



Found in space!

The why, how & what of satellite connectivity

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November 2023

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Introduction

Whether it's the CEO who finalizes an e-mail to an important client while flying to Frankfurt or whether it's the Gen-Z teenager who scrolls through his Tik-Tok feed while being on a cruise with his parents in the Atlantic Ocean - being always-online, no matter where you are or what time it is, has become a basic need in professional and private life. However, mobile and landline communication only achieve a global network coverage of about 20% [1].

While being online for 24 hours a day all around the world sounds too good to be true, it is currently becoming a reality by adding satellite connectivity to the equation, both in the consumer and business environment. Globally available connectivity offers companies in the telecommunication, transport, logistic, agriculture, energy, mining and environmental sector opportunities to improve their solutions and to introduce completely new offerings.

In various satellite projects, mm1 has helped Telco companies to explore suitable use cases in the previously mentioned sectors. Based on these experiences, we have identified critical success factors for their implementation.

In this paper, we would like to share our insights about satellite connectivity. The article answers the following questions:

1. Why is satellite connectivity a current hype topic in consumer and business markets?
2. How can companies enter the satellite connectivity market?
3. What are opportunities and risks for satellite connectivity applications in relevant sectors?

Definition of satellite-specific terms

Satellite Connectivity refers to the use of a satellite network to establish and maintain connections between different points on Earth. Satellites are launched into orbit and act as relay stations to transmit data over long distances.

Satellite IoT (Internet of Things) refers to the integration of satellite technology with the Internet of Things ecosystem. It enables the connectivity of a wide range of IoT devices and sensors using satellite networks and extends their reach especially in remote and rural locations. Satellite IoT is particularly valuable for applications that require global coverage or connectivity in areas with limited infrastructure.

Converged Connectivity (also known as integrated / unified connectivity) refers to the merging of multiple communication technologies into a single, seamless system. In this paper, it specifically refers to the integration of cellular and satellite connectivity.

GEO (Geostationary Earth Orbit) satellites are placed in an orbit 35,786 kilometers above the Earth's surface, and they remain stationary relative to the Earth's surface. This makes them ideal for providing continuous coverage to a large area, such as a continent or an entire hemisphere. GEO satellites are commonly used for satellite television broadcasting and satellite internet services.

MEO (Medium Earth Orbit) satellites are placed in an orbit between 2,000 and 35,786 kilometers above the Earth's surface, and they move at a faster speed than GEO satellites. MEO satellites are used primarily for navigation and positioning services, such as the Global Positioning System (GPS).

LEO (Low Earth Orbit) satellites are placed in an orbit between 160 and 2,000 kilometers above the Earth's surface, moving at a very high speed relative to the Earth's surface. LEO satellites are used for a wide range of applications, including remote sensing, Earth observation, and communication services such as satellite internet and mobile phone services.

New Space refers to a growing sector within the space industry that involves innovative approaches to space-related activities. It represents a departure from the traditional government-dominated and large corporation-driven space exploration known as Old Space.

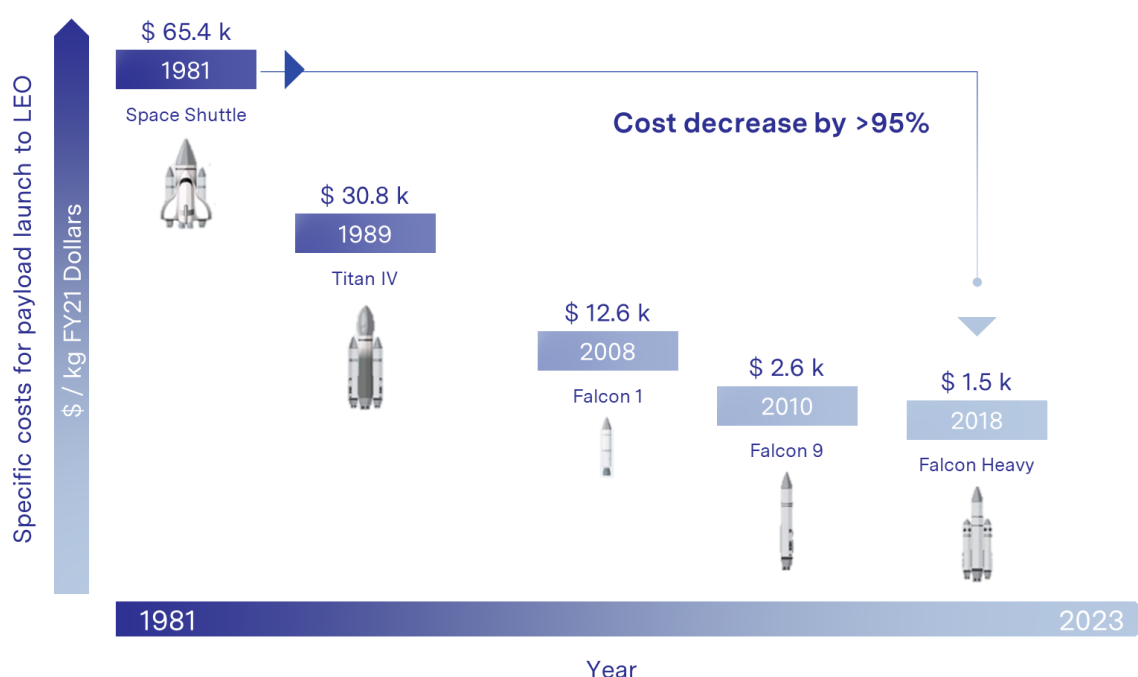
Why is satellite connectivity a current hype topic in consumer and business markets?

Satellite connectivity is a hot topic both in business and in consumer marketplaces. Apple has already integrated satellite connectivity into their flagship product, the iPhone [2]. Using satellite connectivity, Apple launched an emergency SOS service allowing consumers to call for help while being off the cellular grid. Furthermore, Amazon plans to provide globally available broadband connectivity by deploying thousands of satellites in low earth orbit (LEO) by the end of 2024 [3]. Both examples illustrate how satellite connectivity-based offerings are beginning to enter the consumer market. With Big Tech putting their chips on the technology, it becomes a topic worthwhile to evaluate for all businesses. But what are the reasons for this seemingly sudden emergence of satellite products?

Consumers don't care how they are connected (cellular, fixed-line or satellite), but they do care that they are connected without service disruption so they can continue to browse the internet or work on documents in the cloud. While globally available connectivity is much appreciated by consumers, their willingness to pay for ubiquitous connectivity depends on their price sensitivity.

In the B2B context companies are willing to take up high investments to close connectivity white spots and track their assets, either to improve resilience of critical infrastructure or to enhance connection quality. Hence, the B2B market has longed for reasonably priced satellite connectivity complementary to already existing cellular connectivity. Up until recently, satellite connectivity was considered too expensive to be economically justifiable. However, this changed with the emergence of "NewSpace" companies like Starlink.

Through a paradigm shift in the satellite industry, "NewSpace" companies have been shaking up the conventional approach to manufacturing, launching and operating satellites. They are approaching the satellite industry with a silicon valley like operating model – cross functional teams developing minimum viable products in short development cycles. This innovative approach decreased manufacturing, launch and operation costs while improving product features at the same time. The cost to launch a satellite into Low Earth Orbit (LEO) has decreased by 95%, from 65,400 \$ per kg to 1,500- \$ per kg [4].



Development of specific satellite launch costs into Low Earth Orbit (LEO) [4]

Why is satellite connectivity a current hype topic in consumer and business markets?

Additionally, the cost of operation was decreased by achieving significantly smaller satellite sizes. Nowadays, satellites, like Cubesats, weigh between 1-10 kg and have the size of a watermelon [5]. With cheaper satellite communication in the market and technical bodies like 3GPP recognizing the relevance of non-terrestrial networks, the way towards a converged communication path, that unifies cellular and satellite and covers 100% of earth's surface, is paved. Consequently, converged connectivity is gaining traction, as the advantages of both cellular and satellite connectivity can be combined. This leads to attractive offerings for customers requiring connectivity all over the world, or at least in remote areas.

With a projected growth of 22% CAGR until 2031, resulting in a value of 6.1 bn \$ in the respective year [6], the satellite IoT market is more than just a matter of prestige or fulfillment of science-fiction fantasies. Hence, many players e.g. Old Space companies, Telco companies and Big Tech are evaluating their chance of winning in the satellite connectivity game.

How can companies enter satellite connectivity and satellite IoT markets?

Consequently, three major European mobile network operators (MNOs) presented their new converged connectivity propositions at the Mobile World Congress 2023 in Barcelona. All three are partnering with SatCo companies, who are dominating the satellite connectivity market. Telefónica and Vodafone are complementing their cellular networks in cooperation with a single satellite network operator each - Telefónica with Sateliot, Vodafone with AST SpaceMobile. Deutsche Telekom is opting for an ecosystem entailing various providers (at the time of our research Intelsat and Skylo).

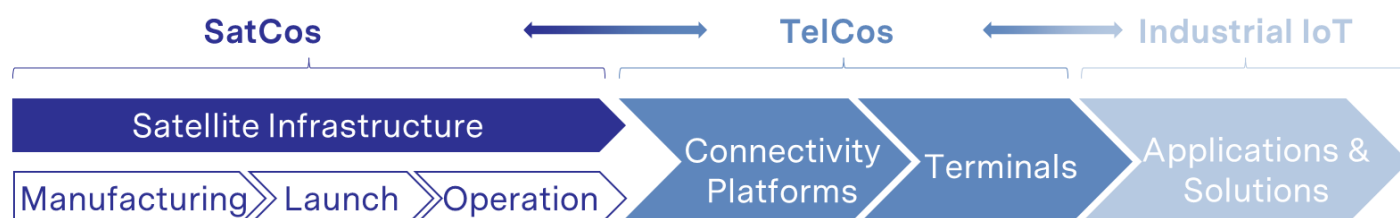
Customers of converged connectivity propositions look for global connectivity with a one-stop solution and appreciate convenience of usage. Therefore, partnering with SatCos is crucial for Telco players, otherwise they risk being by-passed by newly arising competitors. Big Tech is already entering the connectivity race by integrating backwards in the value chain as the example of Amazon's project Kuiper shows.

To decide their entry point into the satellite market both Big Tech and Telcos need to understand the satellite value chain if they want to provide additional value. With a focus on technology, a satellite connectivity value chain consists of four main components - infrastructure, platforms, terminals and applications & solutions:

- **Infrastructure** value creation consists of three activities, which are manufacturing, launch & operation of satellite assets. Satellites receive signals from other satellites or from earth-based transmitters, which can be either terminals or ground stations that relay the signals to earth-based locations. There are three types of orbits that satellites can be placed in: Geostationary Earth Orbit (GEO), Medium Earth Orbit (MEO), and Low Earth Orbit (LEO). LEO satellites are closest to earth and have thus become an attractive option for providing connectivity. This is due to lower cost for launch and operation and a better connectivity profile (latency & data rate) than for MEO or GEO satellites. Both Starlink and Amazon use LEO satellites.

- **Connectivity Platforms** enable connectivity data management. This includes the interworking between satellite and cellular networks as well as access/configuration via standard API-interfaces. The domain of connectivity management is quite familiar to Telcos. The three MNOs mentioned above offer two different options for their solutions: The first option is to use a data management platform supplied by the connectivity provider and the second option is to connect and use self-developed software via APIs.
- **Terminals**, also known as Very Small Aperture Terminals (VSATs), establish a connection to satellites. They consist of a dish antenna, LNB and modem installed at the user's location to communicate with the satellite network. Currently, commercially available satellite terminals are still large, require professional setup services and do not connect to cellular networks. Hence, separate devices for cellular and satellite connectivity are needed with high connectivity fees and the mentioned significant upfront investments. However, in-device convergence for both connectivity types is projected to be commercially available by 2026.
- **Applications & Solutions** utilize satellite connectivity to provide value to consumers and businesses, especially in the industrial IoT domain. Technological capability to offer satellite-based connectivity is only one part of the coin to provide value. The other part of the coin is recognizing current short-comings of IoT-based solutions that can be solved with satellite and potentially cellular convergent offerings. This becomes increasingly important in the wake of achieving a sustainable future.

How can companies enter satellite connectivity and satellite IoT markets?



Satellite Connectivity Value Chain (based on Eutelsat) [7]

In order to enter the satellite connectivity market, both Big Tech and Telcos need suitable partners, as satellite manufacturing, launch and operation are highly specialized technical domains.

Using Telco companies as an example, the beginning of the value chain including satellite manufacturing and satellite launch is not well suited for market entry. Partnerships are required in the domain of satellite operations. The scope of the partnership depends on the level of integration that is intended by Telcos from simply buying satellite data volume to hybrid infrastructure that provides both satellite and cellular backhaul connectivity.

However, Telco companies may find their sweet spots in the areas of connectivity platforms and/or terminals. These are the areas where Telcos have a right-to-play because they already provide cellular-based offerings and customer relationships. While Telco companies initially offered IoT services based on cellular connectivity, the road ahead allows for multiple bearers, mobile network, satellite network or even both as long as connectivity is provided in accordance to service-level agreements.

Looking further downstream the value chain industrial companies need to start evaluating and designing potential satellite IoT use cases while Telco companies need to understand the different needs of industrial companies in order to successfully sell their newly established applications and solutions.

The Telcos' B2B customers will benefit from partnerships between Telcos and SatCos and enjoy the luxury of choosing an individually suitable solution for their specific IoT use cases at a better price. Currently, only market pioneers with a high need for satellite connectivity are entering the market, as prices for satellite connectivity remain relatively high due to upfront installation costs. But these are expected to drop by 30%-50% within the next 5 years due to further technological progress. Ultimately, self-install options and in-device convergence will enable mass market adoption.

What are opportunities and risks for satellite connectivity application in various sectors?

Satellite connectivity has four key benefits that make it an attractive solution for various sectors. Firstly, satellite coverage enables global connectivity, in contrast to cellular coverage. Secondly, satellite connectivity is highly reliable, since it has less terrestrial infrastructure than cellular connectivity, making it less prone to outages caused by natural disasters. Thirdly, satellite connectivity is considered very scalable. It thus supports large numbers of devices spread over wide geographical areas. And finally, satellite connectivity is more cost-effective for IoT applications that operate in areas where terrestrial networks are not available. In summary, global connectivity, high reliability, better scalability and increased cost-effectiveness make satellite connectivity especially suitable for applications requiring continuous connectivity in remote areas.

Hence, the potential of satellite connectivity is certainly not limited to Apple’s emergency SOS service or Amazon’s satellite broadband internet service mentioned earlier. In fact, several sectors can leverage satellite connectivity to implement IoT use cases that aim at monitoring and managing business assets. The forecasted market potential for satellite IoT connectivity estimated until 2031 is significant.

The satellite IoT market in **transport and logistics** is projected to be worth 1.784 billion US dollars in 2031 with satellite connectivity enriching use cases like real-time monitoring of freight and supply chains.

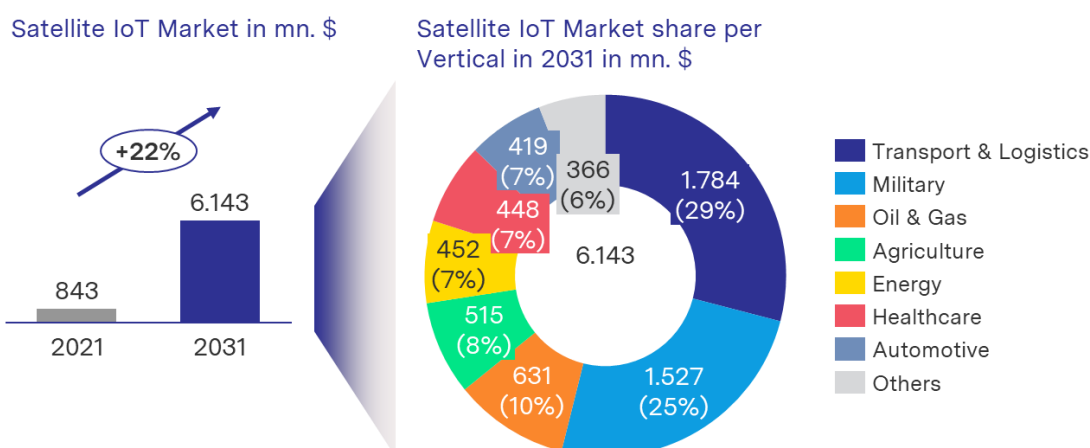
The second biggest market potential is found in the area of **military** with a volume of 1.527 billion US dollars. The military market is followed by the segment of **oil & gas** with a volume of 631 million US dollars. Satellite broadband has always played a key role in this vertical due to the remote nature of assets like oil rigs, pipelines and ocean going tankers. Satellite broadband connectivity enables a more powerful exchange of data, thus enabling further optimization of digitalized processes.

The expected value of the satellite IoT market in **agriculture** amounts to 631 million US dollars. In agriculture, satellite connectivity can for instance be used to monitor crop and irrigation conditions in order to optimize crop growth and yields.

Further promising use cases include energy management of renewable energy facilities and smart grid optimization for the energy and utility sector. The **energy** market potential is valued at 452 million US dollars.

In **healthcare**, possible satellite IoT solutions are emergency medical services support or remote patient monitoring. The market for healthcare satellite IoT is valued at 448 million US dollars.

Lastly, satellite IoT offers interesting use cases for the **automotive** sector, such as connected car services, with a market value of 419 million US dollar.



Development of the satellite IoT market until 2031 [6]

What are opportunities and risks for satellite connectivity application in various sectors?

However, the implementation of satellite-based IoT use cases also poses challenges. Potential pitfalls in end customer experience must be addressed, such as higher latency, smaller bandwidth, signal interference, higher cost compared to Wi-Fi or cellular in less remote areas and regulatory compliance. Higher latency can be especially challenging for applications that require real-time response or control, such as autonomous driving. Higher up-front cost compared to Wi-Fi or cellular connectivity, particularly for small-scale IoT applications, may limit commercial viability. Furthermore, smaller bandwidth may be a limitation for B2B2C business models, such as in-car streaming and navigation services, due to higher traffic demand. And lastly, signal interference due to atmospheric conditions, solar flares, and physical obstructions, as well as regulatory compliance issues, such as licensing and spectrum allocation, can be bothersome for technical implementation.

Conclusion & Key Takeaways

In summary, satellite connectivity is the missing piece of the puzzle for providing ubiquitous connectivity. While the benefits for consumers are significant as Apple's SOS emergency service shows, businesses have been waiting for a globally available IoT coverage improving e.g. location-based services and condition monitoring. With continuing technological progress in the area of LEO satellites, crucial cost reductions and 3GPP attention, satellite technology is set up for mass market penetration within the next couple of years.

Companies that wish to enter the market must clearly identify their right-to-play in the satellite connectivity game. For Telco companies the sweet spot lies in connectivity platforms and terminals. The beginning of the value chain including satellite manufacturing, launch and operations is better served by native SatCos.

The opportunities in satellite connectivity will result in an overall 6.143 billion \$ market for various sectors by 2031. However, the envisioned satellite-solutions pose challenges as well like exploration of relevant use cases, identification of a business case to ensure funding and finding the right partners.

mm1 has helped companies to identify their right-to-play in the satellite game and to develop their market entry strategy by identifying suitable use cases, developing business cases and identifying critical success factors in the implementation of satellite-solutions. With these insights and our personally crafted Satellite Provider Database, we are keen to further support companies to introduce satellite-based solutions in the near future.

- 1 Satellite technology is the missing puzzle piece to global connectivity coverage**

- 2 Recent satellite technology progress enables attractive market entries for companies**

- 3 With a growth of 22% CAGR the satellite IoT market will reach 6 bn \$ by 2031 and will offer many appealing use cases**

- 4 Telcos and Big Tech companies need to identify suitable Satco partners to enrich their value propositions**

- 5 Connectivity providers need to understand customer needs to successfully sell their tailor-made offerings**

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