LoRaWAN® Sector Reports Series

Leveraging LoRaWAN® for Smart Cities:

Cost-Effective, Scalable, Sustainable Connectivity

LoRa Alliance®

beecham research

Shaping the IoT future

As smart city solutions grow more complex and span wider areas, choosing the right connectivity mix has never been more critical. LoRaWAN® (Long Range Wide Area Network) is emerging as a powerful alternative to traditional options, offering a robust, scalable, energy-efficient, and cost-effective solution for a wide range IoT applications in smart cities.

For solution providers looking to expand their smart city offerings, LoRaWAN provides a complementary technology to existing networks. It integrates easily into hybrid models, working alongside cellular and Wi-Fi, and offers flexibility in deployment through both public and private networks.

This report includes a market analysis and forecast for smart cities growth to 2030, together with details on where and why LoRaWAN is well suited as the IoT connectivity technology for smart city applications. A selection of case studies illustrate the growing use of LoRaWAN for a wide range of smart city applications in all regions worldwide.

What are smart cities about?

Smart City projects differ from IoT projects in other market segments in that they cover a lot of application areas, are larger scale, and entail many participants and skillsets. Cities globally differ widely in terms of size, reach, populations, geography and business areas. City IoT projects are high level and ambitious: they aim to improve urban infrastructure, public services, citizens' quality of life, enhance public safety and stimulate economic growth. Also, in recent years cities worldwide have come to the realisation that resources are not infinite, and that all projects must have sustainability in mind.

In the twenty first century, the workings of smart cities will be based on their digital infrastructure and the data generated from this. How this data is analysed, managed and used for decision making will provide the best value for the cities and their citizens. It is therefore essential that city governments understand the future needs of citizens, and put in place systems that will support these needs in an integrated and sustainable way.

> ***"A smart city can start with one building or several buildings ...you have roads, then you have pipelines, energy pipelines, water concerns, everything. But this is only infrastructure; then you have another type of smart city, this is all about processes, admianistration, and what the city does for the citizens. This is why we are involved in the Internet of Things and digitization for smart cities: we want more value for the citizens, we want to save resources, breathe clean air and have better services."***
>
> Boris Stöckermann: Chair, Smart Cities Work Group LoRa Alliance

Drivers towards smart cities are evident at several levels, with **Figure 1** illustrating some of the key factors at each of these levels.

Regarding economic imperatives, global evidence shows that if well-managed, cities can spur economic development by boosting incentives for investment through higher economic density and proximity – to support clusters of firms, and to more efficiently connect workers with jobs and opportunities.

Regarding regulatory imperatives, in 2015 for example, Heads of all 193 United Nations (U.N.) Member States adopted the Sustainable Development Agenda, which includes a total of 17 Sustainable Development Goals (SDGs) with numerous indicators to building a more sustainable, safer, more prosperous planet for all humanity by 2030. Regulations in other areas are also increasing, for example air and water quality, as well as the recognition of noise as a health hazard.

The execution of these complex concepts required across the whole city is then at a higher level. These include such areas as sustainability and resilience, energy usage and monitoring, and flood monitoring.

New technologies and analytics are then applied to specific application areas.

Figure 1. *Smart city drivers are at several levels*

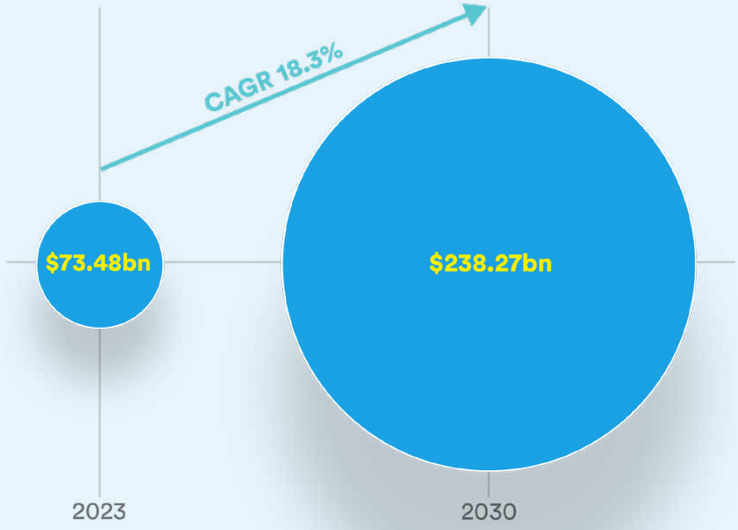
IoT in smart cities is a big growth market

Some 56% of the world population lives in cities and the United Nations predicts that this will increase to 66% by 2050, placing increasing pressure on resources, services and infrastructure.

As such, governments are increasingly turning to technology to manage the running of urban areas. To illustrate this, the Xiangtan municipal government of China secured a loan of USD200 million in 2020 to invest in their smart city program. Meanwhile, in 2022, the Singapore government deployed solar panels on the roofs of 6,000 buildings intended to provide energy-efficient lighting for every public road.

Beecham Research estimates that the global IoT smart city market accounted for 22% of the total IoT revenue in 2023, attaining a value of USD 73.5 billion. Annual growth is expected to occur at a rate of 18.3%, leading to a market value of USD 238.3 billion in 2030.

Figure 2. *Global IoT Smart Cities*



This market valuation is inclusive of six smart city activity segments, each of which includes applications relevant to the use of LoRaWAN :

City Services including cleaning equipment, heating/ cooling, energy balancing, garbage trucks and, utility services

Environmental including air quality, climate monitoring, flood monitoring, leak detection, smoke detection, water quality

ICT including cloud/edge computing, IoT platforms and IT systems

Lighting including campus/stadia, highways, residential and digital signage

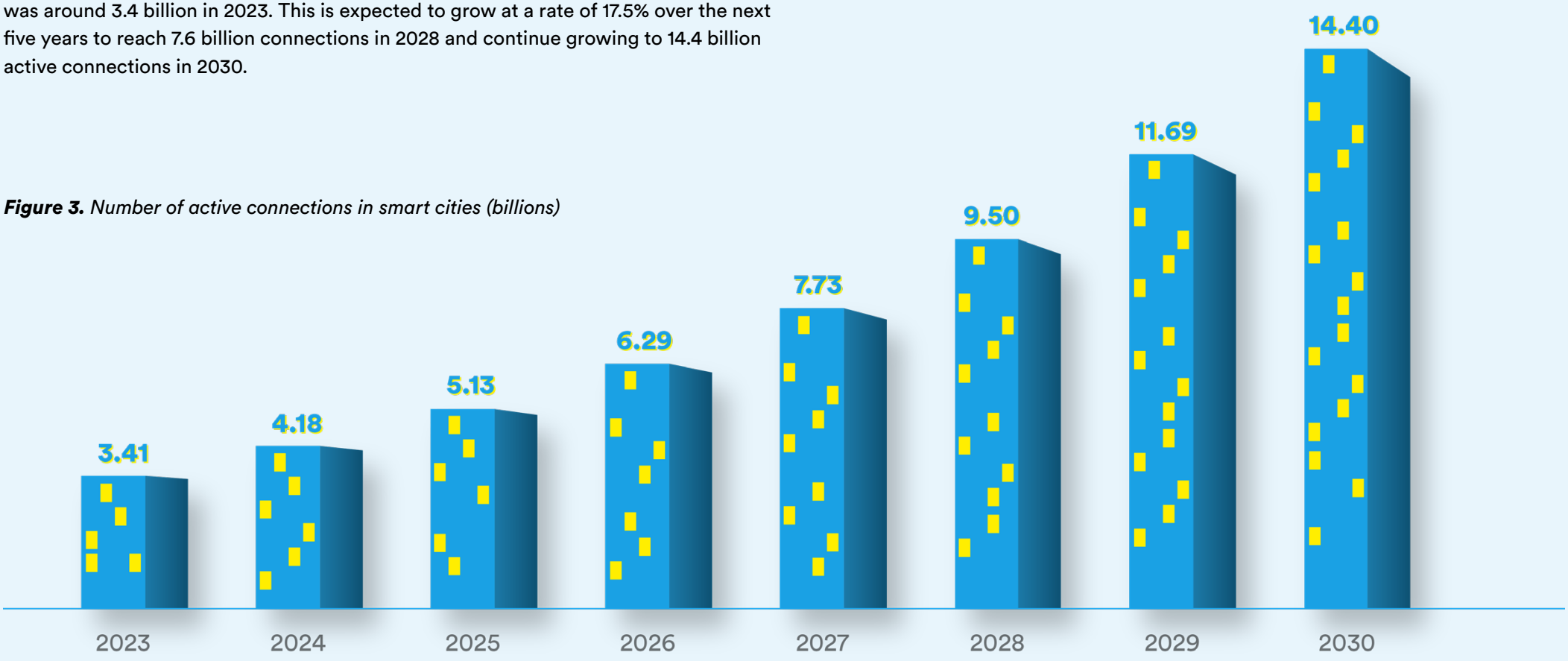
Public Safety & Security including backup power, disaster planning, emergency vehicles & equipment, evacuation strategies and panic buttons for active shooter

Transportation & Infrastructure including EV charging, fleet management & tracking, Intelligent traffic management, passenger information, parking and ticketing

The number of different applications in each of these segments is rapidly increasing, while many are also becoming more complex. However, they do not include a wide range of other IoT application areas, such as industrial IoT, healthcare IoT, smart buildings or smart homes. Transport and infrastructure refers to the management of traffic within a city, through smart traffic lights, parking and digital signage, rather than the vehicles themselves.

Beecham Research estimates that the number of active connections in smart cities was around 3.4 billion in 2023. This is expected to grow at a rate of 17.5% over the next five years to reach 7.6 billion connections in 2028 and continue growing to 14.4 billion active connections in 2030.

Figure 3. *Number of active connections in smart cities (billions)*



Why LoRaWAN® is well suited as the IoT connectivity technology for smart cities

The following are key reasons why LoRaWAN® is well suited to low data rate smart city applications.

1. Technology

Long Range: LoRaWAN networks can penetrate dense urban or deep indoor environments, and up to 30 miles in rural areas. LoRaWAN works by battery-operated devices sending small amounts of data at infrequent intervals to the Internet. It requires minimal energy, with a prolonged battery lifetime of up to 10 years, minimizing battery replacement costs.

Devices broadcast data via radio waves to a nearby LoRaWAN gateway. The gateway forwards the data to an Internet server, which relays the data to an application in the Cloud or a data centre.

LoRaWAN networks can co-exist with other wireless networks including public wireless, private wireless, satellite & hybrid networks; hybrid solutions may utilise both low data rate and high data rate connectivity technologies like cellular. They are complementary with Wi-Fi, Bluetooth, 5G, RFID, and BACnet, making IoT deployments more responsive to particular needs.

Remote monitoring operations suit these actions, and LoRaWAN is ideal for low data rate applications. LoRaWAN is also suited to event driven measurements or alerts; in each sensor application example, there is some event or state change that the sensor is trying to capture.

2. Security

LoRaWAN is considered secure by default; it uses two layers of 128-bit encryption to secure data sent from devices. One encryption key authenticates the device against the network server and the other against the backend application. LoRaWAN security is designed to fit the general LoRaWAN design criteria: low power consumption, low implementation complexity, low cost and high scalability. As devices are deployed in the field for long periods of time (years), security must be future-proof.

3. Deployments

LoRaWAN® networks need minimal cost for deployment. They are high capacity, supporting millions of messages per gateway, meeting the needs of public network operators serving large markets. LoRaWAN networks can simplify IoT setups; it is easier to install a few gateways in a contained area rather than installing many Wi-Fi routers or fitting SIM cards into each individual device.

LoRaWAN sensors may be added to both new and existing construction and integrating with legacy building management systems (BMS).

LoRaWAN is an open standard backed by a large ecosystem of vendors, giving project managers a wide variety of solutions that can be tailored to meet their specific needs. It also means that project managers do not need to worry about being “locked-in” to a single vendor, ensuring flexibility over the city solution’s lifetime.

Firmware Update Over the Air (FUOTA) is a standard for distributing firmware updates using unicast or multicast messages. Its greatest benefit is delivering updates over the air to many devices at the same time in an efficient and secure manner, without disrupting operations. It also provides future-proofing of connected device deployments, ensuring that devices will continue to operate over long lifetimes.

4. Device Certification

As an internationally recognized standard, LoRaWAN offers device interoperability and global availability for speedy deployment of IoT applications.

LoRaWAN certification of IoT devices ensures devices made by different OEMs operate correctly with each other once they are deployed in the field; interoperability between different OEMs’ products is critical to growing the LoRaWAN market. A LoRaWAN Certified℠ mark indicates that a LoRaWAN device has been tested, de-bugged, and will function on any LoRaWAN-compliant network.

Figure 4. *Key Properties of LoRaWAN®*

Smart city IoT applications most suitable for LoRaWAN®

With these properties in mind, LoRaWAN® is considered by industry players to be most suitable for the following smart city IoT applications:

- Public services including waste collection and disposal, street cleaning, city wayfinding systems
- Smart parking (public spaces) and EV charging stations
- Water management – supply for buildings and public areas, floods management, city managed utilities
- Environmental sensing - indoor air quality management, fire risk management; outdoor air pollution
- Street lighting management
- Sustainability monitoring
- Energy management including detecting overuse of heating and lighting
- Heating, ventilation and air conditioning (HVAC) in large public buildings – updates expected with climate change
- Vertical transportation – smart elevators
- Smart roads infrastructure

In addition to this, a recent survey conducted by Beecham Research of solution providers specializing in smart city solutions indicated current priorities. **Figure 5** combines two questions in the survey – the highest priority low data rate applications for smart cities now and in three years' time. Of these, water management and environmental sensing scored highest now and higher in 3 years. While street lighting was considered important now, it would be overtaken by sustainability monitoring in 3 years, which had the largest change in score between the two time periods. Public services had about the same score across the two periods but smart parking declined in the 3 years' time view. The decline in priority for smart parking and street lighting in 3 years' time may reflect that both of these are often recognised as being addressed early in smart city implementations, so may already have been implemented by then.

Figure 5. *Which of the following LOW DATA RATE IoT applications do you consider to be highest priority for smart cities now/in three years' time?*

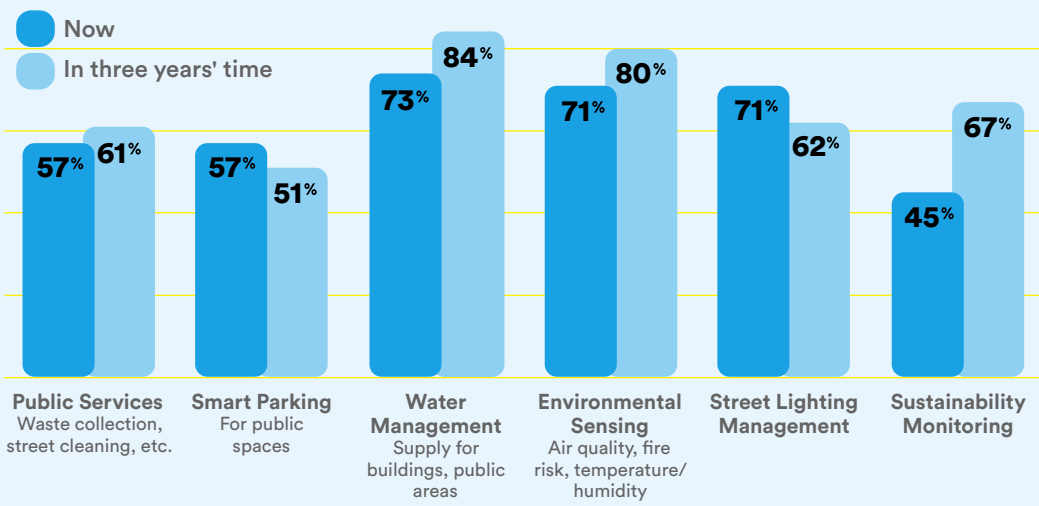
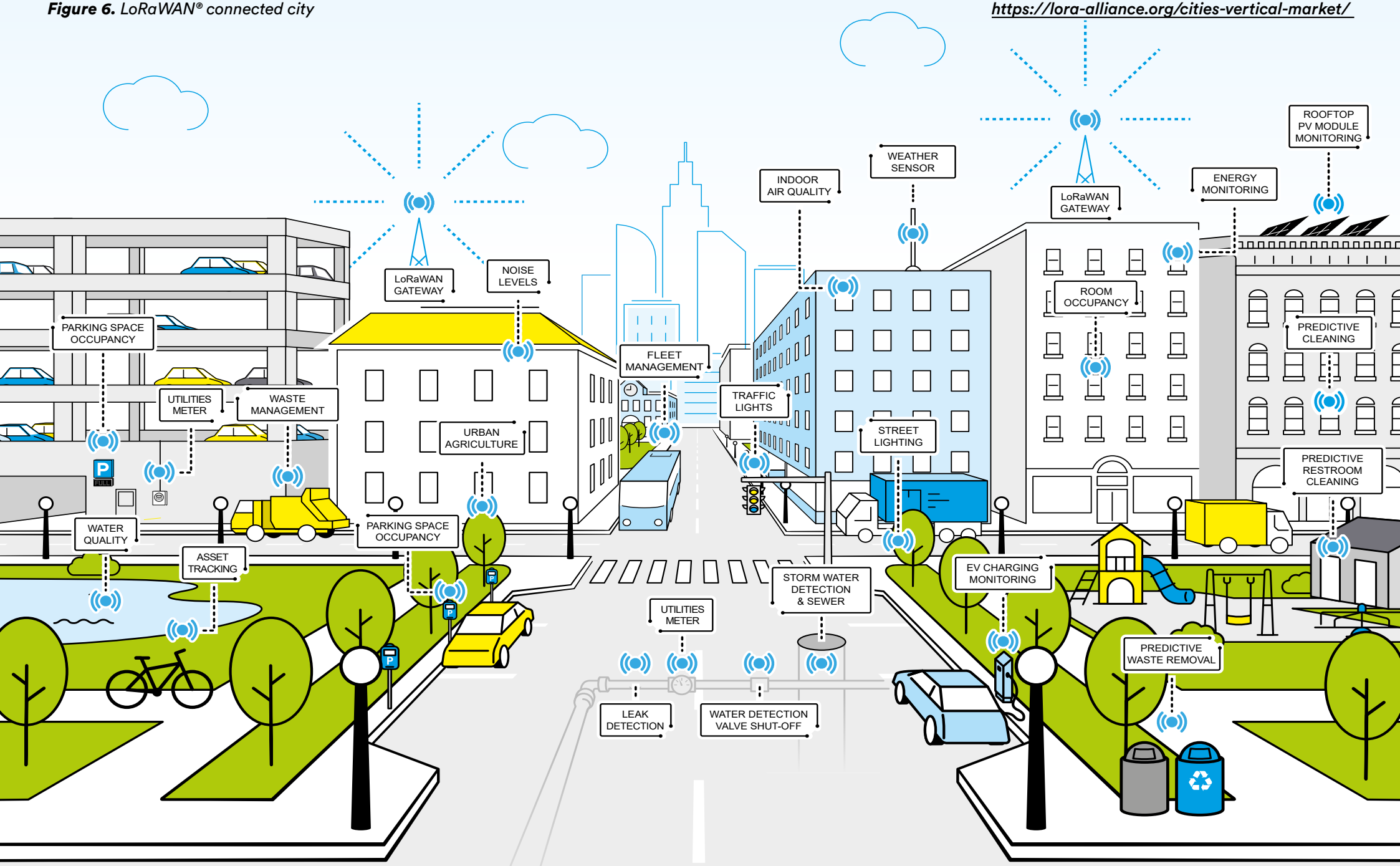


Figure 6. *LoRaWAN® connected city*

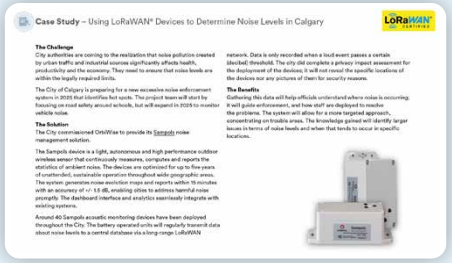
https://lora-alliance.org/cities-vertical-market/



Example Case Studies

Use cases implemented by smart cities have grown over the years, from relatively simple point solutions (e.g. smart parking) to complex cases addressing - for example - the climate emergency and reducing wastage in precious resources like water. In this report we are highlighting case studies in the following areas:

Traffic noise monitoring in Calgary



Case Study – Using LoRaWAN® Devices to Determine Noise Levels in Calgary

The Challenge

City authorities are coming to the realization that noise pollution created by urban traffic and industrial sources significantly affects health, productivity and the economy. They need to ensure that noise levels are within the legally required limits.

The City of Calgary is preparing for a new excessive noise enforcement system in 2025 that identifies hot spots. The project team will start by focusing on road safety around schools, but will expand in 2026 to monitor vehicle noise.

The Solution

The City commissioned OrbiWise to provide its Senspods noise management solution.

The Senspods device is a light, autonomous and high performance outdoor wireless sensor that continuously measures, computes and reports the statistics of ambient noise. The devices are optimized for up to five-years of unattended, sustainable operation throughout wide geographic areas. The system generates noise evolution maps and reports within 15 minutes with an accuracy of +/- 1.5 dB, enabling cities to address harmful noise promptly. The dashboard interface and analytics seamlessly integrate with existing systems.

Around 40 Senspods acoustic monitoring devices have been deployed throughout the City. The battery operated units will regularly transmit data about noise levels to a central database via a long-range LoRaWAN network. Data is only recorded when a loud event passes a certain (decibel) threshold. The city did complete a privacy impact assessment for the deployment of the devices; it will not reveal the specific locations of the devices nor any pictures of them for security reasons.

The Benefits

Gathering this data will help officials understand where noise is occurring. It will guide enforcement, and how staff are deployed to resolve the problems. The system will allow for a more targeted approach, concentrating on trouble areas. The knowledge gained will identify larger issues in terms of noise levels and when that tends to occur in specific locations.

Smart parking solutions in Huntington Park

Case Study – City of Huntington Park Implements Smart Parking Solution Using LoRaWAN®

The Challenge

Parking in a busy urban environment is a common struggle. Huntington Park faced growing congestion, fewer available parking spaces, and outdated payment systems that frustrated drivers. Manually operated meters often required coins, a method that was increasingly inconvenient for citizens. Additionally, city enforcement officials needed a better system to monitor parking availability and ensure timely payments. The city aimed to solve these issues by introducing a new parking system that would enhance efficiency and usability for all parties involved.

The Solution

To bring this vision to life, Huntington Park partnered with Nobel Systems, an expert in cloud technologies and IoT solutions. Nobel Systems proposed a solution that leveraged LoRaWAN technology, renowned for its low power consumption and long-range communication capabilities. The Helium Network, the world's largest public LoRaWAN network, and MultiTech Conduit® IP67 Gateway were selected to provide seamless wireless connectivity.

The smart parking system used PNI PlacePod sensors embedded in the ground at parking spots. These sensors, paired with LoRaWAN technology, communicate real-time parking availability through Nobel Systems' GeoViewer Parking app.

The system provided Huntington Park with a scalable, cost-effective solution that didn't require extensive new infrastructure. LoRaWAN's long-range communication capabilities reduced the number of gateways needed, lowering deployment costs.

The Benefits

Improved Parking Experience: Huntington Park now has sensors deployed at all 1,460 parking spots, giving residents and visitors real-time access to parking availability through the GeoViewer app. This has significantly reduced the time spent searching for parking.

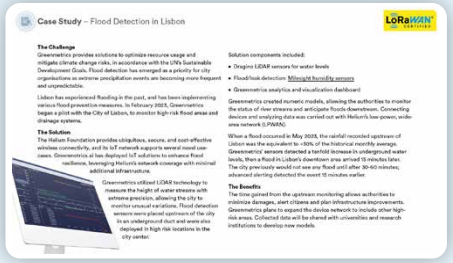
Efficient Payments: The city now offers easy, cashless parking payments, simplifying the process for drivers and allowing the city to track and enforce parking regulations more effectively.

Scalability: The LoRaWAN-powered system is highly scalable. With minimal infrastructure, the city can easily add additional sensors as needed. This flexibility ensures that Huntington Park can grow its smart parking system to meet future demands without significant new investments.

Operational Cost Savings: By reducing the number of gateways needed for the system and enabling remote monitoring, the city has lowered the operational costs associated with maintaining its parking infrastructure.

Huntington Park's successful implementation of this smart parking system demonstrates how LoRaWAN technology can revolutionize urban infrastructure, improving the quality of life for citizens while reducing costs

Flood management and water leaks in Lisbon



Case Study – Flood Detection in Lisbon

The Challenge

Greenmetrics provides solutions to optimize resource usage and mitigate climate change risks, in accordance with the UN's Sustainable Development Goals. Flood detection has emerged as a priority for city organizations as extreme precipitation events are becoming more frequent and unpredictable.

Lisbon has experienced flooding in the past, and has been implementing various flood prevention measures. In February 2023, Greenmetrics began a pilot with the City of Lisbon, to monitor high risk flood areas and drainage systems.

The Solution

The Hallam Foundation provides ubiquitous, secure, and cost-effective wireless connectivity, and its IoT network supports several novel use-cases. Greenmetrics at has deployed IoT solutions to enhance flood resilience, leveraging Helium's network coverage with minimal additional infrastructure.

Greenmetrics utilized LiDAR technology to measure the height of water streams with extreme precision, allowing the city to monitor unusual variations. Flood detection sensors were placed upstream of the city in an underground duct and were also deployed in high risk locations in the city center.

Solution components included:

- Dingtrio LiDAR sensors for water levels
- Flood/leak detection Milesight humidity sensors
- Greenmetrics analytics and visualization dashboard

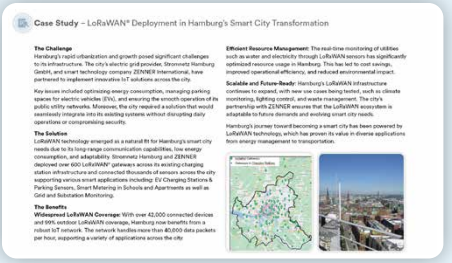
Greenmetrics created numeric models, allowing the authorities to monitor the status of river streams and anticipate floods downstream. Connecting devices and analyzing data was carried out with Helium's low-power, wide-area network (LPWAN).

When a flood occurred in May 2023, the rainfall recorded upstream of Lisbon was the equivalent to ~30% of the historical monthly average. Greenmetrics' sensors detected a rainfall increase in underground water levels, then a flood in Lisbon's downtown area arrived 15 minutes later. The city previously would not see any flood until after 30-60 minutes; advanced alerting detected the event 15 minutes earlier.

The Benefits

The time gained from the upstream monitoring allows authorities to minimize damages, alert citizens and plan infrastructure improvements. Greenmetrics plans to expand the device network to include other high-risk areas. Collected data will be shared with universities and research institutions to develop new models.

Smart city transformation in Hamburg



Case Study – LoRaWAN® Deployment in Hamburg's Smart City Transformation

The Challenge

Hamburg's rapid urbanization and growth posed significant challenges to its infrastructure. The city's electric grid provider, Stromnetz Hamburg GmbH, and smart technology company ZENNER International, have partnered to implement innovative IoT solutions across the city.

Key issues included optimizing energy consumption, managing parking spaces for electric vehicles (EVs), and ensuring the smooth operation of its public utility networks. Moreover, the city required a solution that would seamlessly integrate into its existing systems without disrupting daily operations or compromising security.

The Solution

LoRaWAN technology emerged as a natural fit for Hamburg's smart city needs due to its long-range communication capabilities, low energy consumption, and adaptability. Stromnetz Hamburg and ZENNER deployed over 600 LoRaWAN® gateways across its existing charging station infrastructure and connected thousands of sensors across the city supporting various smart applications including: EV Charging Stations & Parking Sensors, Smart Metering in Schools and Apartments as well as Grid and Substation Monitoring.

The Benefits

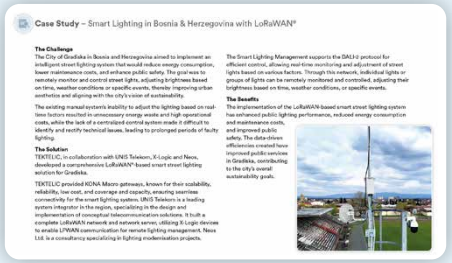
Widespread LoRaWAN Coverage: With over 42,000 connected devices and 99% outdoor LoRaWAN coverage, Hamburg now benefits from a robust IoT network. The network handles more than 40,000 data packets per hour, supporting a variety of applications across the city

Efficient Resource Management: The real-time monitoring of utilities such as water and electricity through LoRaWAN sensors has significantly optimized resource usage in Hamburg. This has led to cost savings, improved operational efficiency, and reduced environmental impact.

Scalable and Future-Ready: Hamburg's LoRaWAN infrastructure continues to expand, with new use cases being tested, such as climate monitoring, lighting control, and waste management. The city's partnership with ZENNER ensures that the LoRaWAN ecosystem is adaptable to future demands and evolving smart city needs.

Hamburg's journey toward becoming a smart city has been powered by LoRaWAN technology, which has proven its value in diverse applications from energy management to transportation.

Street lighting in Bosnia & Herzegovina



Case Study – Smart Lighting in Bosnia & Herzegovina with LoRaWAN®

The Challenge

The City of Gradiska in Bosnia and Herzegovina aimed to implement an intelligent street lighting system that would reduce energy consumption, lower maintenance costs, and enhance public safety. The goal was to remotely monitor and control street lights, adjusting brightness based on time, weather conditions or specific events, thereby improving urban aesthetics and aligning with the city's vision of sustainability.

The existing manual systems inability to adjust the lighting based on real-time factors resulted in unnecessary energy waste and high operational costs, while the lack of a centralized control system made it difficult to identify and rectify technical issues, leading to prolonged periods of faulty lighting.

The Solution

TEKTELIC, in collaboration with UNIS Telekom, X-Logic and Neos, developed a comprehensive LoRaWAN®-based smart street lighting solution for Gradiska.

TEKTELIC provided KONA Macro gateways, known for their scalability, reliability, low cost, and coverage and capacity, ensuring seamless connectivity for the smart lighting system. UNIS Telekom is a leading system integrator in the region, specializing in the design and implementation of conceptual telecommunication solutions. It built a complete LoRaWAN network and network server, utilizing X-Logic devices to enable LPWAN communication for remote lighting management. Neos Ltd. is a consultancy specializing in lighting modernisation projects.

The Smart Lighting Management supports the DALI-2 protocol for efficient control, allowing real-time monitoring and adjustment of street lights based on various factors. Through this network, individual lights or groups of lights can be remotely monitored and controlled, adjusting their brightness based on time, weather conditions, or specific events.

The Benefits

The implementation of the LoRaWAN-based smart street lighting system has enhanced public lighting performance, reduced energy consumption and maintenance costs, and improved public safety. The data-driven efficiencies created have improved public services in Gradiska, contributing to the city's overall sustainability goals.

Waste bins monitoring in Canada

Case Study – Smart Garbage Can Level Sensing Solution

The Challenge

In North America, the EPA regulates household and industrial wastes under the Resource Conservation and Recovery Act (RCRA). This aims to protect citizens from the hazards of waste disposal, while conserving energy and natural resources.

The Solution

Canadian based X-Telia offers X-TRASH for real-time garbage can fill level monitoring. X-TRASH allows waste collectors to remotely monitor the level of waste in their garbage cans, sending real-time notifications when the levels reach a critical threshold. The system also detects fire in the can, and the position of the lid.

X-TRASH can be accessed from any mobile device. The system generates reports regarding the fill levels of the reservoirs which are easy to integrate into other systems.

The solution uses battery-powered wireless sensors, with a battery life over 10 years; these can be installed on different sizes of garbage cans, bins or containers. The system is compatible with LoRaWAN® or cellular wireless technologies, and require no additional local electricity supply.

X-TRASH can be easily integrated into existing systems for more efficient and transparent waste-level management. It uses advanced encryption technology to ensure the security of level monitoring data, and data is hosted in a world-class data center.

The Benefits

Waste collectors can reduce collection costs by 40-60%, while cutting down on travel and greenhouse gas emissions. By optimizing operations, collectors can save costs and unnecessary truck movements or emergency emptying. X-TRASH also facilitates inventory management, allowing collectors to track and manage their container inventory in real-time, facilitating maintenance and collection planning.

Smart building transformation in Singapore

Case Study – Suntec City Office Towers in Singapore Embarks on Smart Building Transformation with LoRaWAN®

The Challenge

Suntec City, an iconic commercial complex in Singapore's Marina Bay Precinct, is undergoing a major infrastructure upgrade as part of its mission to enhance tenant comfort and environmental sustainability. The project focuses on upgrading Suntec City's Air-Conditioning and Mechanical Ventilation (ACMV) systems and deploying a cutting-edge indoor air quality (IAQ) monitoring solution to ensure consistently high air quality standards across its extensive 300,000 square meters of office space while optimizing energy consumption. The project also required a robust communication network to manage real-time data collection and system monitoring seamlessly across all five office towers.

The Solution

Unalto partnered with U-Team Engineering to overhaul Suntec City's ACMV systems and implement an advanced IAQ monitoring network, integrating Milesight's IAQ sensors and LoRaWAN gateways with Actility's ThingPark Enterprise platform. The deployment includes:

1. Replacement of Air-Handling Units (AHUs)
2. Installation of Variable Air Volume (VAV)
3. Deployment of IAQ Sensors and LoRaWAN Network

Actility, a key partner in this project, provided the LoRaWAN IoT mediation platform to ensure reliable wireless communication across the entire Suntec City complex. Actility's platform supports seamless data transmission from the IAQ sensors, allowing building managers to monitor air quality and system performance continuously.

The Benefits

Improved Air Quality in Singapore's Central Business District: With real-time IAQ monitoring powered by Milesight's advanced nine-in-one sensors, Suntec City can ensure consistent air quality standards, creating a healthier environment for tenants and visitors alike. The system continuously tracks air quality metrics, enabling building managers to address fluctuations proactively.

Energy Efficiency and Reduced Carbon Emissions: The integration of the new AHUs, VAV controllers, and real-time data from the IAQ system has optimized the ACMV system's efficiency, resulting in lower energy consumption. Steven Kong, senior manager of operations at AIPM Property Management, noted that the system helps maintain stable temperature and air quality while contributing to Suntec City's environmental sustainability goals by reducing energy usage and carbon emissions.

Data-Driven Building Management: The combination of LoRaWAN technology and Actility's ThingPark platform provides actionable insights that enable Suntec City to optimize building operations. With remote monitoring capabilities, building managers can reduce the need for manual inspections and improve the overall efficiency of maintenance processes.

Scalability for Future Smart City Initiatives: The deployment of LoRaWAN technology positions Suntec City for future smart building innovations. The network can easily support additional IoT applications, such as smart lighting and energy management, further contributing to Suntec City's sustainability goals.

Smart street lighting in India

Case Study – Tata Communications' Smart Lighting Solution in India Using LoRaWAN®

The Challenge

In cities across India, maintaining streetlights is a labor-intensive and expensive process. Traditional lighting systems often remain on longer than required, wasting energy and increasing operational costs. Moreover, frequent manual inspections to ensure proper lighting functionally contribute to higher fuel consumption and increased carbon emissions. Tata Communications sought to create a more efficient, sustainable solution for Indian cities that could be easily deployed with minimal infrastructure investment.

The Solution

Harnessing the power of LoRaWAN, Tata Communications developed a smart street lighting solution that enables Indian cities to remotely control streetlights through a centralized platform. This innovative system offers:

- Auto-scheduling and Lamp Dimming
- Remote Monitoring and Control
- Scalability Across Indian Cities

The Benefits

Energy Savings in India: By automating streetlight operations, Indian cities utilizing Tata Communications' smart lighting solution have achieved energy savings of up to 30%. The combination of auto-scheduling and dimming during off-peak hours optimizes electricity consumption and cuts down costs.

Operational Efficiency: With remote monitoring, the need for frequent manual field visits is reduced, resulting in up to a 30% reduction in operations and maintenance costs. This allows Indian cities to manage streetlighting networks more efficiently.

Enhanced Safety: The system ensures that streetlights provide optimal illumination when and where it's needed, improving the safety of citizens and public spaces across Indian cities. Lighting levels can be adjusted remotely based on real-time data.

Sustainability Impact in India: Tata Communications' smart streetlighting solution has contributed significantly to the reduction of greenhouse gas (GHG) emissions in India. By automating lighting control and minimizing fuel consumption from manual inspections, the solution has reduced GHG emissions by more than 20,000 metric tons of CO_2 equivalent ($MTCO_2e$) in India to date.

Tata Communications' smart lighting solution, powered by LoRaWAN, is transforming urban infrastructure across India. The solution's combination of energy efficiency, reduced operational costs, and enhanced public safety positions it as a critical enabler of India's smart city initiatives. By leveraging IoT technology, Tata Communications is helping Indian cities reduce their environmental impact while improving urban life.

Case Study – Using LoRaWAN® Devices to Determine Noise Levels in Calgary

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The Solution
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The Sampols device is a light, autonomous and high performance outdoor wireless sensor that continuously measures, computes and reports the statistics of ambient noise. The devices are optimized for up to five years of unattended, sustainable operation throughout wide geographic areas. The system generates noise evolution maps and reports within 15 minutes with an accuracy of +/- 1.5 dB, enabling cities to address harmful noise promptly. The dashboard interface and analytics seamlessly integrate with existing systems.

Around 40 Sampols acoustic monitoring devices have been deployed throughout the City. The battery operated units will regularly transmit data about noise levels to a central database via a long-range LoRaWAN network. Data is only recorded when a loud event passes a certain (decibel) threshold. The city did complete a privacy impact assessment for the deployment of the devices; it will not reveal the specific locations of the devices nor any pictures of them for security reasons.

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As part of its broader smart city initiative the City of Calgary operates several LoRaWAN projects, supported by its city-owned, carrier-grade LoRaWAN network. Calgary's network is expected to continue growing as more IoT applications are deployed in:

- Soil and Water Monitoring
- Golf Course Management
- Air Quality and Flood Monitoring.

Case Study – City of Huntington Park Implements Smart Parking Solution Using LoRaWAN®

The Challenge

Parking in a busy urban environment is a common struggle. Huntington Park faced growing congestion, fewer available parking spaces, and outdated payment systems that frustrated drivers. Manually operated meters often required coins, a method that was increasingly inconvenient for citizens. Additionally, city enforcement officials needed a better system to monitor parking availability and ensure timely payments. The city aimed to solve these issues by introducing a new parking system that would enhance efficiency and usability for all parties involved.

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To bring this vision to life, Huntington Park partnered with Nobel Systems, an expert in cloud technologies and IoT solutions. Nobel Systems proposed a solution that leveraged LoRaWAN technology, renowned for its low power consumption and long-range communication capabilities. The Helium Network, the world's largest public LoRaWAN network, and MultiTech Conduit® IP67 Gateway were selected to provide seamless wireless connectivity.

The smart parking system used PNI PlacePod sensors embedded in the ground at parking spots. These sensors, paired with LoRaWAN technology, communicate real-time parking availability through Nobel Systems' GeoViewer Parking app.

The system provided Huntington Park with a scalable, cost-effective solution that didn't require extensive new infrastructure. LoRaWAN's long-range communication capabilities reduced the number of gateways needed, lowering deployment costs.

The Benefits

Improved Parking Experience: Huntington Park now has sensors deployed at all 1,460 parking spots, giving residents and visitors real-time access to parking availability through the GeoViewer app. This has significantly reduced the time spent searching for parking.

Efficient Payments: The city now offers easy, cashless parking payments, simplifying the process for drivers and allowing the city to track and enforce parking regulations more effectively.

Scalability: The LoRaWAN-powered system is highly scalable. With minimal infrastructure, the city can easily add additional sensors as needed. This flexibility ensures that Huntington Park can grow its smart parking system to meet future demands without significant new investments.

Operational Cost Savings: By reducing the number of gateways needed for the system and enabling remote monitoring, the city has lowered the operational costs associated with maintaining its parking infrastructure.

Huntington Park's successful implementation of this smart parking system demonstrates how LoRaWAN technology can revolutionize urban infrastructure, improving the quality of life for citizens while reducing costs

Case Study – Flood Detection in Lisbon

The Challenge

Greenmetrics provides solutions to optimize resource usage and mitigate climate change risks, in accordance with the UN's Sustainable Development Goals. Flood detection has emerged as a priority for city organisations as extreme precipitation events are becoming more frequent and unpredictable.

Lisbon has experienced flooding in the past, and has been implementing various flood prevention measures. In February 2023, Greenmetrics began a pilot with the City of Lisbon, to monitor high-risk flood areas and drainage systems.

The Solution

The Helium Foundation provides ubiquitous, secure, and cost-effective wireless connectivity, and its IoT network supports several novel use-cases. Greenmetrics.ai has deployed IoT solutions to enhance flood resilience, leveraging Helium's network coverage with minimal additional infrastructure.

Greenmetrics utilized LiDAR technology to measure the height of water streams with extreme precision, allowing the city to monitor unusual variations. Flood detection sensors were placed upstream of the city in an underground duct and were also deployed in high risk locations in the city center.

Solution components included:

- Dragino LiDAR sensors for water levels
- Flood/leak detection: Milesight humidity sensors
- Greenmetrics analytics and visualization dashboard

Greenmetrics created numeric models, allowing the authorities to monitor the status of river streams and anticipate floods downstream. Connecting devices and analyzing data was carried out with Helium's low-power, wide-area network (LPWAN).

When a flood occurred in May 2023, the rainfall recorded upstream of Lisbon was the equivalent to +30% of the historical monthly average. Greenmetrics' sensors detected a tenfold increase in underground water levels, then a flood in Lisbon's downtown area arrived 15 minutes later. The city previously would not see any flood until after 30-60 minutes; advanced alerting detected the event 15 minutes earlier.

The Benefits

The time gained from the upstream monitoring allows authorities to minimize damages, alert citizens and plan infrastructure improvements. Greenmetrics plans to expand the device network to include other high-risk areas. Collected data will be shared with universities and research institutions to develop new models.

Case Study – LoRaWAN® Deployment in Hamburg's Smart City Transformation

The Challenge
Hamburg's rapid urbanization and growth posed significant challenges to its infrastructure. The city's electric grid provider, Stromnetz Hamburg GmbH, and smart technology company ZENNER International, have partnered to implement innovative IoT solutions across the city.

Key issues included optimizing energy consumption, managing parking spaces for electric vehicles (EVs), and ensuring the smooth operation of its public utility networks. Moreover, the city required a solution that would seamlessly integrate into its existing systems without disrupting daily operations or compromising security.

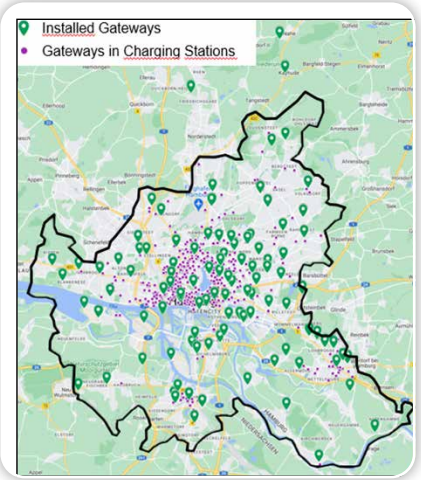
The Solution
LoRaWAN technology emerged as a natural fit for Hamburg's smart city needs due to its long-range communication capabilities, low energy consumption, and adaptability. Stromnetz Hamburg and ZENNER deployed over 600 LoRaWAN® gateways across its existing charging station infrastructure and connected thousands of sensors across the city supporting various smart applications including: EV Charging Stations & Parking Sensors, Smart Metering in Schools and Apartments as well as Grid and Substation Monitoring.

The Benefits
Widespread LoRaWAN Coverage: With over 42,000 connected devices and 99% outdoor LoRaWAN coverage, Hamburg now benefits from a robust IoT network. The network handles more than 40,000 data packets per hour, supporting a variety of applications across the city.

Efficient Resource Management: The real-time monitoring of utilities such as water and electricity through LoRaWAN sensors has significantly optimized resource usage in Hamburg. This has led to cost savings, improved operational efficiency, and reduced environmental impact.

Scalable and Future-Ready: Hamburg's LoRaWAN infrastructure continues to expand, with new use cases being tested, such as climate monitoring, lighting control, and waste management. The city's partnership with ZENNER ensures that the LoRaWAN ecosystem is adaptable to future demands and evolving smart city needs.

Hamburg's journey toward becoming a smart city has been powered by LoRaWAN technology, which has proven its value in diverse applications from energy management to transportation.



Case Study – Smart Lighting in Bosnia & Herzegovina with LoRaWAN®

The Challenge

The City of Gradiska in Bosnia and Herzegovina aimed to implement an intelligent street lighting system that would reduce energy consumption, lower maintenance costs, and enhance public safety. The goal was to remotely monitor and control street lights, adjusting brightness based on time, weather conditions or specific events, thereby improving urban aesthetics and aligning with the city's vision of sustainability.

The existing manual system's inability to adjust the lighting based on real-time factors resulted in unnecessary energy waste and high operational costs, while the lack of a centralized control system made it difficult to identify and rectify technical issues, leading to prolonged periods of faulty lighting.

The Solution

TEKTELIC, in collaboration with UNIS Telekom, X-Logic and Neos, developed a comprehensive LoRaWAN®-based smart street lighting solution for Gradiska.

TEKTELIC provided KONA Macro gateways, known for their scalability, reliability, low cost, and coverage and capacity, ensuring seamless connectivity for the smart lighting system. UNIS Telekom is a leading system integrator in the region, specializing in the design and implementation of conceptual telecommunication solutions. It built a complete LoRaWAN network and network server, utilizing X-Logic devices to enable LPWAN communication for remote lighting management. Neos Ltd. is a consultancy specializing in lighting modernisation projects.

The Smart Lighting Management supports the DALI-2 protocol for efficient control, allowing real-time monitoring and adjustment of street lights based on various factors. Through this network, individual lights or groups of lights can be remotely monitored and controlled, adjusting their brightness based on time, weather conditions, or specific events.

The Benefits

The implementation of the LoRaWAN-based smart street lighting system has enhanced public lighting performance, reduced energy consumption and maintenance costs, and improved public safety. The data-driven efficiencies created have improved public services in Gradiska, contributing to the city's overall sustainability goals.

Case Study – Smart Garbage Can Level Sensing Solution

The Challenge
In North America, the EPA regulates household and industrial wastes under the Resource Conservation and Recovery Act (RCRA). This aims to protect citizens from the hazards of waste disposal, while conserving energy and natural resources.

The Solution
Canadian based X-Telia offers X-TRASH for real-time garbage can fill level monitoring. X-TRASH allows waste collectors to remotely monitor the level of waste in their garbage cans, sending real-time notifications when the levels reach a critical threshold. The system also detects fire in the can, and the position of the lid.

X-TRASH can be accessed from any mobile device. The system generates reports regarding the fill levels of the reservoirs which are easy to integrate into other systems.

The solution uses battery-powered wireless sensors, with a battery life over 10 years; these can be installed on different sizes of garbage cans, bins or containers. The system is compatible with LoRaWAN® or cellular wireless technologies, and requires no additional local electricity supply.

X-TRASH can be easily integrated into existing systems for more efficient and transparent waste-level management. It uses advanced encryption technology to ensure the security of level monitoring data, and data is hosted in a world-class data center.

The Benefits
Waste collectors can reduce collection costs by 40-60%, while cutting down on travel and greenhouse gas emissions. By optimizing operations, collectors can save costs and unnecessary truck movements or emergency emptying. X-TRASH also facilitates inventory management, allowing collectors to track and manage their container inventory in real time, facilitating maintenance and collection planning.

Case Study – Suntec City Office Towers in Singapore Embarks on Smart Building Transformation with LoRaWAN®

The Challenge

Suntec City, an iconic commercial complex in Singapore's Marina Bay Precinct, is undergoing a major infrastructure upgrade as part of its mission to enhance tenant comfort and environmental sustainability. The project focuses on upgrading Suntec City's Air-Conditioning and Mechanical Ventilation (ACMV) systems and deploying a cutting-edge indoor air quality (IAQ) monitoring solution to ensure consistently high air quality standards across its extensive 200,000 square meters of office space while optimizing energy consumption. The project also required a robust communication network to manage real-time data collection and system monitoring seamlessly across all five office towers.

The Solution

UnaBiz partnered with D-Team Engineering to overhaul Suntec City's ACMV systems and implement an advanced IAQ monitoring network, integrating Milesight's IAQ sensors and LoRaWAN gateways with Actility's ThingPark Enterprise platform. The deployment includes:

1. Replacement of Air-Handling Units (AHUs)
2. Installation of Variable Air Volume (VAV)
3. Deployment of IAQ Sensors and LoRaWAN Network

Actility, a key partner in this project, provided the LoRaWAN IoT mediation platform to ensure reliable wireless communication across the entire Suntec City complex. Actility's platform supports seamless data transmission from the IAQ sensors, allowing building managers to monitor air quality and system performance continuously..

The Benefits

Improved Air Quality in Singapore's Central Business District: With real-time IAQ monitoring powered by Milesight's advanced nine-in-one sensors, Suntec City ensures consistent air quality standards, creating a healthier environment for tenants and visitors alike. The system continuously tracks air quality metrics, enabling building managers to address fluctuations proactively.

Energy Efficiency and Reduced Carbon Emissions: The integration of the new AHUs, VAV controllers, and real-time data from the IAQ system has optimized the ACMV system's efficiency, resulting in lower energy consumption. Steven Kong, senior manager of operations at APM Property Management, noted that the system helps maintain stable temperature and air quality while contributing to Suntec City's environmental sustainability goals by reducing energy usage and carbon emissions.

Data-Driven Building Management: The combination of LoRaWAN technology and Actility's ThingPark platform provides actionable insights that enable Suntec City to optimize building operations. With remote monitoring capabilities, building managers can reduce the need for manual inspections and improve the overall efficiency of maintenance processes.

Scalability for Future Smart City Initiatives: The deployment of LoRaWAN technology positions Suntec City for future smart building innovations. The network can easily support additional IoT applications, such as smart lighting and energy management, further contributing to Suntec City's sustainability goals.

Case Study – Tata Communications' Smart Lighting Solution in India Using LoRaWAN®

The Challenge

In cities across India, maintaining streetlights is a labor-intensive and expensive process. Traditional lighting systems often remain on longer than required, wasting energy and increasing operational costs. Moreover, frequent manual inspections to ensure proper lighting functionality contribute to higher fuel consumption and increased carbon emissions. Tata Communications sought to create a more efficient, sustainable solution for Indian cities that could be easily deployed with minimal infrastructure investment.

The Solution

Harnessing the power of LoRaWAN®, Tata Communications developed a smart street lighting solution that enables Indian cities to remotely control streetlights through a centralized platform. This innovative system offers:

- Auto-scheduling and Lamp Dimming
- Remote Monitoring and Control
- Scalability Across Indian Cities

The Benefits

Energy Savings in India: By automating streetlight operations, Indian cities utilizing Tata Communications' smart lighting solution have achieved energy savings of up to 20%. The combination of auto-scheduling and dimming during off-peak hours optimizes electricity consumption and cuts down costs.

Operational Efficiency: With remote monitoring, the need for frequent manual field visits is reduced, resulting in up to a 50% reduction in operations and maintenance costs. This allows Indian cities to manage streetlighting networks more efficiently.

Enhanced Safety: The system ensures that streetlights provide optimal illumination when and where it's needed, improving the safety of citizens and public spaces across Indian cities. Lighting levels can be adjusted remotely based on real-time data.

Sustainability Impact in India: Tata Communications' smart streetlighting solution has contributed significantly to the reduction of greenhouse gas (GHG) emissions in India. By automating lighting control and minimizing fuel consumption from manual inspections, the solution has reduced GHG emissions by more than 22,000 metric tons of CO_2 equivalent ($MTCO_2e$) in India to date.

Tata Communications has deployed smart streetlights in several cities, including Noida, Ahmedabad, Nashik, and parts of Kolkata. Delhi already has around 80,000 smart streetlights, which have been live since August 2019.

Conclusion

By 2030, the UN estimates the world will have over 40 mega-cities with more than 10 million inhabitants. These cities will face challenges in meeting the needs of their growing populations, including basic needs like housing, education, health care, transportation, energy provision and employment, as well as managing increasingly precious resources like water and energy.

IoT smart city projects are burgeoning for two reasons: first, new technologies afford new opportunities for collecting data from new sources not exploited as yet. Second, the global climate emergency and the realization that resources like water and energy are not infinite have added urgency to conservation and sustainability initiatives. LoRaWAN® networks are proving their worth through their ability to support long range, low power, low cost, scalable and secure connectivity. Cities will be able to start with small projects and expand to scale up as needed. The fact that LoRaWAN implementations can co-exist with other wireless networks - including high data rate technologies - will help meet the needs of increasingly complex city networks.

The LoRa Alliance® has a growing network of members which offer advice, resources and partnership opportunities for would-be IoT implementors.

Beecham Research is a leading technology market research, analysis and consulting firm established in 1991. We have specialized in the development of the rapidly-growing Connected Devices market, often referred to as M2M and IoT, worldwide since 2001. We are internationally recognised as thought leaders in this market and have deep knowledge of the market dynamics at every level in the value chain.

Our clients include component and hardware vendors, major network/connectivity suppliers, system integrators, application developers, distributors and enterprise users in both B2B and B2C markets. We are experts in M2M/IoT services and platforms and also in IoT solution security, where we have extensive technical knowledge.

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