TEKTELIC
communications

IoT for Smart Cities

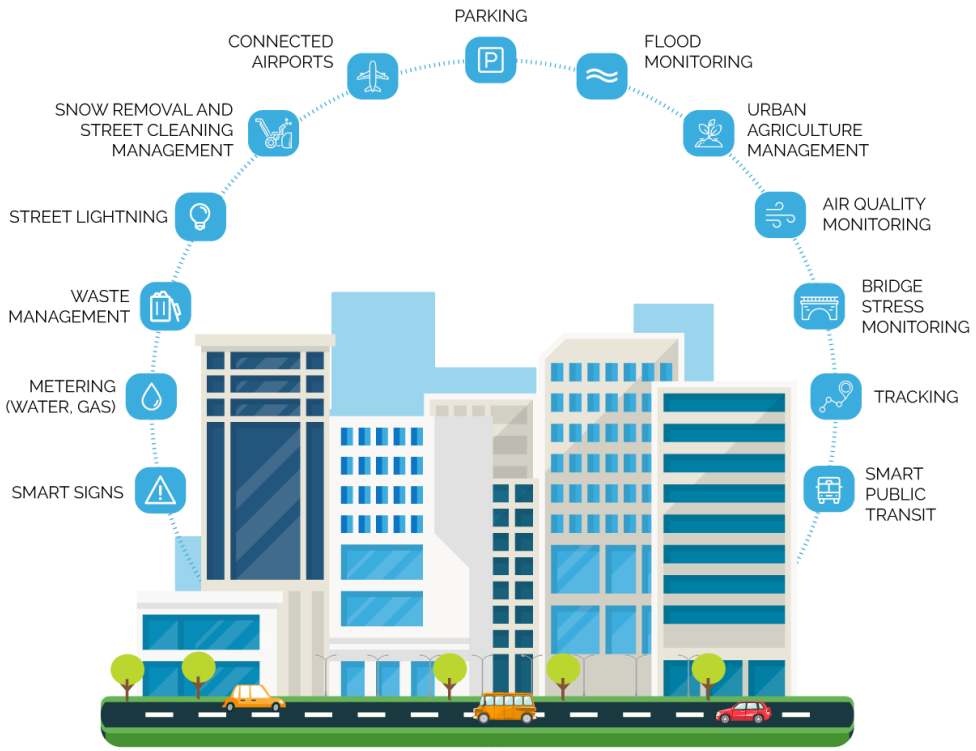
Introduction

For centuries, cities have been key economic and social centers, bringing together people, trade, commerce, and culture. Today, cities are home to over half the world's population, and the UN predicts that this figure will rise to nearly 70% by 2050. A major rural-urban population shift is occurring around the world, and as urbanization ramps up, so does the strain on existing municipal resources, public services, and environmental sustainability. Many cities' infrastructure has neared or surpassed its capacity to accommodate sustainable population growth, and city leaders face increasing pressure to augment their existing infrastructure and public services to deliver a higher quality of life at a sustainable cost.

Historically, governments and municipalities have been behind the curve in terms of embracing technology. However, necessity breeds innovation, and cities are racing to integrate smarter solutions to help mitigate the challenges of increasing urbanization. Around the world, city leaders are becoming comfortable using the Internet of Things (IoT) as the backbone of smart city projects. Many forward-thinking cities, including Calgary and Barcelona, have begun implementing smart city initiatives to achieve measurable improvements in quality of life for citizens, environmental sustainability, and operating budgets.

Smart cities require real-time visibility into all aspects of urban life. To achieve this, smart cities typically utilize wide-area wireless networks to enable connectivity between a vast network of disparate data-generating IoT devices, sensors, and smart meters. Insights generated from this information enable effective, data-driven decision-making, enhancing city resource management and public services, from public transport to waste management.

IoT technologies positively impact many different areas of urban life, including; quality of life, cost-efficiency, and environmental sustainability.

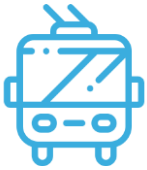


Quality of Life/Public Benefit

Smart cities built upon the Internet of Things are allowing city leaders to reimagine urban life. Digital tools are revolutionizing urban planning, and smart cities aim to make urban life easier by increasing the efficiency, quality, and accessibility of public services. According to a study by McKinsey, cities can achieve measurable improvements in some quality of life indicators of 10-30 percent through the use of IoT and smart city technologies.

There are currently dozens of applications for using IoT solutions to improve the quality of life for smart city citizens, including:

Smart Public Transit



IoT technologies are revolutionizing public transit systems to provide a better, streamlined experience for citizens. Cities committed to modernizing public transit, such as Boston, have seen commuter rail and transit usage increase by more than 3.5%. IoT can help cities collect, analyze, and leverage transit data to reduce delays, optimize routes and schedules, predict and schedule maintenance, and increase the overall reliability of the transit service. Smart public transit will provide citizens with convenient real-time payment options and alerts for service disruptions, delays, and unexpected events.

Smart Traffic

Traffic congestion presents a significant and frustrating challenge to urban residents. Intelligent traffic systems can utilize IoT sensors to monitor the flow of both vehicles and pedestrians to dynamically optimize routes and govern traffic. Real-time updates and alerts for drivers regarding delays can also improve journey times, saving both time and money for citizens. According to a report by McKinsey, smart traffic signals can reduce average commute times by over 5%.

Smart Parking

Smart parking is emerging as one of the most compelling use cases for IoT technologies in urban environments. According to a report by INRIX Research, searching for parking costs Americans $73 billion each year. The report found that drivers in New York City spend an average of 107 hours a year searching for parking, with a cost of $2,2243 per driver in wasted time, fuel, and emissions. Deploying smart sensors in public and private parking lots, on-street

parking bays, and parking meters, enables drivers to be navigated to nearby available spaces and to choose the most efficient payment options. Ultimately, this reduces the stress associated with finding the right parking space, while contributing to less congestion and better utilization of city parking infrastructure.

Smart Signs

Smart cities require an efficient and interactive way to display relevant and timely information to citizens. IoT technologies are enabling smart signage that can deliver real-time, location-based notifications and announcements, from traffic and weather updates to personalized advertisements and news about events going on in the city. Sensors can allow digital signage to dynamically react based on external triggers, such as weather and traffic.

Cost Savings

Using IoT technologies to visualize and analyze comprehensive real-time data, cities can respond dynamically by optimizing asset utilization and allocation of city resources. Cities can integrate IoT into their infrastructure to automate tasks, monitor and manage equipment, and perform predictive maintenance to reduce operational costs. According to a report by ABI Research, smart city IoT technologies could contribute to over $5 trillion in cost savings annually by 2022. Automation, artificial intelligence, along with sensors, data-sharing and analytics, will all be critical in helping cities save costs.

Smart Street Lighting

Street lighting accounts for nearly 40% of many cities' total energy costs. Implementing smart street lighting systems can deliver a return on investment within five years, as smart street lights enable cities to more efficiently manage energy. Smart LED lights can turn on and off intelligently and adjust brightness based on ambient lighting. By centralizing and streamlining the control and maintenance of street lighting, cities can achieve a 70-75% reduction in energy costs, and save around 80% on maintenance costs.

Smart Metering

IoT technology enables a more streamlined approach to water and energy metering operations. By equipping meters with IoT technology, cities can efficiently and remotely collect metering data and drive down costs associated with labour, fuel consumption, and human error.

Tracking of City Fleet Vehicles

Faced with a growing emphasis on reducing fuel consumption, emissions, and maintenance costs, many cities are deploying IoT solutions to track and monitor city fleet vehicles. Equipping fleet vehicles with IoT technologies, including GPS, enables the city to optimize scheduling and routing, resulting in substantial cost savings in labour, fuel consumption, and vehicle maintenance. Common use cases include snow removal, waste management, and street-cleaning vehicles.

Wireless Structural Health Monitoring

IoT technologies can assist in connecting and wirelessly monitoring aging infrastructure in both urban and remote locations, including bridges, tunnels, roads, and railways. Geotechnical sensors can provide operators with real-time data on the structural health of assets to mitigate risk and strategically schedule maintenance and repair. Bridge stress monitoring is an emerging use case for IoT technology in smart cities.

Environmental Sustainability

As urban populations grow, cities face increasing pressure to monitor and measure many sources of environmental data, from waste to pollution levels. A wide range of applications exist for IoT technology to sense and report environmental data, which can be used to create recommendations for environmental sustainability. A report by McKinsey found that IoT solutions can assist cities in reducing emissions by 10–15%, water consumption by 20–30%, and waste per capita by 10–20%.

Waste Management

Waste generation is a growing concern for modern societies, with global annual waste generation expected to rise by 70% to 3.4 billion tons by 2050. Cities such as Singapore, Barcelona, and San Francisco are implementing IoT solutions to promote environmental sustainability and mitigate the environmental impact of waste generation. The most common application of IoT technology in waste management is equipping waste bins with fill-level sensors. These sensors detect when bins are full and send alerts to maintenance personnel. This solution optimizes waste collection routes and reduces operational costs, fuel consumption, and emissions.

The result is a streamlined and efficient waste management system with increased utility, cost-efficiency and environmental value.

Air Quality Monitoring

For cities to manage and improve air quality conditions, pollution levels must be accurately measured and monitored. Cities like Birmingham in the UK are deploying IoT sensors to detect air quality in real time. Insights generated from analyzing air quality data can be used to determine the impact on the environment and citizen health, and develop environmental sustainability initiatives to reduce harmful emissions.

Urban Agriculture Management

Smart urban agriculture is emerging as a viable way to meet the rising food demands in urban environments. Urban farms use space more efficiently and reduce carbon emissions as they do not require long-distance transportation. According to Beecham Research, IoT solutions can increase urban food production by 70%. IoT sensors can track key metrics such as soil moisture, air temperature and humidity, allowing farmers an unprecedented level of control and real-time visibility. Precision agriculture can help urban farmers overcome challenges such as limited space, unreliable sunlight and pollution.

LoRaWAN® for Smart Cities

The breadth of applications for IoT technology to address urban challenges in cities around the world is nearly endless. However, to fully realize the vision of the smart city, the vast spectrum of IoT-enabled devices and sensors must be connected to a network that provides reliable and scalable city-wide coverage at a sustainable cost. Connecting these devices through cabling, LTE cellular, or WiFi connectivity alone is insufficient in meeting the demands of a truly always-connected city. For example, retrofitting city infrastructure to accommodate cabling would be impractical, expensive, and logistically challenging. There are also substantial airtime costs associated with establishing cellular connectivity to tens of thousands of IoT devices across a typical city.

LoRaWAN® has emerged as the ideal technology to address the challenges of smart city initiatives, providing long-range, low power, and secure bi-directional communication and allowing reliable and cost-effective city-wide coverage.

LoRaWAN® is a globally standardized communication protocol that operates in the unlicensed ISM (Industrial, Scientific, Medical) radio spectrum, which reduces operating expenses associated with having licensed wireless connectivity like cellular 4G or LTE for each end device in your network. LoRaWAN® is capable of transmitting over long distances with deep indoor penetration, making it ideal for dense urban environments. One of the primary

benefits of LoRaWAN® technology is it has been proven to result in one-tenth of the power usage, or in the case of battery-powered devices, 10x the battery life of competing M2M technologies.

Not only is LoRaWAN® ideal for long range and low power deployments, its multi-usage capabilities accommodate high device capacity in a single network. A carrier-grade LoRaWAN® collection hub, known as a gateway can have the capacity to simultaneously send and receive hundreds of messages every second from the devices deployed in its vicinity.

Long Range	Maximum Battery Life	Multi Usage	Low Cost
• Greater than cellular • Deep indoor coverage • Star topology	• Low power optimized • 10-20yr lifetime • >10x vs cellular M2M	• High capacity • Multi-tenant • Public/Private network	• Minimal infrastructure • Low cost end-node • Open Software • Growing Eco-system

Geolocalization	Bi-Directional (FDD)	Global Standard	Secure
• In/out door • Accurate • No Battery Impact	• Acknowledge • Scalable Capacity • Broadcast	• Global Standard • True Mobility • Seamless • Roaming	• Unique ID • Application • Network

LoRaWAN® Features, Differentiators and Benefits

Conclusion

Powered by the Internet of Things, today's cities are rapidly deploying smart initiatives to alleviate many of the challenges faced by today's rapidly growing urban populations. The key areas of urban life most significantly impacted by IoT include quality of life for citizens, cost-savings for cities, and environmental sustainability. Not only are cities seeing immediate benefits in these areas, but they are also gathering valuable data to create smart cities that

continuously improve city resource management and public services. IoT technologies and radio solutions such as LoRaWAN® are coming together with existing city infrastructure and systems to deliver massive change on a global scale, in large and small cities alike. As smart cities continue to evolve, today's use cases only demonstrate a glimpse of the innovative smart cities of tomorrow.

Visit www.tektelic.com to learn more about the end-to-end LoRaWAN® solutions being utilized by smart cities around the world today.