

Blockchain in SpaceTech

2021/Q4

December 2021

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This joint case study focuses on the relationship between the most fast-developing frontier sectors: **SpaceTech** and **Blockchain**. With 2021 nearing its end, there have already been several successful applications of blockchain technology in the SpaceTech industry. The basis of this case study is the information on **40+** companies involved in both sectors. While the number of SpaceTech companies with applied blockchain technology and the Blockchain companies with space-focused programs is not large as of 2021, there are numerous opportunities to increase that number. As such, this integration of sectors should not be overlooked by investors.

SpaceTech presents investors with astronomical opportunities for gains at moderate risk levels. It is a frontier industry with rapid growth and development rate. SpaceTech market capitalization is expected to reach **\$10T** by **2030**.

Blockchain represents a direction for optimization and improvement in terms of logistical and data structures. Becoming a hot topic in the second decade of the twenty-first century, it has a lot of potential opportunities for SpaceTech companies to apply, increasing their overall efficiency.

EXECUTIVE SUMMARY

The space economy is currently estimated to be about **\$4T**, and we expect it to reach **\$10T** in value by **2030**. While it is still primarily dominated by huge aerospace and satellite companies serving government-funded interests, private and public companies are increasingly seizing the initiative.

Blockchain as an industry has recently developed into a **major sector in economics**. The market for its application has grown exponentially in the second decade of the twenty-first century. As blockchain technology can have different forms and applications, the market also varies in terms of spheres of the application. SpaceTech and Blockchain industries connect numerous, starting with **tokenizing space assets, supply chain applications**, and many others like **security, data, financing**, and **sustainability** issues.

For example, as of 2021, there have already been several cases of Core SpaceTech companies applying blockchain technology in their operations. Although the application was not to the SpaceTech division of their business, such occurrences show the possibility of **integrating blockchain** into the SpaceTech sector.

As blockchain moves into outer space, its ability to tokenize spacecraft and payloads emerges as a key to its success, which could help in massive upcoming space projects such as the international, collaborative Gateway space station NASA wants to build in lunar orbit. With blockchain, it is possible to **commercialize space exploration** faster and more efficiently. Tokenizing a spacecraft would allow different entities to make other spacecraft components, giving institutions like **NASA** and **ESA** the ability to procure things more efficiently, with much more transparency and traceability.

As such, both of these innovative industries can be considered as the top-performers of the economy in general. The markets provide many **attractive opportunities to investors**, both new and established, minor and significant. While the SpaceTech market provides more **moderate levels of risk**, the Blockchain market, in general, is far more **volatile** and **diversified**. Despite the extreme advancement of both spheres of blockchain and space, due to the nature of the first sphere, no institution yet exists to take over the authority to regulate the intersection of these two spheres.

OUR APPROACH

Database

Identification of relevant:

- Companies
- Investors
- Hubs
- Universities & Research Centers
- Government Ministries, Departments & Agencies
- Space Associations

Applied Research & Analytics Methods

Descriptive
Analysis

Mixed Data
Research

Exploratory Data
Analysis

Comparative
Analysis

Qualitative Data
Collection

Data Filtering

Data Sources*

Media Overview
(Articles, Press Releases)

Industry-Specialized
Databases

Publicly Available Sources
(Websites)

Industry Reports and
Reviews

Interviews with Industry
Leaders

Relying on various research methods and analytics techniques, this report provides a comprehensive overview of the space industry. This approach has certain limitations, especially when it comes to leveraging publicly available data sources and secondary research. SpaceTech Analytics is not responsible for the quality of the secondary data presented herein; however, we do our best to eliminate said risks by using different analytics techniques and cross-checking data. Please note that we did not deliberately exclude certain companies from our analysis. The main reason for their non-inclusion was incomplete or missing information in the available sources. Concerning the investors in the main database, we include only institutional investors who have invested into SpaceTech or SpaceTech-related companies. The companies included in the database belong completely to the SpaceTech industry; that partially belong to it through working with clients from the SpaceTech industry; or that have separate departments in a SpaceTech company that works in this sector or cooperates with clients from this sector.

SPACETECH ANALYTICS METHODOLOGY

Methodology

Since the application of blockchain in space is not sufficiently popularized at the moment, SpaceTech Analytics has gathered more than 40 companies and 40+ of their investors associated with this sector using a manual search, as well as automated algorithms.

Content

The companies themselves have been categorized during the search into three key categories concerning space and blockchain:

- **Full spin companies** (company's core business)
- **Spin-in companies** (blockchain company started space-related business, direction or activity)
- **Spin-off companies** (SpaceTech company started blockchain-related business, direction or activity)

Some findings

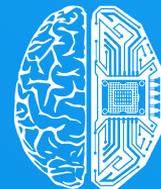
Because the direction of blockchain in space is only in its infancy and there are not many companies specializing exclusively in the intersection of these two industries, the leaders are represented by a fairly limited number of companies.

Both industries are highly developed separately, but it is useful to look for synergy to create mutually beneficial approaches to common issues.

BLOCKCHAIN TECHNOLOGY EXPLAINED

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BLOCKCHAIN TECHNOLOGY EXPLANATION

What is Blockchain?

Blockchain is a subset or type of DLT (Distributed Ledger Technology) that includes cryptographically linked “blocks” (e.g., a list of transactions) and a “chain” where each block is timestamped and placed in chronological order.

DLT is a **distributed digital database** in which transactions and their details are recorded in multiple places simultaneously, without a central database or administrator. Underlying DLT are the following key elements:

Distributed database

Peer-to-peer transmission

Trust

Transparency

Immutable records

How does it work?

Request

A person requests a transaction

Transaction

A transaction is broadcasted to P2P network build of computers (nodes)

Validation

The network validates the transaction and the user with an algorithm

Completion

The transaction is completed and stored on a public ledger

Attaching the block

The new block is attached to the existing blockchain

Block

Once confirmed, a transaction is combined with other transactions to create a block

CONCEPTS AND DEFINITIONS

A Blockchain is a shared, trusted, public database of all transactions in a network. The network stores all transactions in cryptographically secured fragments of data called “blocks” that are “chained” together to form a digital ledger of transactions.

Blockchain

Initial Coin Offering

An Initial Coin Offering (ICO) is a fundraising mechanism for cryptocurrencies, combining the concepts of an Initial Public Offering (IPO) and Crowdfunding. An entity such as a start-up can raise funds for its new project by offering a digital token to the investors. It eliminates the structural regulations of an IPO such as stake ownership and the potential for returns.

Smart contracts are self-executing contracts between a buyer and a seller. The terms of agreement to be executed are directly written into the code on the blockchain network.

Smart Contracts

Asset Tokenization

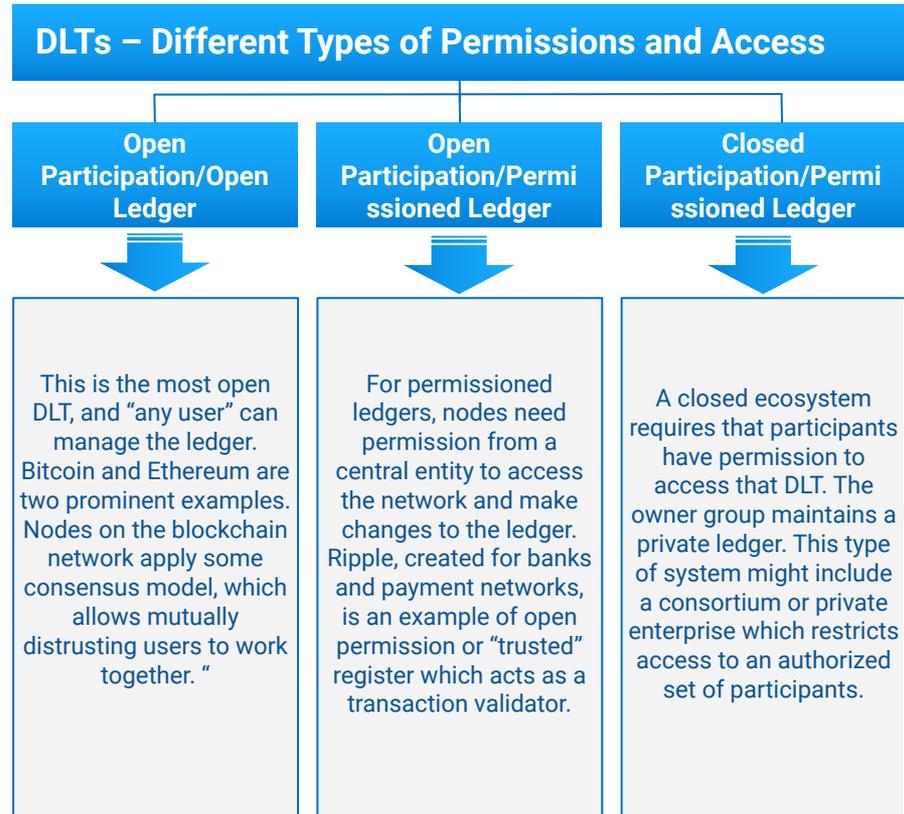
Asset Tokenization is the process of converting some form of an asset into a digital token that can be moved, recorded or stored on a blockchain system, where the asset can be manipulated as a digital token. Tokenizing an asset would enable one to manage its value exchange based on the contract written into the blockchain network. Tokens issued through the Asset Tokenization process are a special type called “asset-backed tokens” or “security tokens”, which claim the underlying assets.

WHAT IS THE DIFFERENCE BETWEEN DLT AND BLOCKCHAIN?

Blockchain-related lexicon has grown and continues to change rapidly. Many terms overlap, which can increase general confusion. To clarify, blockchain is a subset or type of Distributed Ledger Technology (DLT) which includes cryptographically linked “blocks” (e.g., **list of transactions**) and a “chain” where each block is **timestamped** and placed in **chronological order**.

A DLT is a more **general term** and may not necessarily include a construct of **cryptographically linked blocks**. The ledger is stored across many servers, which communicate amongst themselves to ensure that the most accurate and **up-to-date record** of transactions is maintained. This paper will use the term “distributed ledger technology” as it is less specific and more applicable to the space sector.

Both DLT and blockchain are distributed databases which seek to achieve consensus efficiently and without the use of a centralized authority. An open DLT allows anyone to participate. There are two types – available and closed participation.



BLOCKCHAIN USE CASES

The most well-known (and first widespread) use of a Blockchain was to power the famous/infamous cryptocurrency Bitcoin, an online “currency” that enabled its users to pay each other using units of value that existed purely online and without any central bank to oversee their use. Despite Blockchain's significant global penetration and the massive disruptive effect that we have seen by the widespread adoption of Blockchain technologies for a truly astonishing variety of use cases, it is only thirteen years old. First created in 2008 as the underlying infrastructure for recording and executing Bitcoin-based financial transactions, it has since emerged to become its phenomenon, with applications for data storage, security, entertainment, commerce, regulation, governance, and many more so-called "use-cases."

Use cases:

Crypto Trading

Mainly crypto exchange and trading companies using Blockchain technologies or helping consumers to access Blockchain-based services.

IoT

Companies use a combination of IoT devices and Blockchain technology for various purposes, including those focused on tracing the supply chain.

Marketing & Advertising

Companies that are using Blockchain technologies in promoting various services and goods.

Security

Blockchain companies are helping companies establish secured networks.

Entertainment

These are mainly crypto-based companies operating in the gambling industry.

GovTech

These companies are operating in the public sector and providing their services using Blockchain technologies

Healthcare

Mainly crypto-based companies operating in the healthcare industry.

AI

Companies in this sector are using both Blockchain and AI to provide their services.

FinTech

Companies using Blockchain to help companies succeed in the financial industry.

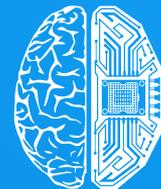
R&D Blockchain Services

Companies in this section research the Blockchain industry, develop their Blockchain platforms, and offer them as a service to other interested companies.

BLOCKCHAIN MARKET OVERVIEW

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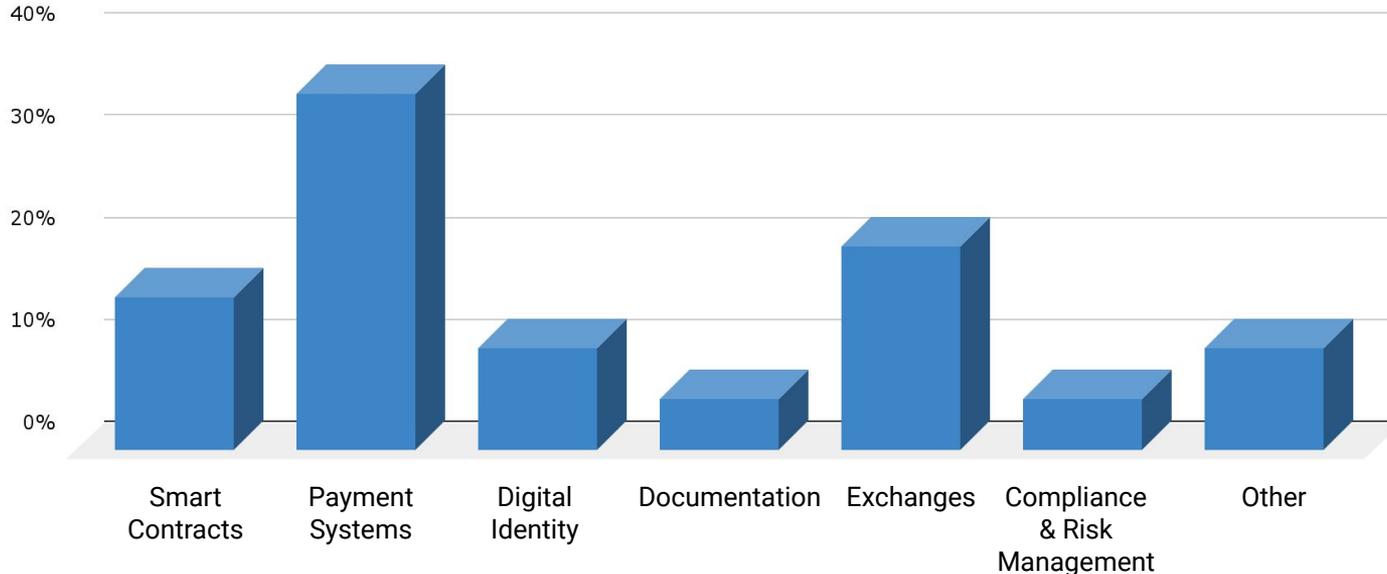


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BLOCKCHAIN MARKET OVERVIEW

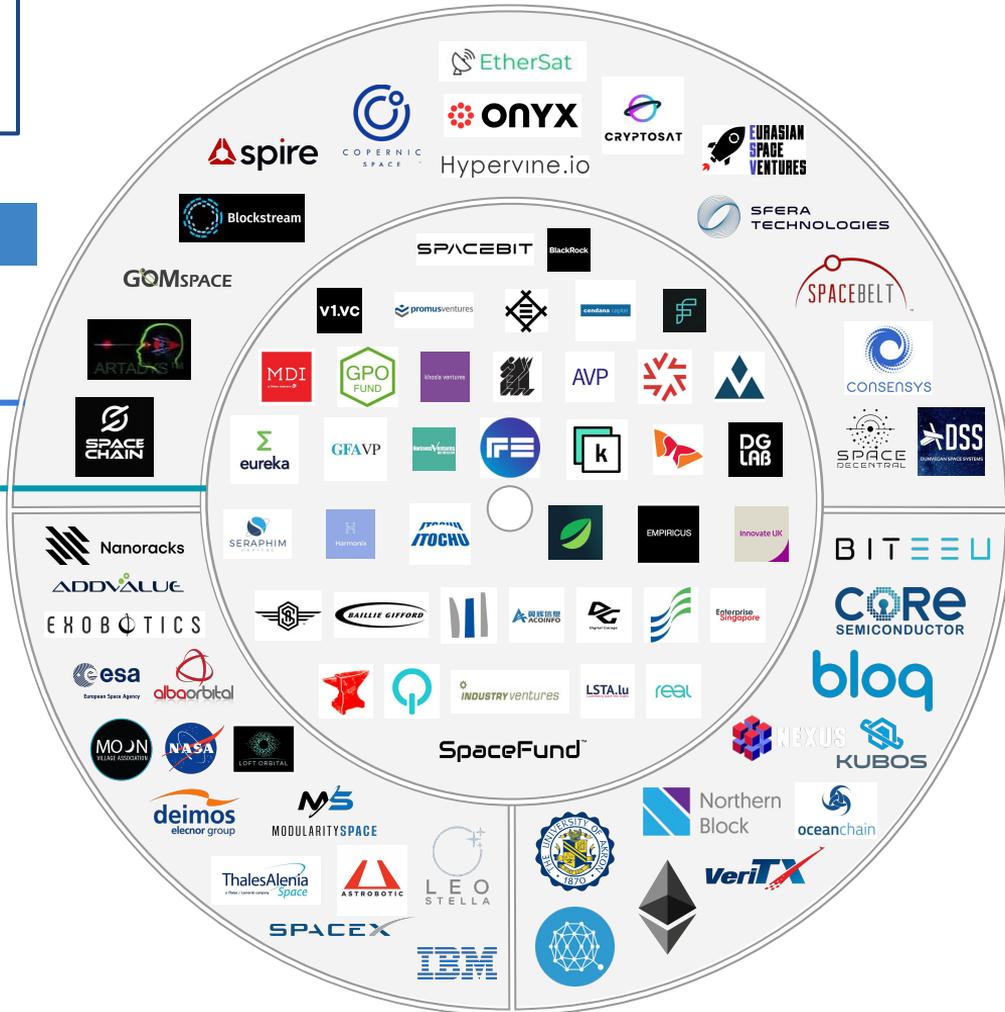
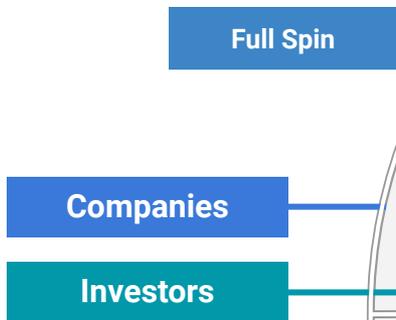
Blockchain as an industry has recently developed into a major sector in economics. The market for its spheres of application has **grown** exponentially in the second decade of the twenty-first century. As blockchain technology can have different forms and applications, the market also varies in terms of spheres of the appliance. Currently, the most prominent usage conditions are **Payment Systems** and **Exchanges**, as cryptocurrency markets have been on the rise in the period of 2010-2021.

Blockchain Technology by Share of Application Form

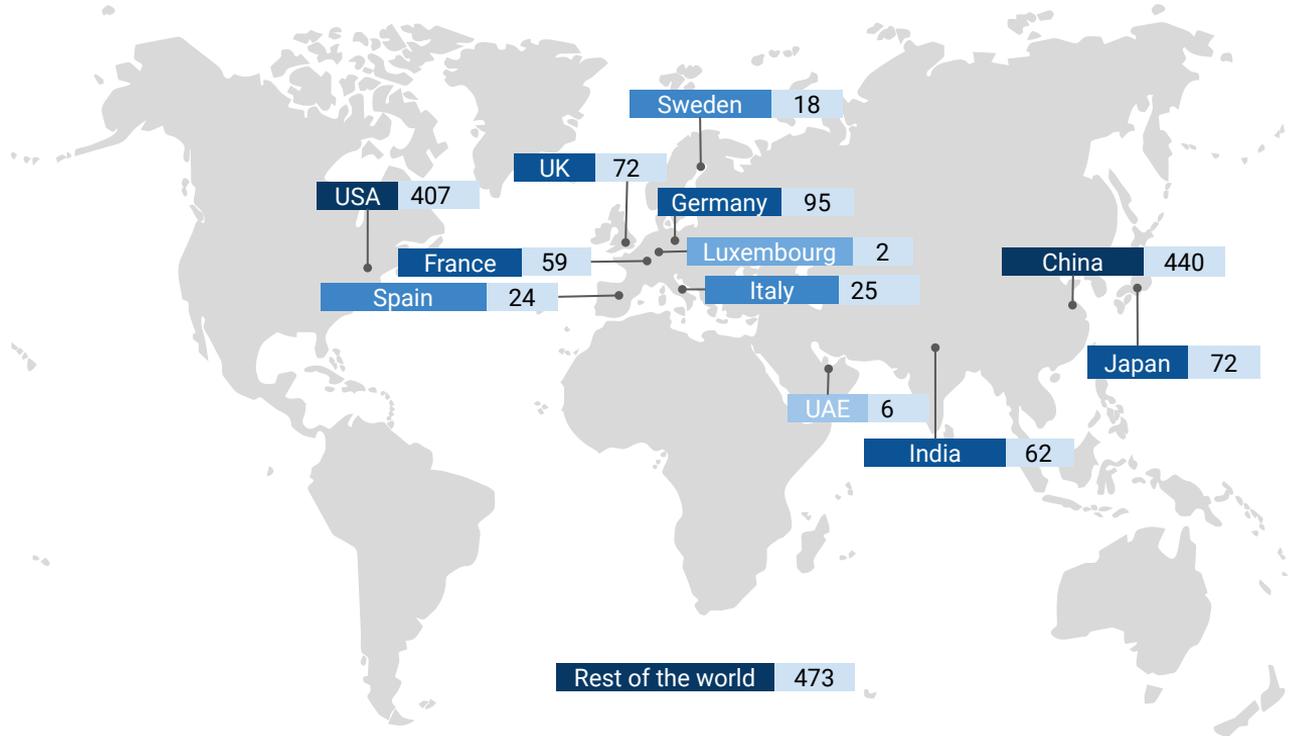


**Blockchain in Space
by Research Field
Q3 2021**

**Companies – 42
Investors – 40**



CORRELATION BETWEEN GDP GROWTH DUE TO SPIN-IN COMPANIES (\$B)



The chart represents the GDP size of countries. This was traditionally dominated by developed countries with market economies. In general, the list has not changed in the last ten years. The Asian countries India and China show strong positive dynamics. The European continent is characterized by economic stability. North America has classically been dominated by the USA.

BLOCKCHAIN ETFs

ETF (Exchange Traded Fund) is a type of security that tracks an index, sector, commodity, or other assets but can be purchased or sold on a stock exchange the same way a regular stock can. An ETF can be structured to track anything from the price of an individual commodity to a large and diverse collection of securities. ETFs can even be structured to follow specific investment strategies.

ETF Name	Symbol	Total Assets (\$M)	Latest ETF Price (as of 10/26/21) (\$)	Volatility of Daily Returns	Mean Daily Return
Amplify Transformational Data Sharing ETF	BLOK	1,150.00	54.35	1.52%	0.09%
Siren ETF Trust Siren Nasdaq NexGen Economy ETF	BLCN	291.09	49.31	0.90%	0.09%
First Trust Indxx Innovative Transaction & Process ETF	LEGR	139.24	44.49	3.43%	0.21%
Bitwise Crypto Industry Innovators ETF	BITQ	88.96	27.56	3.59%	0.15%
Global X Blockchain ETF	BKCH	66.25	30.25	3.98%	0.37%
VanEck Digital Transformation ETF	DAPP	56.30	29.00	3.69%	-0.08%
Capital Link NextGen Protocol ETF	KOIN	29.02	44.53	1.03%	0.08%

- As of the third quarter of 2021, the Blockchain sector contains seven ETFs, with the largest of them being **Amplify Transformational (BLOK)**, with more than **\$1.1B** in assets.
- The volatility of ETF prices is relatively high in the sector, with only **Siren (BLCN)** and **Capital Link (KOIN)** showing moderate fluctuations.
- Overall, all the funds apart from **VanEck (DAPP)** show positive mean daily return, with **Global X (BKCH)** and **First Trust (LEGR)** offering the best performance.

BLOCKCHAIN MARKET IS EXPECTED TO REACH \$40B SOON

The key factors that drive the growth of the global blockchain distributed-ledger market trends include rise in adoption of distributed ledger among various large and medium-sized enterprises to surge their **revenue opportunity** and increase in awareness toward blockchain distributed ledger applications among multiple industries drive the growth of the global blockchain distributed-ledger market growth. In addition, **the low risk of fraudulent data activities** and lower cost of blockchain distributed-ledger **applications propel the development** of the market. However, a lack of awareness of cryptocurrency among developing nations is expected to hamper the market growth.

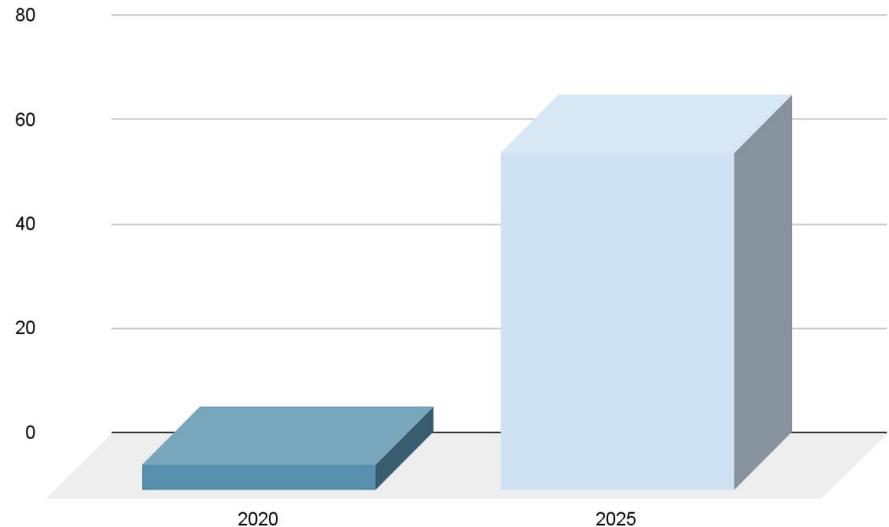


The pandemic has significantly pushed the demand for blockchain distributed ledger in several industries such as BFSI, manufacturing, retail, eCommerce, and healthcare. In addition to this, as businesses across the globe are reopening, many organizations are shifting their focus towards blockchain-distributed ledgers for advanced-security features for their customers to reduce the risk of cyber attacks.

Sources: Markets and Markets

The global blockchain market size is expected to grow from **\$3B** in 2020 to **\$39.7B** by 2025.

Blockchain market projections, \$B



BLOCKCHAIN MARKET IS EXPERIENCING RAPID GROWTH

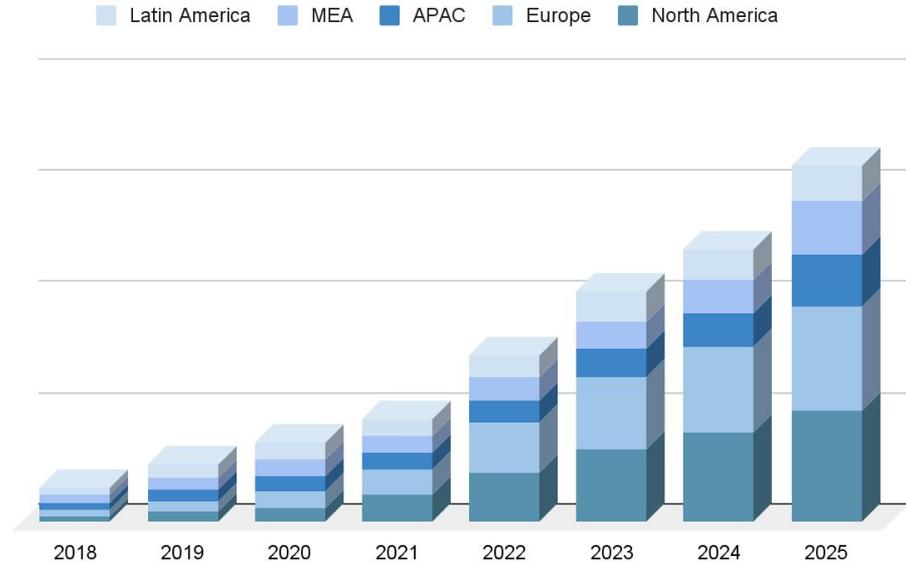
The key factors that drive the growth of the global blockchain distributed-ledger market trends include rise in adoption of distributed ledger among various large- and medium-sized enterprises to surge their **revenue opportunities**, and increase in awareness toward blockchain distributed-ledger applications among multiple industries which drive the growth of the global blockchain distributed-ledger market. In addition, **the low risk of fraudulent-data activities** and lower cost of blockchain distributed-ledger **applications propel the development** of the market. However, a lack of awareness of cryptocurrency among developing nations is expected to hamper the market growth. Integrating the Internet of Things (IoT) in blockchain distributed ledgers is projected to have a definite impact on the blockchain distributed-ledger market development.

CAGR - Compound Annual Growth Rate

68.4%

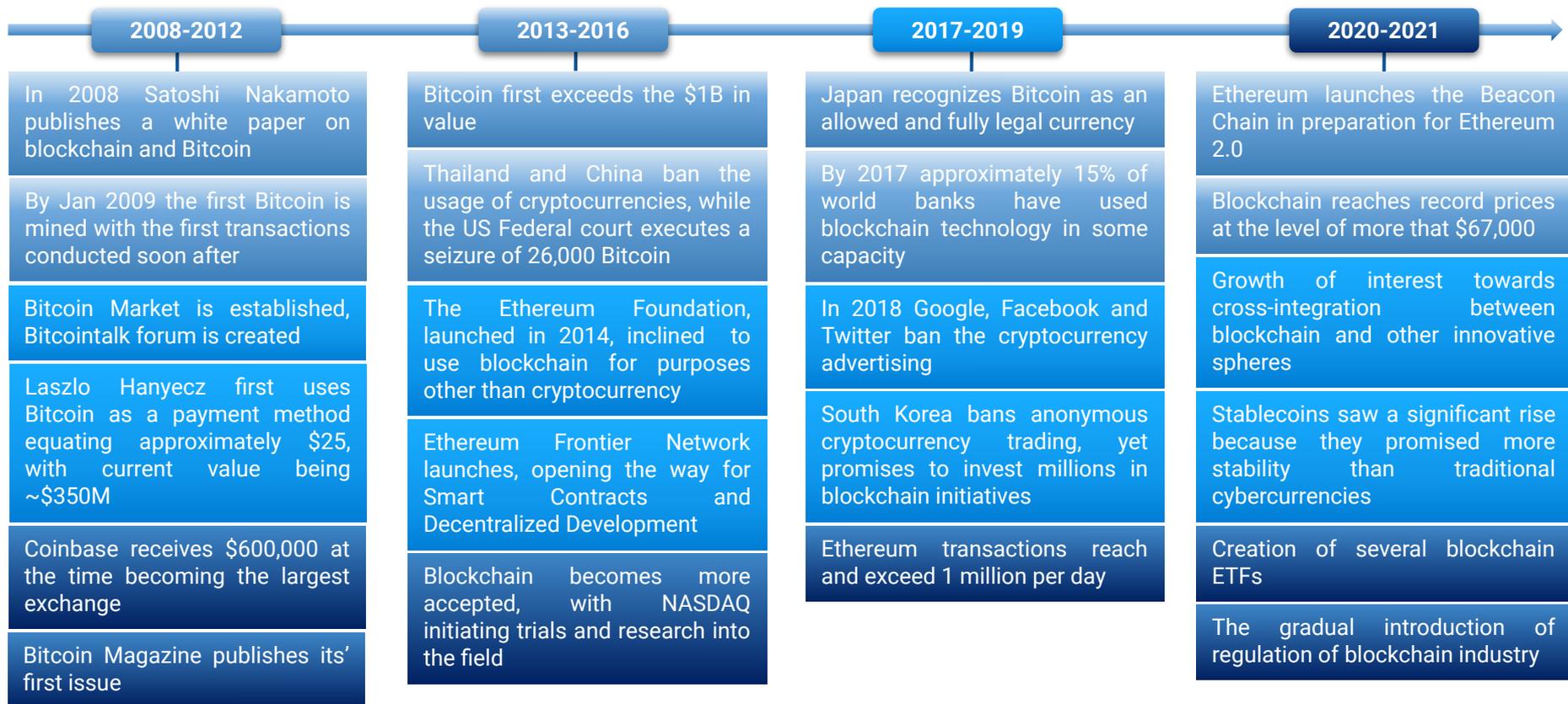
Based on the application area, the banking and financial services segment holds the largest market size in the blockchain market during the forecast period.

Blockchain market projection by region, \$B



The market growth can be attributed to the increasing venture funding and investment in blockchain technology and its popularity in retail and supply chain management.

BLOCKCHAIN INDUSTRY MARKET TIMELINE

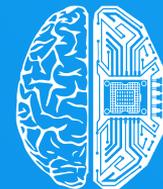


Sources: WhatIs.com

SPACETECH MARKET OVERVIEW

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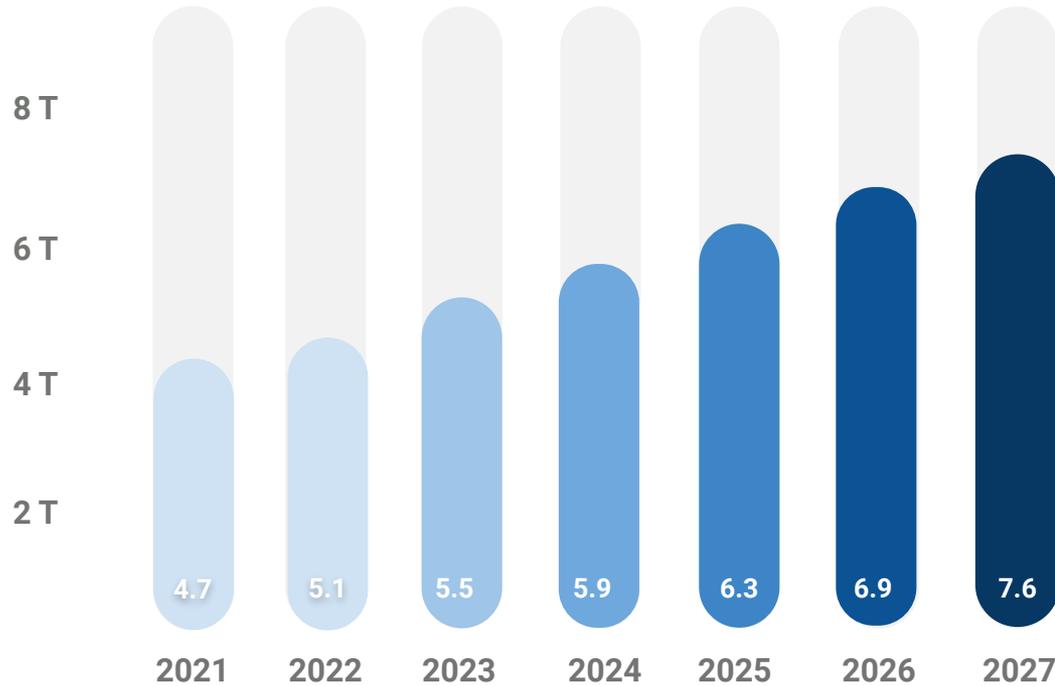
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SPACETECH MARKET OVERVIEW

World SpaceTech Industry Capitalization Projections, \$T



The SpaceTech Industry has attracted a great deal of attention in recent years, so investment growth should not be surprising. Beyond that, the solid media and popular-culture presence of flamboyant **billionaires** like **Elon Musk** have attracted investors and the public interest. Both of these factors have sparked an interest in expanding the sector's horizons. Since the 2010s, this has led to the **explosive growth** of both the industry (the number of companies roughly doubled during that decade) and its subsectors (more and more activities became involved with the SpaceTech sector). The rise of the SpaceTech market caused many new companies with apparent **untapped potential** to appear on investors' radars. Overall, the market capitalization of the SpaceTech Industry equates to **\$4.7T** as of the third quarter of 2021, with an expectation of continued steady growth of capitalization in this sector, reaching **\$10T** by 2030.

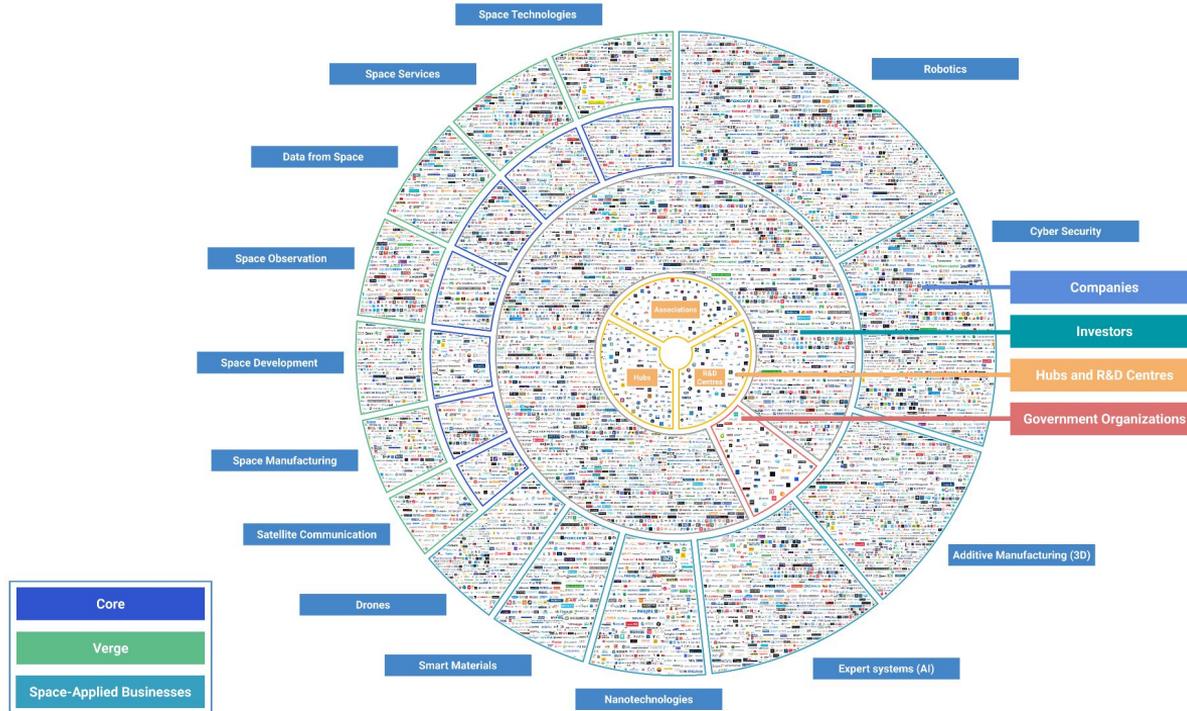
GLOBAL SPACETECH ECOSYSTEM 2021

12,000 Companies

5,000 Investors

200 R&D Hubs and Associations

140 Government Organizations



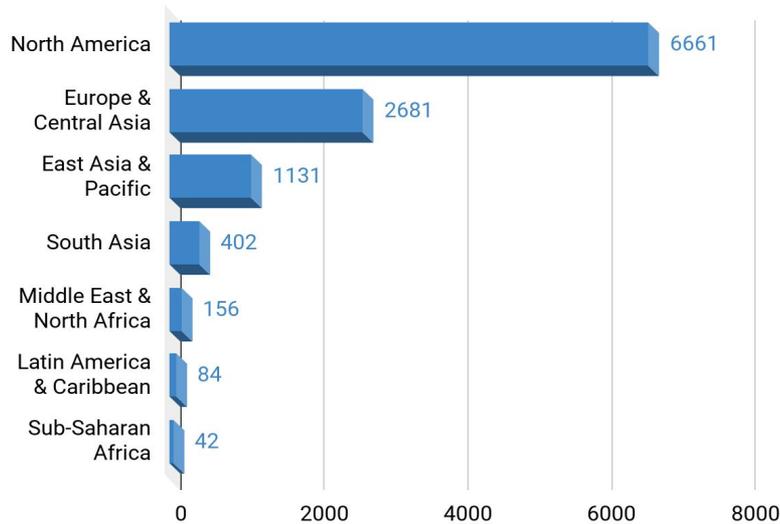
USA	Canada
UK	Germany
China	France
India	Israel
Spain	Japan
Australia	Eastern Europe
Singapore	Turkey
Southern America	Ireland
Gulf Region	EU
Africa	Sweden

SPACETECH ANALYTICS INDUSTRY CLASSIFICATION

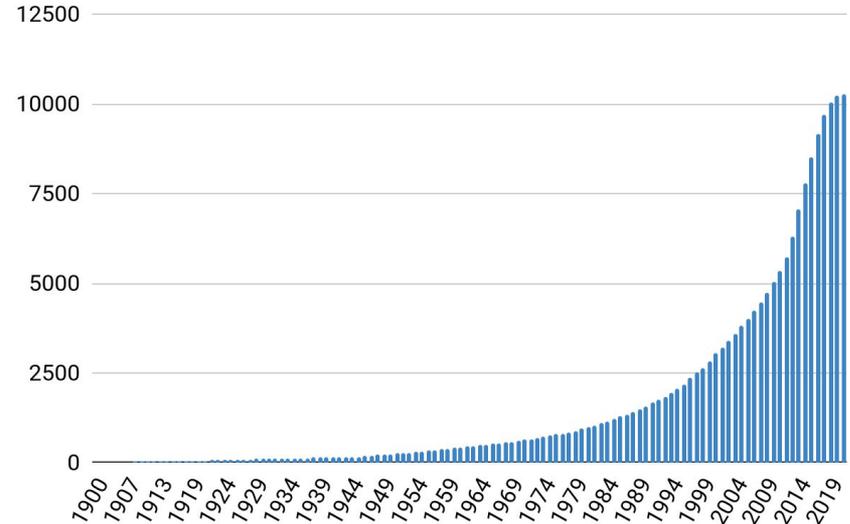


COMPANY REGIONAL AND YEAR OF FOUNDING DISTRIBUTION

Number of companies by regions, 2021

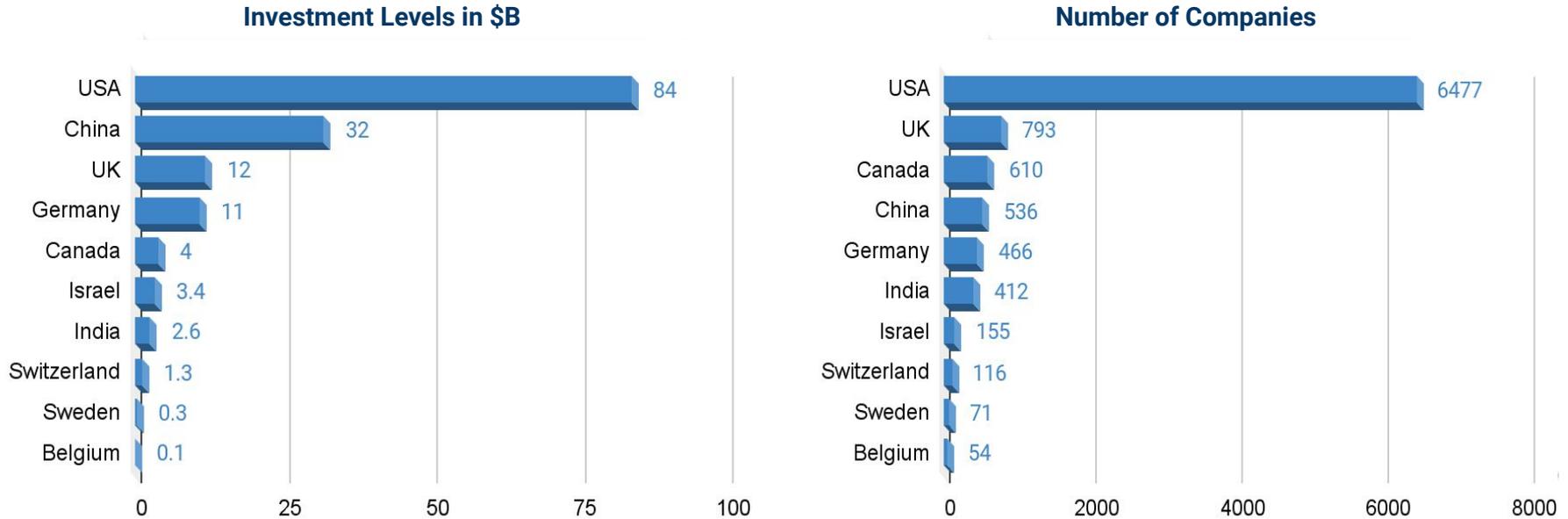


Number of companies by year



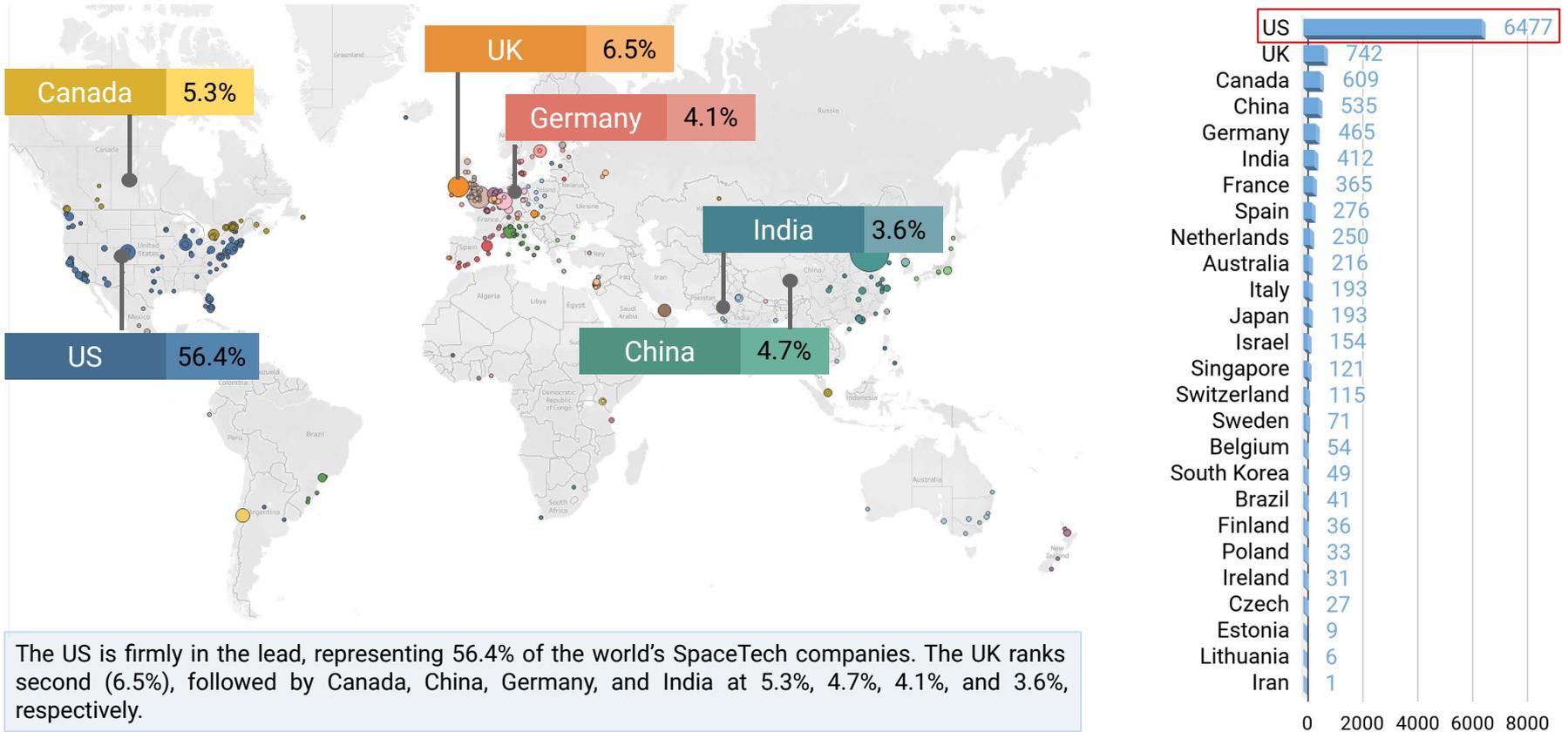
North America is the leading region by the number of SpaceTech companies, with more than 6600 companies in the sector. Europe and Central Asia follow it with 2681 companies and East Asia & Pacific with 1131 companies. Starting in the 1990s, the number of SpaceTech companies has been growing exponentially. There was a boom of companies being founded from early 2009 through the third quarter of 2019. With the pandemic outbreak, the number of new companies dropped, but it should not change the trend of the recent decade.

TOP 10 COUNTRIES IN THE SPACETECH SECTOR IN 2021

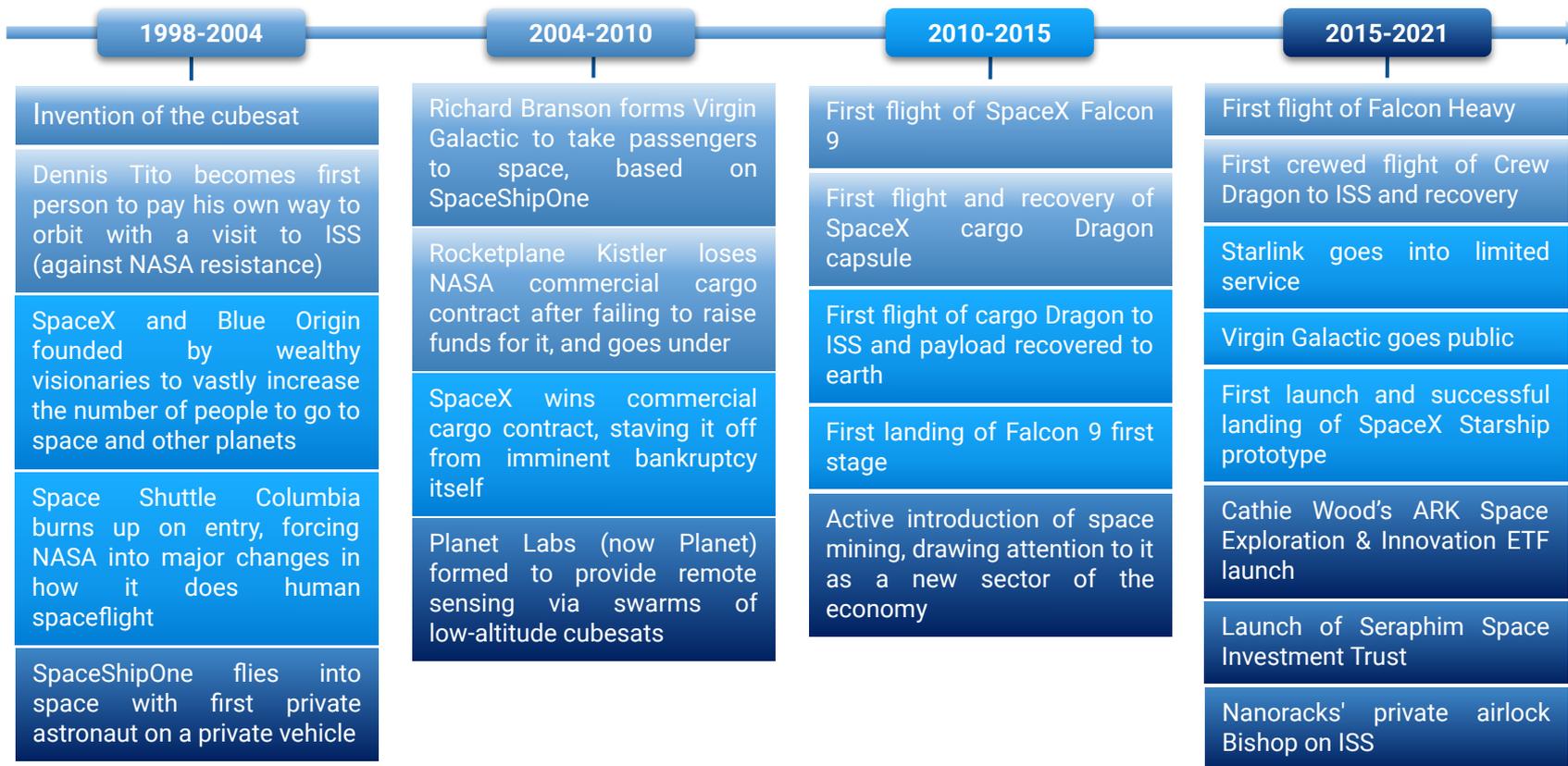


With a total of **\$84B** invested in **6,477 companies**, the **US** is the undisputed leader in levels of SpaceTech investment received by its companies. This is approximately six times the amount invested in SpaceTech companies in **China**, which comes in second place (**\$32B** invested in **332 companies**). China is closely followed by the **United Kingdom**, where funding is mainly raised from public sources and IPOs, and not from private investors.

REGIONAL DISTRIBUTION OF SPACETECH COMPANIES IN 2021



SPACETECH INDUSTRY MARKET TIMELINE



WHAT IS HAPPENING IN SPACETECH NOW



Space Vehicles

The number of satellites in outer space increases every day. The most prominent vehicle to be launched soon is the innovative James Webb Space Telescope.



Space Tourism

The new space race has recently emerged. Three companies: Blue Origin, Virgin Galactic, and SpaceX, conduct civilian trips to outer space.



Mars Rovers

NASA's rover Perseverance made it to Mars, the first aircraft on Mars Ingenuity, and sends novel data back to Earth.



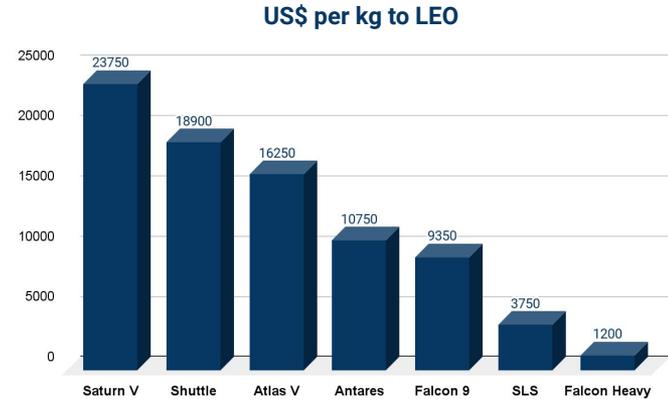
Space Stations

China has successfully launched the first modules of its new space station. The Artemis Program led by NASA is planned to build a lunar station by 2026.



Robotics Utilization

Recent improvements in robotics played a crucial role in spacetechnology. For example, Astrobees, the autonomous robots onboard the ISS, do some essential tasks.



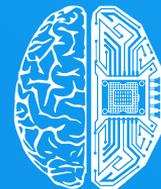
The cost of delivery of one kilogram to Low-Earth orbit defines the overall cost of space activities. It has been plummeting during the last decade, which is undoubtedly a positive thing.

Private companies have strongly influenced the space industry. The development of space technologies is impossible without commercial companies today as they make crucial collaborations with governmental agencies. The connection between the two is vital and drives the improvement of space technologies. Speaking of space agencies, their number has increased during the last ten years and is about to grow even more.

HOW BLOCKCHAIN AND SPACETECH WORK TOGETHER

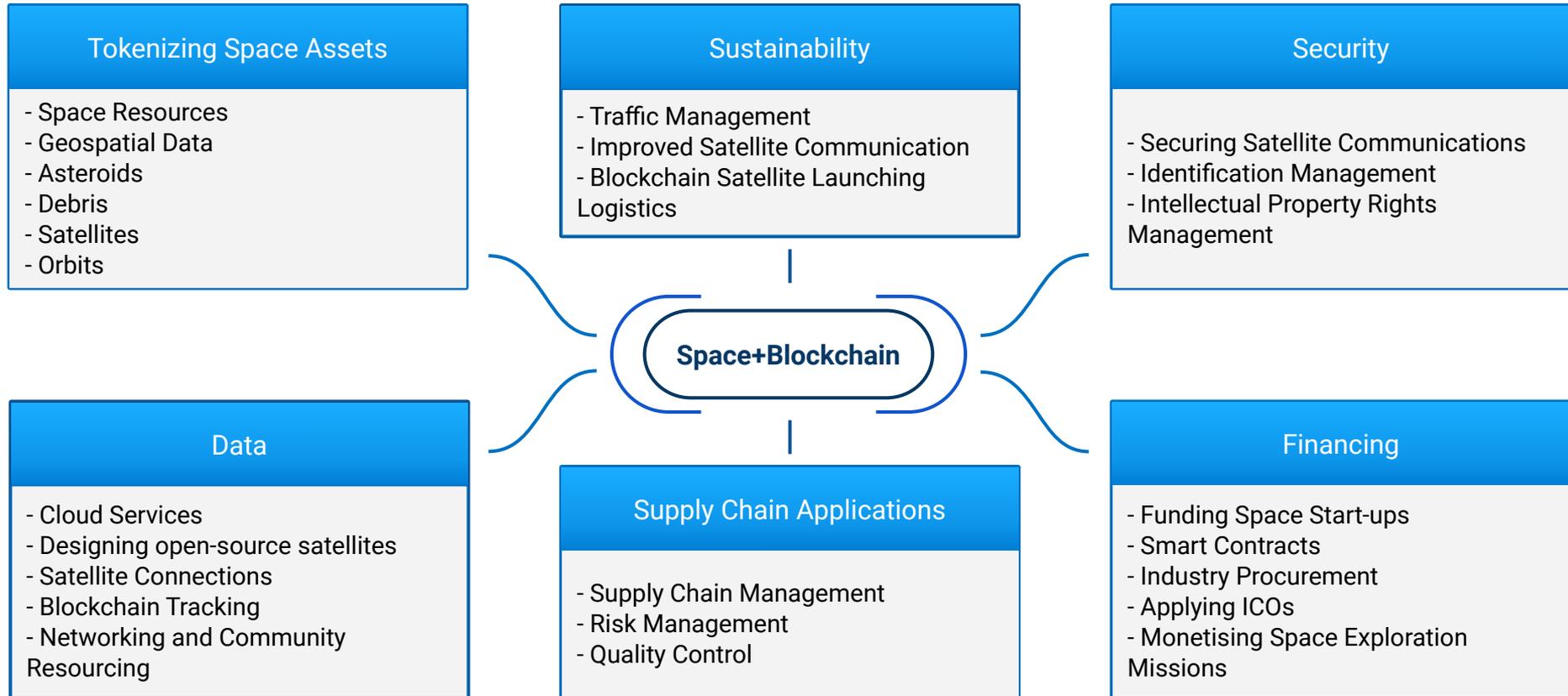
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THE WAYS SPACE AND BLOCKCHAIN CONNECT



DLT BENEFITS FOR SPACE SECTOR

TRANSPARENCY

DLTs can be set up openly or privately. Open ledgers allow anyone to review transaction history without special permission.

EFFICIENCY

DLT technology can automate and improve business processes and organizational efficiencies



NEW PRODUCTS AND SERVICES

Decentralizing traditional models can create new cooperative business models. It remains to be seen what might emerge in the space sector since most efforts are in the concept or demonstration phase.

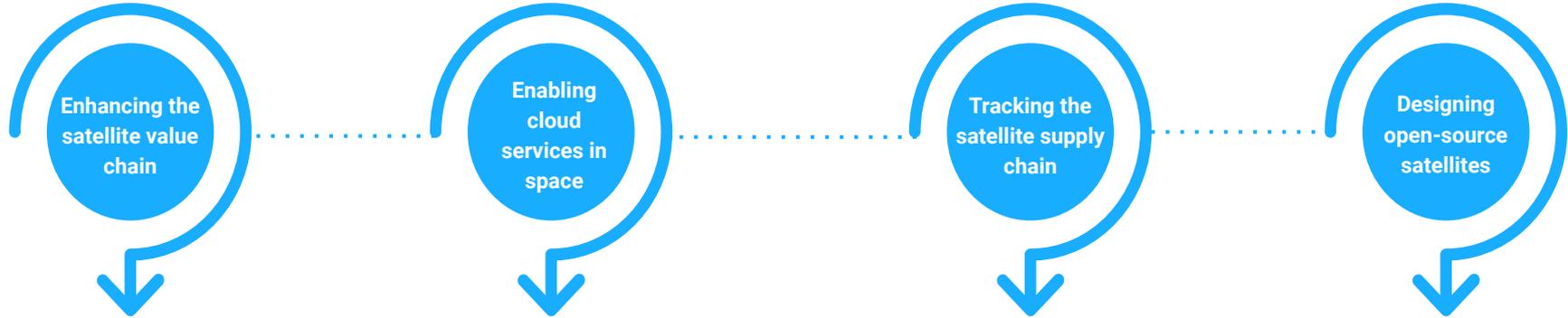
RESILIENCE

DLTs can increase the resilience of communities and ecosystems. Embedded peer-to-peer smart contracts, for instance, do not need to go through a centralized authorization or distribution center.

PRIVACY AND ACCESS

Privacy and permissioned access are facilitated by combining cryptography and data decentralization

BLOCKCHAIN TECHNOLOGY SERVICES IN SPACE



As a smart contract, Blockchain can be used to create transparency, trust, and efficiency in the satellite value chain. For example, intelligent contract-based applications can be developed to launch and operate satellites, access transparent information for insurance purposes, and monitor space operations.

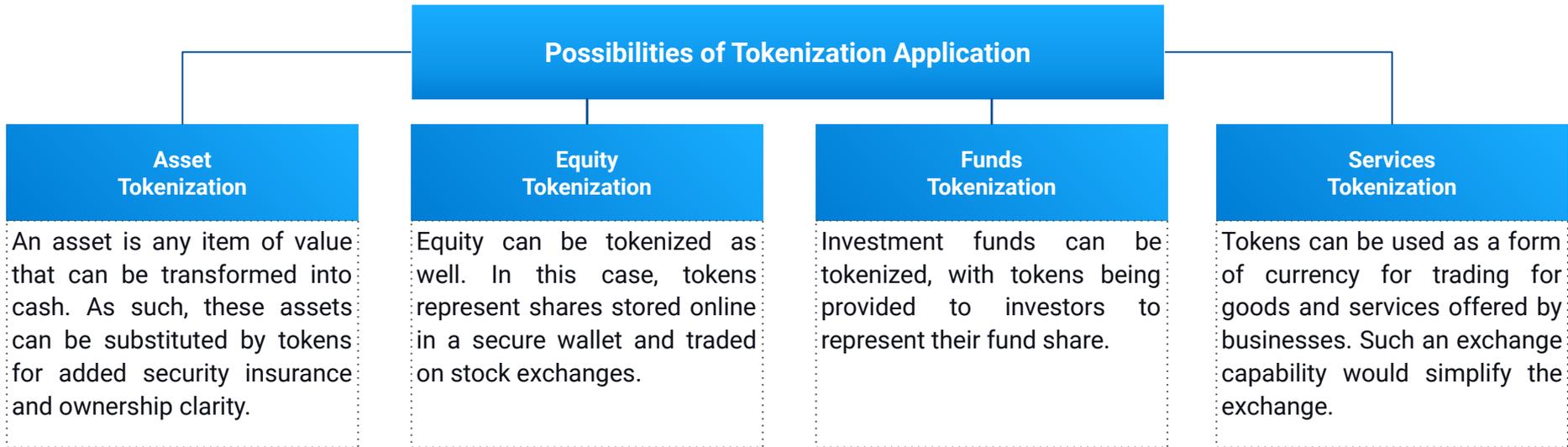
Leveraging both blockchain and AI can enable cloud transformation and processing in space. Blockchain over satellites removes the dependence on terrestrial networks for storage, broadcasting, or processing space data, thereby eliminating significant data breaches or distortion vulnerabilities.

Blockchain can be established as a tracking system to ensure and verify data during each phase of satellite procurement, design, testing, and launch. Blockchain can also be used to monitor a satellite's motion, share space data with all stakeholders, and enforce rules of any updates made to the satellite system.

Large space companies have begun to develop blockchain-based open-source satellite networks to provide many services to end-users on the ground and enable them to access satellite services directly.

WHAT IS ASSET TOKENIZATION?

Tokenization is the process by which the digital tokens are issued on a distributed ledger or blockchain, representing different asset types. Blockchain guarantees that once the tokens representing an asset are bought, no single authority would be able to erase or change ownership of said asset. Henceforth the ownership of that asset remains secure and **entirely immutable**. The possibilities of tokenization are virtually endless, as it can represent fractional ownership and serve as proof-of-ownership. One of the most significant advantages of tokenization is that it allows for the standardization of assets, as virtually anything can be tokenized; subsequently, the less consolidatable assets can be consolidated into one token.



SPACEFUND LAUNCHED THE FIRST SECURITY TOKEN IN SPACETECH

The logo for SpaceFund, featuring the word "SpaceFund" in a bold, black, sans-serif font. The "S" is significantly larger than the other letters. A small "TM" trademark symbol is located to the upper right of the "d". The logo is enclosed in a thin, dotted blue border.

STO Ticker	SF1
STO Date	January 1, 2019
Blockchain Platform	Etherium
Token Standard	ST-20 (Polymath)
Min. Investment	\$500M
Accepted Currencies	USD
Public Sale Price	1SF1 = \$1
Issued By	Abacus

On **October 29th, 2018**, the world's first space security token was announced by Venture Capital firm **SpaceFund**. The new token would allow for increased liquidity and efficiency for investors who wish to participate in the funding of SpaceTech startups.

SpaceFund has officially brought these benefits to the space industry. According to the company, the **Security Token Offering (STO)** can reform the current structure of space-focused startups.

When SpaceFund helps a portfolio company with tokenization, investors can be confident that these companies are successful, well-run, legitimate investment opportunities and that the tokens offered will be secure and highly tradable.

The SpaceFund model also helps mitigate the risks of investing in restricted technologies across borders. While security tokens can help implement transfer restrictions and enforce regulations, tokens cannot allow companies and investors to navigate the intricacies of foreign investment restrictions specific to the space industry.

APPLYING BLOCKCHAIN TECHNOLOGIES IN SPACETECH FINANCING

Blockchain Usage Financial Advantages

Secured
Ownership Rights

Degree Of
Automatization

Additional
Financial Security

Crowdfunding
Potential

Cryptocurrency
Access

Logistics
Augmentation

Supply Chain
Optimization

Audit
Simplification

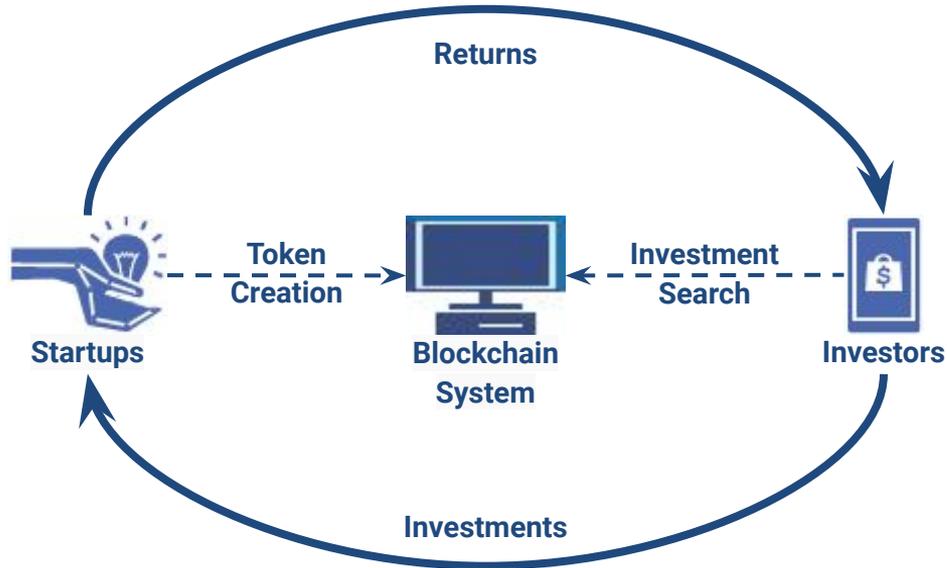
Although investments in the space industry have been on the rise in recent years, access to finance is still considered one of the biggest challenges for entrepreneurs. Blockchain technologies present several opportunities to the newer startup companies to attract the capital necessary to start their rise in the industry.

The options that blockchain offers to SpaceTech could be used to optimize further and improve the industry. Such technologies as **tokenization** allow for access to cryptocurrency markets for investments and provide additional security in terms of ownership rights to the holders. **Smart contracts** enable optimizing the processes of agreement conduction. The process of **ICO**, specifically the public form, gives companies a chance for straightforward crowdfunding. Additionally, blockchain technology can be used to optimize **logistics and accounting**, therefore increasing the overall efficiency of the company's business.

Henceforth the application of blockchain in SpaceTech would improve the whole ecosystem of the industry. The financial benefits of the technology are apparent and shouldn't be overlooked.

INITIAL COIN OFFERING: HOW BLOCKCHAIN ASSISTS STARTUP FUNDING

An **Initial Coin Offering (ICO)**, also known as a “**token sale**” or “**token launch**,” is the process, analogous to the **Initial Public Offering (IPO)**, where a company is creating a new product and wants to attract investors who would benefit from purchasing it early. Such a sale enables the company further to develop its’ product with the attracted funds. ICO can be both public and private, with the public being a form of crowdfunding, while private focuses on the select group of investors.

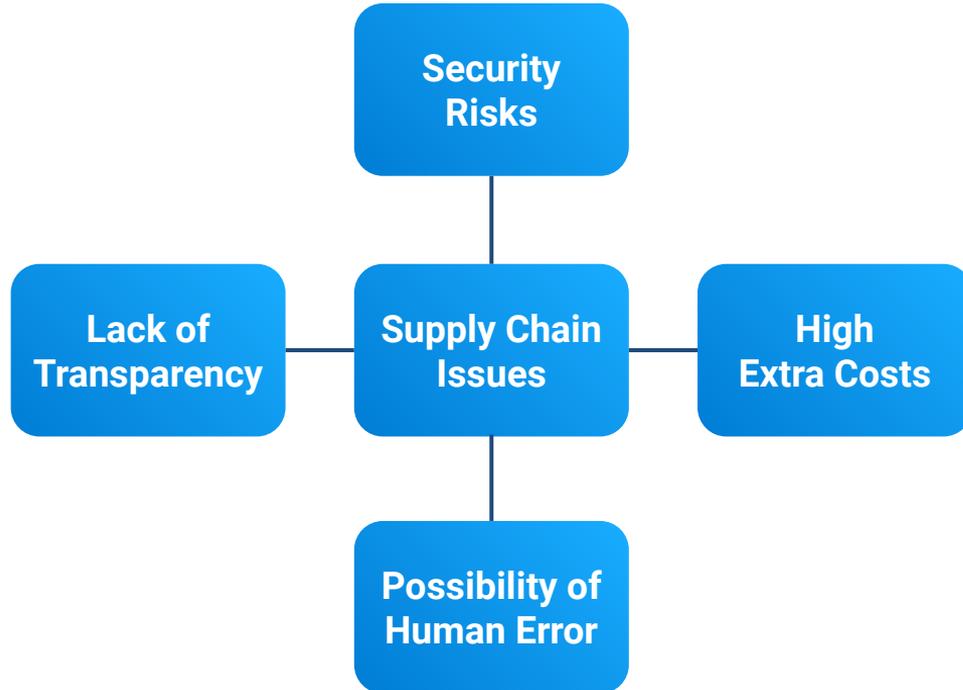


Stages of ICO:

- **Targeting Investment.** Every ICO starts with the company’s intention to raise capital. The company identifies the targets for its fundraising campaign and creates the relevant materials and media about the company (or project) to attract potential investors.
- **Token Creation.** The next step for the company is to create the token using specialized platforms. The process is relatively simple due to the code for it being provided by major platforms like Ethereum.
- **Promotion.** At the same time, the company runs the promotion company to attract the attention of the investors.
- **Initial Offering.** After the token is created, the company offers it to potential investors.

APPLICATION OF BLOCKCHAIN IN SUPPLY-CHAIN MANAGEMENT

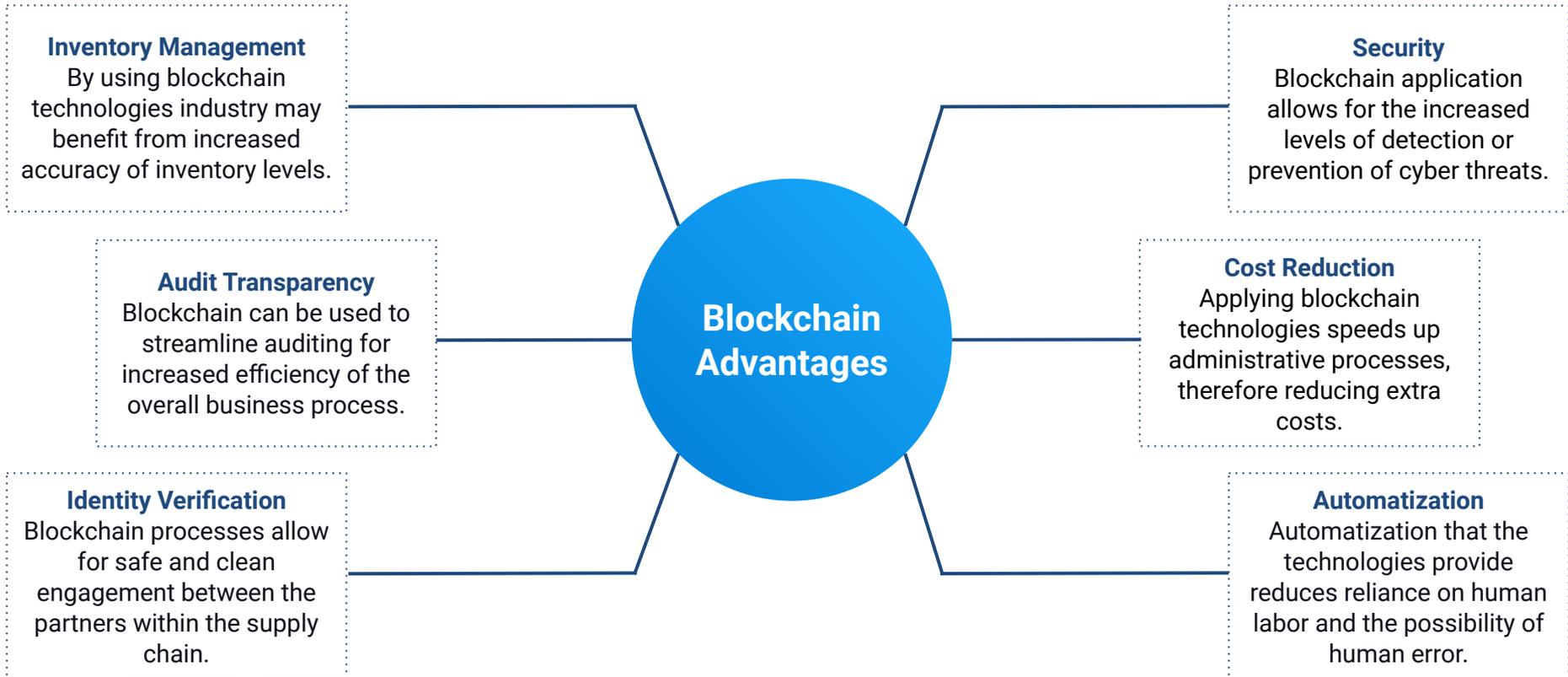
While the most popular use of blockchain technologies has been in the financial sector, precisely due to **cryptocurrency**, other forms of its usage could be applied for space. One of these possible applications is in supply chains, where it could be used to track resources during space mining or to manage large space-construction projects.



The application of blockchain technology would mitigate the impact of several issues that the supply chain may encounter. It would be beneficial for the overall space industry, as supply-chain management is an essential factor for SpaceTech.

- **Security Risks.** One of the most prominent issues that supply procurement faces is the security risks associated with the process. As blockchain allows for increased security, it would enable additional mitigating risks.
- **Possibility of Human Error.** Additionally, such things as Smart Contracts would allow for automatization, reducing the risk of human error.
- **High Extra Costs.** High costs can hinder the financial stability of the company, but they can be mitigated by blockchain.
- **Lack of Transparency.** Additional identification that technology provides would allow making the supply chain more transparent.

HOW BLOCKCHAIN APPLICATION WOULD HELP THE SUPPLY CHAIN



SPACETECH COMPANIES ARE APPLYING BLOCKCHAIN IN OTHER FIELDS

As of 2021, there have already been several cases of the Core SpaceTech companies applying blockchain technology in their operations. Although the application was not to the SpaceTech division of their business, such occurrences show the possibility of integrating blockchain into the SpaceTech sector.

Application in Logistics

Major companies in SpaceTech, such as Boeing, Honeywell, and Lockheed Martin, have already started applying blockchain technology in their logistics and infrastructure. Lockheed Martin has signed an agreement with SyncFab, a distributed manufacturing platform, to streamline its supply chain. Using blockchain technology, Honeywell and Boeing have agreed to join the GoDirect platform to track and sell \$1B worth of spare airplane parts.



MRO Blockchain Alliance

In 2020 several companies, including major core public SpaceTech companies like Safran, have formed MRO Blockchain Alliance, a cooperative effort between several aerospace companies (with one of the largest ones being SITA) to investigate and find applications for blockchain technology in supply systems of the entire transport sector. Alike with Boeing and Honeywell, the initial focus of the research is on tracking and selling aircraft parts.

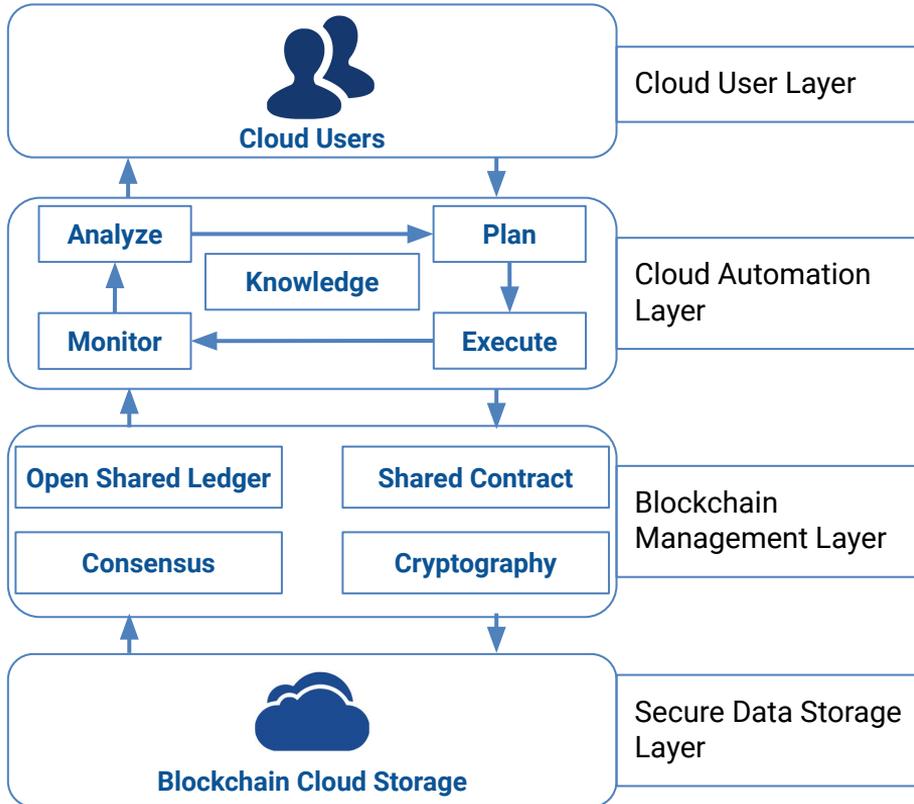


Airbus Heritage

In 2019 A-Cubed, a division of Airbus has started the development of the Heritage Project. This open-source blockchain project hopes to drive donations and charity fundraising in the future. Project Heritage incorporates the Ethereum blockchain to provide collectible tokens based on the ERC-721 specification. The result is that when you donate, a unique token is generated that you get to keep, trade, or sell.



BLOCKCHAIN APPLICATION IN CLOUD SERVICES



Over the past few years, the blockchain has become a method of implementing **cloud storage services**, reducing the chances of human error and increasing the overall trust and security in the system.

Blockchain can be considered as the answer to the **eternal need for storage space**. One of the ways of applying blockchain could be the decentralization of the storage space with blockchain-based cloud storage. Decentralization **eliminates** the need for large storage farms and the environmental impacts that come with it. Decentralized data ultimately means more security and privacy. All the parts of a file created due to sharding are protected with their private keys.

Security is one of the biggest reasons that using blockchain for cloud services is better than traditional cloud services. In the blockchain, the protection of both data and identity is ensured in ways like no other. **No third party has any control over any data**, be it personal or public. Due to sharding, data remains secure, as complete contents of the file cannot be gauged from just one fragment.

TRACKING AND DATA RELAY SATELLITES



NASA Second-Generation TDRS

During the first decades of the Space Age, NASA required a worldwide network of ground stations to communicate with satellites and human-operated spacecraft. **The Tracking and Data Relay Satellite (TDRS)** system, a constellation of three spacecraft placed into geosynchronous orbit beginning in 1983, was designed to replace this expensive, far-flung system.

Positioned equidistant in orbit, they provide nearly continuous contact with spacecraft in **low Earth orbit** and, an especially crucial capability for ensuring the safety of International Space Station crews. A **TDRS** transmits both voice and data communications. Under optimum conditions, it can transfer in a second the equivalent of a 20-volume encyclopedia.

In the TDRS system, blockchain can sync and manage many **connection patterns** between the TDRS and its follower satellites or between the follower satellites and ground stations network for **optimizing user queries** from TDRS. For example, users can send a specific image request pattern to the TDRS system by entering their request information (e.g, locations and timeframes) into the blockchain, stored as user request digital tokens.

BLOCKCHAIN TECHNOLOGY SERVICES IN SPACE

The blockchain protocol is responsible for verifying the new space transactions to **add a new valid block** to the blockchain. All space stakeholders can then access the newly added blocks through the connected dashboard to the blockchain platform that manages a satellite constellation. Each space transaction has to be converted into a Space Digital Token (SDT). This new transaction has to be verified using a blockchain protocol (or consensus) to validate a specific transaction between two satellites in the same constellation.

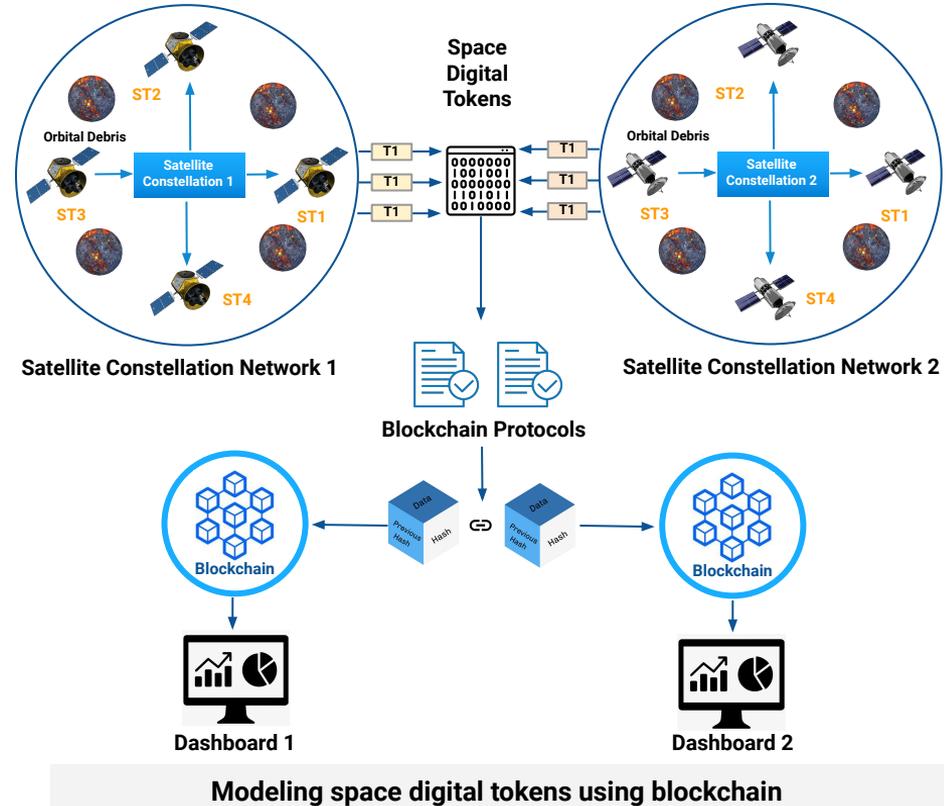
Additionally, the blockchain protocol is **responsible for validating all transactions exchanged within a satellite constellation**. If the handled SDT is valid, a new block is added to the blockchain. The new block contains all details of the new space transaction. This further information can be used by space stakeholders who are authorized to access the blockchain.

Advantages of tokenizing space transactions as SDTs:

Greater control over space transactions

Faster transactions and automated compliance

Security



SUSTAINABILITY

There are some ways that blockchain technology can improve the sustainability of the space industry.

Traffic Management

ConsenSys Space TruSat addresses space sustainability by creating a system that tracks space debris using **Ethereum** blockchain solutions. They explain their idea by proving that a distributed ledger controlled by multiple stakeholders is more effective for the independent assessment of space sustainability practices than data managed by a single government.

In-Space Communication

Using blockchain-based systems for in-space communication has found both commercial and governmental uses.

NASA leads a couple of research projects to find out the optimal way to achieve scalable decentralized cognitive networks in deep space, meaning utilizing the blockchain to design an autonomous system capable of own decision making.

SpaceChain from the United Kingdom invented a hardware piece installed on a satellite to make it a node in a global in-space system.

They made it using the Qtum blockchain application and now make it possible for the users to develop different types of space-based applications on a single satellite, maximizing the efficiency from this expensive resource with a high level of security.

EtherSat Inc. from California is developing an open-source networking standard for ground-to-space communications to improve the communication between ground facilities and spacecraft. Blockchain-based technology is supposed to help new space companies save some investment funds as it would be easier for them to deploy their services using a new communications network.



SECURITY

In addition to sustainability, DLT technologies can provide a high level of security throughout the whole industry system. It mainly involves **secure data storage** and **transference**.

Intellectual Property Rights Management

Currently, the legal issues with **intellectual property rights** can be quite complicated. It is difficult to track down a transfer of such rights after it occurs. Moreover, intellectual-property protection is still a topical issue, and the increased rate of database breaches only threatens the situation even more. The space industry is not an exception as there are many designs, blueprints, copyrights, and data to secure. Those assets may be protected by tokenizing them, containing them in unique digital wallets, and later using them with the help of **Token-as-a-License** software. Additionally, to prove the transfer of ownership, DLT may help by creating a constant record of the intellectual property, with the records about the original owner and the complete chain of ownership.

Identification Management

Another example of DLT technology contributing to the space industry without being directly implemented is **Identification**

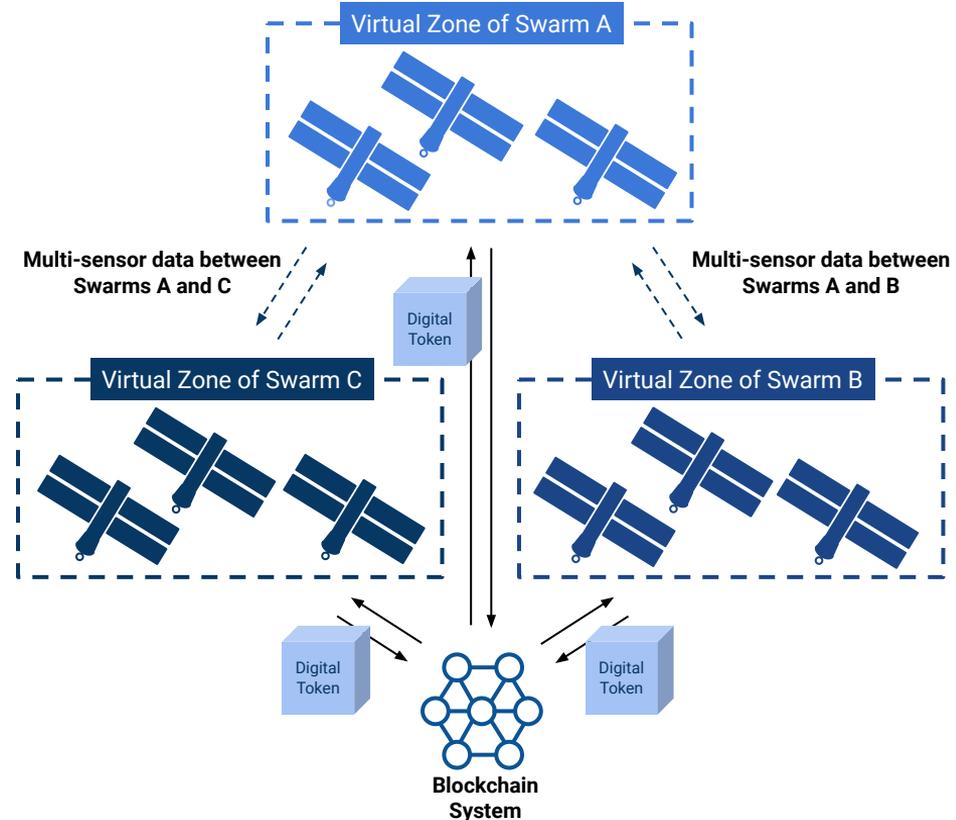


Management. This approach may save lots of money for the satellite service distributors by protecting them from data leaks. The same works for various **space agencies and manufacturing companies** that may need to identify their employees for the same reasons. It is either implemented by a self-sovereign identity where the validators are distributed among trusted institutions like **banks or academies** or by a **decentralized trusted identity** that provides identification services using available biometric data.

SECURING SATELLITE COMMUNICATIONS

Blockchain technology can be implemented in satellite communications in a variety of ways. Spacecrafts can either be nodes in the network or act as validators; they can only request some data stored in the blockchain. The establishment of communications between ground stations and satellite swarms requires decentralized tracking and monitoring of space objects. When the connections are set up, it becomes possible to develop a **virtual zone** for each **satellite swarm** in its orbit. The zones are made for the security of a swarm. If a single satellite senses a collision hazard, it notifies every other vehicle in the swarm. Moreover, a swarm in LEO orbit may establish another connection with another MEO/GEO satellite swarm for providing the data as a digital token.

The graph on the right shows how blockchain can manage and secure the connection patterns between three satellite swarms with their virtual zones. Any satellite in **Zone A** can connect with another satellite from **Zone B** or **C** via a multi-sensor system to transmit data. The feedback of this connection is saved as a new digital token and brought into a new block in the blockchain system.



Even though **NASA** is a leading governmental agency, it has only started experimenting with blockchain technology. However, there are some ongoing projects.

SensorWeb

NASA arranges the Ethereum blockchain SensorWeb program to utilize smart contracts in IoT and **Sensors** spheres.

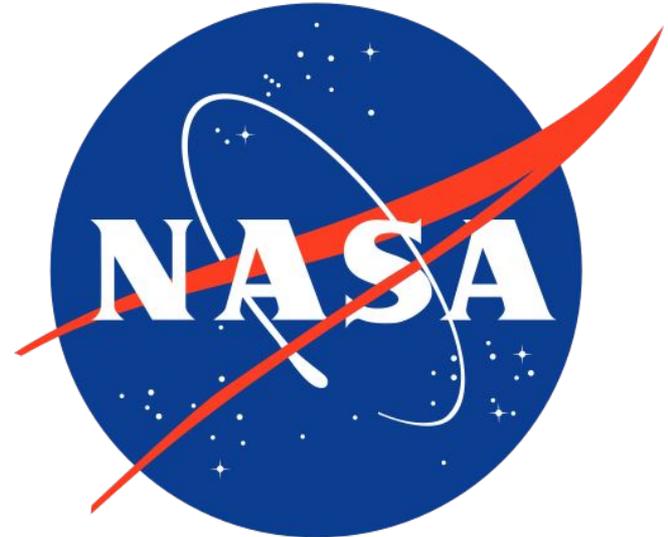
Satellites That Can Dodge

The University of Akron in Ohio has been awarded a **\$330K** grant from **NASA** for developing an **Ethereum-based** system that would allow a spacecraft or a swarm to dodge any space debris. Blockchain-based technology will enable a satellite to securely avoid collision somewhere in space faster than a human on Earth could help out the vehicle.

The **NASA Glenn Research Center** team is currently examining the technologies that enable trusted autonomous operations in space and is searching to develop a simple representative distributed system that will emulate how far apart nodes in deep areas can work to ensure trusted independent operations.

Identification and Authentication

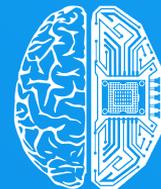
NASA, as well as some other organizations, may want to secure their personnel authentication procedures. As the industry grows at rapid speeds, any data leakage could be vital. Companies close to space tech will access the state-of-art **blockchain-enabled** security level with ease, or at least be eager to.



LEADING BLOCKCHAIN IN SPACETECH COMPANIES

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30 LEADING BLOCKCHAIN IN SPACE COMPANIES BY PERFORMANCE

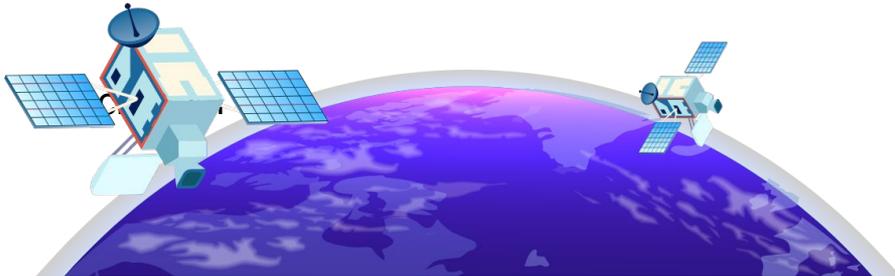
1	ARTADYS // KNOT Communications	11	GomSpace	21	Qtum
2	Astrobotic	12	Hypervine	22	Sfera Technologies
3	Blockstream	13	IBM's Space Tech group	23	Space Decentral
4	ConsenSys Space	14	LeoStella	24	SpaceBelt
5	Copernic Space	15	Loft Orbital	25	Spacechain
6	Cryptosat	16	Moon Village Association	26	SpaceX
7	Dunvegan Space Systems	17	NexusInc	27	Spire Global
8	Ethereum	18	Northern Block	28	Thales Alenia Space
9	EtherSat	19	OGroup	29	University of Akron
10	Eurasian Space Ventures	20	Onyx by J.P. Morgan	30	VeriTX



Cryptosat plans to build satellites that will power cryptographic, blockchain, and ledger applications. They believe that satellites possess unique properties that make them well suited for these tasks. By launching these platforms into space, they think they can unlock new and exciting opportunities in the realm of computing.

Cube Satellites

Cryptosat is to build satellites that power cryptographic, blockchain, and ledger applications. We believe that satellites possess unique properties that make them well suited for these tasks. By launching these platforms into space, we can unlock new and exciting opportunities in the realm of computing.



Tamperproof

Once in orbit, no one can physically access them which means no one can physically hack them or modify them for malicious purposes.

Transparent

Everyone with an antenna can listen to the satellites' transmissions which means they cannot lie without people noticing.

Monitoring

Every satellite ever launched is monitored by space agencies such as NORAD. If something happens to our satellites we will know about it.

Blockchain

Cryptosatellites take a completely different approach to trust: taking a single compute node and putting it beyond people's reach.

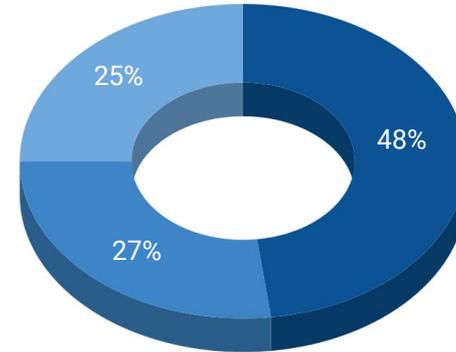
SpaceBelt Data Security as a Service

A network of ten Low Earth Orbit (LEO) satellites offers space-based secure cloud data storage and global connectivity services. Cloud Constellation Corporation is engaged in the cloud transformation of space.



Global Cyber Security Breach Cost = \$400B

● Malicious or Criminal Attack ● System Glitch ● Human Error



SpaceBelt™ DSaaS serves as a key market differentiator for their global partners, offering the ultimate air gap security to their enterprise customers reliant on moving susceptible, high value and mission-critical data around the world each day. Cloud Constellation's mission is to ensure that their customer's data is securely stored while providing robust, secure global connectivity.

Enabling access to space assets and ventures

The digital marketplace for the global space economy allows entities to commercialize their digital data, software, and IP and get support for their project. An NFT and Smart Contract-powered platform, Copernic Space enables these "digital space assets" to be commercialized globally with trust and security on the Copernic marketplace. Asset ownership and payment transfers are tied to smart contracts and executed through a blockchain-based system(SmartOffer), allowing for automatization and simultaneous value transfer related to digital Space assets such as satellite data. Equally important on the Copernic Marketplace is the "SmartFund" feature that allows the public to provide funding of various kinds to these private and public space projects.



Space enterprises can better manage and monetize their digital space assets while the global market benefits from an easy way to discover and access them.

Commercialize Space Assets

Acquire Space Assets

Invest in Space

“

No matter who you are or how much you know, you will have equal access to the benefits of space.

Grant Blaisdell - CEO, Copernic Space

COPERNIC SPACE

At the end of 2022, **Lunar Outpost's MAPP Lunar Rover** will launch aboard a **SpaceX Falcon 9** rocket and land on the Lunar South Pole. In partnership with **Lunar Outpost**, **Copernic Space** will launch the first tokenized sale of payload space for the **MAPP Rover**. On the Copernic Space platform, companies and the retail market will be able to buy and sell space on the rover, in the form of the **NFTs**. Implementing that means creating most possibly the first space asset market and secondary market enabled by the fractionalization and resale features of the **NFTs**, while also creating a new standard for broad market participation in the commercialization and ownership of Space. The sale happens in two stages, a private sale and public sale.



This platform not only represents a substantial step forward in making Space accessible to everyone but will also help to unlock the full potential of this burgeoning sector.

Julian Cyrus - Co-Founder, Copernic Space



Once the public sale begins in **Q1 of 2022**, payload space purchased in the private sale can be resold or even divided into smaller space assets for additional applications and resale. **Copernic Space** will create a new economic model for the space economy in the digital age and enable the public to participate economically by teaming up with **Lunar Outpost** to execute the first tokenized space cargo sale.

Rethinking Trust

Blockstream is a Bitcoin and blockchain technology company. The field of applications of their products and services is wide. They have also implemented a system that lets you use the blockchain without internet connection.

The Blockstream Satellite network broadcasts the Bitcoin blockchain worldwide 24/7 for free, protecting against network interruptions and providing areas without reliable internet connections with the opportunity to use Bitcoin.



Why Satellite?

Internet Not Required

Blockstream Satellite broadcasts the Bitcoin blockchain to the entire planet via satellite, reducing Bitcoin's dependency on internet access.

Massive Cost Savings

By eliminating cost barriers, people can now receive blocks at no cost, allowing more people to utilize Bitcoin and participate in the Bitcoin network.

Network Stability

Blockstream Satellite provides an alternative method for receiving the Bitcoin blockchain that is not affected by connection failure.

 GALAXY 18 North America Long: 123W Band: Ku Freq: 12016.40 MHz Pol: Horizontal	 EUTELSAT 113 South America Long: 113W Band: Ku Freq: 12066.90 MHz Pol: Vertical	 TELSTAR 11N Africa Long: 37.5W Band: Ku Freq: 11480.70 MHz Pol: Horizontal	 TELSTAR 11N Europe Long: 37.5W Band: Ku Freq: 11484.30 MHz Pol: Vertical	 TELSTAR 18V Asia Pacific Long: 138E Band: C Freq: 4053.83 MHz Pol: Horizontal	 TELSTAR 18V Asia Pacific Long: 138E Band: Ku Freq: 11506.75 MHz Pol: Horizontal
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SpaceChain - is a private company founded in 2017 that integrates both space and blockchain technologies into infrastructure. The company also provides space-as-a-service for other businesses and conducts researches on the implementation of blockchain for the space industry. The company aims to develop and better the SpaceChain Operating System based on a Qtum blockchain to enable open-economic models in space that empower new projects. SpaceChain launched its first SpaceChain OS blockchain node into space in 2018 alongside other projects.

- **2017** Jeff Garzik and Zee Zheng founded **SpaceChain** .
- **Feb 2018** Launched the first **Qtum-based** blockchain node into space.
- **Jan 2019** Performed the first space-based transaction on the Qtum blockchain.
- **Oct 2019** Created the first Bitcoin wallet hardened for use in space.
- **June 2020** Executed the first multisignature blockchain transaction in space as part of the ESA Kick-start Activity program.
- **Dec 2020** SpaceChain UK received a grant from EUREKA GlobalStars-Singapore Call to develop the decentralised satellite infrastructure with consortium partners.
- **June 2021** Launched the first commercial **Ethereum** blockchain integrated satellite payload into space.

SpaceChain is developing a Decentralised Satellite Infrastructure (DSI) with various endeavors and methods. Their technology and implementation could be split up to different sections.

Blockchain Infrastructure

The network shall consist of heterogenous constellation of satellites, with each spacecraft and user performed as a network node. Moreover, the companies from all around the world are invited to join the DSI in order to make it more effective. The company has also released the ERC-20 SPC token, which is fully compatible with Ethereum DeFi.

Manufacturing

SpaceChain actively arranges partnerships with different manufacturing and hardware companies in order to make the blockchain work properly.

Application

SpaceChain's DSI could fulfill various applications, but these are the most promising ones: Satellite multisignature wallet, Space data access and ordering services, and also Satellite and blockchain-enhanced IoT network.

Some of the partnership projects:



Kubos

Work on the optimization and application development of the SpaceChain OS



Nanoracks

NanoRacks

Host a CubeSat Deployer and equipment for experiments on the International Space Station



GomSpace

Designed a blockchain hardware, that was later installed on the ISS in order to conduct novel tests



Elecnor DEIMOS

They develop an e-commerce platform with payment services and blockchain-enabled credit management.



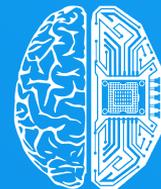
Alba Orbital

A satellite manufacturing company that helps with developing a Decentralised Satellite Infrastructure.

LEADING BLOCKCHAIN IN SPACETECH INVESTORS

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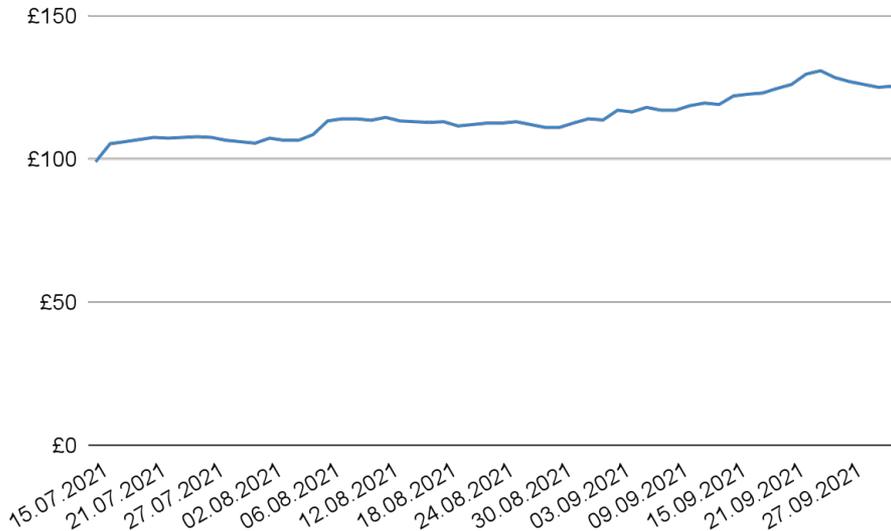


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40 LEADING BLOCKCHAIN IN SPACE INVESTORS BY INVOLVEMENT

1	Alumni Ventures Group	11	European Investment Bank	21	Innovate UK	31	RRE Ventures
2	Baillie Gifford	12	European Space Tech Angels	22	Itochi Corporation	32	Scottish Enterprise
3	Bitfindex	13	Foundation Capital	23	Khosla Ventures	33	Seraphim Capital
4	Cendana Capital	14	GFA Venture Partners	24	Kima Ventures	34	SK Group
5	DG Lab Fund	15	GPO fund	25	Lemnos Labs	35	Softtech VC
6	Digital garage	16	Harmonix Fund	26	Luxembourg Future Fund	36	Space Angels
7	Empiricus Capital	17	HCH Group	27	MDI Ventures	37	SpaceBit
8	Enterprise Singapore	18	Horizons Ventures	28	Mitsui Ventures	38	SpaceFund
9	Eureka GlobalStars	19	Idea Foundry	29	Promus Ventures	39	Swell Partners
10	Eureka Network	20	Industry Ventures	30	Real Ventures	40	Ubiquity Ventures

Seraphim Capital Stock Price Dynamics 3Q 2021



Mean Daily Return
0.44%

Volatility of daily returns
1.40%

Seraphim Capital is a leading visionary company that invests in both the blockchain and space sectors. Its goal is to develop and strengthen the companies operating in the two. On July 14th, 2021, Seraphim Capital completed its IPO at 180 million shares listed at £100 per share.

- Seraphim Capital completed its IPO on July 14th, 2021, marking the first day its stocks were traded on the London Stock Exchange.
- Since beginning to trade, the stock price has grown by 25%, from £100 to £125.
- The stock price reached its peak on 09/23/2021, closing at £130.80 per share.
- The maximum price during the trading day was on the same day, peaking at £132.78 per share.
- Overall the stock has shown steady growth and performance over the almost three months it has been trading through Q3.

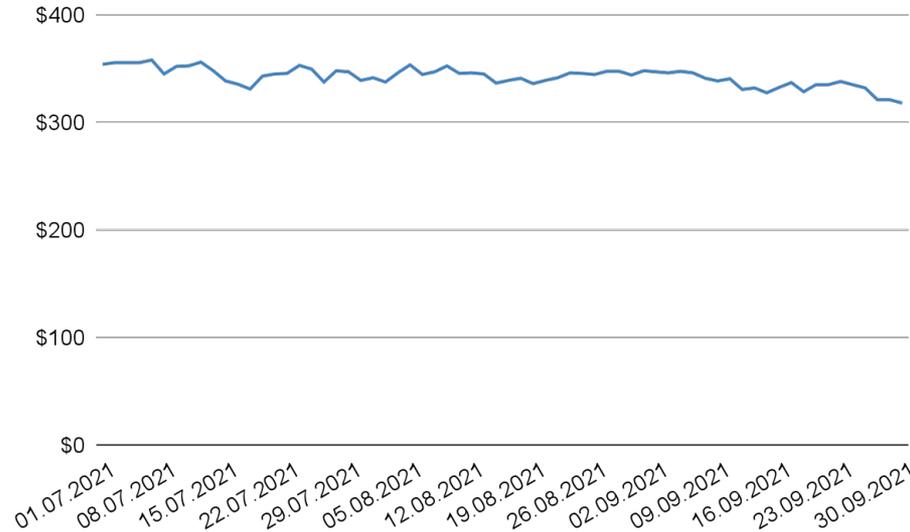
Latest Investment

Company:
Spire Global

Amount:
\$40M



Baillie Gifford Stock Price Dynamics 3Q 2021



Mean Daily Return
-0.16%

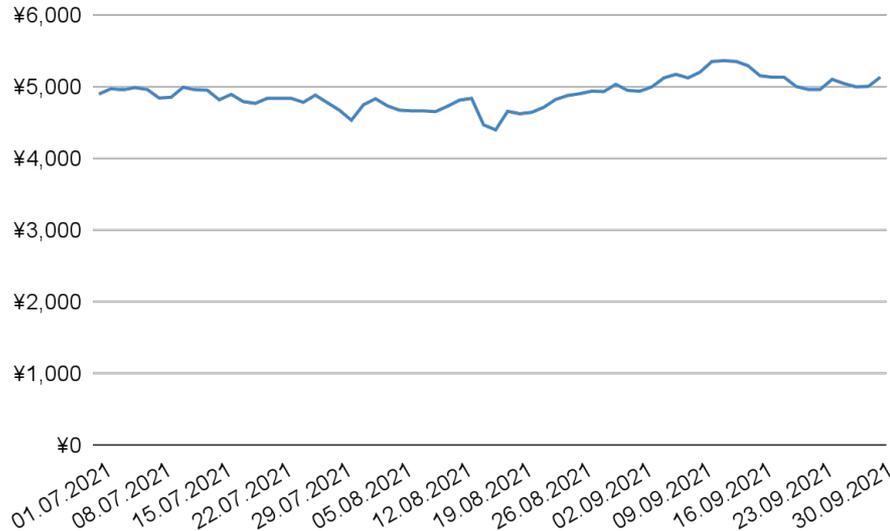
Volatility of daily returns
1.60%

Baillie Gifford is an independently owned firm that focuses on investment and asset management. Majority of the company investment goes towards high-tech and innovative industries. The latest of the funding provided went toward the more innovative companies, some of which belong to blockchain and space sector.

- The company's stock has been on the decline during the third quarter of 2021.
- Since the start of the quarter, the stock price has decreased by 10%, from \$354 to \$318.
- The stock price reached its peak on 07/07/2021, closing at \$358 per share.
- The volatility stood at low levels during the period, while the mean daily return resulted negative, in line with the overall decline of the stock price.
- Nevertheless the trend for the fourth quarter is positive with the stock price regaining its former levels.

Latest Investment	Company:	Amount:
	Blockstream	\$210M

Digital Garage Stock Price Dynamics 3Q 2021



Mean Daily Return
0.07%

Volatility of daily returns
1.60%

Digital Garage is a Japanese company covering web business advice, research, web creation and enhancement, and customer database marketing. It also stands as a prominent multi-stage investor in innovative and developing industries, including blockchain and space.

- Digital Garage Group is represented on several stock exchanges, with the Tokyo Stock Exchange being the main regional one.
- Since the start of the quarter, the stock price has grown by 5%, from ¥4895 to ¥5130.
- The stock price reached its peak on 09/13/2021, closing at ¥5360 per share.
- Overall volatility of the company's stock stayed at low levels resulting in a steady and stable performance. The mean daily return resulted positive during the period.
- The company ended the quarter with a steady growth trend for the fourth quarter.

Latest Investment

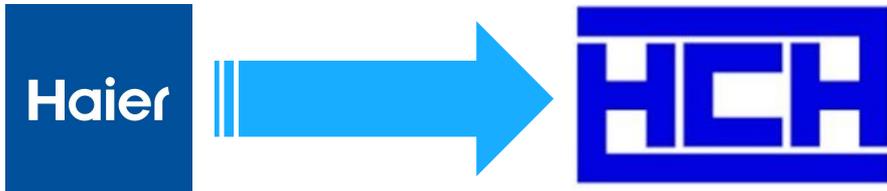
Company:
Blockstream

Amount:
\$57M

HCH GROUP

HCH Group is a subsidiary of Chinese consumer electronics giant **Haier Group**. Founded in 2014, HCH provides one-stop incubation services, including investment, supply chain, accelerating, space, manufacturing, and innovation.

HCH Group Company Limited was incorporated on 07-SEP-2009 as a Private company limited by shares registered in Hong Kong. The date of annual examination for this private company limited is between Sept 07 and Oct 18 upon the anniversary of incorporation.



LOS ANGELES & HONG KONG, Dec. 20, 2018 – Cloud Constellation Corporation, a space-based cloud service provider of data security services, announced today the commitment of \$100 million from HCH Group Company Ltd. towards its Series “B” equity round.



Clifford W. Beek, CEO and president, Cloud Constellation Corporation, said: “HCH’s financial commitment to SpaceBelt builds on our momentum to execute on our vision to offer global data protection that leverages commercial space.”

Haier is an appliances brand, launching a wide range of innovative products in all categories, including refrigerators and more.

\$506.9M	Total funding amount		
12	Investments	2	Exits
1,224	Contracts	10,000+	Employees

FOUNDATION CAPITAL

Foundation Capital is a venture capital firm located in Silicon Valley founded in 1995. By 2012 the company managed more than **\$2B** in investment capital.

Foundation Capital is famous for its innovative investments. For example, they are one of the **Netflix** and **Atheros** original investors. The company has an **Entrepreneur-in-Residence** program that selects several intellectual people to train and graduate them in developing solid business plans for emerging technologies.



Loft Orbital is a manufacturing company that produces software and hardware to help businesses get their payload in orbit. They have partnered with **SpaceChain**.



28 IPOs	80+ Acquisitions		
\$3.4B	Total Fund Raised		
640	Investments	153	Exits
10	Funds	11-50	Employees

UNCORK CAPITAL

Uncork is a seed-stage venture capital firm with over **\$500M** under management. We are currently investing out of two funds: a \$100M Seed fund (Uncork VI) and a **\$100M** Opportunity fund earmarked for more significant investments in mature, existing portfolio companies (Uncork Plus II).

15 + years

240+ companies

85+ successful outcomes

The company mainly invests in **e-commerce, mobile services, and SaaS** (software as a service). Focusing on the start-up and Series A financing stages. As a rule, Uncork Capital seeks to secure 7-10% ownership of the companies it invests in.

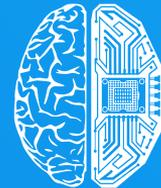


\$505M	Total Fund Raised		
374	Investments	95	Exits
3	Contracts	1-10	Employees

REGULATION OF BLOCKCHAIN IN SPACETECH

December 2021

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SPACE AND BLOCKCHAIN REGULATIONS

Space Law

The active law regulation of space-related activities began in 1957 when the Committee on the Peaceful Uses of Outer Space (COPUOS) was established. It later resulted in the Outer Space Treaty in 1967. It was an essential stage for the future of space exploration as the introductory statement in the treaty was that *“the exploration and use of space is the province of all mankind.”*

Other agreements were signed later. The Commercial Space Launch Act was signed in America in 1984, ending the active phase of space legislation. It granted the private sector *the right to develop and operate commercial expendable launch vehicles*. It has been amended several times, but the stage was set for commercial space operations.



Blockchain Regulation

Since the very introduction of blockchain to the world in 2008, the technology has been quite controversial. In particular, cryptocurrency has not been trusted much, as it was unclear whether its anonymity would serve lawbreaking activities. This issue has not gone away. However, the number of countries that have already allowed the use of bitcoin as legal currency is rising. Some countries are still worried about questions like: “the cryptocurrency is not backed by tangible assets,” which may be a possible reason why countries like Canada or Turkey impose certain restrictions on legal uses of cryptocurrencies. Other blockchain technology use cases remain primarily unregulated.

REGULATION OF BLOCKCHAIN IN SPACE

Regulatory challenges, uncertainty with legal frameworks, and the prevalence of scams in bitcoin and ICO have slowed down blockchain-technology adoption rates. There is a country-dependent regulatory framework for ICOs, and as such, it is one of the biggest hurdles. Concerning tokenization, the lack of clarity of the legal rights of a token holder discourages companies from tokenizing their assets. However, although adoption has been slow, the potential of blockchain technology is increasingly being investigated in the space sector, particularly in supply-chain management. ICOs and asset tokenization present some interesting challenges and opportunities for the space industry, particularly its feasibilities and capabilities. Thus, the private sector and space agencies need to conduct feasibility studies to identify areas where blockchain adoption could help enhance the space ecosystem.



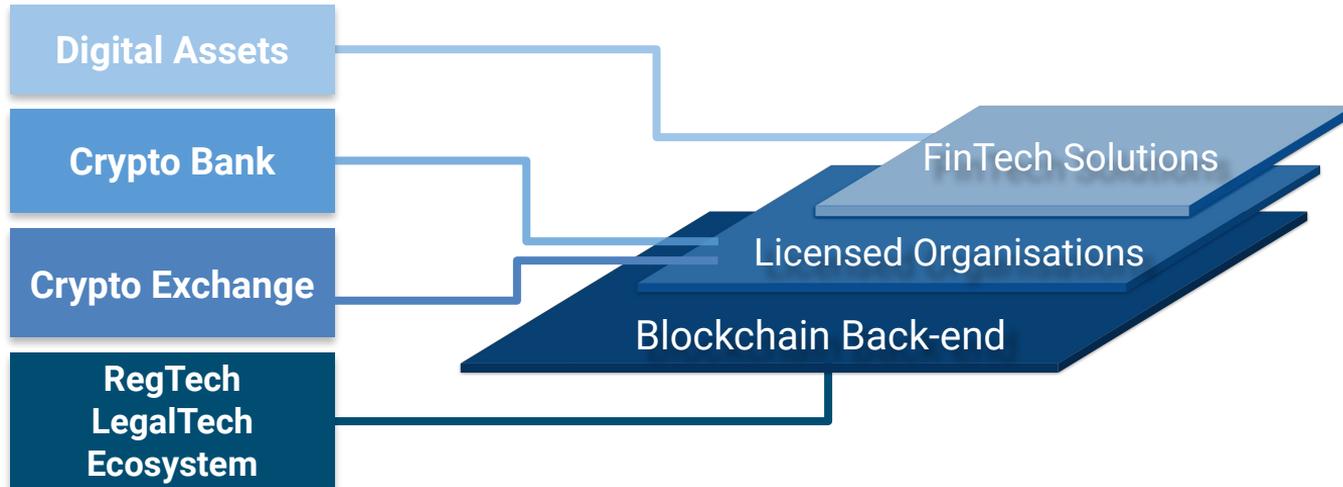
Despite the extreme advancement of both spheres of blockchain and space, due to the nature of the first sphere, no establishment has yet been found to take over the authority to regulate the intersection of these two spheres.



CRYPTO ECONOMY

A crypto-economy offers economic relations that are not directly mediated by the state, opening possibilities for a financial organization that does not comply with the state's conception of economic order. In the absence of state control, the crypto economy needs to focus on its internal modes of governance.

The real potential is in cryptocurrencies as units of account: modes of measuring economic activity conceived differently from those intrinsic to fiat money. Fiat money has become tied to conventional framings of profit and loss, income and expenditure, and a market-centered calculus. Non-fiat funds have the potential for developing new ways to calculate economic activity, ways that represent different social and economic values, and measure performance by criteria other than profit.



CRYPTO ECONOMY



"With the advent of the new space industry, it becomes necessary to rethink the previous transactional nature of space endeavors." - stated Julian Cyrus, Co-Founder and COO of Lunar Outpost.

Space assets are tokenized products, services, ownership, data, and investments in the space economy. The current situation features many months long and manual processes to acquire space assets, severely limiting accessibility and commercial scale in a global digital economy. Investments and liquidity in the space economy is also archaic, with no access for the retail market to access space investments, which also stops space ventures from attaining the **liquidity** they need to push progress.

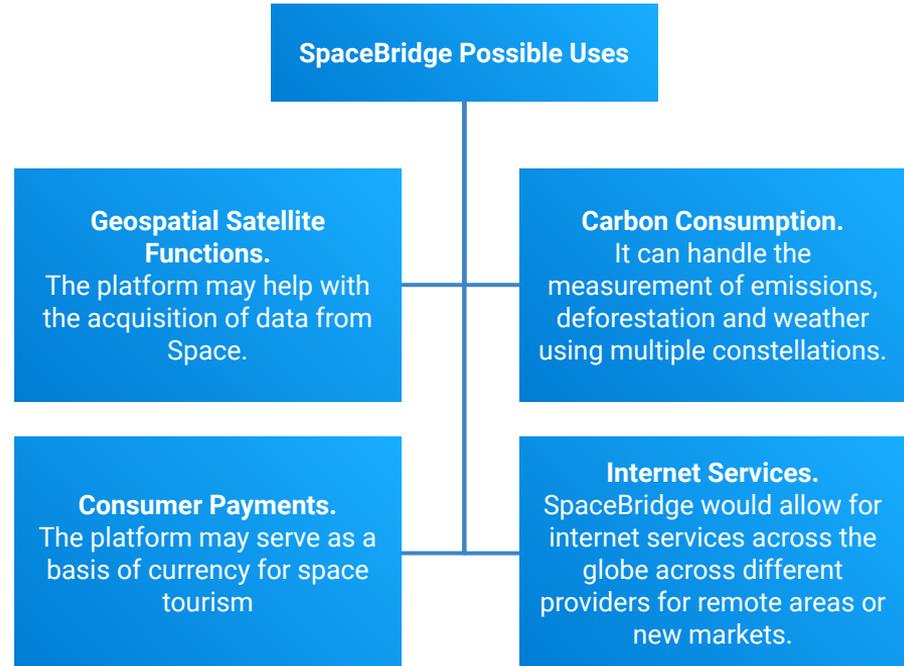
Through applying token **sales and liquidity pools**, early-stage, as well as more mature space ventures, can tap the retail and investment markets globally for the funds they need. Applying **tokenization, and crypto models** provides Space with an entirely new economic operating system and an array of revenue models. Giving space entrepreneurs the fuel they need by empowering the public to participate economically with ownership can become **one of the largest opportunities** in multiple ways. It will push applications that the average person doesn't realize but have a monumental positive impact on Earth. The platforms and tools facilitating this access and transactional scale for space assets are **what's most needed** to provide the foundation for all of this. And it's happening now.

CRYPTO ECONOMY IN SPACE

One of the examples of Crypto Economy intertwining with SpaceTech would be the transfer of the **crypto mining and maintenance processes** into space field. Such cases include the usage of satellite networks for the purposes of cryptocurrency activity. This activity encompasses, but is not limited to **data-sharing, blockchain broadcasting and inter-satellite transactions.**

An example of such implementation projects is the **SpaceBridge** project by **Onyx**. The platform would allow parties to request and pay for services without having to worry about complex inter-satellite communications and transactions. The project itself is currently in the **prototyping phase**, henceforth is still speculative, yet the prospects it promises are quite significant.

As it stands, the platform represent the movement of the payment systems into the space playing field. The requests by users would be sent directly to the satellite for various transaction types, after which the satellites would commence with executing the transaction using the established blockchain network.



BARRIERS OF IMPLEMENTATION BLOCKCHAIN IN GOVERNMENT

Incompatibility between blockchain-based solutions and existing legal and organizational frameworks is a significant barrier to unlocking blockchain's transformative capability. The main policy objective should be to develop the technological and ecosystem maturity of distributed ledgers. Policy actions should aim not only to adapt the technology to existing ecosystems but also to transform existing processes, organizations, and structures using the disruptive potential of blockchain.

According to the European Commission research, primary policy targets are the following:

Guidance and knowledge sharing



Creating programs for sharing best practices on blockchain deployments and providing guidelines and recommendations to develop knowledge on the technology. A better understanding of the topic for all ecosystem actors will result in easier adoption and increased effectiveness.

Focused pilot development



Identifying key use cases and ongoing implementations and co-financing pilot projects which experiment with blockchain technology and new re-engineered administrative processes in the areas of relevance. It could still result in the various blockchain protocols being used in similar use cases while allowing for the development of common requirements for standards and infrastructures.

Standards definition



Supporting the development of international standards on security, privacy, and governance, creating certification processes to ensure compliance of blockchain architectures with these standards. Standards compliance will mark a critical point on the maturity scale of distributed ledger technologies.

Blockchain foundational components



Providing foundational components to support the utilization of blockchains, such as data model for certificates credentials and distributed identity management. This policy action would require a lot of research and market consultation, yet it could enable a high degree of interoperability on a service level.

Use case-based dedicated infrastructures



Defining reference conditions and creating shared infrastructures most suitable for specific use case types, such as land title registries or tax systems.

Sources: JRC Science for Policy Report

SPACE POLITICS AND OPEN SOURCE TECHNOLOGIES

Space politics could be one of the issues to form a DHN. Some Space Agencies would not like their satellites to be discovered or tracked. **Military satellites may become exposed** because of such a network, even though it is challenging to identify a detected object.

As no entity governs space, one of the parties from the predicted conjunction would have to perform the avoidance maneuvers. This is where it gets complicated, in deciding which party should perform the maneuver. DHN's blockchain is **immutable** and **provides transparency** in its operations which will help in that decision. All the hysterical data about the orbit makes it easier to determine who occupied the orbit first. This is a case of a collision involving one or more cooperative parties. If a conjunction between two debris objects is predicted, it will not be possible to move either of the objects.

DHN - (Decentralized Horizon Network) a network of satellites, ground stations, and potentially any device that has the capability of connecting to a wireless network.

Sources: First Int'l. Orbital Debris Conf. (2019)

Smart contracts in space

This is the basis of the idea of **space governance**, where private organizations would agree to sets of rules that are then carried out and enforced through smart contracts.



“If you gaze a little bit into the future and imagine a whole supply chain based on celestial body resources, that’s easy to envision, especially if transactions are negotiated between robots,” Brian Israel, lecturer of space and blockchain law at UC Berkeley Law School, told Forkast.News.

The programmable nature of smart contracts — which execute actions and reactions automatically based on a variety of inputs and predetermined rules — could give users confidence that space interactions and **potential conflicts between parties** would immediately be worked out and activities would not be slowed, halted, or be hindered by delays in communications or confusion over rules.

SHAPING EUROPE'S DIGITAL FUTURE

Blockchain and distributed ledgers are currently subject to legislation instruments at the EU and national levels. In October 2018, the European Parliament issued a resolution on **“Distributed ledger technologies and blockchains: building trust with disintermediation”** to step up the EU regulation in this field. The elements of this document are aimed to resolve the challenges of legal protection and competitiveness related to the use of distributed ledgers, the principle of **technological neutrality**, and fair competition among players. It also highlights various usages of **DLTs in finance**, including implications for e-commerce, energy, healthcare, education, and creative industries (e.g., for the management of copyright or patents), as well as in the public sector (e.g., digitalization and decentralized management of public databases, licensing, certification, etc.).

Moreover important questions of related to data privacy on blockchain, are increasingly at the centre of many legal considerations, in particular issues related to the 'right to be forgotten' (vis-a-vis the irreversibility and immutability of data in a blockchain), and the Privacy by Design approach required by the EU GDPR.



A joint statement by the European Commission and the ECB outlined their cooperation on a digital Euro.

The European Central Bank (ECB) and the European Commission services are reviewing a broad range of policy, legal and technical questions relating to the possible introduction of a **digital Euro**. They are considering this in the context of their respective mandates and independence provided for in the Treaties.

US CRYPTO FRAMEWORK

Regulation

On September 21, 2021, the **U.S. Treasury Department's Office of Foreign Assets Control (OFAC)** issued an updated advisory about the sanctions risks of facilitating ransomware payments using cryptocurrencies. OFAC's advisory reminds organizations that it applies a strict liability standard when imposing civil penalties for sanctions violations. Thus, organizations may be liable for making a ransomware payment even if they do not know that the recipient has been designated a malicious cyber actor by OFAC. If payment is made to a sanctioned entity, the advisory noted that OFAC would consider in its **enforcement response**: (1) whether the organization took meaningful steps to reduce the risk of extortion by a sanctioned actor, citing practices highlighted in the **Cybersecurity and Infrastructure Security Agency's (CISA)** September 2020 Ransomware Guide; and (2) whether the organization reported the attack "to appropriate U.S. government agencies," as well as "the nature and extent of [any] cooperation with OFAC, law enforcement, and other relevant agencies, including whether an apparent violation of U.S. sanctions is voluntarily self-disclosed."

Legislation

On August 10, 2021, the U.S. Senate passed a **\$1 trillion bill** to increase infrastructure funding over the **next eight years**. To help pay for these expenditures, the Senate included a provision imposing reporting requirements on cryptocurrency "brokers," with estimates that such reporting would allow the Internal Revenue Service to collect an additional **\$28 billion in tax revenue over ten years**.



GOVERNMENTS' AND AGENCIES' CONCERNS ON BLOCKCHAIN+SPACE

Blockchain is a **controversial technology** and has some issues. Particularly in use of blockchain in space, some specific concerns have been expressed by some space agencies and governments.

NASA

NASA has been actively working on SCRAMBL (Space Communication Reconstruction and Mapping with Blockchain Ledgering) and the University of Akron to implement them into satellite communications. However, **the American government addressed the concern of privacy**, especially regarding the military sector, after NASA deployed a blockchain prototype for transmitting air-traffic data. That is supposed to be regulated by restricting access to the platform.

ESA

However, the European agency is said to be more focused on utilizing blockchain for Earth Observation data storage and distribution. This direction is not the only one that ESA is experimenting with right now, but the most prominent one. In 2018 the European Parliament issued a resolution on **“Distributed ledger technologies and Blockchains: building trust with**

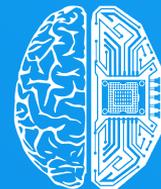
disintermediation” to regulate the use of blockchain. ESA later addressed specific problems mentioned there that are related to space utilization. The amount of **energy used** for DLT is rising daily. The numbers are so high that, even with the implementation of energy-efficient technologies, blockchain-based data centers would consume up to 20% of the world’s available electricity by 2025. The **data privacy** topic was also mentioned in the paper. It addressed the European **“right to be forgotten”** or simply the requirement for every piece of data to be “deletable.” That can be a tricky question because the blockchain-based data is made to be immutable and irreversible.



POTENTIAL OF THE SECTOR AND FUTURE PROJECTIONS

December 2021

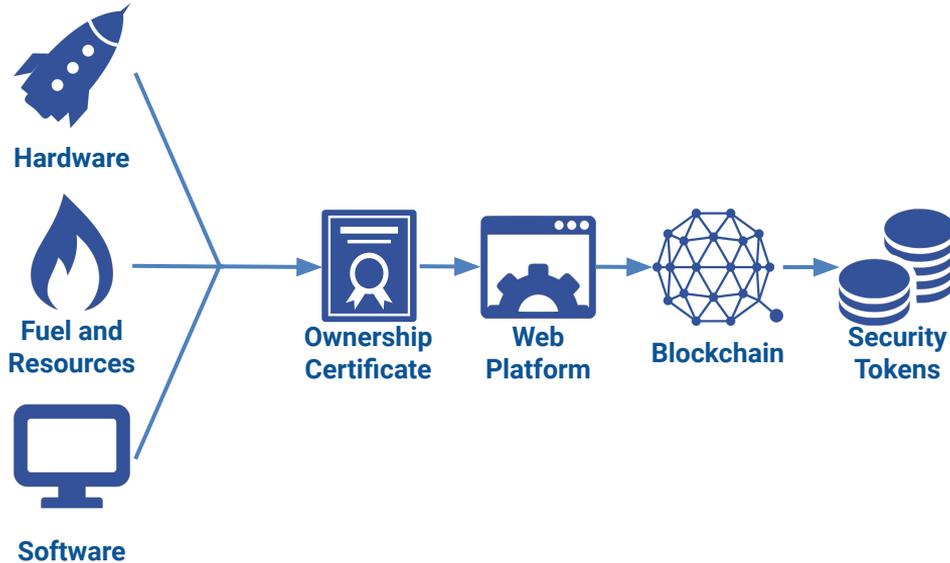
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POTENTIAL OF BLOCKCHAIN IN SPACE

As blockchain moves into outer space, its ability to tokenize spacecraft and payloads emerges as a key to its success, which could help in massive upcoming space projects such as the international, collaborative **Gateway space station NASA** wants to build in cislunar space near the Moon. With blockchain, it is possible to commercialize space exploration faster and more efficiently. Tokenizing a spacecraft would allow different entities to construct various components of the spacecraft, giving institutions like **NASA** and **ESA** the ability to procure things efficiently, with much more transparency and traceability.



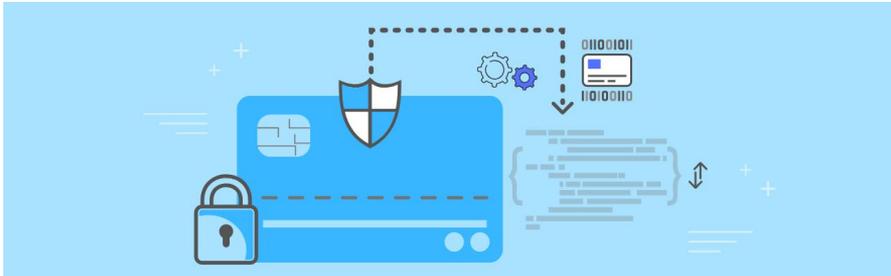
Because of the immutable nature of the blockchain, where every transaction is recorded transparently, tokenized assets are **immutable, verifiable, and always accessible** to all interested parties. The most crucial application of asset tokenization is that there are no territorial barriers to investing in assets. Hence, any interested entity from anywhere in the world can invest in an asset without complicated procedures, with high-security models and the speed of transfer offered by the blockchain network, due to the absence of middlemen.

Any asset can be tokenized into the blockchain network, including venture capital funds, materials, hardware, software, etc.

ADVANTAGES OF TOKENIZING SPACE ASSETS

The advent of blockchain technology brought one unexpected benefit with itself – the tokenization of assets. With the rise of asset tokenization and **DeFi** (decentralized finance), we are starting to see the real impact that asset tokenization can have on **financial markets**.

In an increasingly globalized world, the tokenization of assets in a way that ensures trust, transparency, and contractual obligations are guaranteed is becoming paramount. DLT enables transactions in which trust is **distributed among the nodes** participating in the network, without the need for a central authority or intermediary to validate a relationship between two parties carrying out a transaction.



Greater Control over Space Assets:

Tokenizing space assets into secure digital tokens will enhance tracking, processing, verifying, and securing all space behaviors triggered by space objects.

Faster transactions and Automated Compliance:

Compliance and fast response is a major factor in space asset management.

Security:

Blockchain-enabled decentralization for space networks eliminates the risks involved in the traditional single-point-access model of space communications.

CRYPTOCURRENCY AS BLOCKCHAIN IN SPACE

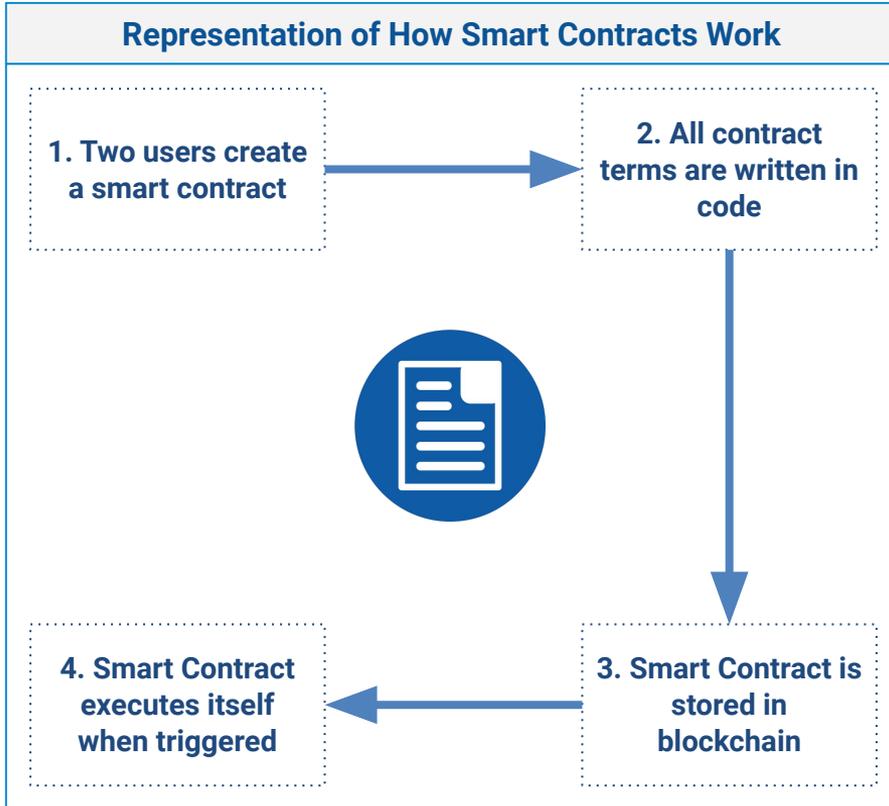


Blockchain promises to become a **new foundation** for all forms of transactions. A blockchain is a digital database that disintermediates and records transactions between parties. To achieve this, it cryptographically secures its records and relies on a distributed network to replicate its data across many locations. These features allow the blockchain to operate as a self-sufficient network without a central authority or oversight.

Blockchain transactions can take over payments, notary functions, supply chain management, identity, and digital rights management. An **Initial Coin Offering (ICO)** is a fundraising mechanism for cryptocurrencies, combining the concepts of an **Initial Public Offering (IPO)** and Crowdfunding. An entity such as a start-up can raise funds for its new project by offering a digital token to the investors. Blockchain-based transactions can provide additional security and insurance for the users.

Alternative token-based financing for space missions through **ICOs** can be a new source for funding the expansion of the SpaceTech Industry. As such, cryptocurrency and token application can be considered a possible future to the **space financial infrastructure**. In terms of already existing examples of application, several cryptocurrencies have already moved the processes of mining into space, increasing the overall efficiency of the said process. Additionally, it can be expected that several new **space-centered tokens** will appear shortly, further solidifying the place of blockchain in the SpaceTech industry.

SMART CONTRACTS AS A POTENTIAL FORM OF AUTOMATION



Smart contracts, or self-executing contracts, digitally facilitate, verify, or enforce the negotiation or performance. They rely on a set of if-then statements that automatically trigger events when certain conditions are met.

Given the complexity of participants involved in space, from launch to orbit, and the number of stakeholders who must monitor their vested equities, it is reasonable to expect that the space sector presents many opportunities to use **smart contracts**.

Blockchain smart contracts allow the creation of **trustworthy** protocols. This means that two parties can make commitments over blockchain without knowing or trusting each other. You can be sure that if the conditions are not met, the contract will not be executed. Also, smart contracts eliminate the need for intermediaries, which significantly reduces operating costs.

It is worth noting that each blockchain can represent a different method of **implementing smart contracts**. In simple terms, a smart contract works as a deterministic program. It performs a specific task when certain conditions are met.

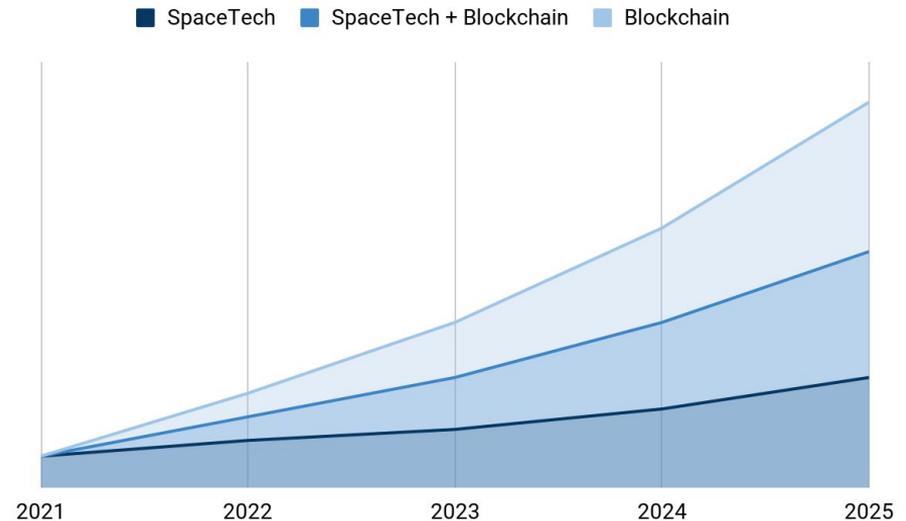
IMPACT OF BLOCKCHAIN AND SPACETECH GROWTH

As stated previously, the SpaceTech market is expected to grow more than twice the size up to the end of the second decade (**from \$4.7T to \$10T**). The Blockchain market projections are even more optimistic, showing an order of magnitude in growth in half a decade.

As such, both of these innovative industries can be considered as the top-performers of the economy in general. The markets provide many attractive opportunities to the investors, both new and established, minor and significant. While the SpaceTech market provides more **moderate levels of risk**, the Blockchain market, in general, is far more **volatile and diversified**. Different applications of blockchain technology provide different levels of risk and rewards. Overall, disregarding the application, all of them equate to an approximately similar average to the SpaceTech sector. Hence with the dangers being moderate and the rewards being significant, the fusion of two sectors can be considered attractive to investors.

With both Blockchain and SpaceTech industries showing **impressive growth potential**, it can be expected that cooperation between the two sectors will bring in the fusion with astronomical growth projections.

Market Growth Rate Projections From the Current Size



USAGE OF BLOCKCHAIN TECHNOLOGIES AS A SECURITY MEASURE

As data security is growing as a significant concern to the overall economy, the SpaceTech industry is also affected by such a trend. The **security of the supply chain**, the question of the safety of data from space, and the confidentiality of communications are the parts of SpaceTech sector that are heavily affected by the issues of having a secure technology.

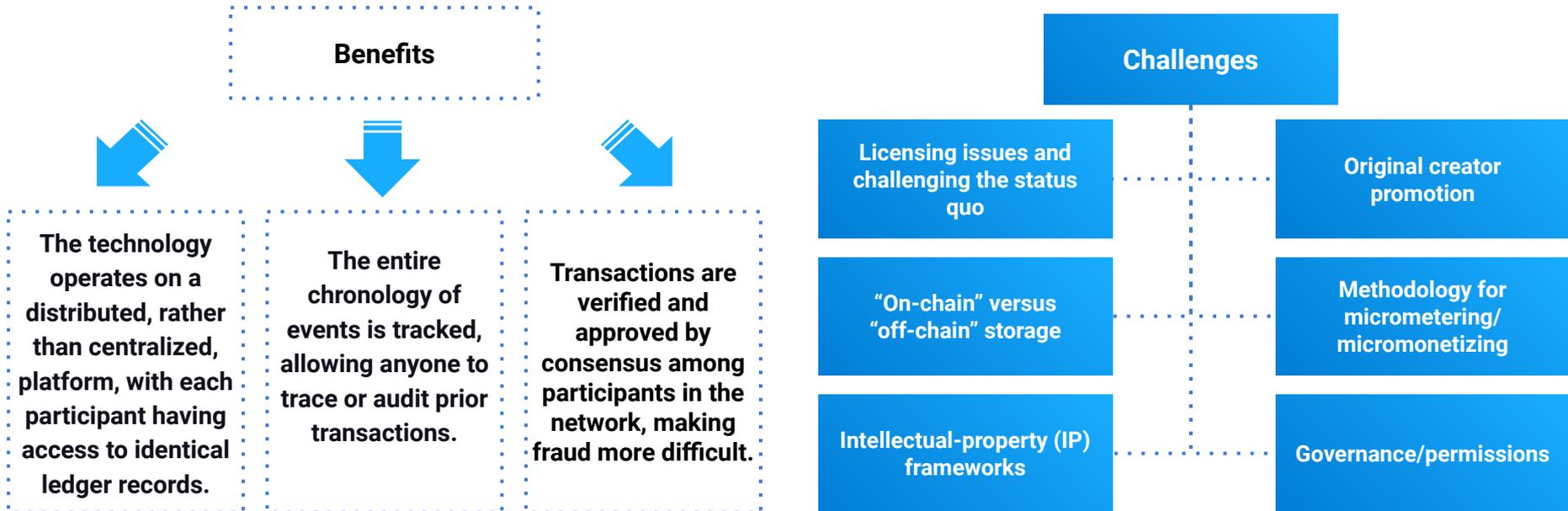
As such, Blockchain technologies can be used in conjunction with SpaceTech Industry to improve both systems' overall security, efficiency, and stability. Several of the major forms of blockchain are **primarily security-focused**, subsequently can be applied in the Space Industry. The usage of additional security measures can also become a positive factor in the overall public opinion on **both sectors**. Additionally, it can create more incentive to develop the technologies even further. The development of the SpaceTech Industry can also bring in the push for the expansion of the sphere of application of blockchain technologies.



In today's digital world, it is essential to take steps to ensure the security of both your blockchain design and environment. While blockchain technology produces a tamper-proof ledger of transactions, blockchain networks are not immune to cyberattacks. A comprehensive security strategy for an enterprise blockchain solution includes using traditional security controls and technology-unique controls.

THE BENEFITS AND CHALLENGES OF BLOCKCHAIN

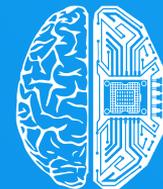
As blockchain technologies become more popular, bringing on their **benefits**, there arise multiple **challenges** to overcome for the significant increase of data-usage efficiency and overall quality of infrastructure. The most common challenges when talking about blockchain stem from the methodological and legal standpoint. With the industry itself being somewhat new and still in the process of self-defining, there is still a lack of fully-developed legislative and scientific backing toward defining the sector. At the same time, it's apparent that both governmental and private entities are working towards rectifying these issues.



KEY MARKET TAKEAWAYS

December 2021

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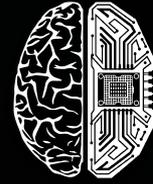
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KEY TAKEAWAYS

1. The direction of blockchain in space is only in its infancy, and at the moment, there are not many companies specializing exclusively in the intersection of these two industries. Therefore, the leaders are represented by a relatively **limited number of companies**.
2. Blockchain as an industry has recently developed into a major sector in economics. The market for its application **has grown exponentially** in the second decade of the twenty-first century. As blockchain technology can have different forms and applications, the market also varies in terms of spheres of the application. Currently, the most prominent forms of usage are Payment Systems and Exchanges, as cryptocurrency markets have been on the rise in **2010-2021**.
3. As of the third quarter of **2021**, the Blockchain sector contains **7 ETFs**, with the largest of them being **Amplify Transformational (BLOK)**, with more than **\$1.1B** in assets.
4. The rise of the SpaceTech market caused many new companies with apparent untapped potential to appear on investors' radars. Overall, the market capitalization of the SpaceTech Industry equates to **\$4.7T** as of the third quarter of 2021, with an expectation of continued steady growth of capitalization in this sector, reaching **\$10T** by **2030**.
5. On October 29th, 2018, the world's first space security token was announced by Venture Capital firm **SpaceFund**. The new token would allow for increased liquidity and efficiency for investors who wish to participate in the funding of the SpaceTech startups.
6. The options that blockchain offers to SpaceTech could be used to optimize further and improve the industry. Such technologies as **tokenization** allow for access to cryptocurrency markets for investments and provide additional security in terms of ownership rights to the holders.
7. While the most popular use of blockchain technologies has been in the **financial sector**, specifically due to **cryptocurrency**, other forms of its usage could be applied for space.

KEY TAKEAWAYS

8. As of 2021, there have already been **several cases** of the Core SpaceTech companies applying blockchain technology in their operations. Although the application was not to the SpaceTech division of their business, such occurrences show the **possibility of integrating** blockchain into the SpaceTech sector.
9. The use of blockchain in space can be divided into the following directions: tokenizing **space assets, sustainability, security, data, supply-chain applications, and financials**.
10. The blockchain protocol is responsible for verifying the new space transactions to add a new valid block to the blockchain. All space stakeholders can then **access the newly added blocks** through the connected dashboard to the blockchain platform that manages a **satellite constellation**.
11. **SpaceChain** from the United Kingdom invented a **hardware** piece installed on a satellite to make it a node in a global in-space system.
12. The blockchain technology can be implemented in satellite communications in a variety of ways. **Spacecraft** can either be **nodes** in the network or act as validators, and they can also only request some data stored in the blockchain.
13. Despite the extreme **advancement** of both the spheres of blockchain and space, due to the nature of the first sphere, no instance has yet been found to take over the **authority to regulate** the intersection of these two spheres.
14. While the SpaceTech market provides **more moderate levels of risk**, the Blockchain market, in general, is far more **volatile** and **diversified**. Different applications of blockchain technology provide different levels of risk and rewards. Overall, disregarding the application, all of them equate to an **approximately similar average** to the SpaceTech sector.



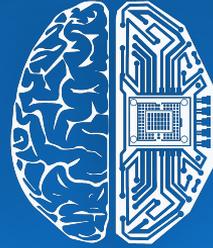
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SpaceTech Analytics

*New Era in Big Data Analytics
for SpaceTech Industry*

VALUE PROPOSITION

1

Deep analysis of the deal-making prospects in the SpaceTech space, identification of top mini-trends, and larger tendencies in innovations and technology adoption.

2

Palpable forecasts on the 3-5 years horizon, providing an overview of future scenarios of various technologies in the SpaceTech industry.

3

Practical guides for adopting various technological solutions and best practices, vendor profiling, and contract research strategy building.

4

Analysis of key market players in the emerging and high-growth areas of the SpaceTech industry.

5

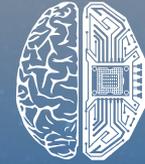
Comparative competitive analysis of companies, investors, and government agencies makes automated algorithm-driven analytics for scoring and ranking industry entities.

6

Technical reports and case studies on different topics related to the SpaceTech industry as a business development assistance services and analytics.

7

White-label solutions in the form of interactive IT platforms, extensive data analytics dashboards, and interactive mindmaps.



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Value Proposition

Custom Consulting Projects

“Ready-to-Use” Proprietary
Reports

Covering M&A Prospects

Strategic Growth Ideas

COOPERATION



Private Investors

Institutional Investors

- Acquisition of investments
- Access to the dashboard with algorithm-driven data
- SpaceTech ETF development
- Technical Due Diligence
- M&A Target search
- Market Consulting
- Specialized case studies and thematic proprietary analytics

Startups

Corporations

Private Companies

Public companies (IPO and SPAC)

- Joint reports
- Market investigation and insights
- Investment fundraising
- Proprietary analytics
- Joint ventures
- Assistance in business development and investors and government relations

Space Agencies and other Government Organizations

Non-Profits and Universities

Hubs and R&Ds / Associations

- Joint reports
- Market research and analytics
- Cross-communication support
- Partnership network contribution
- Mutual promotion
- Joint Ventures reports

Think Tanks

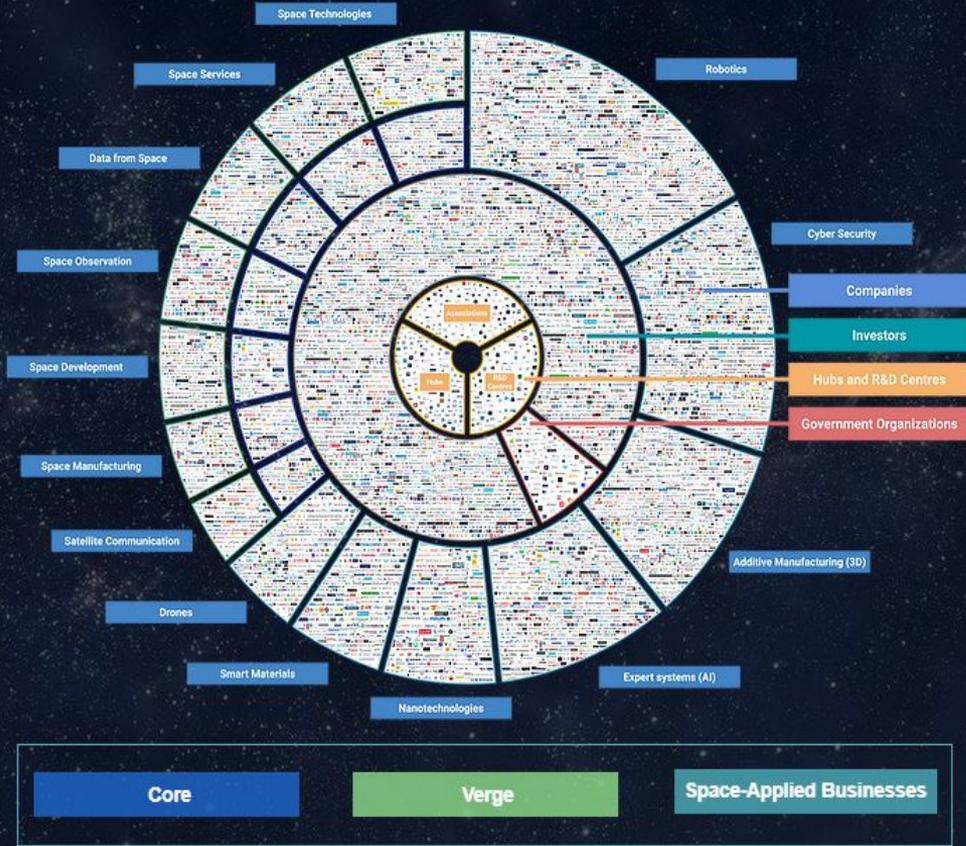
Analytical Agencies

Journalists and Industry Leaders

Consulting Companies

- Joint reports
- Conferences
- Webinars
- Early access to reports
- White label personalized content
- Mutual promotion

SPACETECH INTERACTIVE MINDMAPS



- Space Technologies
- Space Services
- Data from Space
- Space Observation
- Space Development
- Space Manufacturing
- Satellite Communication

- Drones
- Nanotechnologies
- Smart Materials
- Cyber Security
- Robotics
- Expert systems (AI)
- Additive Manufacturing (3D)

SpaceTech Investors

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R&D Hubs, Associations, and Governmental Organizations

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Introduction the new home for SpaceTech:

[SpaceTech Analytics: Dashboard](#)

Access now!

Navigate 12,000 spacetech companies & more

The dashboard is organized into two main horizontal sections. The top section, 'SpaceTech Companies', features a sidebar with 'Top Public Companies', 'Funding Rounds', and 'Leading Companies & Investors'. The main content area includes a 'SpaceTech Mindmap' (a circular network diagram), a 'Dashboard Parameters' table, and a 'List of Companies' table. The bottom section, 'Other Assessments', features a sidebar with 'Space Medicine Industry', 'Space Law & Economics', and 'Unidentified Aerial Phenomena'. The main content area includes 'National Space Programms' (with a satellite image), 'Space Travel Industry' (with a space window view), and 'SpaceTech Industry 2021 Report' (with a report cover image).

COMPANIES	INVESTORS	HUBS AND R&D
10000+	5000	280
INDUSTRY SECTORS	PARAMETERS	DATA POINTS
20+	100+	1499985

Company Name	Investment	Year
SpaceX	\$1.2B	2002
Boeing	\$1.0B	1996
Space.com	\$0.5B	2000
SpaceHub	\$0.3B	2015



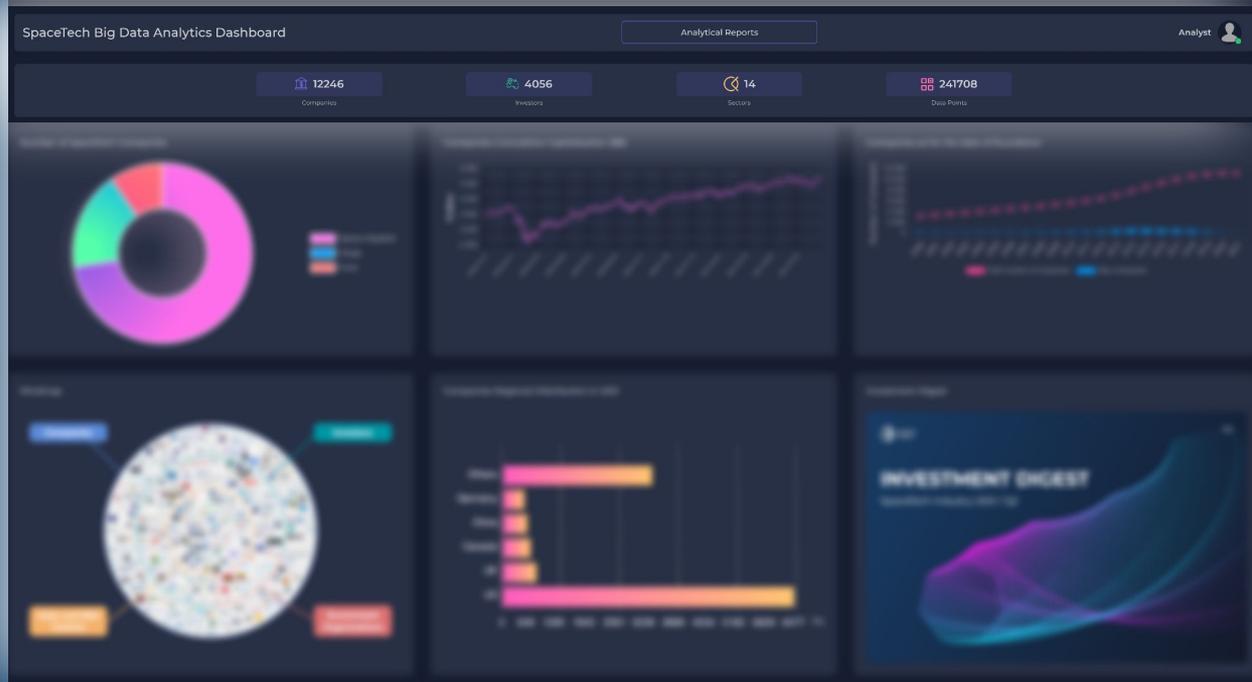
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Introduction the new SpaceTech Big Data Analytics Dashboard

Coming Soon!

SpaceTech Analytics will be soon releasing an analytically sophisticated Dashboard that will incorporate big data analytics, machine learning, AI engine, and investment analytics technologies already developed and validated by SpaceTech Analytics' parent company, Deep Knowledge Group, and its various analytical subsidiaries (including Aging Analytics Agency and Deep Pharma Intelligence).



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OUR CONSORTIUM

Deep Knowledge Group is a consortium of commercial and non-profit organizations active on many fronts in the realm of DeepTech and Frontier Technologies (AI, Longevity, FinTech, GovTech, InvestTech), ranging from scientific research to investment, entrepreneurship, analytics, media, philanthropy and more.

Analytical Subsidiaries

[Aging Analytics Agency](#)

[Deep Knowledge Analytics](#)

[Deep Pharma Intelligence](#)

[NeuroTech Analytics](#)

[GovTech E-Governance Analytics](#)

[COVID-19 Analytics](#)

[Innovation Eye](#)

[Interactive MindMaps](#)

For Profit & Non-Profit Activities

[Deep Knowledge Ventures](#)

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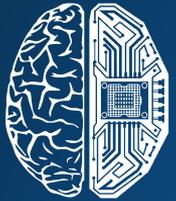
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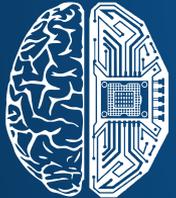
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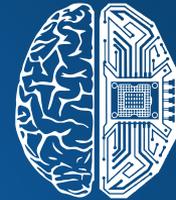
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