Constellation Network, Inc.

INFORMATIONAL OVERVIEW

Constellation Network for Processing and Securing Complex LiDAR Data

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LiDAR is currently used by many emerging industries, including Mobility, Air and Space, to generate precise, 3-D data on everything from autonomous vehicle and aircraft telematics to infrastructure sensors, atmospheric conditions, surface topography and GPS tracking. Due to growing security concerns within LiDAR systems and a lack of protocols around data collection and analysis, an urgent solution is required that would accurately and securely process, protect and verify large volumes of complex LiDAR data. To tackle these problems, Constellation Network provides a highly scalable and interoperable solution that uses distributed ledger technology and a novel consensus algorithm to cryptographically process LiDAR data at scale and in transit through a data authentication pipeline that provides end-to-end security.

LiDAR is an active remote sensing method for measuring distances to objects and surfaces by illuminating a target with infrared lasers and measuring the reflections with a sensor. By “sweeping” a light beam and receiver array mechanically, differences in laser return times and wavelengths are used to provide 360-degree viewing angles and generate dense, 3-D representations of the environment, in contrast to the 2-D images created by cameras. The generated data is often displayed in 3-D array known as a “point cloud” – a set of data points in

space that describe an object or surface that helps humans to visualize what the LIDAR is "seeing". This provides highly accurate, enhanced and detailed imagery of that object or surface and data generation for a range of applications, including image recognition and classification, terrain mapping and surveillance, and navigation for autonomous and semi-autonomous vehicles and aircraft.

There are numerous benefits associated with using LiDAR technologies. LiDAR collects data quickly and with high accuracy, and requires minimum human dependence because most of its processes are automated. It can be used to map inaccessible and featureless areas, and can be integrated with other data sources – making it easier to analyze complex data automatically. Further, LiDAR does not have any geometry distortions and provides a much higher surface density when compared to other methods of data collection such as photogrammetry. These features allow LiDAR to identify significant "events" that may impact on command and control. For example, LiDAR is the core sensor in providing situational awareness for any autonomous vehicle and can detect obstacles and generate data to ensure collision avoidance. This occurs when a LiDAR sensor scans the road's surface several hundred times a second and feeds information to the vehicle's on-board computer, which processes it in a fraction of a second and adjusts the car's suspension based on this information.

Despite these benefits, there are numerous points of failure that can occur when utilizing LiDAR that must be addressed to ensure sensitive data is both processed efficiently and secure at scale and in transit. Of primary concern is the large volume of data generated by LiDAR; for instance, the hundreds of on-vehicle sensors for autonomous vehicles can generate and consume approximately 40 terabytes of data for every eight hours of driving. This data needs to be extremely detailed and timely to effectively navigate lane control and road hazards and

continuously update based on road conditions. Transmitted at high speeds, at high volume and across periods of time, these data sets are complex and difficult to interpret in real time, leading to potential problems processing and accessing data on relevant information, and consequently delayed responses to time-critical decisions that could have serious consequences. In the case of autonomous vehicles, this not only means that it may take significant time to determine the cause of system errors and anomalies, but could also lead to events that endanger human lives.

Further, LiDAR data is vulnerable to both external and internal attacks because it relies on a variety of interfaces that act as sources of data that can be exploited when data is in transit in the data pipeline. For example, cyberattacks might target LiDAR data using what is known as a "man in the middle attack", whereby either someone in physical proximity to the data or a malicious threat vector like malware is used to spoof both the data and its source. This occurs when there are vulnerabilities in the schema that allow encrypted data to be decrypted by someone who understands the schema being used and is therefore able to exploit it. When compromised, such data can create an erroneous perception of the environment being sensed and measured by LiDAR, leading to incorrect decisions that could have negative outcomes for command and control.

Traditional data pipelines struggle to manage complex LiDAR data at scale and in transit and are largely ineffective at providing quick access to relevant information and preventing cyberattacks. Firstly, they do not provide a simple way of locating relevant information such as errors or anomalies in the pipeline, meaning that processes involved in fixing such problems may be lengthy and highly involved. Secondly, these pipelines usually rely on certificate authorities – whereby one authoritative source grants access – and on multiple stages where data passes between "clusters" of nodes, which process that data in parallel. This often does not provide any

real authentication because it is neither a distributed nor scalable system, leaving many opportunities for data to be spoofed, damaged or stolen within the data pipeline. The issues associated with these traditional pipelines are significant roadblocks to mass adoption. These will need to be overcome as LiDAR is used for an increasing variety of applications requiring time-critical decisions.

The development of standards for data processing and safeguards against the spoofing, loss or corruption of complex data sets will ensure the reliability of LiDAR systems and devices. Constellation provides the means to achieve this by creating an authentication pipeline with end-to-end security to both process LiDAR data more efficiently and protect it from malicious threats. It does so by utilizing distributed ledger technology to cryptographically secure LiDAR data at scale and in transit by compressing original data into data packets in real time. These compressed representations allow technologies using LiDAR to quickly identify an "event" in the data pipeline without having to sift through high volume data sets. Instead, Constellation provides a way for LiDAR technologies to reference the unique compressed representations and pinpoint the event in real time by assigning triggers around any anomaly or error in the pipeline.

Constellation is also able to efficiently process and store high volume LiDAR data – an insurmountable task for traditional data pipelines. Rather than authorizing and processing data through parallel clusters of nodes, Constellation's distributed nodes ensure that big data can be processed efficiently, making significantly faster analytics and diagnostics possible. The network provides immutability around details such as those in firmware – creating an ecosystem to allow measurement of data in point clouds to view specific features and identify any changes within them. This presents a powerful solution to the problems associated with managing LiDAR data at scale.

By streamlining the ways in which data is managed, Constellation is able to cryptographically guarantee LiDAR data while simultaneously providing the computational power needed to extract useful insights from the data itself, with important outcomes for security and safety. Constellation is also highly scalable and interoperable, meaning it can be easily integrated into existing systems. For instance, Constellation can be embedded early in the development process for autonomous vehicles, working with existing software to ensure its capacity for accurate and timely navigation and collision avoidance. Constellation also has numerous potential applications for other enterprises requiring efficient and immutable data pipeline processing and security. For example, space industries also require a time-sensitive approach to processing and securing LiDAR data to prepare for and respond to vulnerabilities, incidents and threats relating to satellites and other spacecraft. Industries that utilize LiDAR data on drones and other autonomous aircraft for time-critical decision-making will also benefit from Constellation's scalable and interoperable solution.

Constellation is an active member of the Mobility Open Blockchain Initiative (MOBI) – the world's largest mobility consortium – which is working to make transportation greener, more efficient and more affordable through smart mobility blockchain adoption to address the needs of emerging, connected and on-demand multi-modal transportation ecosystems. Constellation is a core driver in the Connected Mobility Data Marketplace (CMDM), a MOBI working group that aims to create interoperability standards for a mobility blockchain and support the development of an efficient digital, multi-sided mobility marketplace using distributed ledger technology. Constellation co-authored the working industry standard on how autonomous vehicles securely communicate data amongst different mobility constituents. In this effort, Constellation has

become known as the distributed ledger technology of choice to securely process LiDAR and other big data sets.

Ultimately, Constellation's standard for data in transit will make it easier and more efficient to process and secure complex and high volume LiDAR data. Partnering with Constellation will provide new opportunities for cutting-edge enterprises to access and analyse this data in real time, offering them crucial insights into data analytics that will be essential for the future development and adoption of LiDAR across a range of industries.