

**Truly global coverage for IoT is becoming a reality**

## Introduction

What was once a patchwork of multiple IoT connectivity technologies is evolving to become a homogenous global network.

The Internet of Things (IoT) is rapidly maturing, transforming from a futuristic concept into a practical, integral part of the modern enterprise. As devices become smarter and more interconnected, industries like healthcare, manufacturing, and agriculture are leveraging IoT for real-time data analysis, predictive maintenance, and automation. Advances in Artificial Intelligence (AI), 5G connectivity, and edge computing have enhanced the speed, scalability, and reliability of IoT systems, making them more efficient and secure. Standards and protocols are also evolving, promoting interoperability across devices and platforms and enterprises are shifting from pilot projects to full-scale deployments, indicating confidence in the value of IoT solutions.

Since every IoT device must be connected, connectivity is a critical part of the IoT landscape. However, truly global coverage for IoT has traditionally been challenging for end-user adopters to secure. Particularly in wide-area wireless contexts, available connectivity options have

typically been more of a fragmented patchwork rather than a homogenous global proposition.

Meanwhile, the demand for connectivity of IoT devices is often global in nature. Such global connectivity requirements could arise either because an IoT solution vendor wants to sell a product or solution globally, or even just to multiple countries. In addition, many of the world's biggest and most innovative companies that have driven the development of the IoT to date are, in fact, global companies that have a requirement for homogenous IoT solutions to support their operations worldwide.

The challenges associated with procuring global coverage for IoT have thus acted to hinder the development of the market. However, now, truly global connectivity propositions are emerging. This report explores the evolving landscape for global connectivity in more depth.

## Cellular connectivity is a good baseline for any global need

Cellular connectivity has long been the go-to option for connecting devices that are mobile, or that are simply impractical to connect to terrestrial networks due to their location. And with typically multiple cellular networks available to provide connectivity for an IoT device in any given country around the world, the world's community of cellular operators provide a good baseline for any enterprise looking to secure global connectivity.

An enterprise could thus use connectivity provided by multiple cellular operators to support any global connectivity requirement. In years past, many such enterprises would simply equip their devices with a standard single-identity SIM sourced from a preferred operator, relying on established international roaming arrangements between operators to support connectivity when the SIM roams beyond the reach of that preferred operator's networks. However, increasingly either multi-IMSI or eSIM techniques are preferred, so that the SIM credentials used by an IoT device can be changed even when the device is active

in the field. This allows the connection to switch to a local carrier identity, with the cellular network then offering connectivity as it would to a local subscriber, unlocking benefits in terms of cost efficiency, regulatory compliance, better performance and latency, and more.

The most widely deployed cellular generation that is relevant for today's IoT deployments is 4G, and with claimed 4G cellular population coverage approaching 100% in many regions (for example China, Europe, USA) the technology will be able to support a significant majority of connections for many global IoT needs. However, in some regions, population coverage does fall significantly short of 100% (for example, in Latin America and Sub-Saharan Africa). In addition, many IoT deployments will require coverage in unpopulated areas or deep inside buildings or campus environments. To reach these kinds of connections, it's necessary to introduce some new tools including satellite connectivity and optimised campus-level networks.



## Non-Terrestrial Networks fill in many cellular coverage gaps

Traditionally, satellite communications have been used to provide connectivity in locations that terrestrial technologies are unable to reach. However, until now satellite connectivity technologies have not been well-integrated into the cellular ecosystem.

The 3rd Generation Partnership Project (3GPP, the standards body for cellular networks) Non-Terrestrial Networks (NTN) initiative aims to address this, expanding cellular connectivity beyond traditional terrestrial networks by integrating satellite and high-altitude platform systems into the 5G framework. The 3GPP's NTN initiative is intended to provide global coverage, especially in remote, underserved, or disaster-hit areas. Use cases include emergency services, maritime and aviation connectivity, rural broadband, and IoT in isolated regions. A critical goal is seamless integration, allowing users to switch between terrestrial and non-terrestrial networks without disruption or changing devices. 3GPP's Release 17 (in March 2022) focused on NTN support

for NB-IoT and LTE-M, while future releases will enhance capabilities for higher bandwidth needs. Over time, NTN may offer seamless support alongside terrestrial 5G.

Transforma Insights has defined two key types of NTN connections:

- NTN-Centric connections, for which NTN connectivity is critical (but which may connect using terrestrial 5G networks if these are available).
- NTN-Overspill connections, which typically use terrestrial networks but shift to NTN in coverage gaps.

In total, we forecast that there will be a little over 8.2 million NTN-Centric connections by 2034, driven by applications such as UAVs (Unmanned Aerial Vehicles), Livestock Monitoring, Supply Chain Monitoring, Container Tracking, Stolen Vehicle Recovery, and more.

Some 5G connections associated

with IoT applications might generate a requirement for NTN-Overspill connectivity. These will typically be devices that have a clear view of the sky when in use and that can be expected to move distances that are potentially material for NTN connectivity purposes during use. Transforma Insights forecasts that non-terrestrial networks could potentially play a role in providing connectivity for around a third of IoT connections in such contexts, approaching 1.5 billion devices by 2034.

Clearly, not all of these connections would be exclusively supported by satellite connectivity, and it is likely that each device would only be fleetingly connected to a NTN. Accordingly, we have defined a Notional Connection to be the equivalent of a single connection, but potentially distributed across multiple devices. For example, if 100 devices are each connected using NTN for 1% of the time, then that represents one (100 x 1%=1) Notional Connection. As a result, the Notional Connections that we expect would potentially be

connected via NTN represents a small share of the total opportunity. In total, we forecast that there will be around 57.7 million Notional Connections using NTN in 2034, assuming that the required NTN connectivity is available. This is approximately equal to the traditional (non-3GPP NTN) satellite opportunity for IoT in 2034 (54.7 million).

In total, this equates to a NTN opportunity of around 120 million connections (including 57.7 million Notional Connections). Critically though, the 57.7 million Notional Connections will be distributed across around 1.5 billion physical IoT devices, suggesting that this number of connections could potentially be 'improved' by the advent of 5G NTN propositions.

Accordingly, there is a significant opportunity for existing terrestrial-only connectivity solutions to be enhanced with the integration of NTN connectivity, and NTN capabilities are likely to become a key aspect for any truly global connectivity solution.

## LoRaWAN further enhances options for ubiquitous connectivity

LoRaWAN® is the break-away leader in the licence-exempt Low Power Wide Area (LPWA) connectivity market. LoRa® is a physical proprietary radio communications technique, owned by the US company Semtech Corporation and operating in licence-exempt spectrum. Meanwhile, LoRaWAN, an ITU approved standard, is a communications protocol and system architecture that has been developed for deployment on LoRa chipsets. In recent years, LoRaWAN has become the default LPWA connectivity option for campus networks supporting one or more IoT solutions. The technology has significant traction in smart cities contexts, either supporting multiple smart cities applications, or just a single application, and particularly for supporting smart metering. In addition, a number of network-as-a-service LoRaWAN offerings exist, either deployed to support initial 'anchor' clients or deployed as nationwide networks (for instance in France, the Netherlands, and Switzerland).

LoRaWAN standards support device

roaming between networks, and individual networks are a simple and low-cost option to deploy for any end-user needing coverage of a specific campus area, or multiple such areas. Examples of multi-campus deployments include the deployment of LoRaWAN to support seaport operations or chiller monitoring in quick serve franchise locations. Nationwide networks-as-a-service, meanwhile, unlock new types of opportunity such as, for example, support for remote patient monitoring in the Netherlands.

The key aspect of LoRaWAN from the perspective of an enterprise seeking a truly global connectivity solution is that it is ideally suited to supporting in-building connectivity in locations that are hard to reach with cellular networks. Any coverage gaps that exist within a campus environment can be readily addressed by the deployment either of a suitably placed gateway or repeater. The technology operates in licence-exempt radio bands, so avoiding the need for any potential adopter to secure spectrum access before deploying a network.

### Case Study : Net Feasa Transforms Container Tracking with Integrated Connectivity

Net Feasa's IoTTPASS™ solution demonstrates how a truly integrated connectivity approach can unlock significant efficiencies and enable capabilities that were previously impossible in global supply chain management.

As a Semtech IoT connectivity solution customer, Net Feasa combined cellular LPWA (LTE Cat-M with 2G fallback), LoRa® and satellite NTN connectivity in a single tracking device to overcome the fundamental challenge of container tracking across diverse environments. Traditional single-technology solutions failed because containers traverse locations with vastly different connectivity requirements—from cellular-enabled highways and warehouses to cellular-sparse shipping ports and remote ocean routes.

The integrated approach delivered transformative benefits. Real-time visibility became possible regardless of location, eliminating security vulnerabilities and operational blind spots. The IoTTPASS™ device intelligently adapts its behaviour based on context—entering semi-sleep mode when on vessels to conserve power, then awakening for detailed tracking when containers return to land transport. This seamless connectivity integration enabled Net Feasa to deliver always-on coverage with a single device installation, dramatically reducing complexity while providing unprecedented supply chain intelligence. The solution's 10-14 year lifespan matches container lifecycles, proving integrated connectivity approaches deliver both immediate operational benefits and long-term value. Most significantly, the approach positions Net Feasa to pioneer containers becoming autonomous participants in the global supply chain, actively coordinating with AI systems to optimise logistics workflows.

## A unified management platform for truly global connectivity

The advantages of pulling together a diverse range of connectivity options, including potentially cellular, satellite and LoRaWAN, to become a global connectivity solution are clear. But the resulting solution has the potential to be fragmented and challenging to manage. Accordingly, there is a need to combat fragmentation at several levels of the solution stack, using standardised devices and a centralised dashboard or platform that consolidates data, tools, and insights from multiple systems into a single, unified view, often referred to as a 'single pane of glass'.

Device fragmentation can be combatted by ensuring that devices are equipped with communications modules and associated capabilities that allow them to connect to whatever connectivity technologies are available. Clearly, in the case of a global IoT need, connectivity options supported by a device should include cellular and non-terrestrial networks, and LoRaWAN.

Devices should also support connectivity to multiple carriers,

including multi-IMSI and eSIM technologies, in a single SKU (Stock Keeping Unit) so that devices can attach as local connections to different available networks at any time. The choice of which network to connect to should take into account device-level local context and also commercial priorities.

At the device level, considerations include factors such as network availability and signal strength and would ideally be supported by automated selection and switching rules configured on the device. Meanwhile, commercial priorities may dictate a requirement for rate optimisation and even arbitrage, so that different carriers or even communications technologies are used to support different communications requirements. For instance, high bandwidth transfers may be configured to transmit only when a device is connected to the terrestrial network of a preferred carrier.

Clearly, NTN adds a dimension of complexity, with any 5G device

potentially having the option to connect via satellite. Such connectivity should be carefully managed though, since satellite connectivity is currently, and likely to remain, significantly more expensive than terrestrial alternatives. Accordingly, a level of coordination is needed between on-device functionality and remote device management functionality, in order to minimise both the periods of time for which a device is connected via satellite and the quantities of data that are transmitted when a device is so connected.

The management of connectivity using LoRaWAN networks also needs to be considered, potentially encompassing a range of both private campus networks and public networks-as-a-service. Again, the time periods for which devices are connected to different LoRaWAN networks, and their behaviour when connected to these, needs to be carefully managed. Meanwhile, the integration of LoRaWAN networks into a unified connectivity platform unlocks access to an extensive ecosystem of LoRa-based sensors supporting applications ranging

from employee safety to assisted living for the elderly, and from predictive maintenance for industrial machines to environmental monitoring.

The final element required to simplify and enable efficient control of devices across all these communications technologies is a single pane of glass management interface, through which all aspects of device connectivity as discussed above can be managed, across all technologies and in a unified and homogenous way. The interface should also support device management ranging from troubleshooting through to supporting firmware updates over the air and also include contextual information like device geolocation.

The aim of the single pane of glass control interface should be to both simplify the control of IoT devices across an entire estate and reduce the total cost of ownership of an overall IoT solution.

## Summary

Cellular connectivity remains the backbone for global IoT, offering wide coverage through multiple mobile networks and technologies like 4G and 5G. However, cellular still faces limitations in remote and indoor areas. To close these gaps, satellite-based Non-Terrestrial Networks (NTNs) are being integrated into 5G standards via the 3GPP, enabling seamless switching between terrestrial and satellite networks.

LoRaWAN, a leading LPWA technology using licence-exempt spectrum, complements this by offering low-cost, in-building, and campus-wide connectivity. Its strength lies in localised deployments, particularly for smart cities and metering. The ideal global IoT connectivity strategy therefore blends cellular, NTN, and LoRaWAN technologies. To efficiently manage this complexity, standardised devices with multi-network support and a central 'single pane of glass' platform are key. This unified system allows smart switching between networks based on signal, cost, and location, ensuring efficient connectivity while minimising costs through automated and policy-driven network selection and device management.

## About Semtech

Semtech Corporation (Nasdaq: SMTC) (formerly Sierra Wireless) is a high-performance semiconductor, IoT systems, and cloud connectivity service provider, with over 30 years of IoT solution leadership. They are dedicated to delivering technology solutions that enable a smarter, more connected, and sustainable planet. To learn more about Semtech, visit [www.semtech.com](http://www.semtech.com) or contact their experts at [sales@semtech.com](mailto:sales@semtech.com).