LoRaWAN® Sector Reports Series

# Global Asset Tracking with LoRaWAN®

LoRa Alliance®

beecham research

Shaping the IoT future

# Global Asset Tracking Market

**LoRaWAN® has come a long way in a short time. Global roaming is now available using both terrestrial and non-terrestrial networks and, thanks to the introduction of new scalability and network resilience features, can robustly handle high densities of connections at once. As a result, LoRaWAN now increasingly represents a strong option for tracking assets regionally and even globally at low cost.**

## Asset tracking needs are growing quickly

At the present time, the logistics industry has many challenges, for example:

- Enormous numbers of man hours and fuel wasted due to congestion in ports. In North America alone, an estimated 15 million man-hours and 2.3 billion gallons of fuel are wasted due to trucker congestion at ports annually.
- Huge growth in cargo thefts and consequent costs, at best delaying shipments and at worst resulting in the total loss of goods. At a conservative estimate, cargo theft costs businesses and consumers USD35billion a year in the US alone.
- Global shortage of manpower for warehousing and other logistics operations.
- Huge amounts of cargo spoilage and wastage of food in transit. One third of all food produced globally is lost or wasted largely due to temperature sensitivity, which accounts for half of all food waste.
- Increasing incidences of unpredictable delays to deliveries caused by extreme weather, wars and other such events.

These and other challenges have driven an increasing need for asset tracking and cargo condition monitoring, as shown in **Figure 1**. The rate of growth is substantial, making asset tracking one of the fastest growing areas in the IoT market over the forecast period.

Trailer and cargo container tracking focuses on enhancing operational efficiency and security within transport chains. This approach typically involves real-time tracking solutions that include data logging, satellite positioning, and data communication to a back-office application. These devices enhance decision-making, improve asset utilisation, save costs, and reduce environmental impact for supply chain stakeholders.

***Figure 1:*** *Forecast of installed base growth for trailer and cargo tracking (m units)*

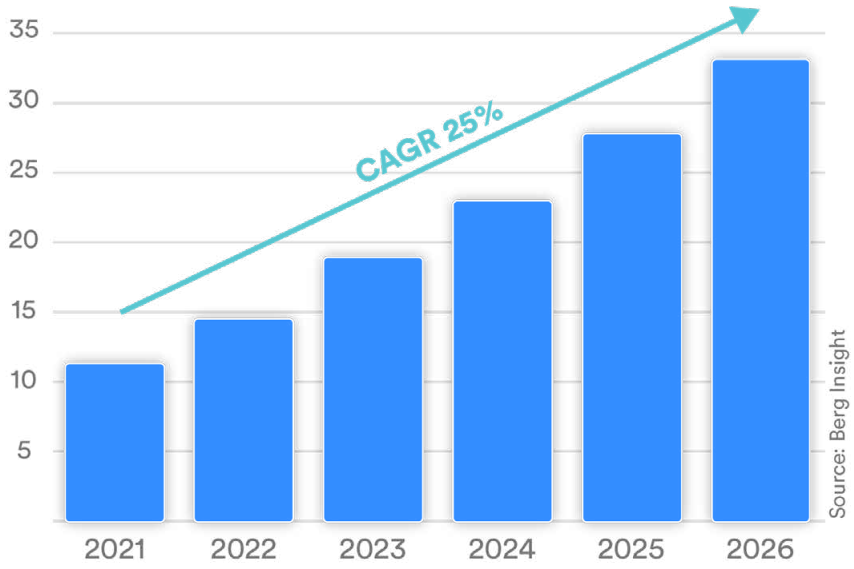
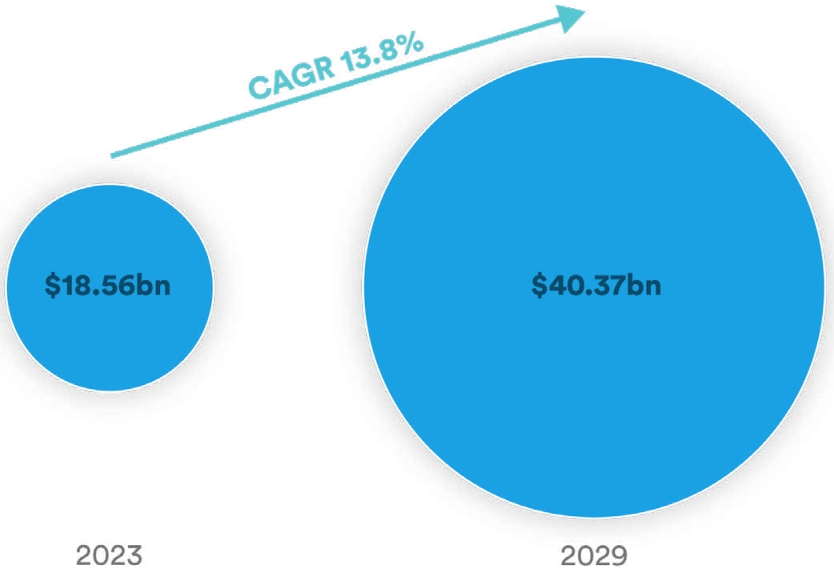



***Figure 2:*** *Forecast Global Asset Tracking Market Revenue 2023-29*




Such tracking devices are adaptable for monitoring various assets such as trailers, intermodal containers, rail freight wagons, air freight Unit Load Devices (ULDs), or the cargo itself.

**Figure 2** shows Beecham Research estimates drawn from a wide range of different analyst forecasts, pointing to an overall growth of around 13.8% per annum in global asset tracking revenues during the period 2023 through 2029.

# LoRaWAN® Roaming – Terrestrial Networks

The LoRaWAN® Roaming Hub enables seamless communication for IoT devices moving across different networks by facilitating the exchange of device- and network-related information between LoRaWAN® network servers. This includes device authentication data, session keys, and other relevant parameters required for seamless roaming. As such, devices can retain constant connectivity, preventing the downtime that typically arises when a device leaves one network and manually re-joins another.

This applies to international roaming for countries with national LoRaWAN coverage and roaming-enabled public networks as shown in **Figure 3**.

This also covers domestic roaming when no single LoRaWAN® network covers the whole region, as shown in **Figure 4**.

As of 2021, LoRaWAN® roaming was available in 27 countries. Since then, the number of countries with nationwide roaming-capable networks has continued to expand with countries such as Austria and Thailand now adding to that count. The Connect EU initiative, launched by the LoRa Alliance® to support and encourage collaboration amongst members) is making LoRaWAN® technology more widely accessible across Europe and accelerating roaming opportunities.

Aside from the number of countries with LoRaWAN® Roaming, there are over 160 countries in which LoRaWAN® networks are operating.

Within these countries there are three types of LoRaWAN® network architectures:
**1. Public** – the customer subscribes to an operator's connectivity infrastructure to transfer data from their devices to the end application.

**2. Private** – the customer deploys their own gateways and network servers, ensuring that the end-to-end architecture is entirely self-owned.

**3. Community** – the gateways are managed by a range of parties whilst the network server is run by a single public operator.

***Figure 3:*** *LoRaWAN® roaming between countries*

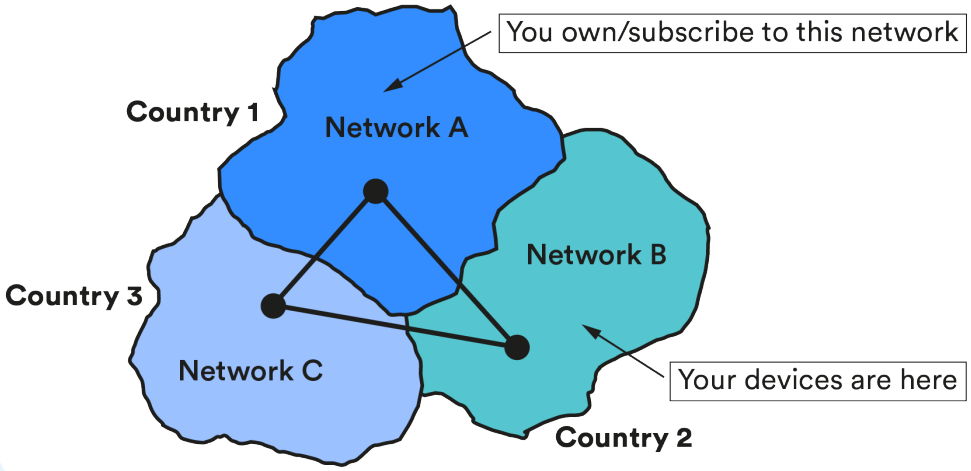
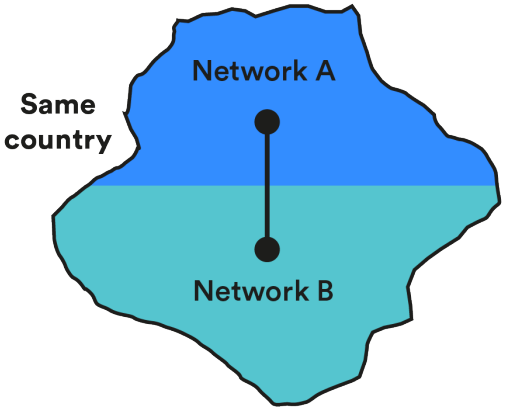



***Figure 4:*** *LoRaWAN® roaming within one country*

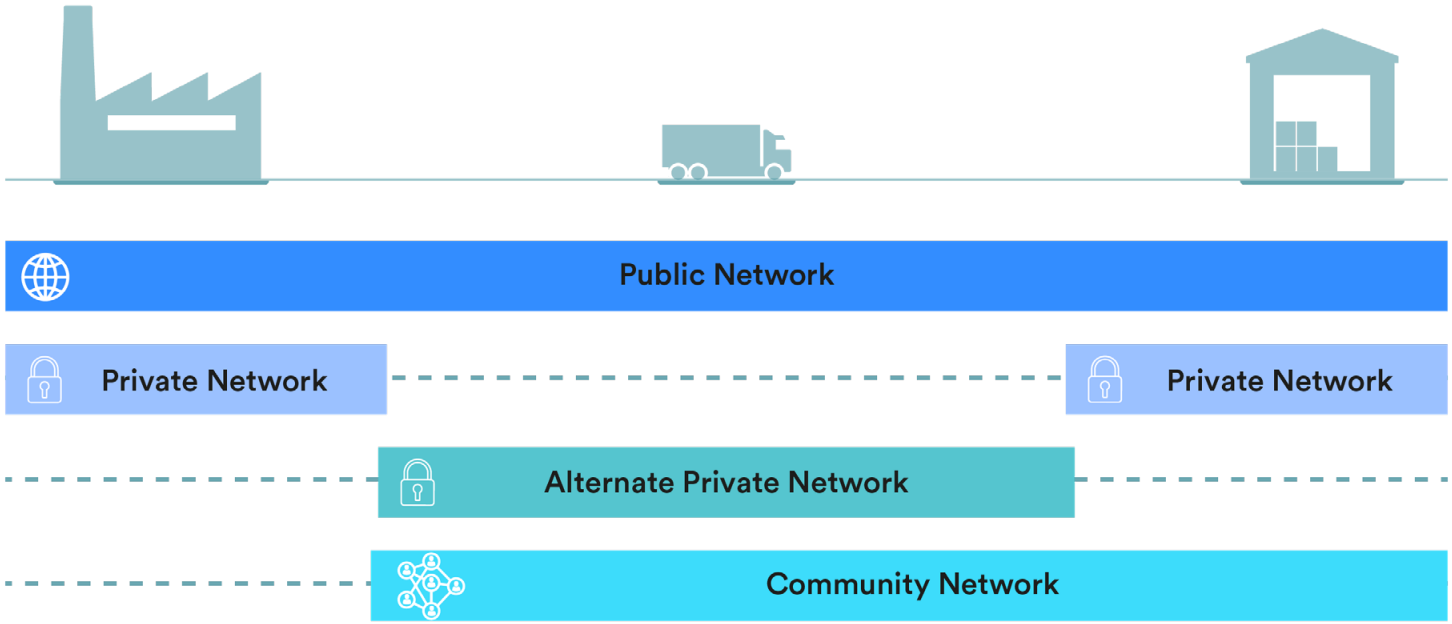


This creates opportunities for companies to create hybrid LoRaWAN® networks – a combination of public, private and community networks - that optimally meet their connectivity needs. This enables assets to be seamlessly tracked throughout their journey.

For instance, referring to **Figure 5**, a company has a private LoRaWAN® network at a factory where assets are packed and a private network at a warehouse where they are delivered but no connectivity infrastructure between the two. To ensure the assets can be tracked from factory to warehouse, the company can subscribe to a public network or community network to create a hybrid private-public-private or private-community-private network. Alternatively, they could come to an agreement with a company that has private LoRaWAN® coverage in the required region to create a private-private-private hybrid network. Public-community hybrid options are also a possibility, as are networks that begin on a public or community network and end with a private network.

Such network arrangements are now rapidly being set up in the IoT market. Ultimately, there is huge flexibility in terrestrial roaming and hybrid networking. This enables companies to develop connectivity solutions that meet their coverage, security, and – in particular - budget requirements.

***Figure 5:*** *An example of LoRaWAN® network coverage options from factory to warehouse*



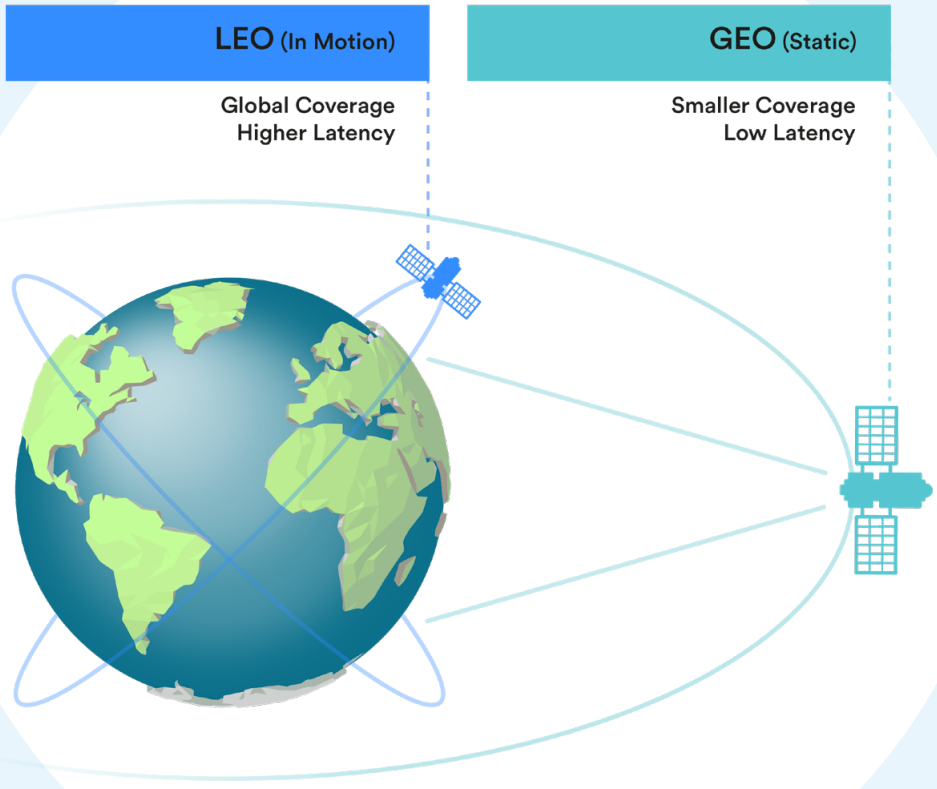
# LoRaWAN® Non-Terrestrial Networks – GEO and LEO

> ***"Satellite together with LoRaWAN is digitalising areas where digitalisation wasn't previously possible"***
>
> **Eric Hewitson, Wyld Networks**

In addition to this, LoRaWAN®-enabled satellite constellations are now growing in number and proving to be valuable in connecting remote areas that have limited or no terrestrial coverage. This includes rural land regions as well as the oceans.

LoRaWAN® technology is being applied to low earth orbit (LEO) satellites – which are constantly in motion around the Earth – as well as geostationary (GEO) satellites which remain fixed relative to a specific location on the planet's surface.

***Figure 6:*** *The flight paths of LEO and GEO satellites*




LEO satellite constellations offer global coverage with their flight paths taking them across all regions around the Earth. Typically travelling at 8 km/sec (29,000 kph) and at a height of between 400 and 1500 km, LEO satellites pass overhead very rapidly. Depending on how many satellites there are in the constellation, this can lead to a high latency for transmitting data and a limited transmission time. Such options are useful and cost-effective when constant monitoring is unnecessary. It can also be useful for consistent monitoring and reporting across a wide area or even globally, albeit when real-time action is not required. This can be achieved through the device collecting data at regular intervals and transmitting it to the satellite as a stack as it passes overhead.

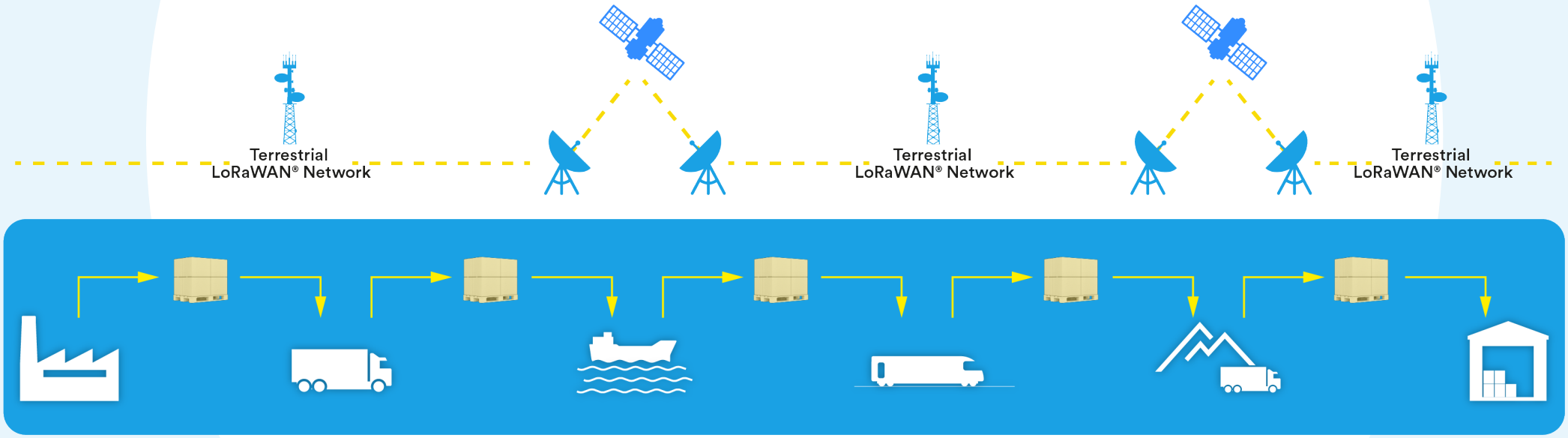
In contrast, GEO satellites are stationary in relation to the Earth's surface and at a height of around 35000 km. As such they are restricted to coverage of a specific area of the planet. Although they cover a smaller area than LEO satellites, they maintain constant connectivity with specific regions, ensuring low-latency data transfers. The differences between LEO and GEO satellites are shown in **Figure 6**.

Both types of LoRaWAN®-enabled satellites are being integrated with terrestrial LoRaWAN® networks to create hybrid inter-satellite networks. This enables companies to fill any connectivity gaps in their assets' journeys – providing coverage and data transmission where no terrestrial LoRaWAN® options exist, such as in the example of **Figure 7**.

Further boosting the development of satellites in LoRaWAN® connectivity solutions is the development of LR-FHSS.

LR-FHSS (standing for Long Range-Frequency Hopping Spread Spectrum) is a low-throughput and uplink only technology that is now being applied to LoRaWAN® networks. It has a high spectrum efficiency, enabling many communications to occur within the same spectrum portion. As such, it is ideal for managing a large number of devices in the same space. As a result, it significantly improves the resilience, capacity and scalability of LoRaWAN® networks as they grow in size.

***Figure 7:*** *An example of satellite use for end-to-end connectivity in multi-regional transit*



# Putting It All Together

LoRaWAN® technology has many attributes which make it suitable for asset tracking. At a basic level, the asset tracking market is essentially not a high bandwidth one, with end-devices typically required to record single data points such as location, delivery status, temperature, moisture levels, or humidity. Instead, it is more important for sensors to have a long battery life and for devices to be ruggedised to withstand changeable weather and environmental conditions. Connectivity must also be highly reliable across both indoor and outdoor environments.

This is where LoRaWAN® excels. **Figure 8** shows the key properties of LoRaWAN® devices – including the fact that it is internationally standardised, offers ultra-low power consumption and is highly ruggedised, managing temperature changes or shocks and vibrations. It can penetrate concrete and steel, enabling connectivity in indoor and underground locations, whilst its long-range allows wide outdoor coverage - up to 50km in rural areas and 5-10km in urban areas.

***Figure 8:*** *Key Properties of LoRaWAN®*

Now, with the coverage options of hybrid private-public-community networks, automatic roaming, and inter-satellite networks, these same LoRaWAN® benefits are becoming globally accessible – offering a reliable, scalable and low-cost option.

**Figure 9** (over) provides a representation of global LoRaWAN® connectivity options that can be used to ensure sufficient coverage for asset tracking requirements, whether they be regional, national or global.

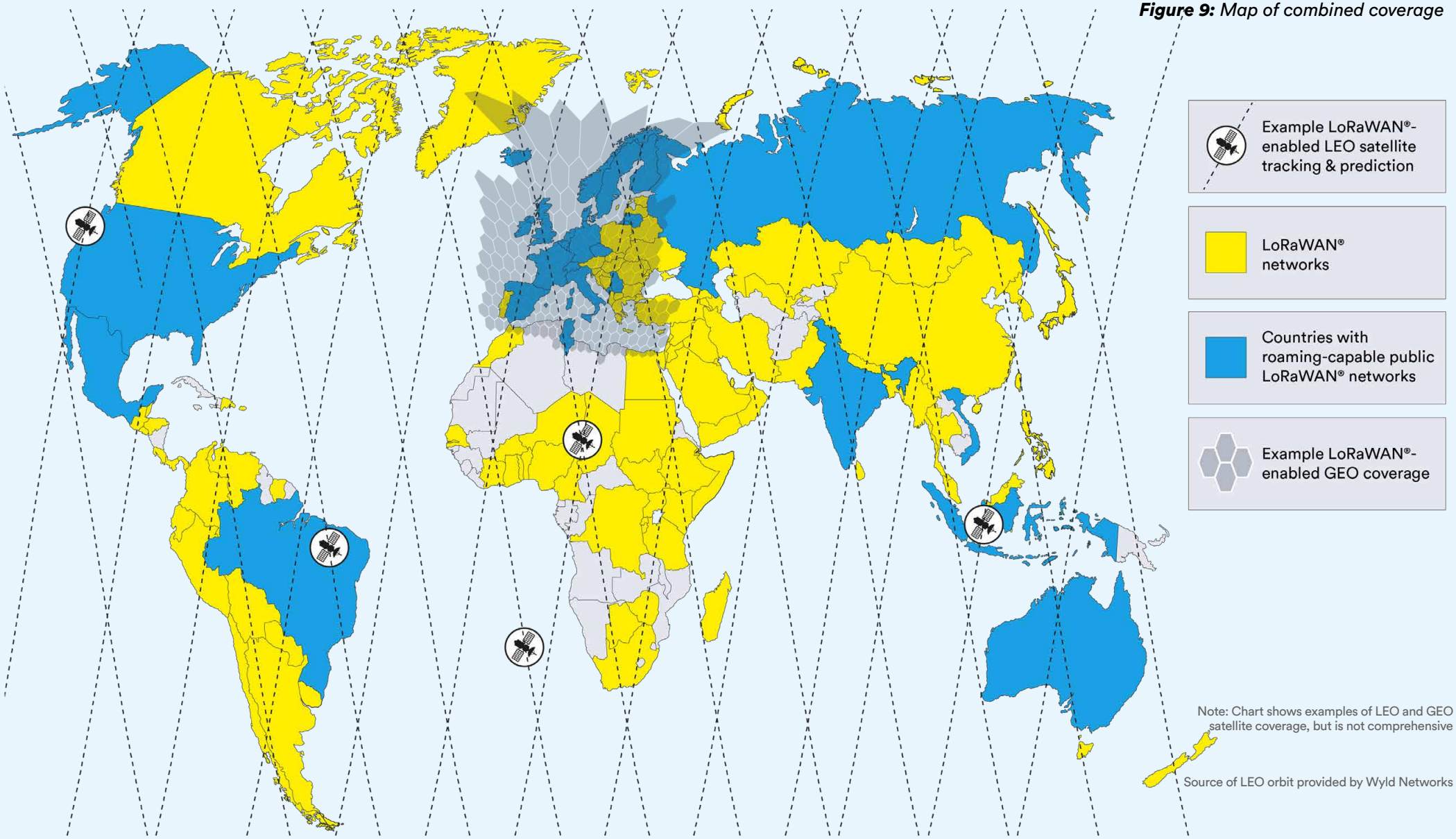
A few things to note:

- LoRaWAN® community network coverage is not shown – this coverage is most prevalent in Europe and North America and adds further coverage to the overall mix.
- The satellite coverage shown is a single example of a GEO satellite (EchoStar) and a single example of a LEO satellite (Lacuna Space via Wyld Network's Fusion platform). Actual LEO and GEO coverage is greater than shown and is constantly increasing..
- Where there may not be universal terrestrial coverage within blue and yellow countries, satellite coverage can assist to overcome this.

The solution required will depend on the regions required for tracking assets. For instance, to track assets that move exclusively in Europe, it is likely that a solution would only include public roaming networks and a Euro-centric GEO satellite to fill in the gaps. To extend tracking to North America, LEO satellite coverage can be added to manage ocean travel. To travel into Canada, network agreements would need to be put in place to ensure tracking can continue via the Canadian LoRaWAN® public networks.

Ultimately, by leveraging multiple networks, tracking devices can access the strongest available signal, minimising communication disruptions and enhancing the reliability of asset tracking data.

***Figure 9:*** *Map of combined coverage*




Note: Chart shows examples of LEO and GEO satellite coverage, but is not comprehensive

Source of LEO orbit provided by Wyld Networks

# Innovative Technologies Enabling Tracking with LoRaWAN®

There is a growing range of devices and applications compatible with LoRaWAN® that are suitable for tracking and monitoring assets on the move.

The following examples demonstrate the variety of options available in 2024.

**RAK2270**

RAK2270 by RAKwireless (represented in figure 10) is a compact and versatile sticker tracker with LoRaWAN® connectivity. Its sleek form factor allows easy attachment to any asset, making it ideal for industries looking to optimise supply chains and improve operational efficiency.

Key features include long battery life as well as a built-in temperature sensor for monitoring sensitive goods.

RAK2270 is compatible with public and private LoRaWAN® networks, and can be used optimally with Helium's decentralised network of hotspots. This allows the device to provide accurate geolocation without the need for power-hungry GPS. Furthermore, LoRaWAN® roaming on Helium enables seamless connection to other compatible networks, expanding coverage and utility.

***Figure 10:*** *A representation of the RAK2270 sticker tracker*


**SenseCAP T1000**

The SenseCAP T1000 by Seeed Studio (shown in Figure 11) is a compact GPS tracker similar to size of a credit card. It is compatible with LoRaWAN® networks, as well as Wi-FI and Bluetooth, facilitating precise indoor and outdoor location tracking.

SenseCAP T1000 offers self-geo-adaptive capabilities, local data storage and months of battery life. This makes it suitable for global shipments, with its miniature form even enabling tracking of assets inside envelope post.

As well as location tracking, its integrated sensors enable temperature, motion and light monitoring, facilitating quality verification of assets.

***Figure 11:*** *SenseCAP1000 compact GPS tracker*

**STORK**

STORK by TEKTELIC Communications (shown in Figure 12) is a rugged tracking device ideal for tracking vehicles, equipment, and other assets in any environment. It's small form factor enables easy attachment and its flexibility in deployment options. Built on Semtech LR1110, it utilises a low-power cloud-based GNSS to ensure a battery life of over 5 years.

The tracker is most commonly used in construction sites, warehouses, manufacturing facilities and multi-building campuses. It easily integrates with LoRaWAN® networks as well as Bluetooth and Wi-Fi to provide accurate location data both indoors and out. This facilitates effective management of assets and reduces the risk of loss or theft.

***Figure 12:*** *STORK rugged device for indoor and outdoor asset tracking and monitoring*

**Miro TrackIt**

Figure 13 presents miro TrackIt - a powerful and flexible low-power GNSS tracking device that incorporates a multi-standard GPS scanner, passive WiFi MAC address scanner, Bluetooth 5.2 (BLE) connectivity and multiple sensors.

Its highly configurable firmware allows for fine-grained adaptation to a specific use case.

***Figure 13:*** *Miro TrackIt for low-power LoRaWAN® use*


This optimises performance and battery lifetime. Meanwhile, its robust design ensures the tracker can perform successfully in harsh industrial environments. Also based on Semtech LR1110 and LoRaWAN® class A compliant, it lasts for up to 10 years on 2x AA batteries.

**The following case studies illustrate the growing effectiveness of LoRaWAN® roaming for asset tracking purposes.**

## **Case Study** – SNCF Implements LoRaWAN® IoT Solutions to Monitor Railway Assets and Rolling Stock

**The Challenge**

Outdated, non-connected infrastructure was limiting SNCF's ability to track and monitor its railway assets in France. Given that SNCF operates approximately 14,000 trains daily, a large-scale, adaptable solution was needed.

**The Solution**

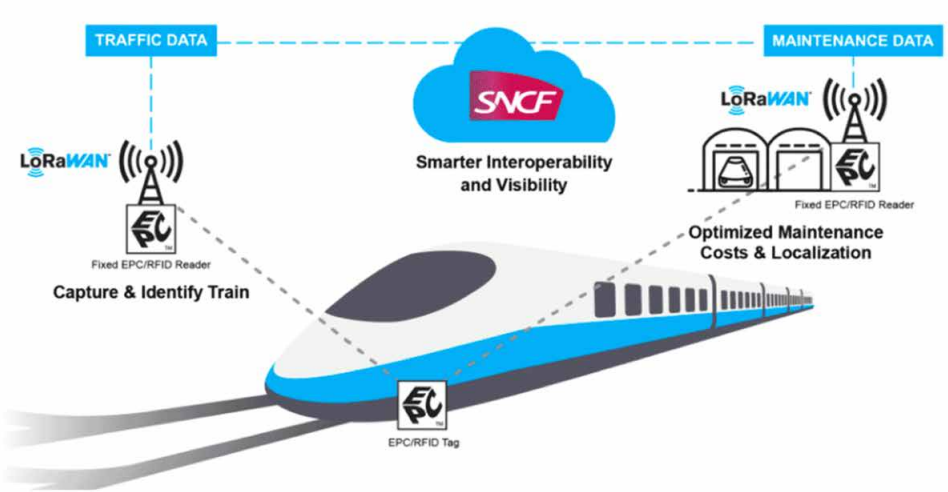
LoRaWAN-enabled IoT-devices were deployed across SNCF's 50,000 km of track, 40,000 technical centres, 2,200 referral systems, and stations throughout France. This was followed by the installation of 6000 MARTI modules and 500 MELI communication gateways, both developed in-house by SNFC's R&D team. In combination, this enabled integration into public and private LoRaWAN® networks and data transmission from the sensors to Actility's LoRaWAN® network server.

Today, all SNCF locomotives are equipped with LoRaWAN IoT devices, facilitating remote sensing, data collection and control.

**The Benefits**

The easy integration and deployment flexibility of LoRaWAN® connectivity has simplified the data collection process for SNFC. The long battery lives of the IoT objects minimises maintenance costs, whilst the wireless nature of the sensors allows new use cases – future-proofing SNFC's investment. Together, this delivers cost-efficiency and an improved ROI than would be expected with traditional M2M solutions.

As well as enabling location and temperature tracking of railway containers, the new system can monitor train conditions to allow predictive maintenance planning, prevent accidents and delays, and reduce the likelihood of downtime due to malfunctions or end of product lifecycle.

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https://resources.lora-alliance.org/infographic/lora-alliance-gs1-railway-inforgraphic#main-content

## **Case Study** – Bouygues Construction Matériel connects over 20,000 pieces of equipment in real time

**The Challenge**
Bouygues Construction Matériel manages a large fleet of construction equipment. The challenge is ensuring the equipment is made available and distributed on time to the required construction sites across France.

**The Solution**
Actility's intelligent sensors combined with Abeeway's multi-technology trackers, both optimised for LoRaWAN®, were deployed on more than 20,000 pieces of equipment. This enables GPS tracking of an entire fleet, from electro-portable to multi-ton cranes, as they are transported from site to site.

The data is uploaded to the Omniscient management platform, enabling the fleet manager to virtually navigate and view, in real time, the location and tracking sheet of each piece of equipment.

This digital transformation was supported by Objenious – a Bouygues Telecom brand

**The Benefits**
The devices work perfectly outdoors as well as indoors, including the capacity to penetrate inside buildings and deep basements. This ensures constant connectivity, enabling real-time data management and decision making. It also enables better planning and equipment allocation, reducing costs associated with external rentals as well as an excess of resources.

Since operational staff no longer need to spend time recording the location of the equipment, it frees up time for them to perform other value-added tasks.

The long battery life of the sensors limits the frequency they need to be replaced – reducing maintenance costs.

Furthermore, by adopting this new data-based approach, the equipment division of the construction giant is projecting direct annual savings of 5 to 10% on maintenance and fleet management, and a ROI of 3 years.

https://www.actility.com/iot-roaming-solution/
https://www.abeeway.com/
https://myomniscient.com/?lang=en
https://objenious.com/

## **Case Study** – Consistent and reliable self-hosted LoRaWAN® networks in South Africa

### The Challenge

Network coverage in South Africa varies depending on the region and can be spotty and unreliable. This is exacerbated further by power blackouts of up to 6 hours per day which can lead to interruptions in cellular connectivity. In addition, South Africa has harsh environments, making it extremely challenging to use standard off-the-shelf technologies for tracking purposes.

### The Solution

LNX Solutions built and deployed LoRaWAN® networks in South Africa. These self-hosted networks facilitate consistent and reliable coverage, and support a wide range of IoT solutions across the country.

For instance, combining their self-hosted network with Digital Matter's certified device Oyster3 for LoRaWAN® and Yabby3 for LoRaWAN® has enabled them to provide vehicle tracking solutions for prestigious large-scale sporting events.

### The Benefits

LoRaWAN® networks remove the country's dependence on cellular networks and provide a much more stable and reliable connection. This supports real-time tracking using IoT devices such as the Oyster3 for LoRaWAN® and Yabby3 for LoRaWAN®.

Both trackers are ultra-rugged and waterproof, enabling use in South Africa's harsh environments where tracking and monitoring may not have previously been possible. The ability of these devices to track assets only when they're on the move guarantees battery lives of 10+ and 7+ years respectively, leading to low maintenance costs.

Furthermore, the ability to update firmware and device parameters remotely, offers flexible configurations and control over the data collected and transmitted.

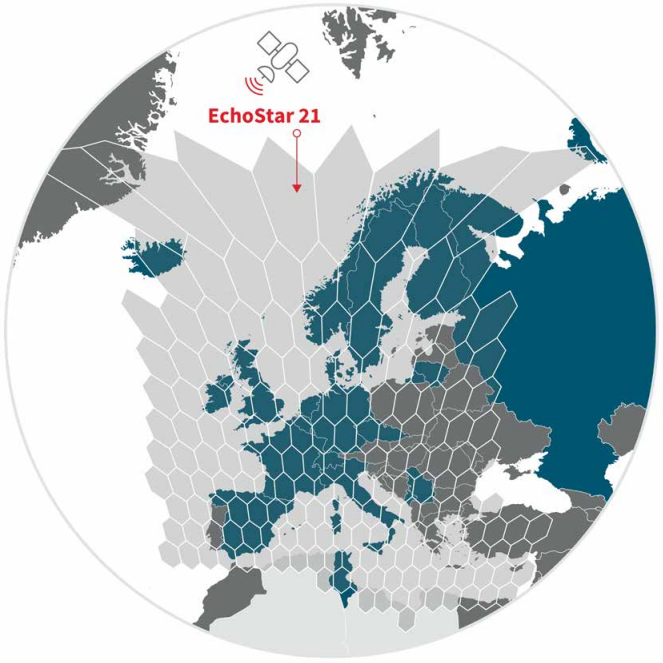
## **Case Study** – Tracking deliveries with satellite enabled IoT

**The Challenge**
Delivery of goods via road transport presents a wide range of challenges, including theft, people stowing away in vehicles, and perishable goods arriving in an unusable state. Whether due to insurance costs or loss of goods, these challenges have a significant cost to logistics companies.

**The Solution**
EchoStar Mobile deploys LoRaWAN®-compatible technologies in its pan-European satellite IoT network. Combining this with terrestrial LoRaWAN® networks creates a wide and highly flexible connectivity system. This enables location and condition tracking of vehicles and goods across borders throughout Europe.

**The Benefits**
Constant connectivity (be it through satellite or terrestrial means) ensures device data can be transferred to processing or control centres in a reliable and timely manner. This provides logistics managers with complete, uninterrupted access to data for road transport across Europe. Combined with two-way communication, this allows real-time decision making and action to prevent the theft of vehicles or loss of goods.

Given that this solution combines terrestrial and satellite-based technologies, it offers a lower-cost solution than pure satellite solutions and wider coverage than pure terrestrial solutions. As such, logistics managers can remain knowledgeable about their vehicles and cargos at all times and can ensure they are delivered as expected, with minimum risk and cost.

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# Takeaways from this report

- The demand for cost-effective asset tracking is growing rapidly worldwide.
- LoRaWAN® increasingly represents a strong option for tracking assets regionally and even globally at low cost.
- Growing roaming capabilities and the ability to establish hybrid networks continues to expand the terrestrial reach of LoRaWAN®.
- GEO and LEO satellites with LoRaWAN® technology are now being used to track assets where terrestrial coverage is not available.
- International standardisation, ruggedness, ultra-low power consumption and the ability to penetrate concrete and steel, in combination with expanding global coverage make LoRaWAN® highly suitable for asset tracking.
- New LoRaWAN® sensors (like smart stickers and no-SIM, scan-and-go trackers) continue to be developed, boosting the versatility of tracking solutions.
- LR-FHSS technology in LoRaWAN® solutions, has advanced satellite development by the enhancing network capacity and resilience to efficiently managing multiple device communications within the same spectrum.

**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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Shaping the IoT future

LoRa Alliance®