Blockchain and Space

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***Abstract* - Blockchain, the technology that gained a lot of popularity with the price burst of Bitcoin in 2016, is one of newest technologies that is being developed and integrated in many fields, but yet not fully used to its full extent. In our work we will try to underpin the importance of blockchain in space application, namely for space satellite and debris tracking, while proposing an innovative mechanism using smart contracts specific for this type of application.**

1 Context

Modern spacecraft, whether destined to stay in Earth's orbit or leave its sphere of influence, are exposed to man-made debris. These debris proved to be of great danger for space exploration namely with the first confirmed accidental collision of a french satellite named *Cerise* with a debris from an Ariane rocket. The incident was reported by *NASA and UK space track network* and justified to the French government the need to build its own debris tracking system. Nowadays high profile space agencies rely on their own tracking systems, and intercommunication about possible collision is scarce and even primitive. The incident that happened September 2, 2019 sets a good example where SpaceX did not respond to an ESA collision risk warning between Starlink 44 and Aeolus satellites because a glitch in the system prevented that.
With no real solution to remove space junk, humankind is facing a real problem with more and more satellites being put to orbit. One collision in Low Earth Orbit (LEO) could entail more space debris and thus produce a chain reaction of collisions. Controversially, our eagerness to thrive and conquer space may also one day hinder us to travel outside our atmosphere. According to a 2020 *ESA safety and security report*, there are 900 000 objects greater than 1cm-10cm of which the Space Surveillance Network is regularly tracking more than 21 000 objects larger than 5-10 cm [4].

2 Problem statement

There are currently 34000 objects bigger than 10cm and the numbers are only getting bigger as no junk removal is envisaged in the near future. One collision could increase the risk dramatically. Let alone the infamous collision between Iridium 33 and Cosmos 2251 produced around 2000 large catalogued objects and 8 million fragments smaller than 1cm. Many studies show that the collision with a 1cm debris in LEO could be the equivalent of a hand grenade explosion, and the need for better tracking capabilities can't be stressed upon enough [1]. If we were to add objects bigger than 2cm as *LeoLabs* prospects, this adds a whopping 300 000 objects to the tracking list.

Luckily space object tracking is an ever growing interest for a lot of private companies like *Northstar Earth and Space* [5] [6] and *LeoLabs* [3] [6], privatisation is imminent. This growing market can be justified by the fact that in the upcoming 10 years, companies plan to orbit 12000 satellites whereas as of 1957 till now only 9600 satellites were successfully put in orbit hence more junk production and more satellites to maintain than ever before in the near future. In an effort to mitigate this problem, a solution is proposed to increase space agencies interoperability and promote the birth of new actors. In the absence of a real-time international space debris database, the use of a blockchain could reply to many problems [8] [9].

3 Blockchain utilities in space

The integration of blockchain in space applications and satellites is an active ongoing research topic in the scientific community. An interesting example would be the simulation in a lab environment for satellites detecting possible tropical cyclones on Earth [7]. The choice of Hyperledger Fabric [2], a blockchain developed atop Linux Fundation technologies, offers many tools that could serve the common interest of both private and public space entities. Hyperledger, like any other blockchain, promotes communication and transparency of information. And in this particular use case, having multiple satellites interchanging data on a single platform could increase cyclone detection certainty, and most importantly assign tasks more efficiently to different satellite owners based on their position in space.

Similarly in our space tracking problem, ConsenSys Space, a blockchain company implied in solving real-world problems with Ethereum technology, is developing TruSat [9] to create a common world-wide database that can be accessed by anyone. Their goal is to encourage not only well-known space agencies, but also science enthusiasts to participate in the quest of observing floating objects whether it was with heavy telescope equipment or a smartphone's camera. Their open source "Proof of Satellite" software engine will allow to inform involving parties what objects are not being tracked or needs an update of their location and rewards participants accordingly with reputation points that we will detail their usage later on. The system would help to eliminate redundancies of tracking a certain batch of objects by multiple agencies thus expanding the capacity to track more targets.

But foremost, before digging deeper in the TruSat project and our interest in contributing to it, it should be stated that the core pillars of blockchain technology is the ability to create an immutable database which can serve to record debris location and hold accountability in case of an unfortunate collision by tracing back the history.

4 Development and contribution

In order to encourage individuals and private start ups to have bigger incentives in the participation of TruSat's project, a smart-contract written in solidity is being developed. The smart-contract will allow the exchange of data using peer-to-peer technology on Etherium mainnet while ensuring safety to both the provider and the client. In simple words, the goal is to develop an algorithm that allows anyone, from individuals to big companies, to use their space debris tracking information, post them using TruSat's interface, give special access to specific addresses or buyers while informing everyone what they are tracking to avoid redundancies. The project aims not only to be applicable to space debris, but to be extended to any problem of which data has a fast depreciation rate.

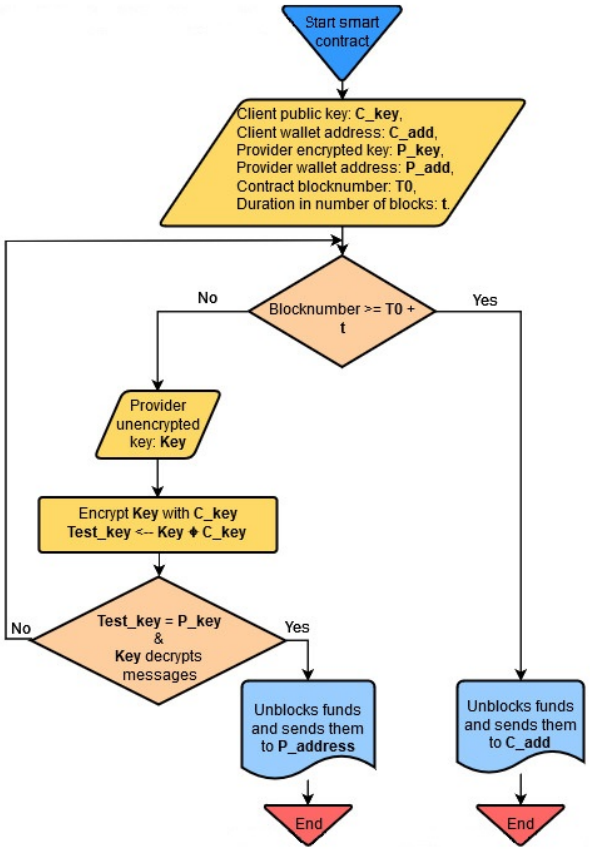

Figure 1: Flowchart depicting the smart contract's logic

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