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Internet of Things for Future Smart City Using 5G Networks

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Abstract: ***The future of cities lies in blending new technologies with existing infrastructure to tackle tangible, pressing issues such as environmental sustainability and economic opportunities. The enormous pressure towards efficient city initiatives by both government and private sector businesses to invest in Information and Communication Technologies to find sustainable solutions to diverse opportunities and challenges (e.g., waste management). Future smart cities are the key to fulfill the ever growing demands of citizens. Successful smart cities will build a strong, flexible, digital infrastructure that integrates new technology into existing structures. The main goal of a smart city is to optimize city functions and promote economic growth while also improving the quality of life for citizens by using smart technologies and data analysis. According to a new report from @NavigantRSRCH, there are more than 250 smart city projects from178 cities around the world, and the majority focus on government and energy, initiatives, followed by transportation.***

Keywords: 5G network, Internet of things (IOT), Smart Waste Management System, Safety and Security, Sustainable.



Figure 1: Development of smart city

I. INTRODUCTION

A smart city is a technologically modern urban area that uses different types of electronic methods, voice activation methods and sensors to collect specific data. There are a number of definitions of what makes a city 'smart', for example IBM defines a smart city as "one that makes optimal use of all the interconnected information available today to better understand its operation. The smart city concept integrates information and communication technology (ICT), and various physical devices connected to IOT (Internet of things) network to optimize the efficiency of city operations and services and connect to citizens. For example, smart meters can measure electricity, gas, and water usage with great accuracy. This helps to reduce costs and resource consumption.



Figure 2: The connected city

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A city smartness is determined using a set of characteristics, including:

1) An infrastructure based around technology.
2) Environmental initiatives.
3) Confident and progressive city plans.
4) Effective and highly functional public transport.
5) People able to live and work within the city, using its resources.

II. CORE INFRASTRUCTURE ELEMENTS IN A SMART CITY

1) Adequate water supply
2) Sanitation, including solid waste management
3) Safety and security of citizens, particularly women, children and the elderly
4) Robust IT connectivity and digitalization
5) Sustainable environment
6) Health and education
7) Efficient urban mobility and public transport.

The purpose of smart cities mission is development of smart cities pan-India to enable economic growth and improve the quality of life of people by enabling local development and using smart technologies to make its citizens life better.

III. TRANSPORTATION

Improving transportation systems using 5G is the biggest area of focus in the market currently in terms of Smart City services and one of the most aggressive telcos in the world in terms of developing 5G traffic management systems is Verizon Wireless in the USA. They will use fast track permits for 5G to ensure a fast and cost- effective network and are also providing free public Wi-Fi in selected areas of the city such as in parks and in major pedestrian thoroughfares.

A. Ways 5G Could Radially Chang Transportation in Smart Cities

1) 5G could help increase the flow of traffic.

IBISWorld explains that the flow of traffic could increase with the help of smart traffic management systems on a 5G network. Traffic signals would change based on the current, real time traffic patterns, which would be monitored by sensors and cameras.
But this isn't a possibility, major cities have already started rolling out such Internet of Things (IOT) initiatives in order to increase their traffic flow.
For example, Kansas City, Mo., installed sensors on streetlights along a 2.2 mile rail line.

2) 5G could help decrease commute times.

Who doesn't get frustrated by commutes to work - especially when you are stuck in traffic for what feels like forever ?
If vehicle to vehicle (V2V) communication technology can be deployed over a 5G network, we could potentially see an increase in how closely cars could travel next to each other (also known as platooning. With platooning would come an increase in highway capacity and, as a result, decreased commute time.

3) Smart driverless cars .

One other possibility that IBISWorld doesn't highlight in their report, but has been covered extensively elsewhere is about 5G and smartr cars . You've probably heard a lot about driverless cars, but one area we culd potentially expect to see them would be in smart cities . And 5G would be the tool for this because of low latency. Driverless cars to become fully autonomous, they'll need to communicate with the cars around them to avoid accidents and minimize congestion. They'll all need to talk to sensors embedded in traffic lights, road signs, and the pavement to navigate more safely. And they'll need to get responses instantly- which is low-latency 5G networks come in."Only fast networks, such as 5G, can support millisecond-level latencies."



Figure 3: 5G for smart traffic and transportation

4) Taxi drivers and contract drivers for companies like Lyft and Uber could save money on gas and pick up more passengers.

Just think: with an increased flow of traffic and a reduction in vehicle wait time, drivers could automatically increase their number of pickups. And not only that, they could possibly save, money on gas, too. In the Mellon University study in Pittsburgh, for instance, smart traffic lights brought about a decrease in vehicle emission of 21.0%.

B. Improved Traffic Management and Smarter Vehicles

Traffic Technology Today says "one of the most important changes that 5G can bring about is making the daily commute to the office much faster. Most transportation agencies rely on outdated schedules and technology, resulting in poorly timed out lights" and lengthy commutes. A city's traffic management system equipped with 5G technology "allows traffic lights to receive real time data about traffic patterns from cameras, sensors, and drones." The result is that the system is more responsive to traffic fluctuations. Tests performed at Crnegie Mellon University indicate this application of 5G should reduce commute times by up to 26%. Other automotive use cases include automated parking, vehicle health monitoring, and high definition map sharing.

IV. PUBLIC SAFETY AND SECURITY

5G will also significantly enhance smart city services related to public safety and security. Real time analytics of video recordings of public venues coupled with biometric software will be able to quickly identify dangerous situations and alert authorities automatically in situations like car accident or terrorist attack. Now four essentials for smart city safety and security are as follows:

A. Video Surveillance

The first thing we need to consider when developing a smart or safety projects is security cameras and surveillance systems. We will require high definition surveillance cameras that can deliver real time video around the clock from any place within the city. This is important if we want to effectively monitor, control and respond to public safety or security situations. There are a many high definitions and Internet protocols (IP) cameras and they come in all shapes and sizes. For example, We have fixed cameras which are great for monitoring very specific areas. We also have PTZ cameras which can pan or tilt to monitor wider areas. PTZ cameras are also great for zooming in on specific people, object or activities. Together with the cameras we can find some great video applications for facial recognition and anomaly detection. These applications provide useful insights and help authorities react more effectively. Some of the leading companies for surveillance system are Axis Communications, Bosch, Samsung and Sony.

B. Smart IOT Sensors and Emergency Devices

IOT means taking all the things you can in the city and connecting them to the internet. This includes everything from lamp posts and traffic lights to smart waste bins and connecting them to a single control or command center. Sensors are placed on these devices and detect everything from bin overloaded to air pollution and believe it or not, even gunshots. It may be helpful to know that Libelium offers a wide variety of sensors for all types of city applications including smart lightning and smart environments. Smart city can also deploy access and even panic buttons so citizens can easily contact the necessary authorities when help is needed. There are many ways that metropolis can improve the quality of life of the people with the right planning upfront.

C. Connection of Smart City Devices

If we want to connect cameras, sensors and any other device you need a reliable and secure broadband connection. This is important specially for bandwidth demanding application such as video surveillance. If your connection is poor, the slightest hiccup in your video transmission could ruin the quality of your visual data.

For this reason, a good broadband connection is critical when transmitting sensor data back to the control center. One way to provide a broadband connection is with fiber or copper network. The only problem with fiber or copper is that it's costly and takes a long time to deploy broadband. Wireless is often used to deliver high speed broadband connectivity and removes the need for expensive wired deployment.

RADWIN, known for its wireless technologies, delivers wireless broadband Point to Point and Point to MultiPoint solutions. These solutions enable robust fiber like connectivity for a range of smart city devices such as HD videos cameras and sensors. RADWIN's products can assure transmission of best video quality through dedicated bandwidth per camera site. Using market proven technology RADWIN products are perfect for challenging urban areas.

D. Command or Control Centers

City command centers are usually equipped with smart city management systems that collect, analyze, and manage enormous amount of open data. This data is collected from sensors, cameras, and devices deployed around the city.

The command center uses customized and integrated views and new video and audio analytics, artificial intelligence and deep learning applications. These applications help recognize number plates, classify vehicles, identify suspicious people and detect anomalies. Thanks to the advanced smart city technology, authorities can better respond to emergency situations and provide much better service. Milestone and Genetec are leading companies who offer video management systems for municipal data centers.

V. HEALTHCARE

5G promises a new health ecosystem, one that can meet patient and healthcare provider needs accurately, efficiently, conveniently, cost-effectively and at scale. 5G networks are poised to transform all critical components of healthcare, a transformation that especially systems around the world.

Since the early days of 5G trials, the technology ‘s potential to transform the medical sector has been frequently cited in scenarios ranging from remote diagnosis to remote surgery. In a GSMA Intelligence survey of mobile operators in early 2020,62 percent of respondents cited telehealth and telemedicine as sectors offering long term business opportunities, 12 percentage points higher than security and almost as high as data analytics systems.

Although surgical procedures performed remotely over mobile networks are still likely many years away, plenty of applications using modern network technology, and systems are being rolled out globally, alongside many other trail projects.

5G has the power to solve many of the problems that have prevented the wider uptake of telemedicine, “In China telemedicine has been studied for 20 years, but communications technology has remained a nig problem. However, 5G will solve a lot of legacy connectivity problem,”. 5G based applications tend to involve AI and big data; for example, the way professionals and patients will be able to access vital pieces of medical information like the results of CT and MRI scans. In the aftermath of the coronavirus pandemic, 5G eMBB technology will enable remote healthcare support and reduce patient exposure to contagious by minimizing in person visits to doctors or healthcare facilities. For patients who can’t easily travel to healthcare providers, 5G will allow the provider to visit them via immersive telepresence systems.

The COVID 19 pandemic has made people realize the advantages of telemedicine and of reducing risk of spreading the virus by travelling to hospitals. “We can use telemedicine to get help from skilled specialists to local hospitals. Patients can stay home and get prescriptions through the internet. Medicines can be delivered to their front door.”

In a project supported by Huawei at the National Telemedicine Center, a remote diagnosis system designed for fighting COVID 19 was set up earlier this year. It connects 147 hospitals covering 1008 counties and 18 cities, aiding collaboration between professionals, allowing better resource allocation, and providing treatment guidance by experts. The system made high quality medical resources and available to remote areas, facilitated remote checks on patients in isolation wards, and powered online workshops with coronavirus experts. Patients and medical centers in towns and counties could help from large hospitals, boosting response capabilities and decreasing the risk of cross infections due to patient transfer.

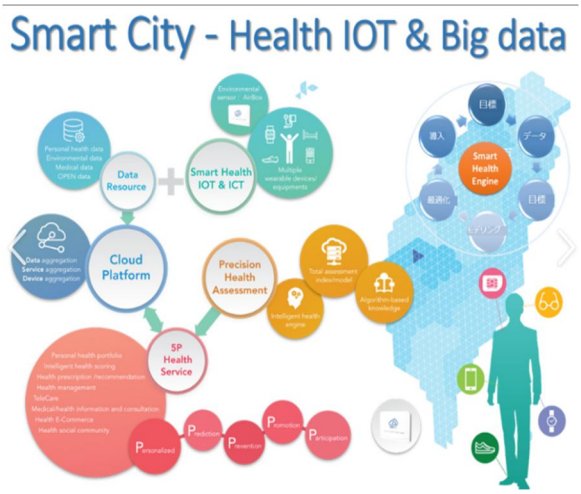


Figure 4: IOT in healthcare to be worth $409.9 Billion by 2022
Much of the connections to be supported by 5G.

VI. SMART WASTE MANAGEMENT

The current situation of smart waste is that there is an increasingly large amount of trash and litter that we as a population create everyday, we throw this away at home or whereover we are, usually in trash cans either inside or out on the street. But, where do people leave their litter when they aren't home and the trash cans on the street are full? Municipalities have a hard time keeping up with these outdoor bins, because it is very difficult to figure out when to empty them or whether they are full or not at all.

A. How Does Smart Waste Management Work?

When it comes to the way this actually works, there are usually two technological parts that work together in order to improve the smart waste management. The first one is physical in nature. Microchips are used to measure all kinds of data, like the times at which the bin receives the most trash as well as how full the bin is.

The second piece is a central software system. All the data that the bin collects is sent here so that it can be used to the advantage of the waste management. When a bin is full, for instance, it will be automatically placed on the route. This way, the pickup service can easily derive the most efficient route. They don't have to check on bins that are not full yet and can empty the ones that are straight way. This reduced the chances of any excess litter being dropped on the street, as well as the amount of greenhouse gases the truck produce.

B. Importance of Smart Waste Management

According to the Environmental Protection Agency (EPA), roughly 75%of the waste stream in the United States is recyclable, but only about 30% of recyclable materials actually get recycled. Considering humans produce just over 2 billion tons of waste each year, that a lot of unnecessary trash ending up in the world's landfills and waterways.

The world's trash problem isn't going away any time soon, and traditional waste management systems aren't equipped to deal with the extra trash produced by growing populations. To help bridge the gap, communities need to adopt smart waste management technologies that increase efficiency, lower collection costs and divert more trash away from landfills.

C. Innovative Technologies Revolutionizing Waste Management

The first step towards creating efficient, sustainable waste management systems is learning why our current ones aren't working. The following technologies combine IoT data analytics with modern solutions to help identify challenges and improve as they go**.**

1) *Smart Waste Bins:* When left to their own devices, people don't always bother to sort their waste into proper waste or recycling bins. To help reduce improper recycling sorting. Polish company Bin-e designed a smart waste bin that uses artificial intelligence based objects recognition to automatically sort recyclables into separate compartments. After sorting, the machine compresses the waste and monitors how full each bin is. Smart waste bins take human error out of the initial sorting process, making material processing faster and easier for recycling facilities. This can lower waste management costs by as much 80% and drastically improve employee efficiency.



Figure 5: Smart Bins

2) *Waste Level Sensors:* Homes and businesses across the country rely on routine waste collection services to dispose of their trash. Weekly services have been around for decades, but they aren't always the most efficient option. To help minimize unnecessary trips to and from landfills, companies and communities can install waste level sensors in bins or dumpsters of any size. These devices collect and store data on fills level, allowing collection services to predict how often bins need to be emptied. This also helps prevent public containers from overflowing and contaminating the surrounding area.
3) *AI Recycling Robots:* Recycling centers play a crucial role in reducing the amount of trash that ends up in landfills each year. However, a reduced workforce during the COVID-19 pandemic has left many centers struggling to keep up with demand.

Fortunately, recycling robots powered by artificial intelligence (AI) can help pick up some of the slack. These robots are designed to accurately identify and sort recyclable materials, increasing efficiency and reducing the need for human workers. This is not only saves recycling centers money over time, but also helps divert materials that would otherwise end up in landfills.



Figure 6: AI Recycling Robots

4) *Garbage Truck Weighing Mechanisms:* Like waste level sensors, weighing mechanisms installed in garbage trucks can help predict fill levels and reduce collection trips. They do this by measuring and storing the weight of waste containers, then the using the data to predict fill levels over time. Cities can use this technology to more accurately predict how often they need to send their trucks out and reduce annual collection costs.
5) *Pneumatic Waste Pipes:* As populations grow in urban areas, so does the need for the waste management solutions can accommodate increasing pneumatic waste disposal bins that connect to a series of underground pipes. Trash travels through the pipes to a waste collection plant where it can be stored or hauled away. This system eliminates the need for traditional waste collection, reduces energy costs and increases overall efficiency.

D. Futuristic Benefits of Smart Waste Solutions

Cities across the globe are implementing smart waste management solutions to help save money and reduce their environmental impact**.**

How Businesses Can Benefits from Smart Waste Tech

1) Companies with comprehensive recycling programs are more likely to attract and retain top talent.
2) Eliminating unnecessary garbage truck trips lowers carbon emissions and reduces transportation costs.
3) Smart waste containers minimize overflow, creating a cleaner and safer working environment for employees.
4) Smart waste technology can reduce collection costs by up to 30% for waste management companies.

VII. CONCLUSION

The smart city agenda entails improving the citizens 'quality of life, strengthening and diversifying the economy while prioritizing environmental sustainability through adoption of smart solutions. Smart city are complex social systems and no technological and data analytics driven solutions along can solve the problems. Smart Cities are the need of the century where everyone's interested in superfast progress and at the same time there is a requirement that the progress becomes sustainable. Thus, smart city is the ideal way in which a country progress.

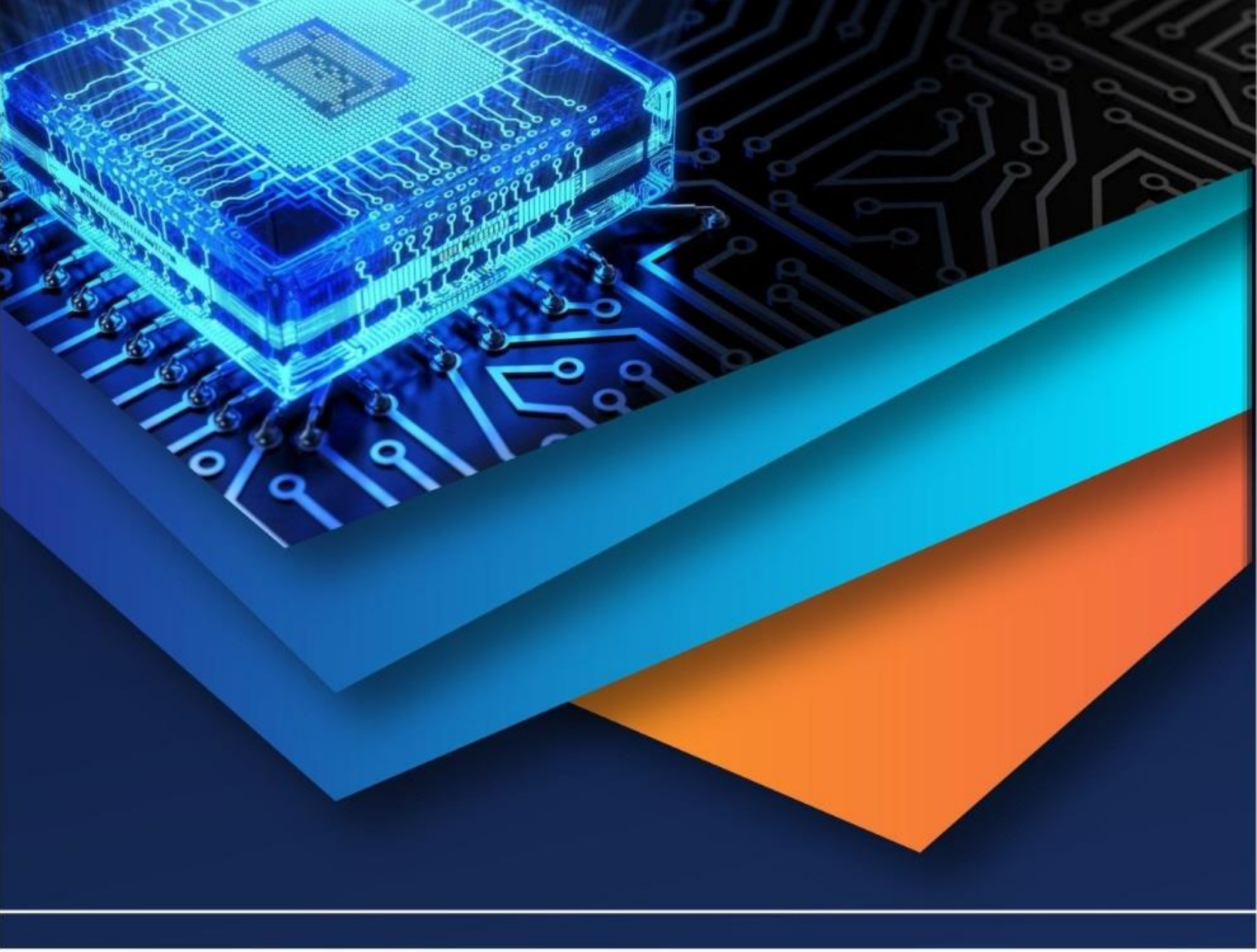
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