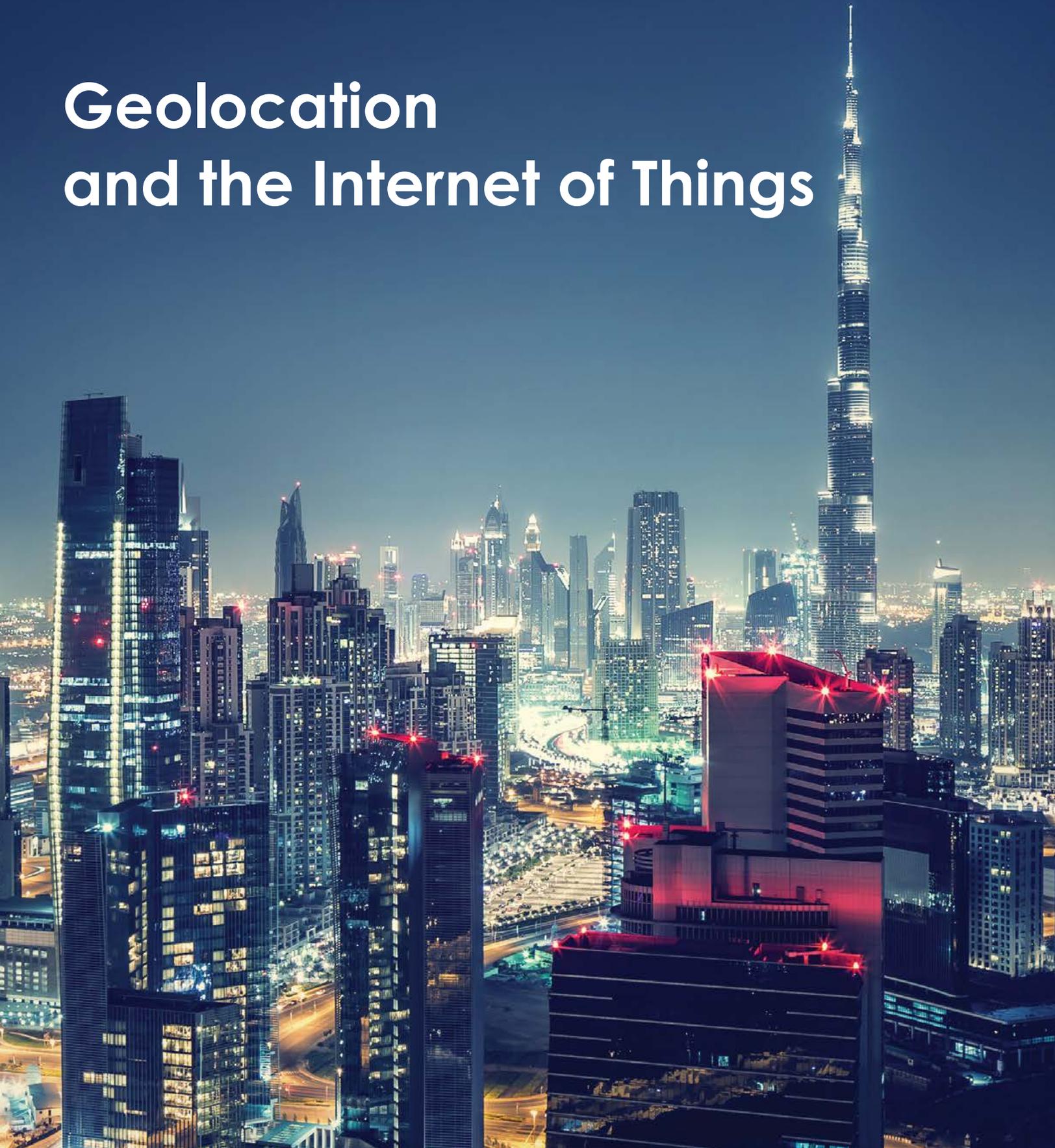


Geolocation and the Internet of Things



Introduction

One of the most compelling applications associated with Internet of Things (IoT) solutions is geolocation - the ability to associate an object with its physical location and digital mapping position. Geolocation allows for example

- a warehouse to track forklifts to ensure efficient use and observe their paths of motion
- a mining company to track location of workers to increase security and safety
- a construction services company to locate and secure building materials on a job site
- a farm to track livestock herds to optimize land use equipment and feed
- an airline to track luggage to avoid loss and deliver enhanced services to travelers.



Almost all IoT solutions can support geolocation, but only low-power wide-area network (LPWAN)

technologies like LoRaWAN® can provide geolocation with

Long battery life. Geolocation using LoRaWAN® simply relies on payloads sent by end-devices, so no additional communication or signaling is required, thereby ensuring long battery life for on-site equipment

Cost efficiency. LoRaWAN® geolocation is native to each LoRaWAN® -enabled connected end-device. There is no need for any additional hardware like embedded GPS equipment, antennas and extra batteries. And geolocation-ready gateways do not need specific firmware or OS updates. Only an application layer is needed that is able to use network metadata attached to the payload to deliver geolocation information either through a user interface (UI) or standards-based API.

Localized precision. Using a combination of mathematical models and algorithms, precision continues to quickly improve for geolocation services. A proper mathematical specification helps deliver accurate geolocation results based on the type of end-device (static or mobile) and environment (rural, semi-urban or urban). Businesses are finding that LoRaWAN™ -based geolocation is reaching levels of precision that allow them to track assets at large scale when sub-meter precision is not critical.

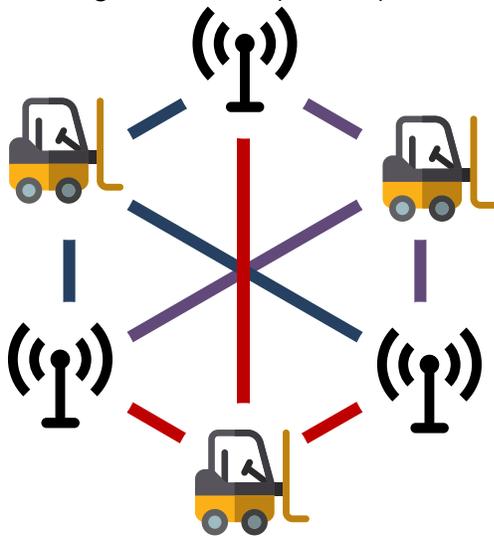
Simplicity. Geolocation is easy to deploy, run and manage. And leading network providers offer geolocation-enabled gateways as part of their standard offering. Each LoRaWAN® end-device has the native potential for geolocation, because geolocation is simply the addition of an application layer on top of existing core network management tools. Geolocation can be deployed for any customer using any type of LoRa® Network Server and is completely compatible in passive and active roaming scenarios.

Benefits of LoRaWAN® geolocation

- ✓ Long battery life
- ✓ Cost efficiency
- ✓ Localized precision
- ✓ Simplicity

Geolocation to mark the way

LoRaWAN® network uses trilateration to geolocate end-devices. Trilateration relies on three or more access gateways receiving signals (or frames) from a LoRaWAN® end-device. Each signal is precisely time stamped on reception and all carrier-grade LoRaWAN® gateways' internal clocks are highly synchronized to optimize the stamp accuracy. Using the exact position of each network access gateway, the nanosecond differences between signal reception and the Time Difference of Arrival (TDoA), an algorithm can precisely calculate the



location of a LoRaWAN® end-device. Assuming that its gateways are carrier-grade and geolocation-ready, an enterprise or service provider can add geolocation services with no additional hardware to its LoRaWAN® deployed network and quickly leverage geolocation as a powerful enabler to create new services and generate additional revenue streams. There are two primary ways to create geolocation services using LoRaWAN®.

LoRaWAN® native. An asset can be equipped with only a LoRaWAN® communications module to provide geolocation services as well. These types of solutions are good for assets that require some location accuracy especially for geofencing and physical security-based services. In addition, this type of geolocation service is particularly good when IoT device battery longevity is important, as these types of devices can last upwards of 10 years on a single

Geolocation	Low priced devices	Long battery life	Moderate precision	High precision
LoRaWAN native	✓	✓	✓	
LoRaWAN plus GPS				✓

battery. Examples of assets that are well-served by a geolocation service using LoRaWAN® alone include cattle on a farm, static assets at a construction site, or container/trolley/pallet management for harbors and airports.

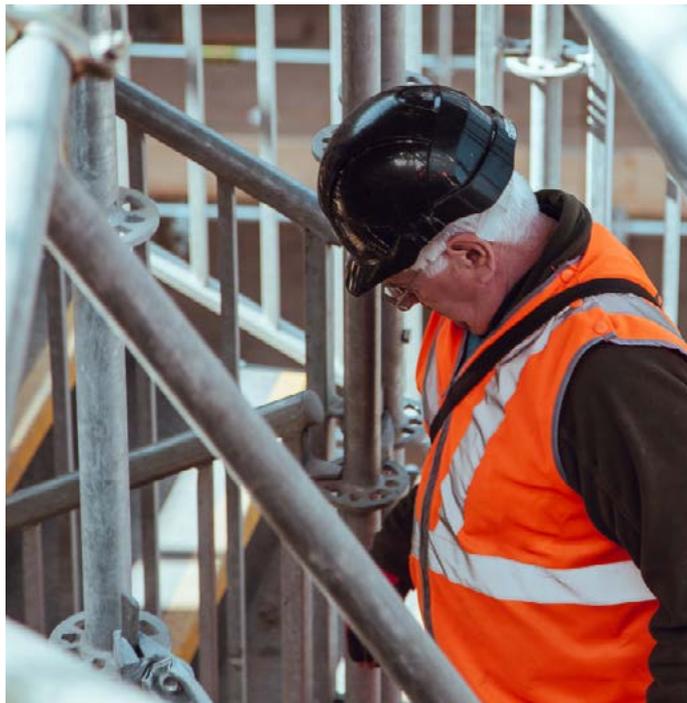
LoRaWAN® plus GPS. An IoT device can be equipped with GPS hardware and a LoRaWAN® communications module. The module can deliver precise outdoor GPS-based location information to an IoT application for geolocation services. These types of solutions are good for assets that require higher location precision and accuracy. Examples of assets that are well-served by a geolocation service using LoRaWAN® plus GPS include a tool at a construction site, a spool of fiber optic cable at a distribution center, or a tracking system for runners/triathletes during races.

Adding value to your business

Geolocation as part of a LoRaWAN® solution allows enterprises and service providers to offer a set of value-added features with small marginal investment. With many use cases, geolocation can enhance asset tracking and security. Let's look at a few examples.

Livestock safety. Large cattle farms need to effectively track cattle location to maintain health and safety or to monitor activity. Using a LoRaWAN® native solution, a cattle farm can create a digital fence to ensure the livestock are located within confines of the farm, optimize space ensuring appropriate levels of livestock activity, maximize health and herd quality and quickly locate and count livestock for immediate reporting.

Construction site monitoring. Construction sites have thousands of assets of varying value that need monitoring. Using a LoRaWAN® native solution, construction services companies can ensure that construction supplies are not accidentally or purposely removed from a site. And using a LoRaWAN® plus GPS solution, construction supplies can be quickly located to increase speed of construction. Equipment and tools can also be easily located in a given area to optimize their use, simplify the counting of inventory and reduce fraudulent usage and theft.



Container, pallet and trolley identification.

Warehouses, airports and harbors can have thousands of containers, pallets and trolleys used to transporting assets inside and outside the facility and the geographic area. Using a LoRaWAN® native solution, a distributor can ensure pallets are placed in vehicles at appropriate times to maximize warehouse operational efficiency and can track empty pallets and trolleys for their collection, thereby reducing the cost of lost, damaged, or stolen equipment. Containers can be easily located in large areas to optimize handling, reduce idle time and improve efficiency of inventory use.

Conclusion

Geolocation is a simple, value-rich service that can be added to any LoRaWAN® deployment that uses a LoRaWAN® ecosystem open-reference implementation. Geolocation services allow enterprises and service providers to track and monitor their LoRaWAN®-enabled assets using trilateration from three or more LoRaWAN® gateways, providing a solution with long-lived IoT devices, cost efficiency, localized tracking precision and simplicity. These geolocation capabilities fully meet the requirements of an increasing number of verticals as they unlock the massive potential of simple, cost efficient geolocation for many use cases. A LoRaWAN®-based geolocation application can dramatically benefit from improved performance and precision when using

- industry-leading and carrier-grade Kerlink LoRaWAN® gateways that generate highly accurate time stamps using a LoRaWAN® ecosystem open reference implementation
- Wanegy® Management Center and especially the Base Station Controllers features that provide time stamp optimization with fine tuning of gateway GPS location (clock synchronization)
- Cloud geolocation services to convert the TDOA (Time Difference of Arrival) information delivered by the LoRaWAN gateways into instant device geolocation coordinates and mapping (for example the solution proposed by [Semtech](#)).

Powering the World's Largest LoRaWAN® Network

With its range of leading IoT products, solutions and professional services, Kerlink is focused on delivering best-in-class IoT network building blocks to maximize the success of the entire IoT value chain while leveraging LoRaWA® LPWA technology running on license-free frequencies. Strategically positioned at the center of the LoRa® ecosystem, the company is creating a strong network of partners around its IoT network solutions to unlock design creativity for connected devices and trigger development of innovative applications that can improve people's lives worldwide.

Kerlink is growing its business by establishing partnerships with MNOs and other major clients while expanding into new markets. It established a subsidiary in Singapore to support its expansion in Asia-Pacific in early 2016, launched a United States subsidiary in January, 2017 and established an office in India in September, 2017. It is partnering with Tata Communications in India to deploy the world's largest LoRaWA® network, and also with Proximus (Belgium), Spark (New Zealand), Yeap! (Argentina), Netemera (Poland) and Pervasive Nation (Ireland).

The company also extended its production and customer-support footprint by signing an agreement with Flex to assure global availability of its equipment and worldwide production flexibility. As proof of its focus on continuously improving quality and processes, Kerlink was awarded an ISO 9001-2015 certificate from Lloyd's Register Quality Assurance (LRQA) for its IoT network solutions' overall design, development and sales processes. This evolution reflects Kerlink's commitment to maintain a customer-centric approach and a culture of continuous innovation – true differentiators for Kerlink.

Using Kerlink carrier-grade IoT network solutions, operators can reduce implementation time and complexity of deployment and management of an IoT network during trial, build and run phases. Streamlined maintenance costs, higher levels of SLOs/SLAs, reduced total cost of ownership (TCO) and increased

customer demand all lead to an overall increase in total return on investment (ROI) for operators' IoT networks.



About Kerlink

Kerlink Group is a leading global provider of end-to-end connectivity solutions for designing, deploying, and operating public & private low power/wide area (LPWA) Internet of Things (IoT) networks. Its comprehensive product portfolio includes industrial-grade network equipment, best-of-breed network core, operations and management software, value-added applications and expert professional services, backed by strong R&D capabilities. Kerlink specializes in enabling future-proof intelligent IoT connectivity for three major domains: Smart City & Quality of Life – urban operations, utilities & metering, retail & public places, infrastructure & hubs, health; Smart Building & Industry – buildings & real estate, industry & manufacturing, asset monitoring & tracking, and Smart Agriculture & Environment – precision agriculture, cattle monitoring & farming, environment & climate, and wildlife protection. More than 200,000 Kerlink installations have been rolled out with over 350 clients in 70 countries. Based in France, with subsidiaries in the US, Singapore, India and Japan, Kerlink is a cofounder and board member of the LoRa Alliance® and the uCIFI Alliance®. It is listed on Euronext Growth Paris under the symbol ALKLLK.

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