



# The Transformative Role of Converged Satellite and Cellular Connectivity in Fleet Management

*March 2024*

# Introduction

The commercial fleet management and logistics tracking market is impacted by a number of trends, including several developments that can alter the market conditions for solution providers and associated players in the coming years. These developments span across the expanding role of converged terrestrial-satellite connectivity, deployment of video-based solutions, integration of AI and the transition to electric vehicles (EVs) and mixed-fuel vehicle fleets. Enhanced connectivity options, including both terrestrial and satellite networks, enable more robust and continuous connectivity capabilities. Camera systems, supported by AI, provide real-time visual insights into driver behaviour, cargo condition and road incidents. Meanwhile, the transition to EVs and mixed-fuel vehicle fleets is reshaping fleet management strategies, requiring new approaches to operations and vehicle maintenance.

This white paper highlights the increasing need for a unified approach to connectivity, key advancements in converged terrestrial-satellite connectivity and how one of the leading cloud-native IoT connectivity service providers – emnify – addresses the long-term market and technology shifts within commercial fleet management and logistics tracking.

## **How unified IoT connectivity enables uninterrupted connectivity and simplifies operations**

Cellular connectivity is an essential enabler for fleet management and logistics tracking solutions, which must be further optimised for coverage, performance and security to match the requirements for the deployment. Traditional roaming can meet the requirements for applications with low to medium data volumes but may lack support for connectivity across multiple networks in any given country. Local sourcing of SIMs from local mobile operators is always a possibility but presents logistical and administrative challenges when scaling to a growing number of countries.

The choice of connectivity solution can significantly impact operational efficiency and costs as multiple contracts, SKUs and integrations, along with different regulatory environments and supported network technologies add additional layers of complexity. A unified approach to manage connectivity needs across different geographical locations is essential for ensuring seamless operations and reducing administrative overhead.

A key differentiator for IoT managed service providers like emnify is the ability to aggregate multiple wireless wide area networks and thus provide superior area coverage, multi-domestic footprints and multi-technology connectivity on a single platform. Due to the nature of their business, these players are becoming increasingly international, supporting customers in many parts of the world, whereas traditional mobile operators typically operate on a national or regional basis.

**The evolving fleet management landscape**

The broader fleet and asset management market includes various telematics and tracking solutions deployed for monitoring and management of different types of commercial vehicles as well as trailers, intermodal containers and other transportation-related assets including air freight cargo containers and other logistics units such as individual pallets or even cargo boxes. Fleet management for commercial vehicles is clearly the largest segment, estimated to account for more than 90 percent of the total installed base of active systems. Trailer tracking is furthermore currently the second largest category ahead of intermodal containers.

The fleet management sector is gradually becoming more international and many of the largest fleet management players in terms of subscriber base today operate on the global arena. There is nevertheless still a fair level of discrepancy between different continents and countries – and sometimes even within larger countries – both in terms of the propensity to adopt fleet management technology altogether and in terms of the specific types of applications that are favoured by the fleets operating on the markets.

**Introducing the emnify IoT SuperNetwork**

The emnify IoT SuperNetwork is a single, distributed service with access to hundreds of networks in over 180 countries, including satellite, for uninterrupted connectivity around the globe. emnify's in-house developed cloud native IoT network core is deployed globally in more than 25 cloud regions, enabling traffic to be broken out locally, instead of routing it cross-continently. By using local numbering resources, enterprises can reduce latency and roaming costs, while ensuring compliance with permanent roaming regulations. The SuperNetwork IoT eSIM brings the world's best cellular networks together with satellite into a single experience. One profile, one APN, and integrated radio access networks mean enterprises get global coverage as standard without the hassle of regional forecasting.

**Unpacking the numbers behind global vehicle and asset fleets**

About 10.0 million semi trucks and 15.0 million construction equipment are in use worldwide today. The global fleet of cargo carrying assets used in transportation includes about 30.1 million containers, 15.3 million trailers and 5.4 million rail freight wagons. There are about 2.5 million refrigerated containers, corresponding to about 8 percent of the global container fleet. An estimated around 14 percent of the global trailer fleet, or about 2.1 million units, are refrigerated trailers. Refrigerated rail freight wagons are uncommon and the number of these amounts to less than 50,000 units.

**Figure 1: Semi truck, construction equipment and cargo carrying unit fleets (World 2022)**

Asset type	Refrigerated	Total
Semi trucks	N/A	10,000,000
Construction equipment	N/A	15,000,000
Containers	2,500,000	30,100,000
Trailers	2,100,000	15,300,000
Rail freight wagons	50,000	5,400,000
<i>Total</i>	<i>4,650,000</i>	<i>75,800,000</i>

Intermodal shipping containers are standardised containers used in both sea and land transports. Trailers are unpowered and non-standardised vehicles often used for hinterland transportation of goods by truck or rail. Semi-trailers are the most common type of trailer for goods transport applications. Semi-trailers have no front axles and need to be coupled with a trailer tractor. Rail freight wagons are used to carry items transported on railways.

#### **Navigating the transition to EV fleets and mixed vehicle fleets**

In line with the growing adoption of electric vehicles (EVs), a growing trend in the fleet management market is the introduction of various types of functionality specifically designed with EVs in mind. Key players in this space today support an ever-increasing range of hybrid and electric vehicle models. Several leading providers have also introduced various types of functionality aimed at assessing the suitability of EVs in order to simplify fleet electrification. Such functionality helps fleets identify ideal EV candidates and make informed model choices, supporting fleet managers in the electrification of their fleets and in maximising their cost-saving potentials. Going forward, it will be increasingly expected from fleet management providers to support management of EVs and fleet electrification processes.

These EV tools can play a vital role in making the conversion to an electric fleet in the most cost-effective way, predicting which vehicles in the fleet will be ready to convert from petrol or diesel to electric and when. However, while electric vehicle telematics and EV fleet management are undoubtedly hot topics in the commercial telematics space at the moment, it is likely that this functionality will only offer a competitive advantage for a relatively limited period of time. The share of EVs in the commercial fleet sector is experiencing strong growth, especially for buses and LCVs but increasingly gaining momentum also for heavy trucks. A few years from now, it will likely be table stakes to offer the ability to manage all fleet assets including ICEs and EVs alongside each other on the same platform.



**The Internet of Transportation Things expands the addressable market**

Another trend that has surfaced over the years includes a diversification among providers of fleet management solutions for commercial vehicles to also support other types of assets. In line with a development sometimes dubbed as the Internet of Transportation Things, several solution providers now offer integrated solutions that can be deployed across off-highway vehicles, non-powered assets and other non-vehicle fleets in addition to the conventional commercial vehicle types traditionally targeted by fleet management providers. This enables fleet owners to monitor and manage all of their business-critical assets through the same interface, using familiar applications and reporting tools.



The development at the same time enables fleet telematics providers to maintain subscriber growth as mature markets eventually approach peak penetration. The telematics penetration is for example already comparably high in the heavy truck and trailer segment especially in mature markets such as North America, but the same cannot be said about most other types of assets used by fleet-owning companies. Asset tracking thus represents a heavily underpenetrated market with considerable potential for telematics providers that are ready to diversify the product offering. Particularly strong growth is expected for solutions that also enable tracking of ancillary items such as portable equipment, handheld tools and similar items in a unified interface.

## **Technology innovations transforming fleet management**

Commercial vehicle telematics and logistics tracking is in many respects one of the pioneering IoT verticals. The market has developed significantly over the past decades, impacted by general trends such as the transition to SaaS-based business models and the increasing integration of mobile devices and applications as part of the infrastructure which goes hand in hand with a general commoditisation of hardware, compute and data storage. Increased use of cameras and analytics is transforming the landscape further and allow for more sophisticated monitoring and management of fleet operations.

### **New features are continuously added to fleet management solutions**

New features are continuously added to fleet management and asset tracking solutions resulting in more value to end users. One recent example of this is the integration of cameras in vehicle environments for various purposes. Applications range from simple dash cams and CCTV-type surveillance to more advanced deployments for vehicle exterior monitoring and driver behaviour management. Some innovative solutions even track eye and head movements for real-time intervention in case of undesirable behaviour. Numerous fleet management players have introduced or are planning to launch integrated video-based solutions as part of the solution portfolios. Also Tier Ones have activities in this market as part of their vehicle safety solutions. Vehicle OEMs are in the future expected to increasingly integrate various video-based technology solutions as part of the overall offerings.

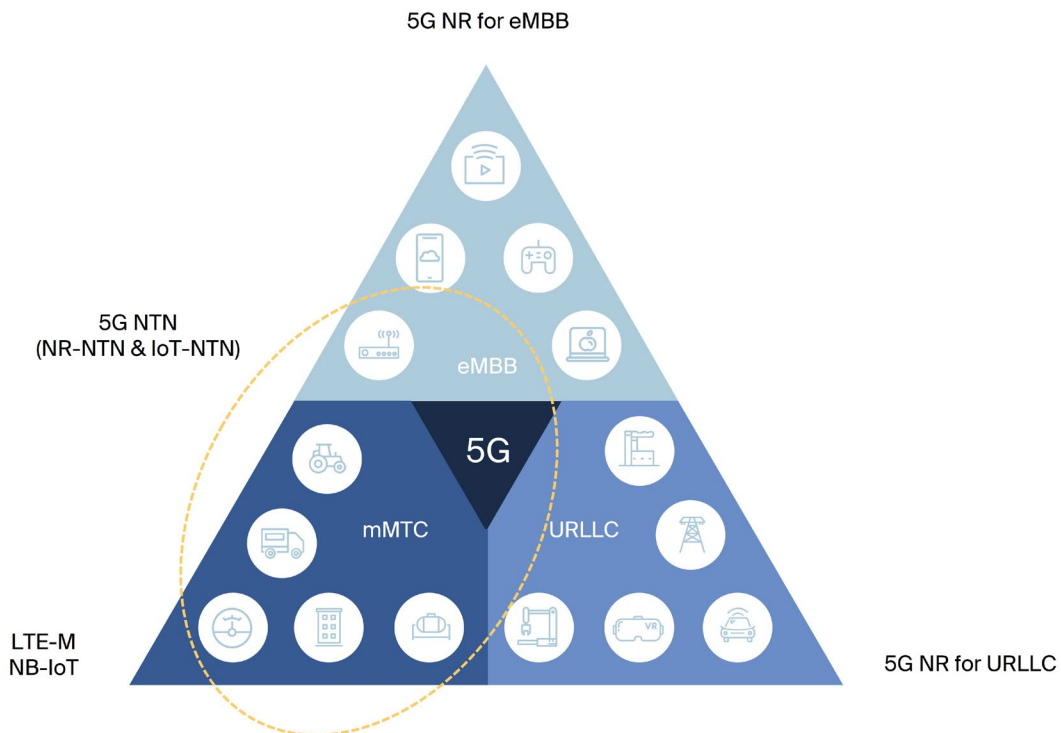
Another example is integration of fuel card data with fleet telematics data which presents several benefits for vehicle fleet operations. In addition to the convenience of being able to access all the relevant fleet information in the same application, fleet managers can also gain access to feature sets which are otherwise not readily available such as fraud monitoring functionality which combines fuel card transaction data with vehicle telematics data to identify suspicious and potentially fraudulent events. Regulatory reporting procedures can also be facilitated. Many fleet management solutions add support for integration with various fuel cards.

### **5G's role in enhancing data capabilities**

Asset trackers, telematics gateways, in-vehicle cameras, displays, electronic logging devices (ELDs), sensors, barcode/RFID scanners and other devices all need reliable and cost-effective connectivity to ensure smooth operations. 5G networks offer higher speeds compared to 4G LTE networks and will also bring the cost per gigabyte down further, making data-intensive use cases like document and HD video downloads more commercially viable. Organisations in the public safety and public transport segments have so far been early adopters of 5G devices to support use cases like in-vehicle Wi-Fi and video streaming. While solutions based on LTE-M and NB-IoT, which are also formally part of the 5G standard, are already widely adopted in the broader commercial fleet management and logistics tracking industry, 5G broadband solutions will

become increasingly relevant as 5G network coverage and hardware pricing improves. As new features like satellite connectivity become available, the rationale for transitioning to 5G technologies becomes increasingly compelling. It's therefore important to select an IoT connectivity partner committed to remaining at the forefront and evaluate the latest technology.

**Figure 2: Use cases better served by convergent terrestrial-satellite connectivity**

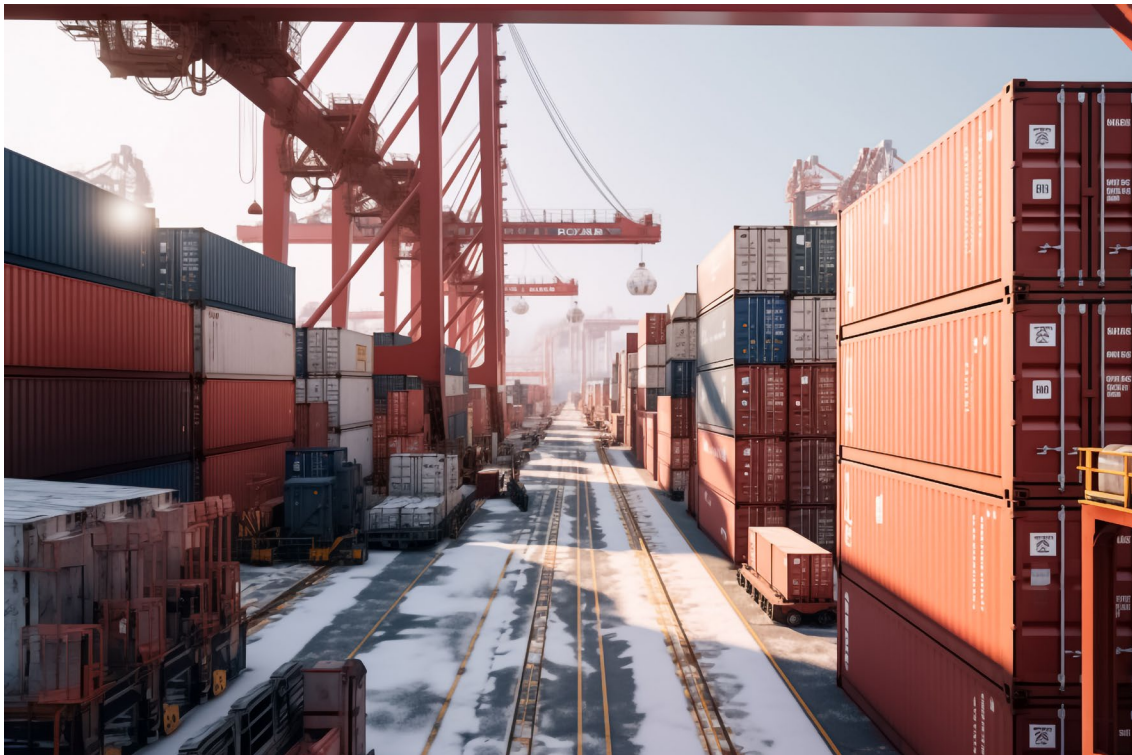


### Integration of AI and machine vision capabilities for enhanced driver safety

Video is indeed a significant technology innovation in the fleet space. There have traditionally been different categories of video-based functionality, suitable for different use cases. The video telematics market has thus been segmented along similar lines. While entry-level camera-enabled features have been offered by a large number of players, mainly competing on price due to comparably low levels of differentiation, certain types of more advanced functionality have been offered by a select number of specialised solution vendors. One example of such specialised functionality is driver distraction and fatigue monitoring enabled by in-cab sensors leveraging proprietary algorithms to measure the driver's head position and eye closure.

Machine Vision (MV) and Artificial Intelligence (AI) capabilities have traditionally been associated with high-end solution providers. Recent years have however seen such capabilities being highlighted by an ever-increasing number of players across various price points. Some industry representatives even claim that machine vision will be a prerequisite to be able to stay

competitive in the video telematics space in the near future. Solution providers may leverage upselling of AI/MV-enabled video telematics applications as a way of counteracting the downward price pressure on standard solutions. The suites of events and behaviours that can be detected by artificial intelligence are in turn growing continuously. Artificial intelligence and machine learning-based systems can indeed also pose a viable alternative to labour-intensive bureau services where teams manually oversee camera systems and provide feedback to clients.



### **The evolution from location tracking to advanced cargo monitoring solutions**

The first tracking solutions developed for the trailer and container market focused solely on location tracking. This helped logistics companies with large fleets of trailers, containers and other assets to know the location of their cargo and assets, which facilitated management of their fleet. These solutions were primarily a tool for internal cost-savings and to make logistics processes more efficient for the fleet owner. Many of the newer systems can to a greater extent be used as a service which logistics companies can offer to their clients (cargo condition and location tracking). Implementing solutions for tracking of individual cargo has previously been too costly and only made sense for tracking high-value cargo. The price for sensors and tracking technology is now at level where it is financially viable to also use these systems for tracking low-value goods.



More advanced tracking and sensor solutions, such as cameras and sensors for measuring cargo load status, are at the same time emerging on the market. New solutions for example feature a high-definition camera and an image recognition processor to interpret what type of cargo is loaded inside a trailer. These advanced solutions will add significant value for customers in the transport industry, and in the long term they will likely become adopted on a wider scale.

### **Advancements in SIM technology**

The IoT market has special requirements on SIM solutions and has been an important driver behind the development of technologies like eUICC and multi-IMSI. eUICCs address many of the shortcomings of traditional SIMs by enabling over-the-air provisioning and management of cellular subscriptions without having to replace the physical SIM itself. This shift to eUICCs also streamlines device design as it allows for the use of embedded SIM form factors such as eSIMs and iSIMs. Even though the many features of eUICCs look attractive on paper, most eUICCs used for IoT deployments are today single-profile eUICCs, where the user has the option of changing the cellular subscription sometime in the future if needed. The use of multi-profile eUICCs are so far rare due to the lack of commercial agreements between mobile operators and costs related to system integration required for performing profile swaps.

Commercial solutions for remote SIM management are today available based on either of the two GSMA standards M2M (SGP.02) and Consumer (SGP.22). The M2M standard addresses most common IoT use cases. In light of the complexity related to the M2M eSIM standard, GSMA has introduced the new IoT specification (SGP.32) for eSIM provisioning, which leverages the benefits of the two existing specifications, and most importantly eliminates the need for integrations between mobile operators. Commercial implementations will likely start in the first half of 2025. Multi-IMSI SIM solutions offer a different approach and enable SIMs with multiple interchangeable mobile subscriber identities. Multi-IMSI SIMs may either be configured to use a domestic network once deployed in its final destination, or change network identity depending on location, coverage or costs. The technology is widely used for global SIMs in the IoT market.

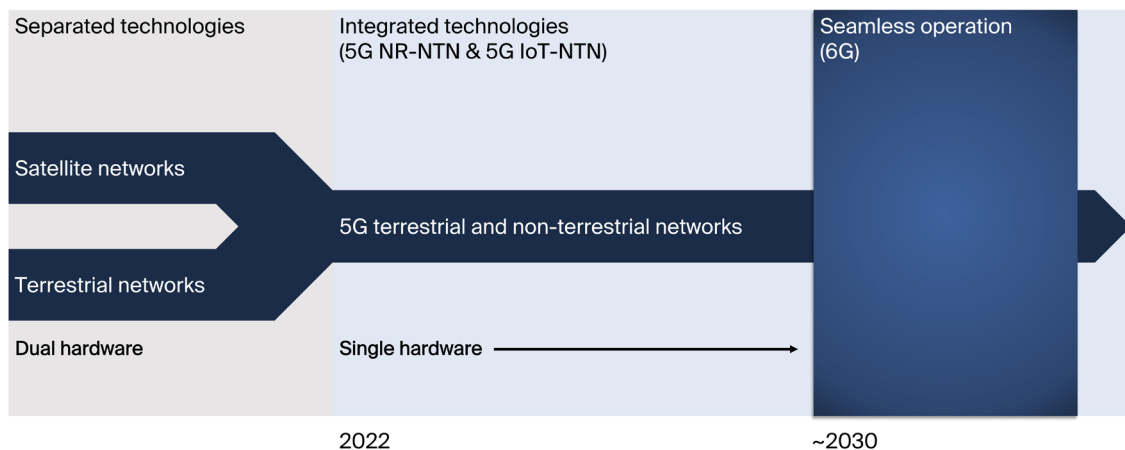
Hybrid SIM solutions, like the emnify SuperNetwork IoT eSIM, leverage both eUICC and multi-IMSI and combines the strengths of the two technologies to provide a more consistent, reliable and network-agnostic connection to meet the needs of IoT solutions. The solutions offer a single SKU solution that can be shipped globally and connect to local cellular networks as well as satellite based on pre-defined criteria, while avoiding lock-in effects.

### **How 5G NTN greatly changes the economics of satellite connectivity**

Tens of billions of dollars are today being invested into the creation of new low earth orbit (LEO) constellations of satellites as well as other types of constellations in a new kind of space race. Non-terrestrial networks (NTN), including satellite networks, are at the same time being included

in the 5G specification as part of 3GPP Release 17 and onwards. Previously, different types of hardware had to be used to connect devices to 3GPP terrestrial networks and satellite networks. Using 5G NTN, all cellular devices will be able to connect to both terrestrial and satellite networks, thereby eliminating the need for separate hardware.

**Figure 3: The road to seamless terrestrial-satellite connectivity**



5G NTN includes 5G NR-NTN and 5G IoT-NTN, each addressing different use cases. 5G NR-NTN is designed to complement terrestrial networks in under-served areas and offer data speeds from 1 to 10 Mbps, whereas 5G IoT-NTN expands the addressable market for IoT applications, enabling true global coverage over land, sea and air. The 5G NTN market has started to establish itself with commercial services based on 5G IoT-NTN being offered by Skylo through its partner emnify.

#### **Enabling operational scale through centralised control**

Using a single IoT connectivity provider offers several benefits that streamline operations and reduce complexity. A unified platform for managing connectivity centralises control of devices and services, making it easier to monitor, manage and troubleshoot the network, and provides one point of integration. With one provider, it's also easier to ensure that all devices adhere to the same security protocols and regulatory requirements, reducing the risk of breaches that can occur due to inconsistent security measures.

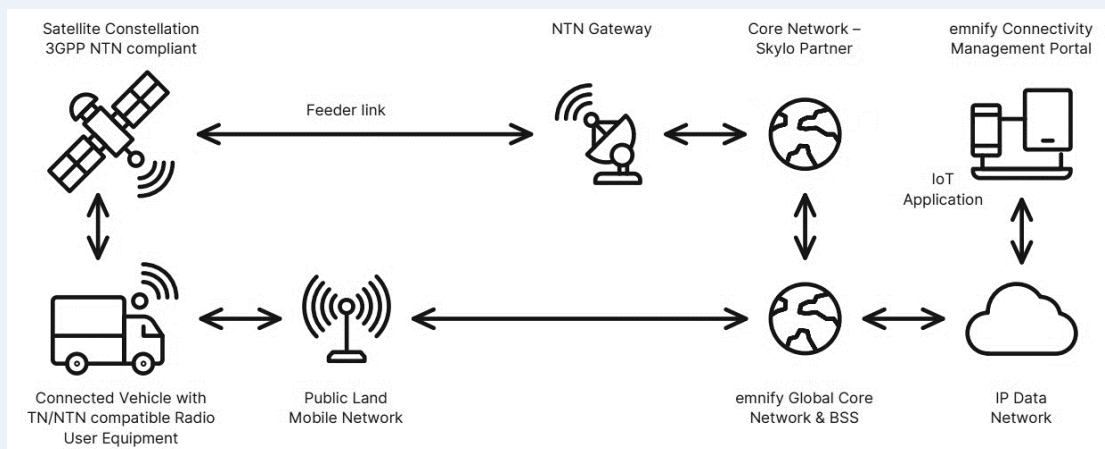
The integration of cellular and satellite connectivity into one service also enables new approaches to unified IoT connectivity management. The convergence brings forth a suite of benefits, particularly in improving affordability through packaged models that includes satellite messages pooled across devices.

### emnify announces IoT SuperNetwork SatPlus

emnify's SuperNetwork SatPlus package combines IoT-dedicated cellular access with Skylo's non-terrestrial network (NTN) satellite service. This is made possible through a single converged form factor, enabling IoT device manufacturers, OEMs, and application and solution providers to add a new level of service enabled by seamless satellite connectivity failover for devices outside of, or disconnected from, cellular coverage. By enabling both cellular and satellite network access from a single eSIM, single management console and single radio module, SatPlus uplevels the user experience and drives down the hardware and connectivity costs as it reduces operational overhead associated with adding satellite connectivity.

Moreover, the SatPlus solution opens new avenues for business models, for example, in the case of fleet management providers. By offering satellite connectivity as a premium connectivity service, companies can unlock new revenue streams and secure a competitive edge, ensuring superior service continuity and customer satisfaction.

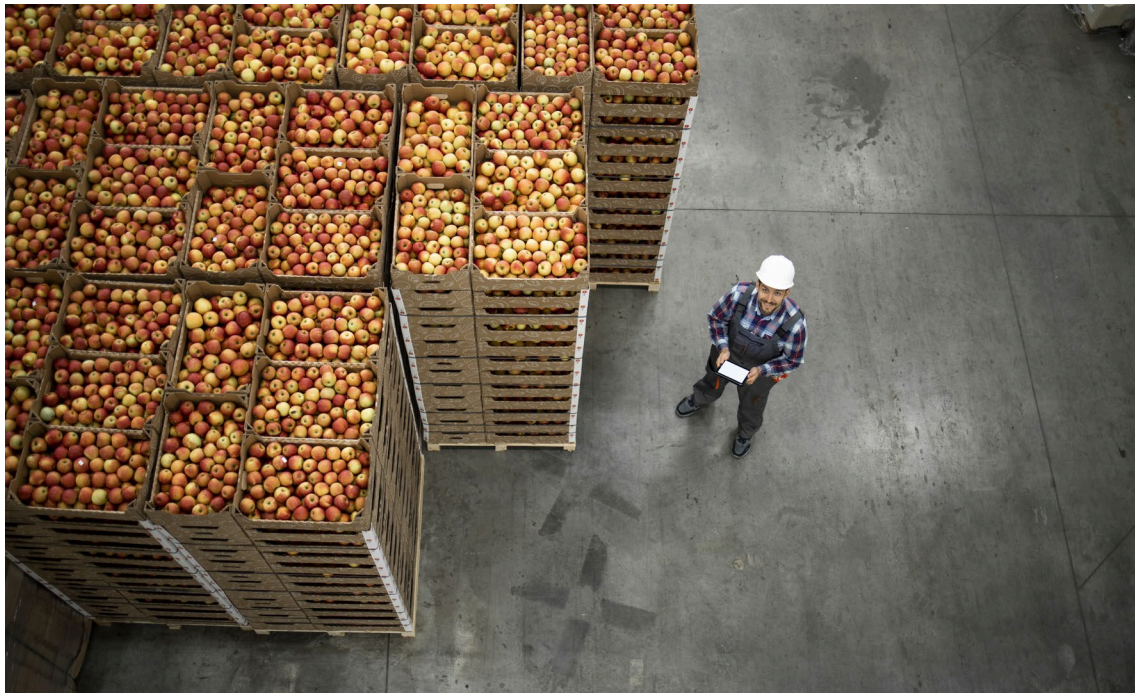
**Figure 4: How emnify's SuperNetwork SatPlus works**



The offering is available in selected countries in Europe and the USA and includes 10 MB of cellular connectivity combined with options for 10, 30 or 60 satellite messages per month. With SatPlus, SuperNetwork customers have the security of ubiquitous, uninterrupted IoT connectivity, with seamless switching to satellite networks as devices leave cellular coverage regions. This converged offering is designed for customers that require high availability and a failover solution to be assured that critical application data, such as a high value asset's position, will always be transmitted.

### Converged cellular and satellite case study: Cold chain logistics

Certain types of goods are especially sensitive to potential hazards faced during transport. Foods, vaccines, pharmaceuticals, chemicals and electronics are typically sensitive to exposure of temperature variations as well as shock, tilt, vibrations and light. These types of goods require a controlled temperature level and environment throughout the entire supply chain, from harvest or production to transport all the way to the end-user. Transporting and storing temperature-sensitive products require a different set of knowledge, capabilities and equipment compared to regular cargo. Goods need to be packed and stored correctly before and after the shipment. Trucks, trailers and containers and other cargo carrying units need to have a cooling system, either passive or active, in order to keep the temperature within the correct range during transports. It is also vital to have well-established rules for handovers between different transport legs and storage. In contrast to the transport of regular goods, a failure in the cold chain often leads to damaged or spoiled goods.



Cold chain tracking and monitoring solutions that enable real-time data on cargo location and condition provide significant value for cargo owners and logistics service providers. About one third of all food produced for human consumption globally is wasted. It is estimated that up to 15 percent of the wastage occurs post-harvest and before reaching the retail store, i.e., mainly during transportation. Temperature excursions during transportation that are not managed properly is a common reason for spoilage. If there is no data available on temperature levels during transportation, supply chain managers will not be able to prevent spoilage.

**Sustainability goals can be reached by using real-time monitoring solutions**

Data loggers connected to cellular, LPWA or satellite networks can provide real-time data on the temperature, humidity and impact of the shipment. This makes it possible to take immediate action if there is an excursion from pre-set environmental parameters, possibly saving the cargo load from spoilage. A single load of pharmaceuticals, electronics or other products that are typically transported in the cold chain can be worth millions of dollars. Real-time shipment data can also help companies keep a good brand reputation as damaged goods can be stopped from reaching the customer. It also enables the shipper to send a new shipment immediately and thus save days or weeks of potential disruption which can be very valuable for e.g., a production company waiting for a key component or a patient waiting for a vaccine. The combination of data on cargo location and condition also makes it possible to see where in the supply chain the goods were damaged, which helps identify recurring issues.

**Figure 5: Main components of IoT solutions in cold chain logistics**

Hardware
<ul style="list-style-type: none"><li>&gt; Tracking devices and real-time data loggers</li><li>&gt; Sensors measuring temperature, humidity, shock, tilt, light and more</li></ul>
Network and GNSS
<ul style="list-style-type: none"><li>&gt; Cellular (2G/3G/4G/5G, LTE-M, NB-IoT)</li><li>&gt; Satellite</li><li>&gt; LoRaWAN</li><li>&gt; GNSS (GPS, GLONASS, Galileo)</li></ul>
Software and services
<ul style="list-style-type: none"><li>&gt; Shipment monitoring portal</li><li>&gt; Analytics applications</li><li>&gt; Integration platforms</li><li>&gt; Live shipment monitoring services</li></ul>

IoT solutions used for the assets that carry the refrigerated cargo during transport, i.e., refrigerated trailers, containers and air freight ULD containers, originate from the fleet management and truck telematics industry. Today’s solutions not only include real-time data on the location of the assets but also temperature, humidity, door opening/closing, cargo loading/unloading and more. There are also connected transport refrigeration units, installed on the trailer or container, that allows for two-way communications. This enables customers to remotely turn the reefer unit on or off, change operating mode, initiate pre-cooling and more. Detailed reports on historical temperature data, utilization and routes transported can typically



be accessed from an online portal for easy compliance with regulations. Many of today's telematics and tracking solutions for trucks, trailers and containers can be connected to external sensors, usually via Bluetooth, for measuring the condition of the cargo on a more granular level.

#### **Advantages of converged terrestrial-satellite connectivity in cold chain logistics**

Cold chain tracking can benefit significantly from satellite connectivity given the sensitive nature of the cargo and need for continuous monitoring. The loss of connectivity, even for a short period, can lead to undetected temperature deviations that result in damaged goods. Cold chain logistics also often involves long-haul transportation across remote areas where terrestrial network coverage is patchy or nonexistent. Satellite connectivity ensures uninterrupted monitoring of the cargo throughout the cold chain, including white spots with insufficient terrestrial network coverage. The data required for cold chain tracking solutions is typically very compact, ranging tens of bytes per message that includes GNSS coordinates, a temperature reading and a timestamp. The compact data size fits easily within message plans like emnify's SuperNetwork SatPlus, making it economically feasible to maintain continuous monitoring of the goods.

#### **Conclusions**

Multiple parallel market and technology shifts that are currently transforming the industry may in the longer term create a playing field characterised by a new type of market dynamics for fleet operations. Below, we highlight key trends that underscore the critical role of continuous IoT connectivity, unified management platforms, and the strategic selection of an IoT connectivity partner in navigating these changes.

- Continuous IoT connectivity for commercial fleet management and logistics tracking solutions not only contributes to increased resiliency in the digital supply chain by providing real-time data on the exact location and condition of each asset but also enhances the ability to respond swiftly to any disruptions or anomalies. This level of insight and control allows for immediate adjustments to routes or operations, minimising downtime and maintaining the flow of goods even under challenging circumstances.
- Satellite connectivity provides a complement to terrestrial networks for tracking of assets in remote areas and at sea, but has historically come at a significant cost premium, both in terms of hardware and data plans. The introduction of satellite connectivity as part of the 5G specification marks a pivotal step towards cost-efficient, resilient global connectivity.

- There is a new need on the market for solutions that can manage different types of vehicles, non-powered assets and other non-vehicle fleets. Fleet management and logistics tracking solution providers thus need to offer the ability to manage these mixed fleets of truly diverse assets on the same platform with a unified management interface offering a “single pane of glass.” This diversification into the broader fleet and asset management market calls for integrated connectivity solutions from flexible providers combining cellular and satellite to enable ubiquitous coverage across all assets.
- A unified platform for managing connectivity centralises control of devices and services, making it easier to monitor, manage and troubleshoot the network, and provides one point of integration. With one provider, it’s also easier to ensure that all devices adhere to the same security protocols and regulatory requirements, reducing the risk of breaches that can occur due to inconsistent security measures.
- It will become increasingly important to select an IoT connectivity vendor committed to remaining at the forefront and evaluate the latest technology as the IoT connectivity landscape becomes more diverse. Regulatory compliance and security considerations add additional layers of complexity, making the strategic choice of an IoT connectivity partner more critical to staying competitive and adapting to changing market demands.



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emnify is the leading cloud building block for cellular communications in the IoT stack, connecting millions of IoT devices globally – from electric vehicles to energy meters, alarm systems to GPS trackers, thermometers to health wearables. The emnify API and SIM technology connect and secure any kind of IoT deployment to its application back-end. emnify's cloud-native integrations and no-code workflows ensure seamless lifecycle scalability for deployments of all sizes – from local start-up to global enterprise. The award-winning emnify IoT SuperNetwork is the largest globally distributed mobile cloud core network of its kind, supporting local network access (2G – 5G, LTE-M, NB-IoT and satellite) in over 180 countries from more than 25 cloud regions – and counting. emnify's solution is built on partnerships with the leading hyperscale cloud service providers, system integrators, and hundreds of network operators worldwide.

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