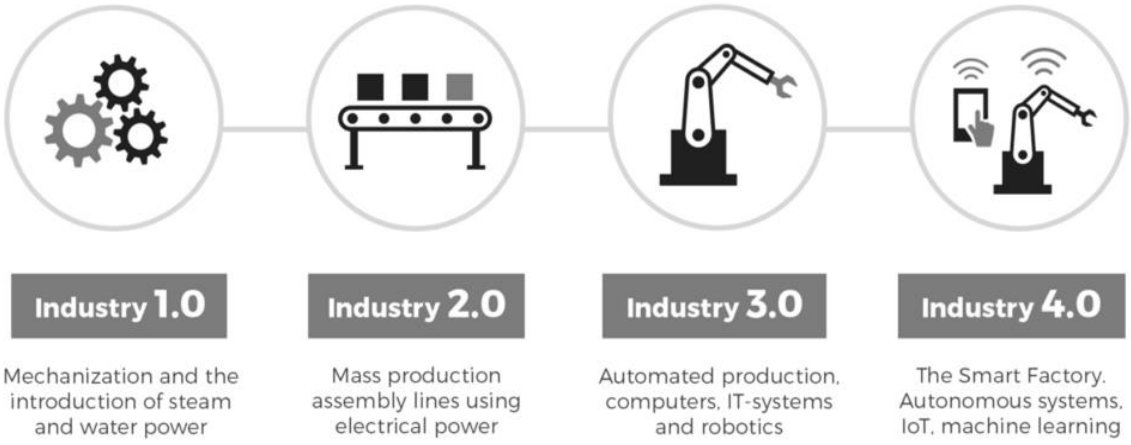


Figure 3. Industrial Revolution [10].

SMART CITY OR INTELLIGENT CITY

Smart cities apply Information and Communication Technologies to manage and provide their different services, such as governance, economy, social affairs, mobility, security, energy, culture, environment, and others [13-21]. For Citizens, this means a better quality of public services, greater administrative efficiency, greater accessibility, more transparency, and better access to public information. Smart City can also mean better economic, social, and environmental quality for the City and Citizens. At the same time, a growing number of private

companies provide services of Smart Cities complementary and integrated to those of the public administration, Figure 12. Citizens interact with the ecosystems of intelligent cities in various ways using smartphones and mobile devices and connected vehicles and homes. Pairing devices and data with the physical infrastructure and services can reduce costs and improve sustainability.

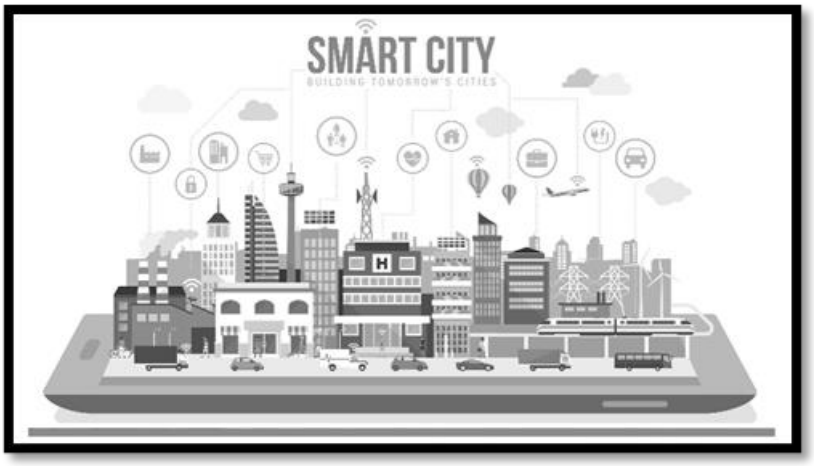


Figure 12. Smart City [21].

E-HEALTH

It is one of the aspects in which the Internet of Things revolution has already begun and whose advances go much further thanks to the real-time interpretation and data that facilitate wearable devices for better and effective service of patients, among many other possibilities, Figure 13.

Figure 13. E-Health [21].

EDUCATION

Not only talking about new formulas or educational systems based on the interaction with objects but the application of the Internet of Things to improve the access and integration of thousands of people who, otherwise, would have much more limited access and your opportunities.

CYBERSECURITY

Security technologies are needed to protect devices and platforms from the two significant dangers they face, attacks on information and physical manipulation of devices. The big problem is that many connected 'things' are elementary and use processors and operating systems that do not support sophisticated security approaches.

Also, the IoT security specialists will have to make an effort there since the solutions are currently very fragmented. There will be new threats because hackers will find new ways to violate protocols and devices. Therefore, considering that they are 'objects' with a long lifespan, they would have to have hardware and software updated during their operation period.

CONCLUSIONS

The virtual and physical joint between infrastructure components and sectors are becoming increasingly permeable as IoT systems become networked and remotely accessible. Increased connectivity, faster speeds, and multi-directional data flow access points into critical infrastructure, changing and stretching the borders that Smart Cities must secure. IoT development depends on different factors such as resource availability, user preferences or scale, and accessibility. Migration to these new technologies will present a significant security challenge for users, industries, and the government. In some areas, merge older and newer infrastructure. There will be points where older equipment continues to dominate but lacks the same – new equipment's ability to report operational status, problems, or efficiency opportunities. More generally, such adaptation challenges developing consistent security policies for cities at different stages or approaches to Smart City development.

One of the goals of the IoT infrastructure is to migrate the control of people to digital systems based on algorithms. This process presents new challenges to be considered. The increase in access points increases the points of attack to the system, due to the size of the system, the complete monitoring becomes complex, cascading failures, automatic response to emergencies (leaving aside the humanity in decision making), involuntary removal of manual overrides.

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