Smart Cities

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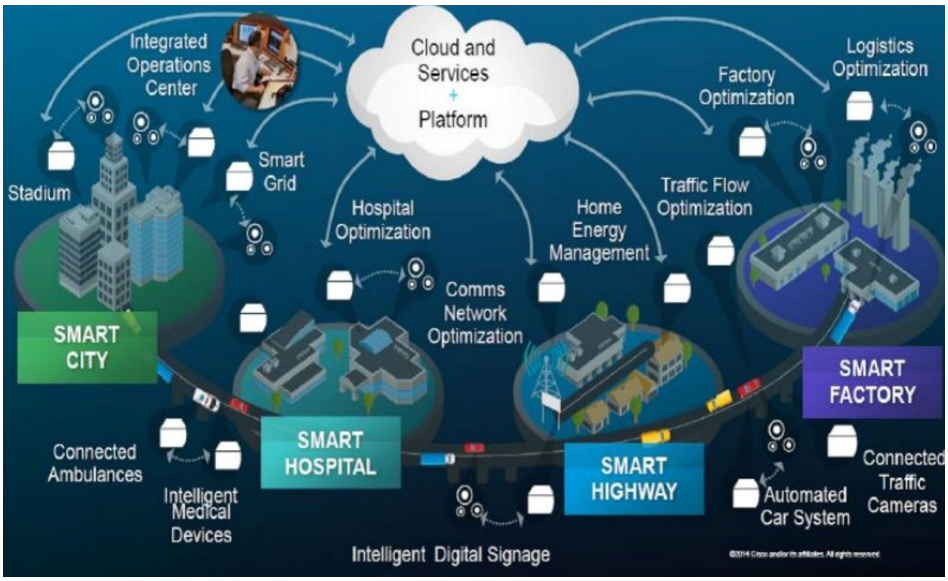
1 Introduction

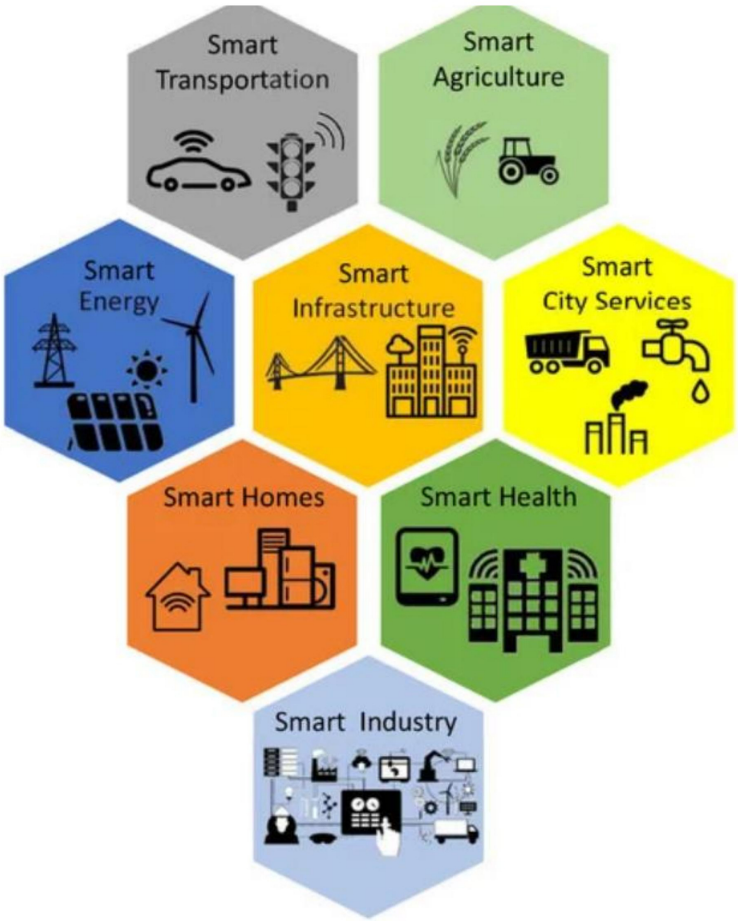
The Internet of Things (IoT) is a system that combines many gadgets and technologies, doing away with the need for human intervention. Everyday items are being given electronic components and protocol suites so they can be networked and connected to the Internet. The internet of things has facilitated the creation of smart city systems for sustainable living, enhanced comfort, and increased productivity for inhabitants by hosting various technologies and enabling interactions between them. The IoT for Smart Cities spans a wide range of industries and depends on a number of underlying systems to function. The global appeal of IOT services and big data analytics has strengthened smart city projects. These services have significantly improved the quality of human existence by improving the infrastructure and transportation system, reducing traffic congestion, providing waste management, and other factors.

People are gradually putting IoT equipment in their homes, like TVs and Internet boxes. Thermostats, smart alarms, smart door locks, and other systems and appliances are examples of linked items in the real estate industry. Several local communities had the chance to reconsider their environmental goals in order to minimize their CO2 emissions through the use of IoT during the United Nations conference on climate change (Cop21).

- If the trash cans on the street are full or not, residents can verify using a smartphone app.
- Businesses might provide route optimization solutions to the teams in charge of garbage collection after waste containers indicate their state.
- Sensors installed in various locations can monitor environmental conditions, bikers and athletes may choose the "healthiest" routes, and the city can react by changing traffic patterns or adding more trees when necessary.

All citizens will have access to the data, which will encourage the development of programs that provide inhabitants with real-time information. Cities are becoming centers for the exchange of knowledge. The solutions and technologies required to build smart cities are just now starting to become available.





2 Smart City Components

Applications for smart cities typically have four components : data gathering, transmission and reception, storage, and analysis.

Data collection is the first component. Application-specific data collecting has been a major force behind sensor development across a range of industries.

Data transmission from the data-gathering devices to the cloud for storage and analysis makes up the second component of the process. Many smart city initiatives include city-wide Wi-Fi networks, 4G and 5G technologies being employed, as well as different types of local networks that can transmit data either on a local level or on a global one. These are just a few of the ways this mission has been accomplished.

Data is arranged and organized using various storage methods in the third step of the process before being stored in the cloud for usage in the fourth stage, which is data analysis.

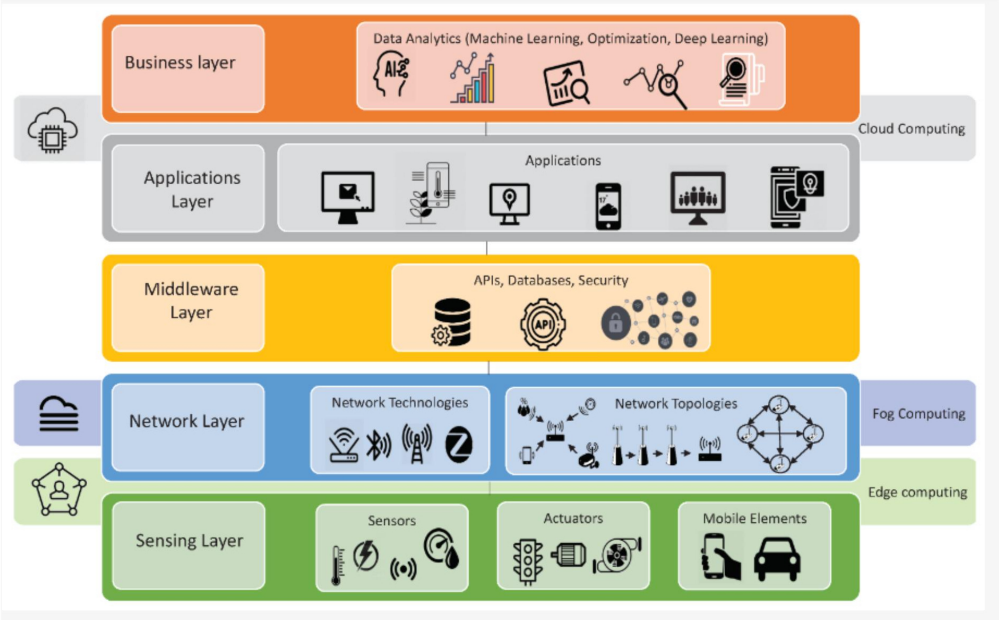
Data analysis is the process of drawing conclusions and patterns from obtained data to use in decision-making.

3 Internet of Things for Smart Cities

Internet of things (IoT), the enabling technology that has allowed pervasive digitalization that gives rise to the concept of smart cities, is at the core of smart city projects. The term "internet of things" describes the pervasive internet connectivity of gadgets, which enables them to send data to the cloud and maybe receive instructions for carrying out tasks. In order to support decision- and policy-making, IoT entails data gathering and data analytics activities to extract information. IoT in the context of smart cities enables sensors to gather and transmit information about the state of the city to a central cloud, where it is mined or processed for pattern extraction and decision-making purposes.

3.1 Iot Architectures for Smart cities

Through the utilisation of cloud services, the Internet of Things integrates the functions of data sensing, transmission/reception, processing, and storage. A generic IoT architecture is composed of five levels based on technology,



each of which operates on data from the one before it. Additionally, it displays the three various IoT system architectures.

The sensing layer, also known as the perception layer, is made up of actuators that may interact with physical objects, such as RFID readers for reading RFID tags, as well as sensors that can gather data about physical quantities relevant to any application. The Middleware layer receives the data read by the sensing layer by using the networking layer and wireless network technologies including Wi-Fi, Bluetooth, Zigbee, and cellular internet, among others. The application layer leverages the data through various APIs and database management services to provide users with services, while the middleware layer provides a generic interface for the sensing layer hardware. The business layer, which is connected to the application layer, is where strategies and policies are created to assist manage the entire system. IoT architectures are often divided into different categories depending on the different types of operational tasks assigned to various IoT system components. This categorization is mostly based on data processing roles. Regarding the stage of the IoT framework where data processing can be done, there are three IoT system architectures: cloud, fog, and edge models. The goal of this hierarchy is to complement the higher layer by giving it only relevant information, increasing the system's dependability and productivity. Any IoT system designer's goal is to strike a balance between the three levels' capabilities while taking system costs and requirements into consideration.

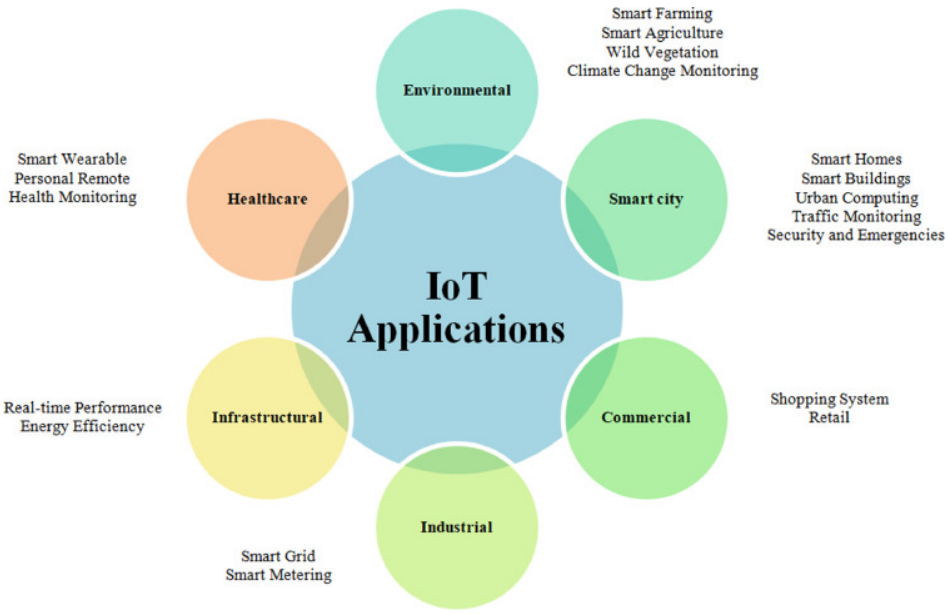
3.2 Smart Parking

Empty parking spaces are located using IoT sensors that have been installed. A cloud server receives the information gathered from the parking lot. Then, using a smartphone or other communication devices, the user can receive the necessary instructions. Ultrasonic, proximity and distance-measuring sensors are all widely used in the smart parking system.

This system shows the parking area and the proper spacing for the vehicles to be parked while also detecting the arrival and departure of the vehicles. Any smartphone can connect to this system using any application or web access. This speeds up and greatly simplify the parking process. No expensive or difficult infrastructure is needed for this system. An MQTT (Message Queuing Telemetry Transport) is a simple messaging protocol that translates messages between gadgets, servers, and software programs. The cloud server manages information on each parking space. Finally, consumers can receive the necessary instruction via communication devices linked to cloud servers.

3.3 Smart waste management

The collection, transportation, processing, disposal, management, reuse, and monitoring of waste materials are only a few of the many sub-processes that make up the vital process of waste management. Many issues are resolved by a smart waste management system, including air pollution, the accumulation of trash in the streets, the development of infectious diseases as a result of subpar garbage upkeep, ineffective waste collection, etc. Once the rubbish reaches a predetermined level established by the system management, level detection sensors are utilized to send a message to the driver of the garbage disposal truck's smartphone indicating the level of the garbage. This makes a significant



contribution to the nation's advanced infrastructure. In several aspects of waste management, IoT infrastructure needs to be implemented.

The primary function of the sensors used in smart waste management is to gather vital information about the amount and types of trash present and transmit it to the system either directly or indirectly through the smart city system and local communication devices that are connected to a cloud server. Biodegradable and non-biodegradable garbage are kept separate under this system. This will lessen the possibility of the trash can overflowing and maintain our environment clean. The efficient coordination of various waste management activities, such as estimating the level of filling at which collection should take place and sorting garbage, would be aided by this type of network, which comprises of sensors and data collection. The Internet of Things (IoT) opens the door for a fully coordinated system with a much wider perspective and a database system to maintain the environment.

3.4 Smart roads

Vehicles can be monitored and traffic lights can be adjusted in accordance with the flow of traffic by employing smart road technology. The construction of smart roads using IoT and sensor technology makes for a smooth and safe driving experience. It provides drivers with up-to-date information on things like traffic, parking, road conditions, weather, and the shortest route to their destination, among other things.

Smart roads might even save lives when traveling through unsafe places like mountainous regions, woodlands, hilly areas, etc. by using motion sensors, ultrasonic sensors, etc. Additionally, this might allow drivers and passengers to annually save 9.4 hours. It increases pedestrian security. By reducing the likelihood of accidents, smart road technology significantly improves public safety.

4 Conclusion

This paper provides an overview of the many technologies used in the creation of smart cities. The current applications of smart cities using IoT technologies and public benefits gained out of it are discussed. In today's busy world, the line between reality and science fiction has blurred, making IoT in Smart Cities a reality. The lives of the people will be bettered if smart cities are constructed in an organised manner with appropriate planning and analysis. Future fulfilment of protection and privacy requirements will allow us to reap the benefits of the adoption of smart cities.

Smart home and smart agricultural technologies will help our nation's economic and general development if they are deployed safely and securely. Future smart city building will produce the greatest quality environment if IoT techniques are properly incorporated. Additionally, it will entice foreign investors to fund the businesses in our nation. It will result in the social, economic, and rural development of our nation on a global scale.