AMO

AMO Blockchain

Blockchain for the CAR DATA Market

Penta Security AutoCrypt® Reverse ICO

Content

Executive Summary

AMO is a blockchain project to create and operate the AMO market, a market where car data can be shared and exchanged.

AMO Market = CAR DATA Market

With the rapid development of connected cars, electric vehicles (EVs), autonomous cars, and smart cars, there is a need for a decentralized, open marketplace for transactions in the automobile industry. AMO Market will support the exchange of data between all stakeholders.

Participants in the AMO Market are all stakeholders within the automobile industry be it car users, automobile manufacturers, or automotive service providers. They participate in AMO Market simultaneously as data producers and consumers in a cycle of value sharing and creation. A technology-enabled economic system, AMO Market is built on the AMO Blockchain and supports the fair valuation of data and distribution of rewards. Accounting for adjustments in supply and demand, payouts and purchases are made with AMO Coin.[1]

Car data is no longer limited to narrow use by a select few, but with express consent of data owners becomes a shared asset that benefits other participants in the AMO Market. When service providers or manufacturers want to access car user data, proper authorization is brokered with data owners, and even then all information and sensitive data is protected using cryptography.

Ultimately, AMO Market aims to create an environment where car data and information are no longer used and held by a few select companies, but are used and shared through legitimate and secure processes and transactions. As a result, car data will become a public asset and return more valuable and optimized services enjoyed by those involved.

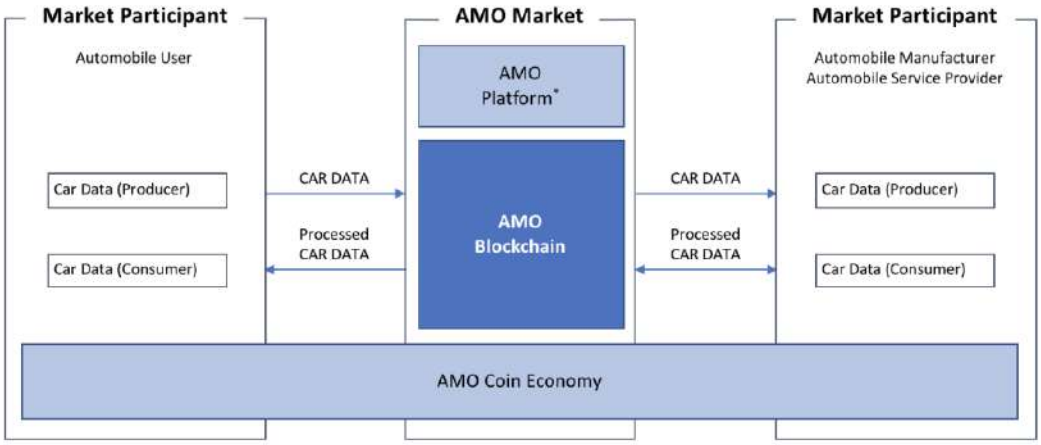


Figure 1. *AMO architecture overview*

[1] Amo Coin refers to both the AMO Token and AMO Coin. AMO Token will later be converted to AMO Coin. Cryptocurrency refers to the AMO Token before its converted state.

*AMO Platform : The AMO Platform uses the AMO Blockchain to provide AMO Market operations. It supports communication among participants and manages operational policies and IT systems including software.

Chapter 1. Overview

The need for a decentralized car data market in the rapidly developing automobile industry

The cars of today are generating and processing unforeseen amounts of data. The advancement of the automobile industry has brought with it developments like the connected car, the electric vehicle, and the autonomous car. Cars are now becoming moving hubs of information, not merely a means of transportation to take one from point A to point B. This new concept of automobiles is changing how we think about time, money management, entertainment, and life overall.

The five key elements driving the smart car revolution are Security, Platform, Autonomous, Connectivity, Electrification—also abbreviated as SPACE. Each element contributes to the car data used to improve the quality of automobile services. In the automobile industry, car data plays a central role in supporting service development; hence the success of business efforts tends to be determined by the availability of car data. This is why there is an urgent need for a car data market that both smoothly facilitates the sharing of car data and also guarantees the security and credibility of the car data and the market itself.

AMO Market is a car data market centered on AMO Blockchain and AMO Platform. AMO Blockchain and AMO Platform will be developed by security experts through the application of blockchain technology to Penta Security's existing technologies, namely AutoCrypt®, AuthentiCA®, and Penta CryptoWallet™. AMO Market will contribute significantly to revitalizing the automobile industry by deriving additional value from car data and incentivizing participation and interaction in the AMO Market.

1.1 Problems with Car Data Management

The value of car data, though invaluable and exorbitant, is limited because of the difficulty in collection, storage, and sharing.

An automobile generates a diverse collection of data throughout its journey from start to finish—beginning at the car manufacturer and ending at the scrapping facility. The data reflects the lifecycle of the car and could be used to improve the state of car manufacturing, car rental, car sharing, insurance, and vacation industries. However, no commonly agreed-upon standard or system currently exists for the systematic collection, storage, and use of this data. On occasion, car data may be utilized by independent service providers, but oftentimes they overlook the potential of generating further value from the car data and fail to make full use of it.

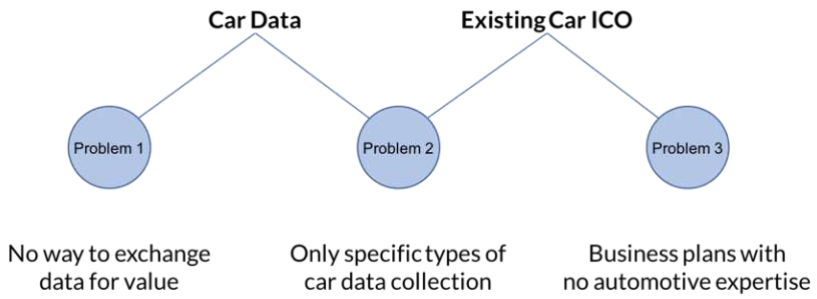


Figure 2. *Problems with car data and existing car ICOs*

1.1.1 Unsystematic Collection of Data

While data from external and in-car sources about vehicle usage, equipment, and components has long been available, the systematic collection and management of the data has been extremely limited. Most car manufacturers and service providers rely on individualized systems for data storage and management. Only with the recent introduction of connected cars, have electric vehicles, and autonomous cars enabled the use of V2X data, generated through interaction with roads, vehicles, pedestrians, and the overall traffic infrastructure. Following advancements in the electric vehicle industry, not only in-car data but also charging and battery-related insights are being recognized as valuable information. The progress on smart cars has also increased demand for user data generated by various applications.

The problem is that the format of collected car data varies by vehicle manufacturer and service provider. In most cases, the data is technically incompatible with other systems and cannot be shared. While legislative limitations might partially account for the lack of data sharing, the main obstacle to sharing car data is the lack of a common technical framework. Since there is no public protocol for gathering data, it is impossible for participants to be properly informed about how their personal information is being used and whether agreed boundaries for data use are being respected. Additionally, even if individuals agree to share their data with service providers under contractual agreements, they are not fairly compensated for their contribution.

Currently, there is no institution or company that performs comprehensive collection of valuable car data generated in each part of the vehicle operation process, covering the communication systems, internal and external systems, and the application layer.

1.1.2 Inefficient and Uncompensated Data Provision

Access to car data opens up new business opportunities for service providers to offer customized services to car users. However, because there isn't an equal relationship in data transactions between car users and service providers (such as car manufacturers, developers of automobile services, car insurance providers, etc.), there is also no means of rewarding car users for their provision of data. Personal data only serves as evidence of contract fulfillment, rather than amounting to any generation of additional value. In particular, service providers that are unable to provide a high level of data protection can easily end up misusing customer data beyond the bounds of agreement and even leaking the data.

Therefore, there is a need to establish a trustworthy platform that can quantify the value of car data and provide a fair compensation system for data contribution. In this way, both data providers and data consumers will stand to benefit from the exchange.

1.1.3 Insufficient Data Security and Privacy Protection

Car data can be categorized based on whether or not it includes personal information. Car data that includes personal information must be collected and stored in a manner that provides adequate privacy protection in accordance with the rights of the data subjects. In particular, any distribution of such data must follow protection protocols and processes. For instance, collection and storage of sensitive data such as daily driving patterns without proper security measures can give rise to social issues regarding privacy. It's crucial to address the current method of relying on portable devices (SD cards, etc.) for storing important data generated within the vehicle, data transmitted via internal vehicle networks, and additional vehicle-related data.

Any information that includes private information must be shared and utilized only after completing de-identification[2] of the data for adequate privacy protection. Car data that is not shared or used only has potential value without any actual value. Due to the current lack of rules and security guidelines surrounding car data, the sharing and use of car data can only be perceived as a risk, rather than an opportunity for creating value.

[2] De-identification refers to the process of removing all personally identifiable information that could be used to identify a person from a dataset. This is commonly performed via pseudonymization, in which real names are fully or partially replaced with symbols, tokens, or temporary IDs. Both methods rely on encryption technology.

1.2 AMO Solutions and Goals

AMO provides a secure and reliable market for car data.

The vision of AMO is to create a secure and reliable environment for sharing car data that builds upon our expertise in the automobile industry. The first step in achieving this is to solve the current problems in the automobile data industry as explained in detail below.

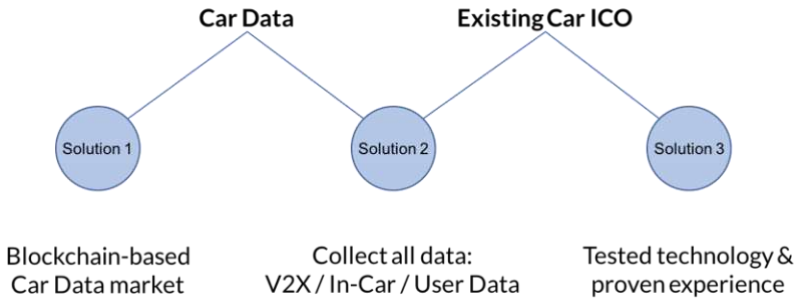


Figure 3. *Solutions to existing issues*

1.2.1 Standardized Data Collection and Car Data as a Transaction Unit

To solve the problem of non-standardized data collection systems, a range of hardware and software data collectors have been developed to deploy with AMO. These include a hardware data collector (AMO Data Collector™), a mobile application (AMO Mobile Wallet™), a car infotainment (IVI) app, software embedded into a car's telematics systems, and software data collector for V2X devices (AMO Auto Wallet™). These tools will perform data collection for all three levels of data involving automobiles: V2X data, In-car data, and User data.

Following a car's entire lifecycle, from the first registration of the car, to records of any accident history or services engaged, to the final scrapping of the car, it is possible to systematically collect car data for a wide variety of uses, regardless of national boundaries or type of vehicle. Furthermore, specification for car data will be publicly available so that anyone will be able to participate and contribute to the car data market. This will prevent any one company or organization from monopolizing car data as a business tool. To this end, a public blockchain like AMO Blockchain is necessary in allowing this type of open data-sharing.

Data will consist not only of what is generated by drivers and other car users (Car Data), but also secondary generated data (Processed Car Data) from those who provide any kind of services within the auto industry. The specifications for Car Data and Processed Car Data will also be defined and shared through the blockchain in order to encourage use.

1.2.2 Compensation System for Data Provision

AMO provides users with the AMO Market, a blockchain-based car data market, which is an environment that facilitates exchange between data producers and consumers. AMO Market solely provides the environment for trade and does not assume data ownership rights. Car data becomes a commodity, and data producers and consumers contribute to determining the value of car data. Any market-based value transaction involving provision of car data will be rightfully compensated with AMO Coins.

This compensation model provides incentive for market participants to supply car data. In the future, active market participation and data generation incentivized by the compensation model is expected to encourage even countries without active automobile manufacturing to establish and grow their automobile-related businesses.

1.2.3 Applying Data Security and Privacy Protection to the Blockchain

Car data which users have agreed to share will be stored on the AMO Blockchain, along with other relevant information about the transaction, data ownership rights and data usage rights. Similar to the way data is typically stored on the blockchain, all this data will be stored in blocks. The raw data, which contains sensitive personal information, will be encrypted, de-identified and fragmented in order to preserve maximum security. This distributed method of storage will be implemented with AMO Blockchain's Peer Storage feature. With Peer Storage, the PCs and IoT devices that make up the nodes of the blockchain will provide data storage resources in exchange for proper compensation. Storage space created through this organic system is therefore potentially limitless.

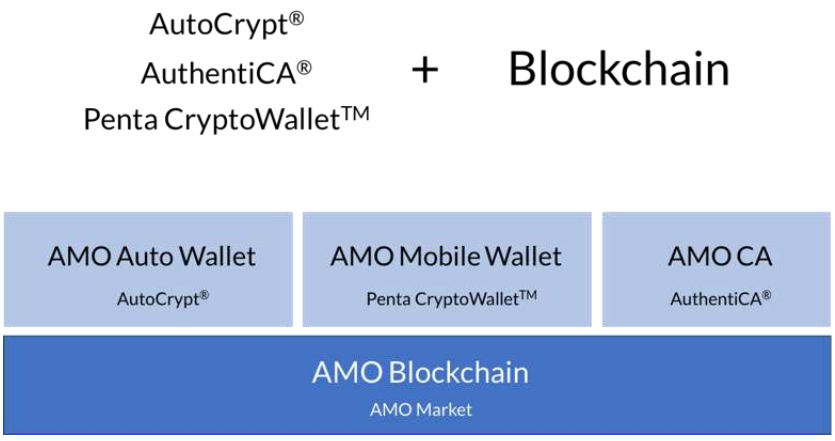
Data in distributed storage is decrypted on request of the data buyer, only with the authorization of the rightful data owner. This process of verifying credentials and permissions is facilitated by AMO Platform. However, AMO Platform is only involved in making the peer-to-peer connections and retains absolutely no access to the data.

1.3 How AMO Differs: Creating a Future Automotive Ecosystem

Deep knowledge and technical understanding of automobiles and the IT industry, along with hands-on experience, is essential for building the car data market

Since automobiles are complex machines consisting of over 10,000 physical parts and hundreds of millions of lines of code, grasping the massive amount of internal and external data is extremely difficult. Moreover, creating a safe and secure blockchain-based ecosystem is certainly not simple. In order to overcome both challenges, the core team of developers must possess comprehensive knowledge and skills in automobile and transportation technology, management of sensitive car-related information, and general system development with integrated security.

Building and sustaining an ecosystem based on blockchain technology is virtually impossible without proven results and capabilities. AMO has the optimum skills and experience required to build the AMO Market.



- Penta Security understands automobiles and transportation infrastructure: as part of Intelligent Transport System (ITS) development efforts, Penta Security has been running the AutoCrypt® project since 2007, working with both the Korean government and major automobile manufacturers. Following the successful construction and operation of autonomous vehicle complexes in Sejong, Yeoju and Hwaseong, the project will be expanded to constructing similar smart roadways in Seoul, Jeju, and Daegu.
- Successful experience in the IoT environment is needed to build and operate a stable infrastructure between cars and smart objects. Penta Security's expertise in solutions optimized for IoT environments is demonstrated by its development of AuthentiCA®, a cloud-based certificate authority service for the smart car, smart factory, smart energy, and smart home environment.
- Using blockchain technology, Penta CryptoWallet™ and AMO Data Collector™ have already been developed.

Not simply a plan in the works or an empty vision, roadmaps with proven results and technology are already underway.

Chapter 2. AMO Market

A virtuous cycle of car data transactions in which all participants benefit

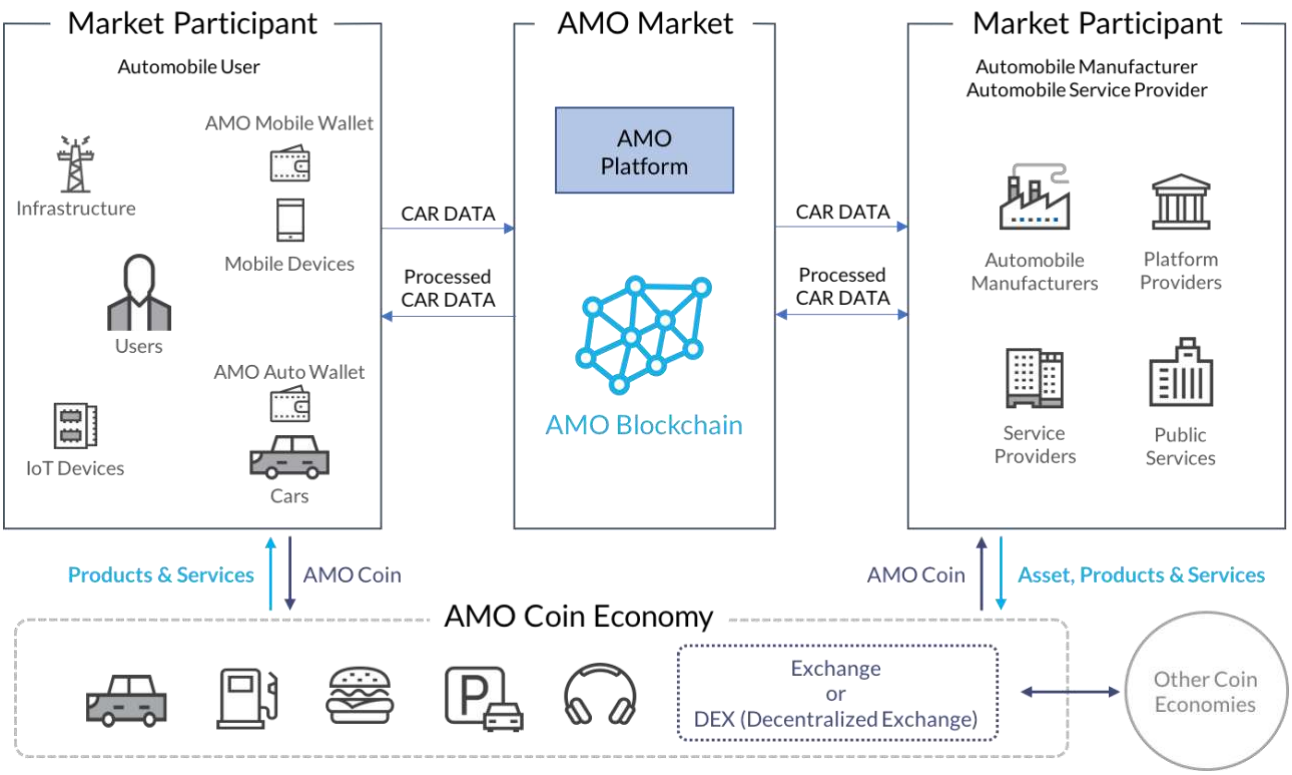


Figure 4. *AMO Market & AMO Coin Economy*

The AMO Market provides an open platform where anyone is able to participate in sharing car data or processing it into more valuable output. Built on blockchain technology and designed with end-to-end security principles in mind, AMO Market is operationally stable while guaranteeing data security, as well as protecting the rights and personal data of market participants. As part of the car data economic ecosystem, AMO Market participants simultaneously reap financial rewards while contributing to the advancement of the automotive industry.

2.1 How AMO Market Works

The market price of provided data determined according to the law of supply and demand

AMO Market utilizes blockchain technology to improve the current automobile ecosystem that consists of numerous stakeholders. The core feature of AMO Market is voluntary provision and appropriate compensation for car data. Car users, manufacturers, service providers, and all other participants in the automobile industry will be able to provide car data and receive appropriate compensation for their contribution according to market value.

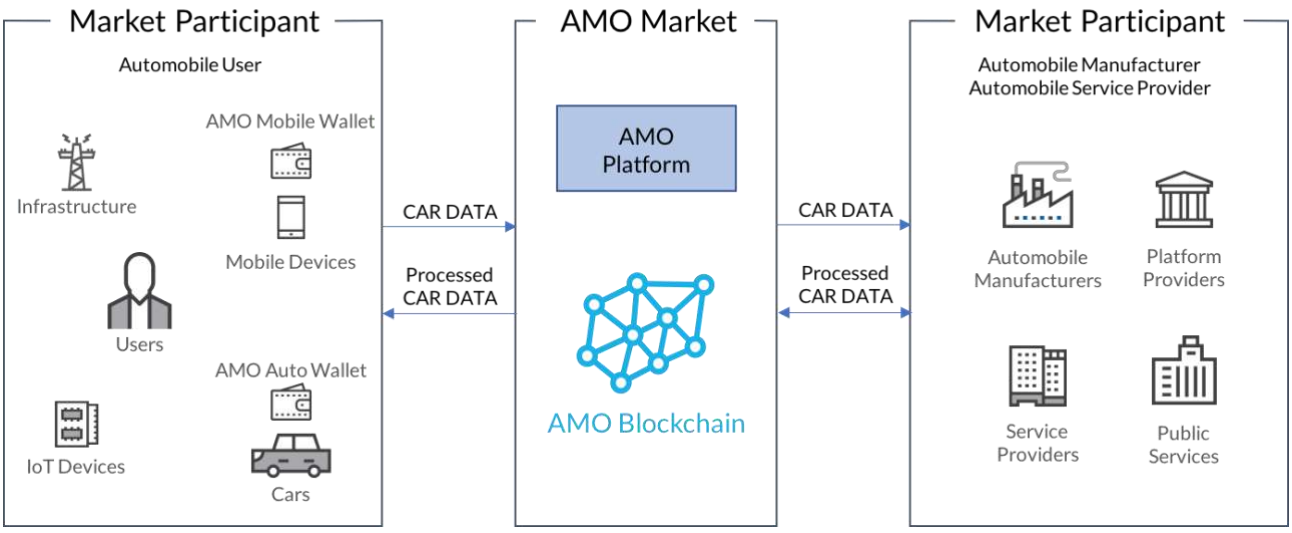


Figure 5. *AMO Market*

AMO Market consists of AMO Blockchain and its supporting feature, AMO Platform. Market participants assume the roles of both data producers and consumers. Car data generated via initial vehicle use along with secondary output (processed car data) will be traded in the market, and the market value of data will be determined based on the law of supply and demand and information gathered through various support systems, provided by the AMO Platform.

2.2 AMO Market Participants

Every participant contributes to market activity simultaneously as both data producer and consumer — a "pro-sumer."

With the AMO Data Collector™ device that can be easily attached to a vehicle's OBD-II port, together with the AMO Mobile Wallet™ smartphone application and AMO Auto Wallet™ software installed in the car, car users are able to collect car data for sharing on AMO Market. The car data that car users have agreed to share is then stored on the AMO Blockchain in exchange for AMO Coin according to the value of the data provided. Using these AMO Coins, car users are able to purchase various products and services offered by manufacturers and service providers participating in AMO Market.

Data producers can share data and receive compensation in AMO Coins according to the evaluated value of the data. Data consumers can obtain the rights to extract and use the data by paying that evaluated value in AMO Coins.

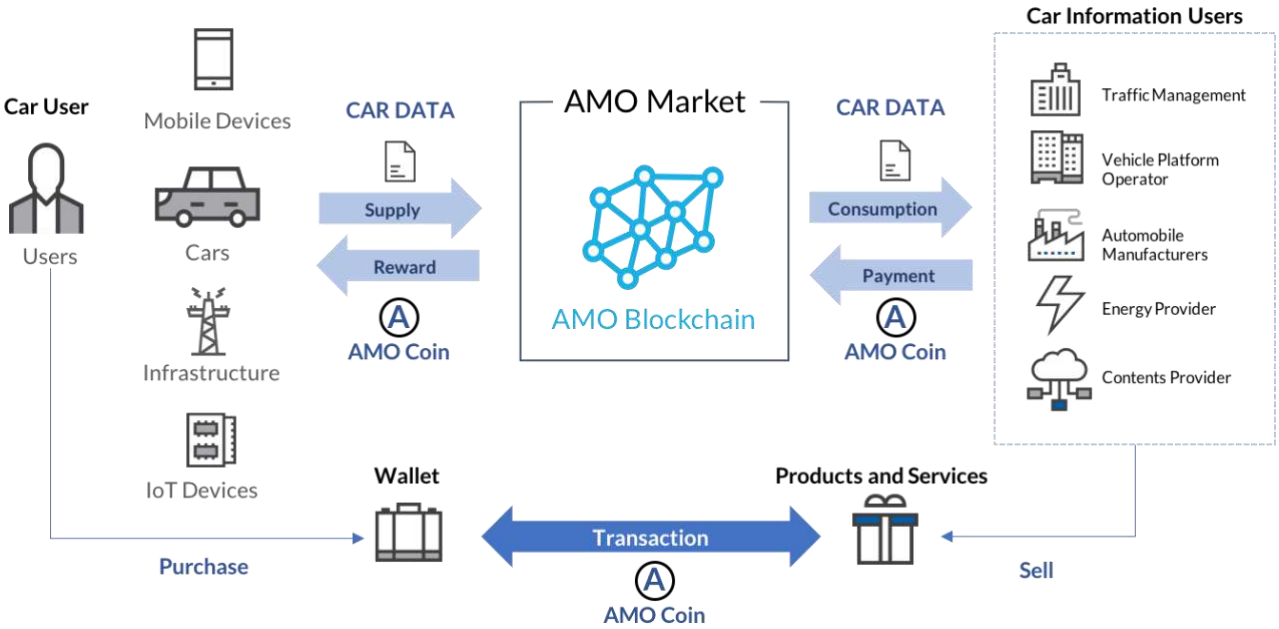


Figure 6. *Lifecycle of car data for car user/data producer*

Automobile manufacturers and service providers can purchase car data recorded in the AMO Blockchain in order to provide up-to-date service to car users. Service providers, manufacturers, and maintenance companies can in turn also submit secondary processed data in the AMO blockchain and receive AMO Coins, according to the value of that data.

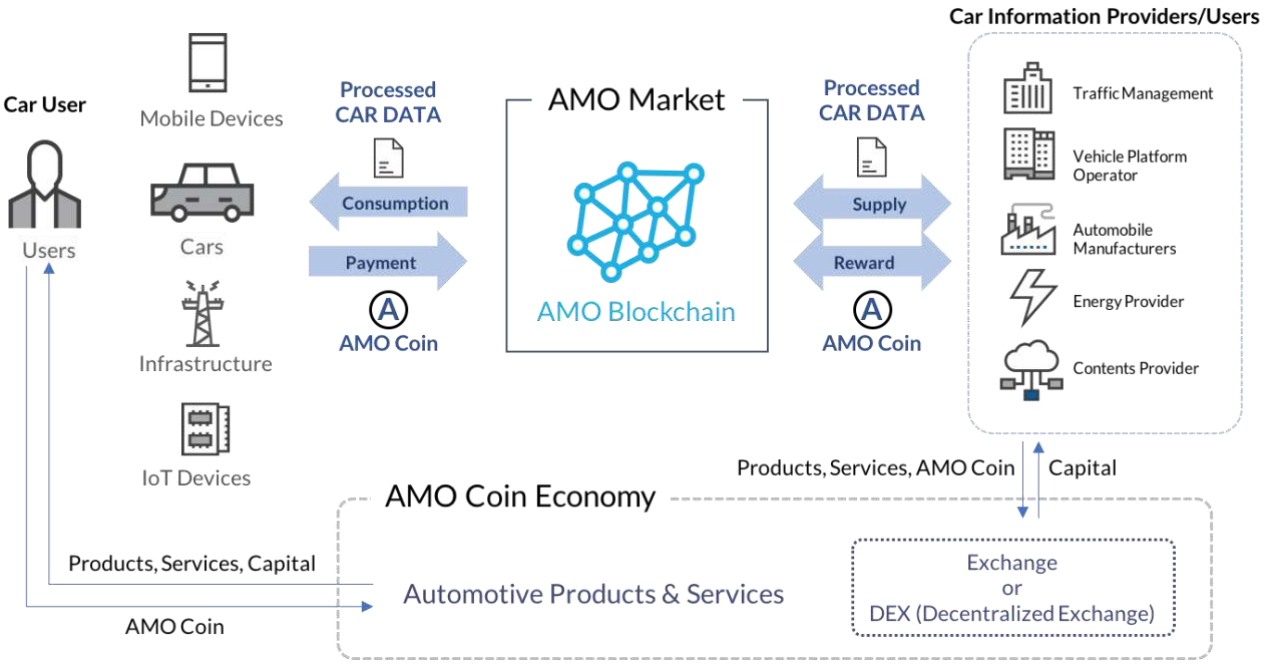


Figure 7. *Lifecycle of processed car data for manufacturers, service providers, and data producers*

As such, car users, automobile manufacturers, and related service-providers become the suppliers and consumers in the AMO Market. Through this structure of providing and receiving data and compensation, a cycle is created in which car data is enriched and the market is activated. The ongoing cycle in turn contributes to the growth of the AMO Market.

2.3 AMO Blockchain

AMO Blockchain is a blockchain optimized for storing and trading car data.

The AMO Blockchain is a network that all participants of the AMO Market take part in. As shown below, whether a car user or a manufacturer or service provider, all participants share car data on the AMO Blockchain.

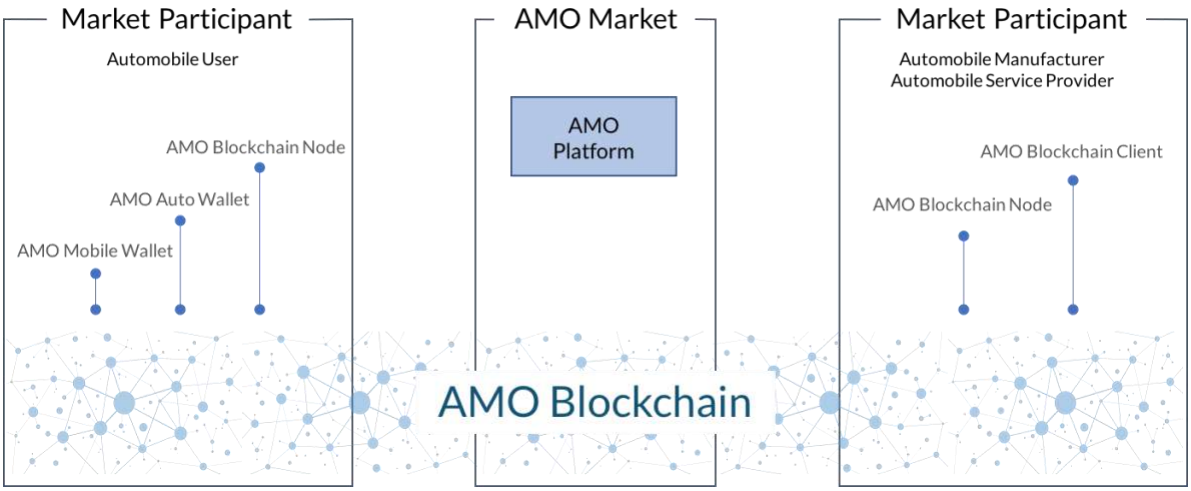


Figure 8. *AMO Blockchain connects to each market participant*

In order to transact, AMO Market participants connect to the blockchain via the AMO Blockchain Client and AMO Wallet. As Market participants, data producers obtain AMO Coin in return for data they share and exchange. On the other hand, those participating in the blockchain as AMO Blockchain Nodes receive rewards in proportion to their contribution in sustaining the blockchain. These rewards are for either block generation or contributing resources to AMO Blockchain's Peer Storage.

The car data generated by car users and the processed car data from service providers are uploaded online and stored on AMO Blockchain. At this point, all communications are encrypted and any transaction details, data ownership and usage rights are stored and managed together as blocks, similar to the way storage is done on a typical blockchain. On the other hand, raw data which includes personal information is encrypted and de-identified before storage on Peer Storage. This data stored on Peer Storage is fragmented and stored in a distributed manner across multiple blockchain nodes. In this way, even if physical access to Peer Storage were to be compromised, data obtained would not have any value since it would be incomplete and thus not possible to decrypt.

Both car data and processed car data are in direct contact with the AMO Blockchain and under no circumstances pass through the AMO Platform. AMO Platform is responsible for the management of policies and software, along with key management and certificate issuance necessary for participant authentication, without any involvement in car data management.

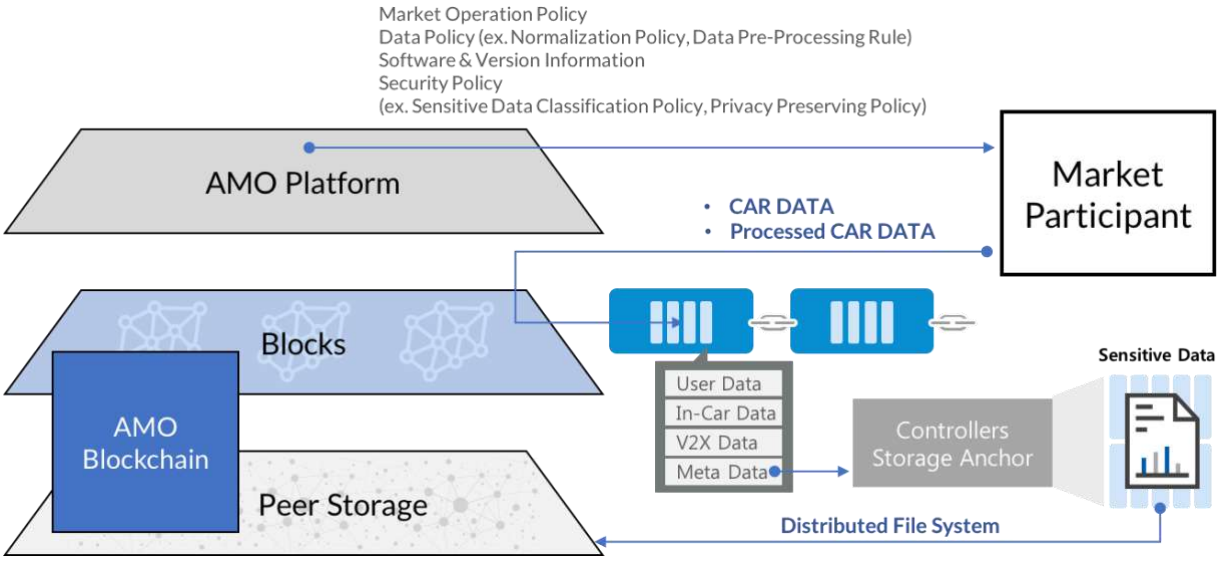


Figure 9. *Data storage structure for AMO Blockchain*

The AMO Wallet[3], which is connected to the AMO Blockchain, contains AMO Blockchain Node functions. This will allow other IoT devices with networks and computing power to join nodes in the future, increasing the scalability of the AMO Blockchain.

Figure 10. *AMO Wallet*

[3] AMO Wallet works as a client and node for AMO Blockchain simultaneously. AMO Wallet can be either AMO Mobile Wallet™ or AMO Auto Wallet™.

2.4 AMO Platform

AMO Platform is responsible for the operational and managerial functions of the car data market

The AMO Platform is essentially the IT system made up of the AMO Market operational policies, data policies, security policies, and software. It's also responsible for community operation among the participants and system support for AMO Blockchain operation. Major components include AMO CA, AMO Coin Management System, AMO Metric Management System, AMO Node Management System, etc.

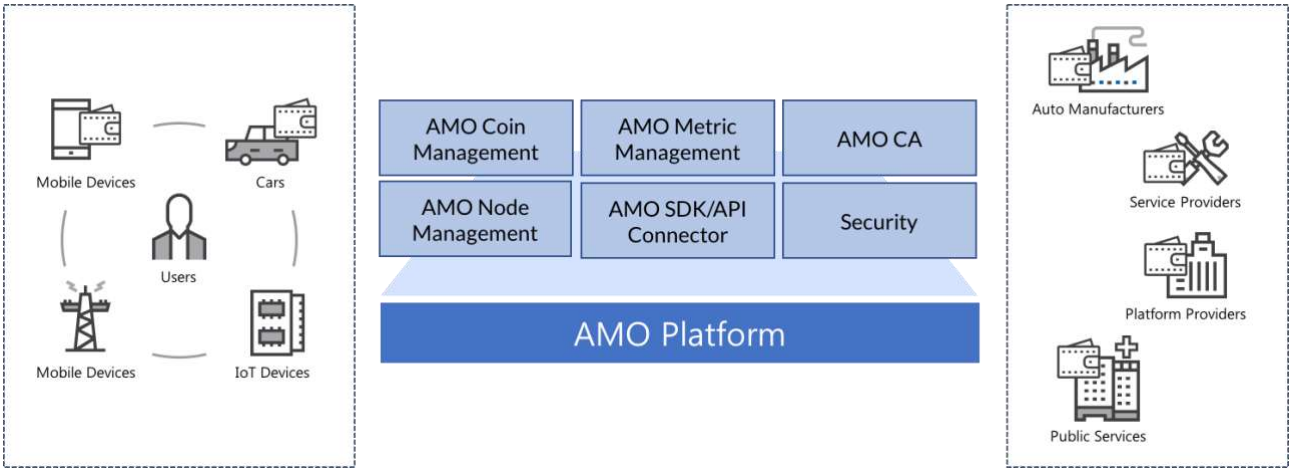


Figure 11. *Conceptual diagram of AMO Platform*

Despite the rise in demand for car data, one of the primary reasons it has not yet been collected and shared is that standards for car data differ depending on the automobile manufacturer. To solve this issue, the car data standards of each of the manufacturers will be converted to match the international standard. While this may rearrange the order of the data values, it will not change the value of the data itself. Additionally, a rich API will be provided for car data users, meaning that data purchasers will be able to conveniently access car data from the AMO Blockchain.

The value of the car data is determined by the supply and demand of the data on the market. The AMO Platform uses machine learning and cooperative agreements in order to calculate optimal valuation, preventing issues of quantity vs. quality of the market platform data when it comes to compensation.

The AMO Platform does not intervene in the flow of both car data and processed data between the market participants and the AMO Blockchain. The platform supports communication for smooth operation of the AMO Market, including policy and software distribution, distribution of keys and certificates for the authentication of participants.

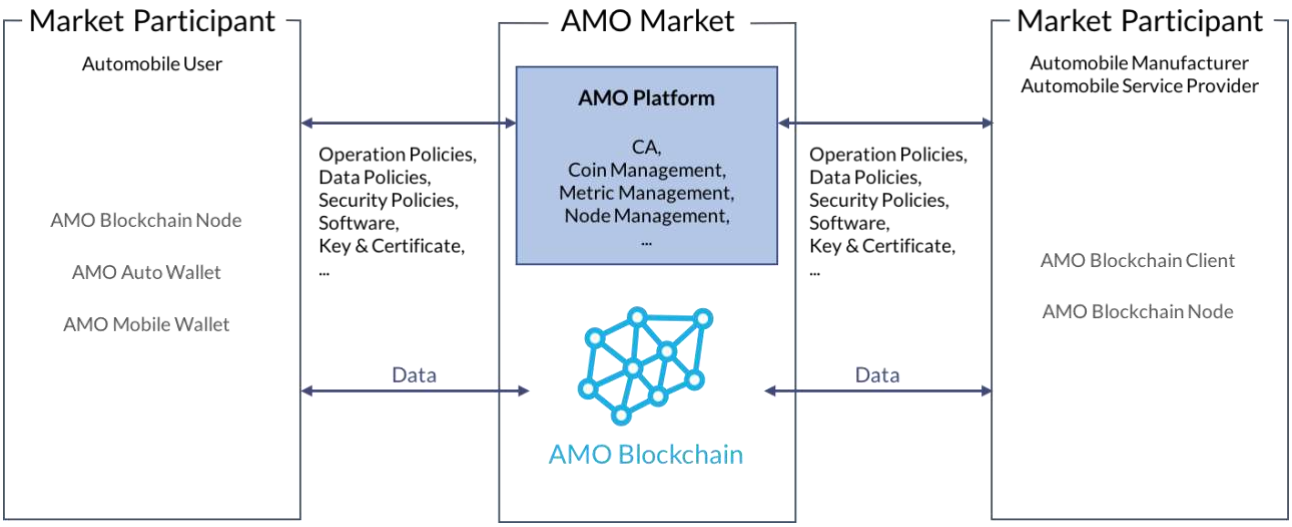


Figure 12. *AMO Platform & Data Flow*

As an example of operational support, AMO Platform intermediates data ownership and usage rights. Encrypted car data can only be decrypted by those who have purchased the data. AMO Platform facilitates interaction between data producers and data consumers to manage who has ownership over the data.

Chapter 3. Technical Details

3.1 Collection of Car Data

In-Car Data / V2X Data / User Data is collected from the automotive systems, networks, and applications

The developments in connected cars, electric vehicles, and in-vehicle infotainment have already made the autonomous car a reality. Car data traded in the AMO Market will include all data generated related to automobiles, including information gathered from the environments that interacts with the next-generation of automobiles.

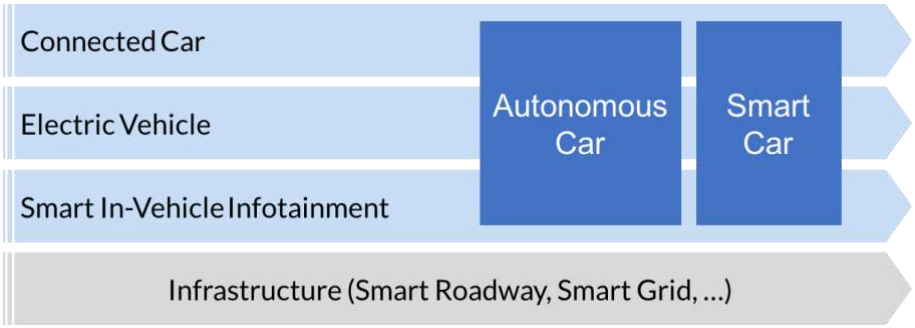


Figure 13. *The range of technologies in car data*

Car data includes all data from the three layers of automobiles.

	Layer	Data	Example
Connected Car	Network	V2X Data	Traffic information Communication information Location information
Electric Vehicle	System	In-Car Data	Vehicle maintenance information Charging information Battery information Sensor detection information
Smart In-Vehicle Infotainment	Application	User Data	Data usage Location information regarding applications Billing information

Figure 14. *Technical scope and categories of car data*

There are three types of data: internal data or data from the car itself (In-Car Data), communication data (V2X data), and data from the use of applications (User data).

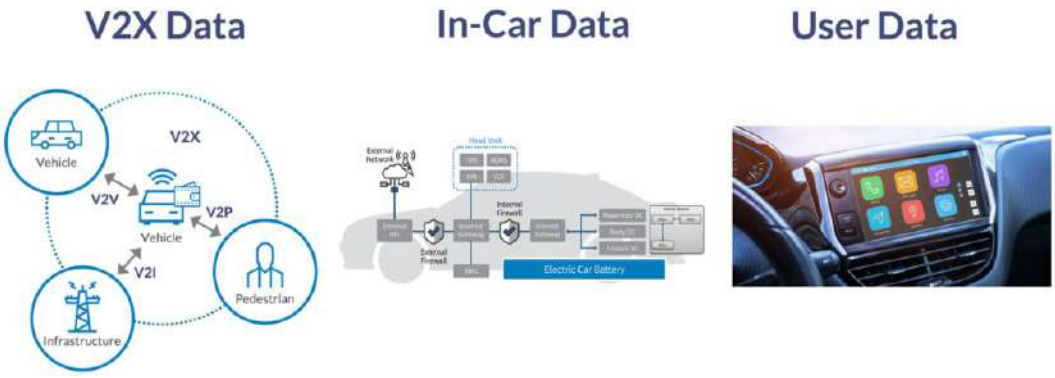


Figure 15. *Definition of CAR DATA in AMO*

V2X data refers to traffic data communicated between vehicles, roads, and other connected nodes via wired and wireless network infrastructure. V2X data can be categorized as follows according to the parties involved in data exchange.

- V2V (Vehicle to Vehicle): Communication between vehicles, e.g. contacting emergency vehicles
- V2I (Vehicle to Infrastructure): Communication between vehicles and road infrastructure, e.g. traffic lights about to turn red
- V2D (Vehicle to Device): Communication between vehicles and mobile devices, e.g. car network sharing
- V2P (Vehicle to Pedestrian): Communication between vehicles and pedestrians, e.g. pedestrians crossing the road

V2X data includes information gathered through vehicle communication between external devices and traffic infrastructure. Real-time traffic information, distance to the vehicle in front, and weather information are difficult to acquire through the internal operations of the car. V2X data allows car users to be fully informed even when facing roads with poor visibility or worsening weather conditions.

V2X data refers to the data about the surroundings of the vehicle, whereas in-car data covers any internal car data including car speed, status, or car model. Further examples include details about the VIN (Vehicle Identity Number), car owner, car insurance, operational data, and car servicing.

User data refers to information gathered from communication between the car and the car user. This information includes frequented locations, preferred music, refueling time, and driving habits.

3.1.1 Limitations in the Collection of Car Data

Presently, car data is only used in special circumstances and for very limited purposes, such as when a service provider needs to perform repairs or troubleshoot the cause of a fault or an accident. In such instances, car users who are the actual owners of the car data are unable to reap any monetary reward for the data they generate, and perhaps are even unaware that their data holds any monetary value.

The result is that car users do not make any effort to preserve or collect the data, and by extension, automobile manufacturers and insurance agencies or other service providers in the auto industry will be unable to obtain reliable car data. Therefore, they may try to generate car data on their own or conduct surveys that give incomplete data lacking objectivity. In addition, there is

no incentive given to encourage the further extraction of value from car data or processed car data because they are not shared as assets belonging to service providers which have spent a great deal of time and resources in processing the data.

As AMO Market thrives, data transactions between and among car users and service providers will enhance the quality of existing services as well as accelerate the development of new ones.

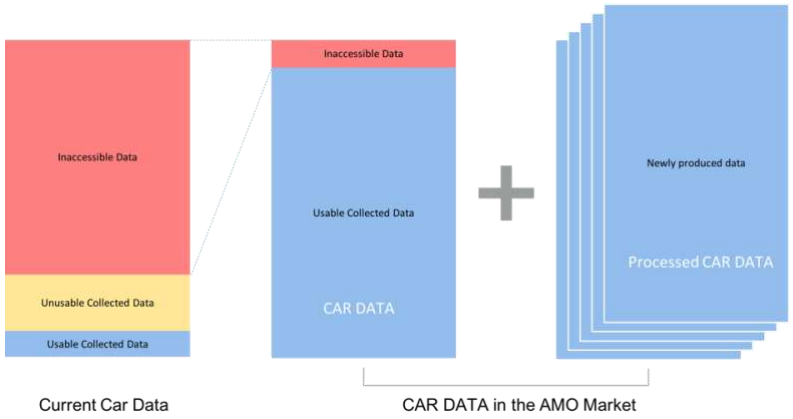


Figure 16. *Data usage and quantity with AMO Market*

3.1.2 Collection of car data

Car data is collected using hardware and software. Car data generated both internally and externally can be collected using the following two methods:

- Collection of data using AMO Mobile Wallet™

AMO Data Collector™ is plugged into the car's OBD-II port for data collection. The collected data is first sent to the AMO Mobile Wallet™, installed on the user's smartphone, which then delivers the transmitted car data to the AMO Blockchain. Any car data that includes personal or confidential information is first encrypted and then transmitted to the AMO Blockchain.

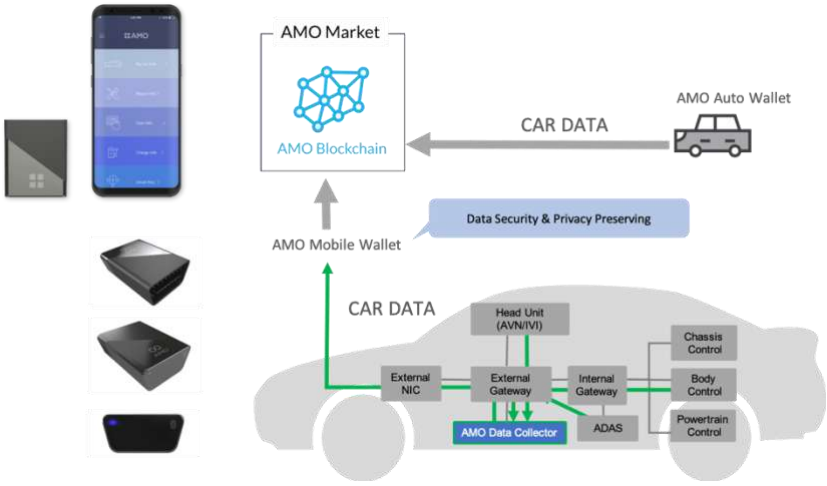


Figure 17. *Data collection process with AMO Data Collector™ and AMO Mobile Wallet™*

• Collection of data using AMO Auto Wallet™

Installed in the vehicle, AMO Auto Wallet™ collects internally and externally generated car data and stores it on the AMO Blockchain. Any car data that includes personal or confidential information is first encrypted and then transmitted to the AMO Blockchain.

3.1.3 Storage/Transmission of Car Data

The In-Car Data and V2X Data collected by AMO Data Collector™ is transmitted to AMO Mobile Wallet™ on the smartphone via Bluetooth. For car data collected by AMO Auto Wallet™, highly sensitive personal information within the data is first encrypted before being uploaded to AMO Blockchain.

Car data only contains partial event data as well as the metadata of any original data. Therefore, due to its small volume, car data can be suitably uploaded in real-time via LTE/3G mobile communication networks. However, if data collected becomes further diversified, and includes data of larger sizes like videos or voice data, they may be uploaded via Wi-Fi or first housed in an additional storage location before uploading in bulk.

Product	Type of Data Collected
AMO Data Collector™ (H/W)	In-Car Data • Operational data (distance, speed, fuel efficiency, etc.) • Various troubleshooting information (over 400 fault codes) • Vehicle condition (engine oil level, tire pressure, etc.)
AMO Mobile Wallet™ (S/W)	User Data • Vehicle identification numbers (user input) • Personal information (user input) • User location (GPS) In-Car Data • Information from AMO Data Collector™
AMO Auto Wallet™ (S/W)	V2X Data • Traffic data including traffic signal information • Real-time traffic information • In-car communication data • Geographic information and Local Dynamic Map (LDM) User Data • Vehicle identification numbers (user input) • Personal information (user input) • User location (GPS) information • Data usage information In-Car Data

	• Operational data (distance, speed, fuel efficiency, etc.) • Various troubleshooting information (over 400 fault codes) • Vehicle condition (engine oil level, tire pressure, etc.) • GPS information • Electric vehicle (EV) charging information • EV battery information • Video/sensor detection information

Table 1. *Examples of collectable data*

3.2 Structure of AMO Blockchain

AMO Blockchain provides higher performance and stronger security than existing blockchains

AMO Blockchain combines existing blockchain technology with AMO Peer Storage. AMO Peer Storage supports peer-to-peer network-based distributed storage for efficient storage, use, and sharing of car data. AMO Peer Storage functions in connection with AMO Storage Anchor and is connected to the node of AMO Blockchain as depicted in the diagram below.

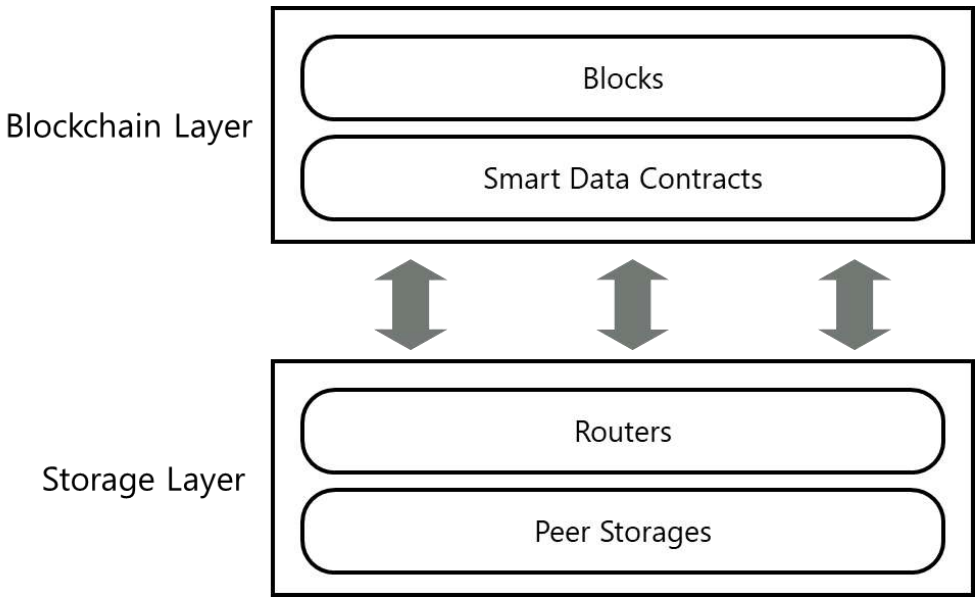


Figure 18. *AMO Blockchain Node Conceptual Architecture*

Generally, a blockchain is designed to scale, and as the number of participating nodes increases, the integrity of data becomes stronger and the data becomes nearly impossible to falsify or forge. However, this is not an adequate method when storing large amounts of data as the efficiency of the entire network deteriorates when there is too much data on each block. Moreover, there are limitations in storing and utilizing time series data that is being generated in time frames of milliseconds (1/100sec). Therefore, to efficiently manage large volumes of car data and time series data, Peer Storage will be activated in AMO Blockchain after the launch of AMO Blockchain Testnet and Mainnet.

AMO Virtual Machine takes care of the processes within the Node's memory by indexing AMO Coin transactions in the market, market participants' coin balances, and other information, while intelligently functioning as a Smart Data Contract for larger volumes of time series data. AMO Blocks are present in the Node's memory as well as the file system (hard disk, etc.) in order to save and store data from the blocks generated in the blockchain. Each block contains key information from AMO Coin transactions, car data transactions, and anchoring data for encrypted sensitive data.

The AMO Peer Storage will be developed and released to the blockchain community as a decentralized, distributed storage space for the safe and efficient storage of sensitive encrypted data that would otherwise be too large and difficult to store on the existing blockchain. With this development, issues that may occur with blocks holding a larger volume of data like synchronization errors or inefficiency when reviewing data can be minimized. Typically for blockchain, attempts to solve the

capacity challenge results in using distributed storage that works as a centralized file system. However, this does not match up with the nature of AMO Blockchain where car data standards are shared and permissions for data use are offered and purchased.

3.2.1 Requirements

AMO Blockchain must meet several requirements to develop a data transaction platform to safely and efficiently handle car data transactions as well as other types of data (IoT, healthcare, etc.). Peer Storage will have to be able to collect data from hundreds of thousands of vehicles, and data should be provided to consumers in real time as they request it. To do this, AMO Blockchain will have to guarantee an initial capacity of 1,000 transactions per second (TPS) and expand the processing capacity as needed thereafter. Due to the unstructured nature of car data, Peer Storage will need to store data that spans from several bytes to even larger sizes of several gigabytes (GB). Data consumers will have to be able to search for the data they desire quickly and efficiently, hence time stamp indexing should be available so that data can be retrieved according to the time and place of data generation. Additionally, continuous query functions should be available for user convenience. Cars and other IoT devices generate a large amount of personal information. Consequently, there must be a platform where this personal information will be secured, de-identified and only decrypted with consent of the data owner.

- Capable of handling capacity of 1,000 TPS and over
- Able to divide and save large-volumes of unstructured time series data
- Quick search and continuous query functions
- De-identification and decryption functions

3.2.2 Consensus Algorithm

AMO Blockchain has been designed to process large amounts of time-series data quickly and efficiently, combining both PBFT and DPoS concepts, similar to Tendermint's algorithm. This approach can take on over 1,000 transactions per second for the first category, eliminating bandwidth waste that can occur when utilizing PoW or PoS consensus algorithms. Cars and IoT devices will generate a tremendous amount of data, and to record this data on the blockchain, AMO will give block creation authority to the nodes with the most computing resources and shares (AMO Coin), instead of having the nodes compete for block generation. Thus, AMO Blockchain has the following advantages:

1) Over 1,000 transactions per second maintained (guaranteeing 1,000 TPS)
2) Block creation authority is held by the validator. Block creation can only proceed with 2/3 majority agreement from the validator, hence there are no issues with the fork.
3) Node participants with limited computing resources, like IoT devices or automobiles, are compensated through coin ownership.

In the existing DPoS consensus algorithm, candidates are selected as validators through a network participant voting process, informing their community of their commitment and computing specifications. However, there are issues for validator selection when it comes to reliance on the voting process.

First, the candidate can register false information about their node (computing specifications, etc.), and it can be difficult to gauge their commitment after the candidate has been selected. Second, there may be a misalignment when it comes to voters voting for candidates who they feel will be sure to win in order to secure compensation. Lastly, and perhaps most importantly, in order to select a validator, network participants have to go through the process of voting repeatedly.

In order to solve these issues, only nodes that have satisfied certain qualification criteria may be considered for selection as validators. Initially, 22 validators candidates will be selected, though numbers may increase in order to accommodate for changes. For every validator needed, 10 candidate nodes will first be identified, bringing total candidates to 220.

The 22 selected validators will remain the same until 500 blocks have been created. After 500 blocks have been created, they will randomly select a new validator from the candidate group. Nodes that have a history of validation in the current group will be excluded, thus ensuring that each node will have equal turn in the role of validator.

The consensus mechanism for block generation follows the "propose → prevote → precommit → commit" process outlined in the Tendermint protocol. Under this protocol, the risk of malicious activity is extremely low, as average block time is expected to be only 1~2 seconds and validators participating in the consensus process stake a bond deposit that may be confiscated if any foul play is found.

By adopting a system that randomly selects a validator through the DPoS consensus algorithm, network participants can maintain an efficient and quick network, without the inconvenience of repeated voting processes.

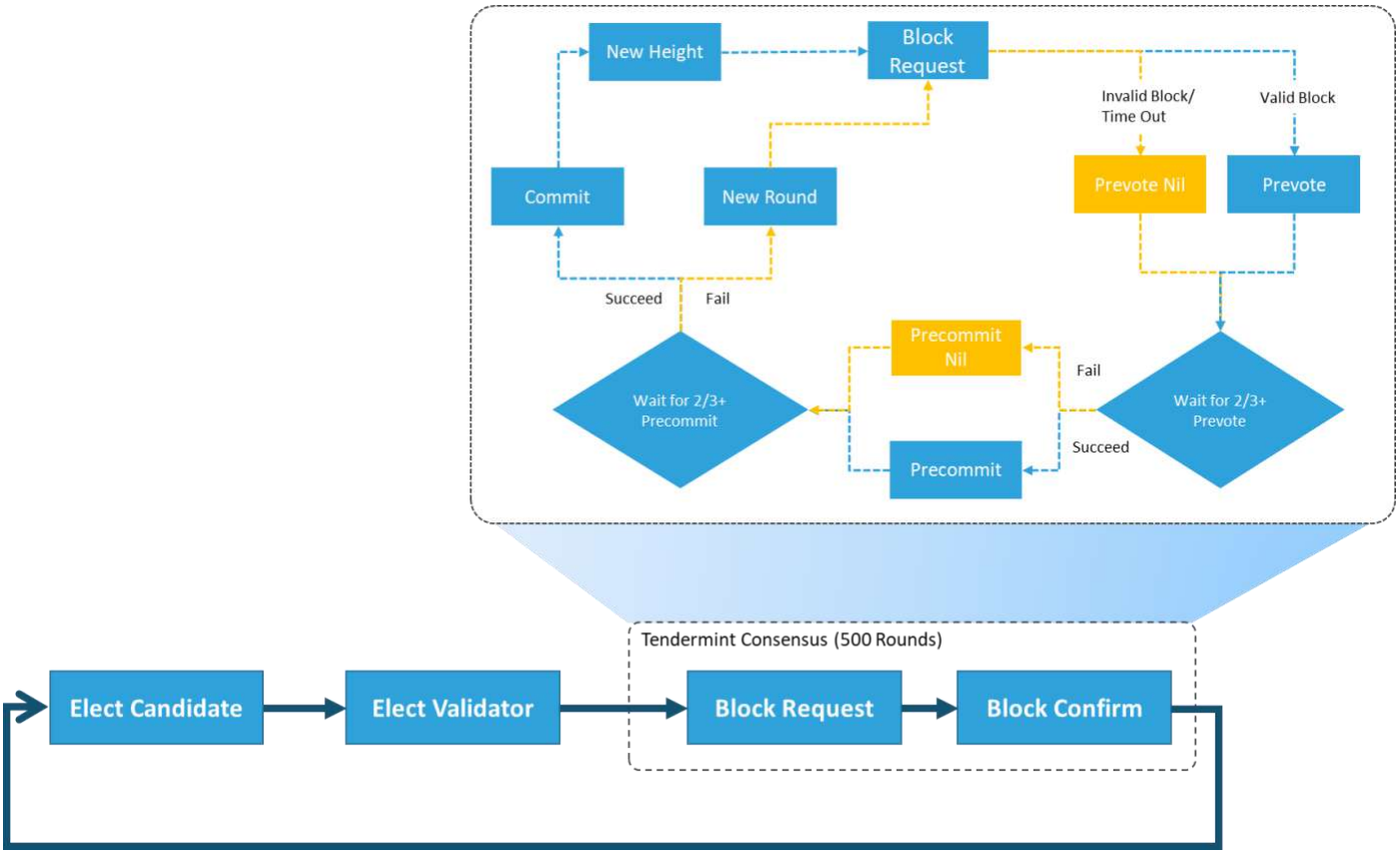


Figure 19. *AMO Blockchain Consensus Algorithm*

The above diagram (Figure 19) briefly outlines AMO Blockchain's consensus algorithm.

1) All nodes that meet the minimum qualifications will have equal opportunity to become a validator. Qualification requirements include a certain amount of contribution to AMO ecosystem and a minimum level of computing power. Proof of the possession of this computing power might be determined by the PoW test.
2) Those that qualify the requirements of 1) will be randomly selected as part of the validator candidates (# of validators * 10). The initial number of validators will be 22, though the number may be subject to change.
3) From the candidate of 220, 22 validators will be picked in order.
4) Selected validators will use the Tendermint consensus algorithm to generate 1,000 blocks.
5) The process of generating one block will be called a round. After 1,000 rounds, the process will begin again from 3) until the cycle has gone through 10 times. The process will then start from 1).

3.2.3 Time Series Data

The ability to store and transact vast amounts of time series data within a decentralized environment is a unique and distinct advantage of AMO Blockchain. In order to efficiently store and search time series data on AMO Blockchain, something similar to a Time Series Database (TSDB) typical in centralized environments will be constructed over the blockchain.

1) Data Model

AMO Blockchain can store time-series data from various types of devices. However, as there are hundreds of different types of devices with all holding various types of data. When different types of data are collected with a single device, the different types of data are called "metrics."

Each metric has data chunks that are created at a certain time point. This data chunk is the minimum data unit that is stored and traded on the blockchain. The data chunk can be divided into a header and a body. The header of the data chunk stores general information, and the data buyer can identify and retrieve information that is stored in the header.

Important parts of the data chunk header include the unique identification value of the chunk, unique identification value of the device that created the chunk, the metric of the data chunk (eg. fuel balance, current speed, etc.) start and end times of the data chunk, user input metadata for searching, etc.

The body of the data chunk will contain data generated in the corresponded metric. Contents stored will contain the exact time of the data and will be stored sequentially for a specified period of time. Each event within a chunk will be called a "record".

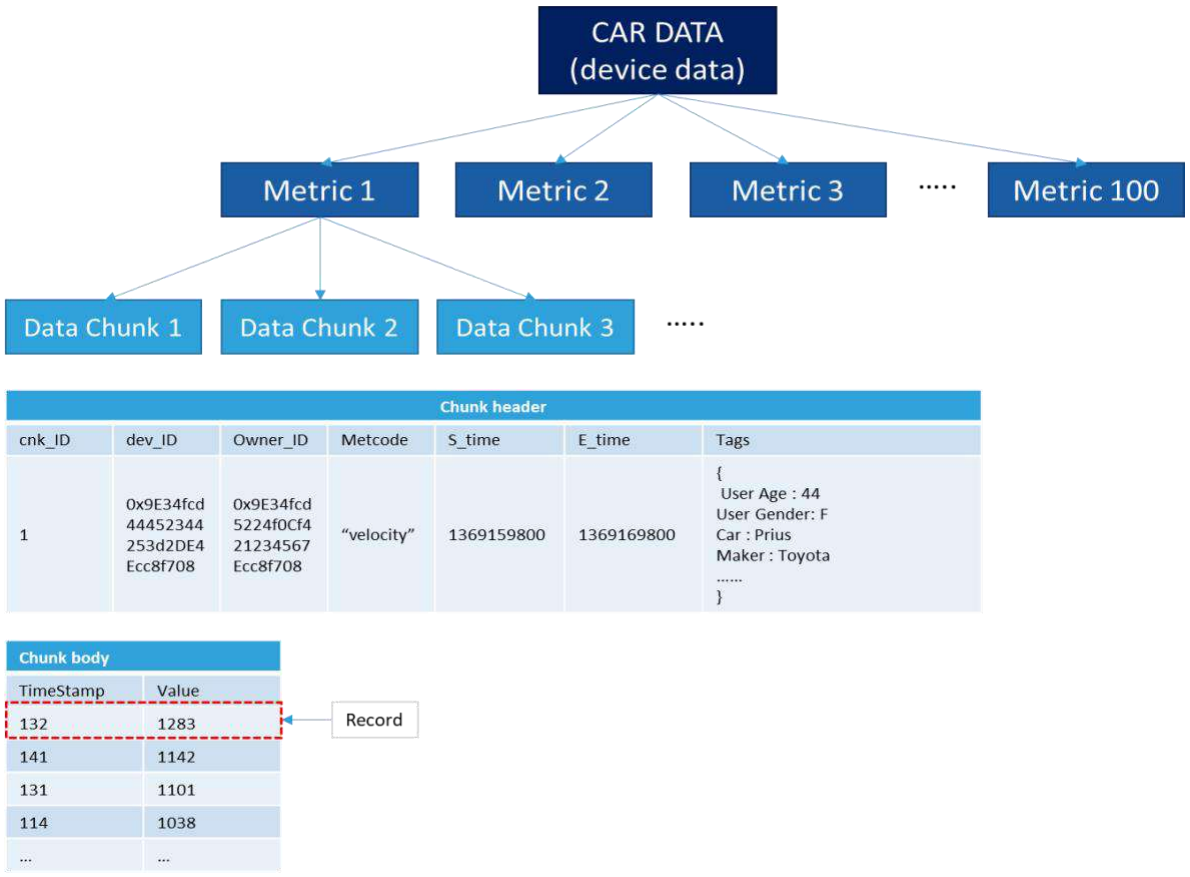


Figure 20. *AMO Blockchain Peer Storage Data Structure*

AMO Blockchain's data structure can be compared with the existing components of a relational database like MySQL as below:

AMO Blockchain	Relational Database
Metric	Database (Scheme)
Chunk	Table
Record	Row

2) Data Compression

The amount of data produced by cars and other IoT devices is enormous, which means efficient network use could be challenging. This is why data has to be optimized and compressed before it is uploaded to AMO Blockchain, so that minimal network resources are consumed. In instances where conventional data compression algorithms are unsuitable for compressing time series data, rapid lossless compression is utilized to sharply reduce the network bandwidth and storage space required.

There are two ways developed by the AMO team to compress data, and the first of which deals with timestamp data. When timestamp data is collected, instead of recording the entire timestamp, the time lapse between the previous record and the new record is calculated to give a first delta value. Next, the time lapse between the previous record and the record before that is calculated to give a second delta value. The Delta of Deltas, which is the difference between the first and second delta values will be the value stored on the blockchain in place of the entire timestamp value, hence minimizing storage consumed.in which data is compressed

delta of deltas: D = (tn – tn-1) – (tn-1 – tn-2)

The second data compression method involves a simple process of XORing the value of the new record with the value of the previous record to maximize compression. The aforementioned two time-series data compression methods have already been proven with methods proposed by the Gorilla Project.

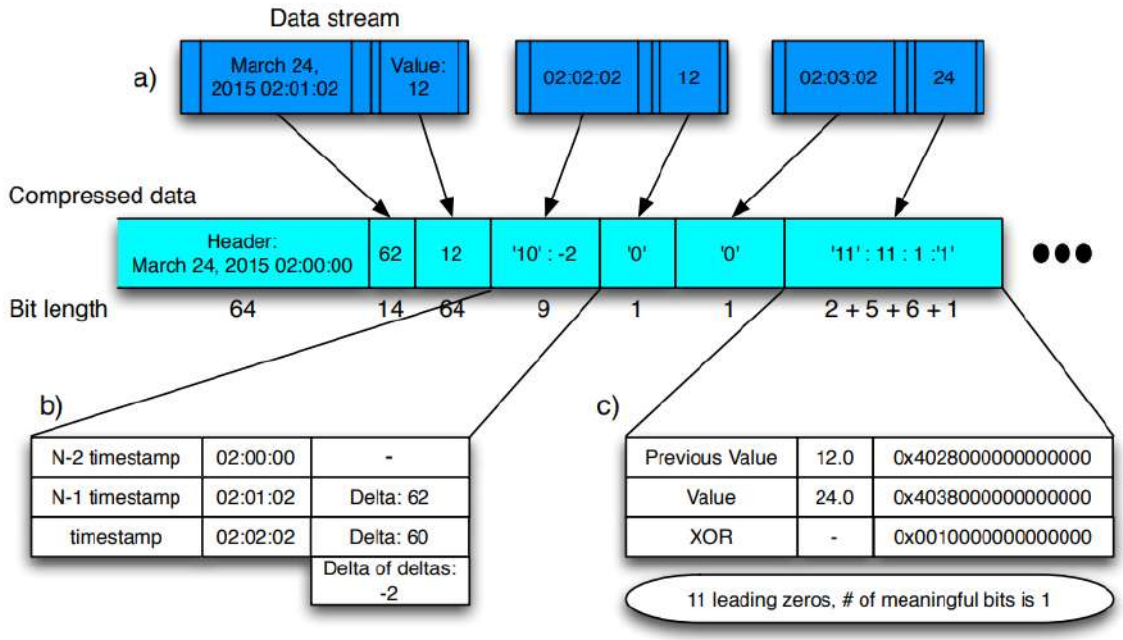


***Figure 21**. AMO Blockchain Peer Storage Data Protocol*

3) Storage Protocol

The storage layer of AMO chain consists of a content addressed network of storage peers. Data chunks from a particular device are linked through a Merkle directed acyclic graph (DAG) structure inspired by the IPFS data structure. The hash digest of data chunks is kept in the AMO Blockchain layer as part of the metadata. This is used not only for addressing purposes, but also for checking the integrity of the chunk content. We use multihash format to store hash digests. This provides flexibility for data collectors to specify hashing algorithms to use depending on the application requirements.

AMO Chain provides peer storage auditability through an efficient merkle-based Proof of Retrievability scheme optimal for immutable data units. This allows the network to perform regular cryptographic audits to ensure that stored data chunks are still available and ready for retrieval. This also serves as one of the metrics for rewarding peer storage nodes. AMO Storage peers are routed using a Distributed Hash Table (DHT) similar to IPFS implementation. The AMO data chunk content corresponds to the data field of IPFSObject.

3.2.4 Smart Data Contract

Moving forward, AMO Blockchain seeks to become a data platform that supports not just car data, but all types of time series data. To this end, the blockchain will employ Smart Data Contracts, a kind of smart contract optimized for data handling. This will allow any entity or individual that wishes to obtain time series data through a decentralized platform to do so by utilizing

AMO or other tokens. In order to allow participants to easily create their own Smart Data Contracts, the AMO team will be making the SDK publicly available. The SDK will have the following features:

1. **Data Ownership API**
   Accurate management of data ownership rights is crucial in decentralized environments and this concept of data ownership rights is central to the sale of data. Besides the original producer of the data, all other market participants may only purchase data usage rights, while data ownership rights themselves remain non-transferable.
   Using the Smart Data Contract's Data Ownership API set, market participants will be able to perform a range of authorization management functions, such as storing and verifying data ownership rights, as well as verifying a user's possession of usage rights when data is accessed.

2. **Data Search API**
   In order to allow for the accurate, selective purchase of data from vast volumes of time series data stored on AMO Blockchain, sophisticated search mechanisms are necessary. Through proper indexation, intuitive search can be performed on both the meta data directly input by data producers, as well as the meta data that is automatically generated whenever a piece of data is uploaded to AMO Blockchain. In particular, AMO Blockchain is optimized for handling time-series data and utilizes time-based indexing, making it capable of supporting rapid and accurate data search.

3. **Data Exchange API**
   When a user has searched for and selected a piece of data for purchase, a complicated process takes place for retrieving the data and obtaining access to it. Firstly, data ownership and usage rights are verified, followed by the retrieval of all the data fragmented and stored across the Peer Storage network, before the data is finally decrypted with the data owner's cryptographic key if necessary. The AMO team will provide an API set for easy management of this entire process.

4. **Data Storage API**
   For storing vast amounts of time series data on AMO Blockchain's Peer Storage, the data has to be processed in a manner instructed by the Smart Data Contract before being distributed and stored across the Peer Storage network. In accordance with the degree of importance of the data, it may have to be replicated multiple times and undergo fragmented distribution in order to prevent data loss. This API set will enable the specification of various storage properties such as the structure, content, and location of the data to be stored on AMO Blockchain.

5. **Service Discovery API**
   With AMO Blockchain as a platform, a variety of dapp (Distributed Applications) can be developed on it. AMO Blockchain can provide dapp developers with an API to allow them to provide a brief description of the dapp and can also provide users with an API to search and retrieve the dapp information. This allows for easy identification of useful dapps on the AMO Blockchain.

3.3 Data Privacy and Security

Privacy-by-Design (privacy-conscious architecture) is critical in the automotive environment.

As the car becomes a more integrated part of its users' lifestyle, car data inadvertently includes personal information that may be considered sensitive in nature. In order to protect AMO Market participants from sensitive data exposure, especially in light of growing cybercrime, multiple safeguards need to be in place.

3.3.1 Compliance with Security Guidelines

Car data is collected, transmitted, stored, and used in compliance with strict legal regulations. International vehicle security and privacy guidelines have been considered throughout the development process. AMO Market has been developed to comply with the following legislations and guidelines.

1) The key principles of vehicle cyber security for connected and automated vehicles (UK, 2017)
2) Security and Privacy in Your Car Study Act of 2017 (US, 2017)
3) The Driver Privacy Act of 2015 (US, 2015)
4) Federal Automated Vehicles Policy (US, 2016)

3.3.2 Encryption of Personal Information

Particular care must be given to any internally or externally generated car data that contains highly sensitive personal information. AMO Wallet identifies and encrypts such sensitive personal data during the collection of car data. The encryption keys used by AMO Wallet are issued by AuthentiCA®. The data consumer is able to decrypt the data only after acquiring permission from the data producer. The process of requesting permission and performing key exchange for decryption is supported by AMO Market Platform. The authorization process between the data producer and consumer is protected with end-to-end encryption, which means AMO Platform cannot decrypt or access any of the communication.

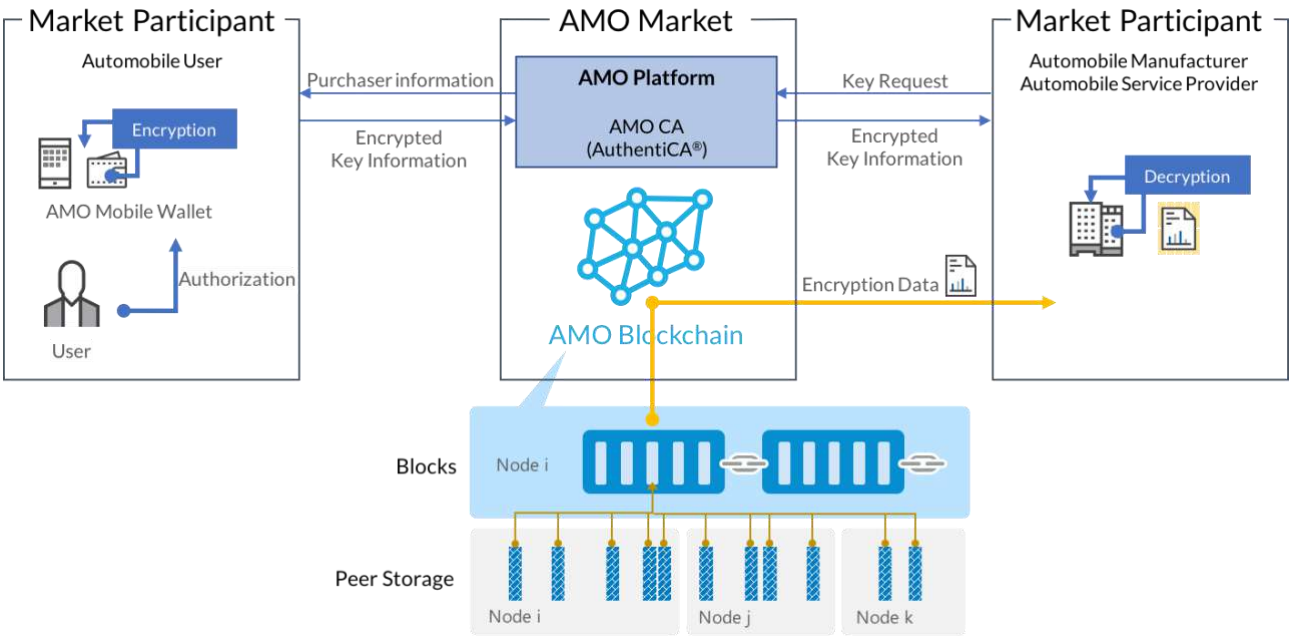


Figure 22. *Acquiring right to use encrypted data through the AMO Platform*

3.3.3 Encrypted Communications and Encrypted Data Storage

Besides the encryption of personal information, AMO Market also encrypts the communication channel itself, by supporting secure communication over SSL/TLS. Multi-layered security is employed firstly to prevent data leakage during the transmission of data between the car and AMO Wallet where car data is not yet encrypted, and secondly, to prevent car data and less sensitive, unencrypted personal information from being leaked during the transmission between AMO Wallet and any AMO Node. Encryption key and certificate management service AuthentiCA® will be deployed to encrypt communication channels.

3.4 CAR DATA Trading

Ownership and rights for acquisition of car data allow for the guarantee of fair transactions

In AMO Market, car data producers supply the market with data and car data consumers obtain permission to use the data. Car data consumers pay for their use of the data with AMO Coins, which are then used as compensation for the production of car data. Data traded in the market includes car data and processed car data.

3.4.1 Data Ownership and Access to Data

Car data producers maintain ownership of the data, but car data consumers are able to gain individual access rights to a specific set of car data upon purchase. As such, any resale of this data is prohibited. Restrictions on time or scale of data use can be applied on a case-to-case basis.

The ownership of processed car data belongs to those that participated in the secondary processing of car data. It is important to note, however, that the data ownership rights do not extend to the initial car data used as the source for processed car data. Any potential dispute regarding the ownership of car data and processed car data will be resolved in accordance to relevant legislation.

3.4.2 Data Ownership Rights

Typically, permission from the data owner is necessary in each instance that the data is being used. However, for the convenience of data owners, there will be an option to automatically grant permission to utilize car data that does not contain no highly sensitive personal information. This authorization process is supported by AMO Platform and implemented by AMO Mobile Wallet™.

Data Category	Data Type	Description
Highly Sensitive Personal Information (Lv1)	• Real name of car user • Vehicle Identification Number (VIN) • V2X communication data	Information that can be used to identify cars and their users
Regular Personal Information (Lv2)	• Car user's age and gender • car make and model, location	Information that can be used to perform fine segmentation of cars and their users

Regular Car Data (Lv 3)	• Speed, operational status (Engine temperature, etc.), • fault data, etc.	Information of a universal nature collected through the OBD that cannot be used to identify cars and their users
Large Capacity Car Data (Lv 4)	• Event information detected through sensors, CAN data, etc.	Implemented after collection method becomes available

Table 2. *Levels of personal information*

3.4.3 Decentralization of Power via End-to-End Encryption

Encrypted car data traded in the AMO Market can only be decrypted by those who purchase the data. Encryption is also a central technology in the AMO Platform which utilizes end-to-end encryption to prevent concentration of control to central servers and high-ranking nodes.

3.4.4 Trade of Encrypted or De-Identified Data

Trade and use of encrypted data requires access to an encryption key owned by the data producer. If encrypted data is used to create secondary output, the processed car data must not include partially or fully decrypted source data. Similarly, access to any encrypted data included in processed car data requires permission from the original key owner. This transaction is supported by the AMO Market Platform. De-identified data must remain de-identified if used or traded.

3.4.5 AMO Metric Management System

AMO Metric Management System of the AMO Platform sets the standard market price for car data and processed car data. AMO Metric Management System considers the supply and demand of data, volume of data, total amount of AMO Coins in circulation, scarcity value and timeliness of data to determine the market price. AMO Metric Management System utilizes machine learning technology to predict and analyze future price movements.

3.5 Reward System

AMO Market enables all participants to receive appropriate rewards for their contribution

3.5.1 Rewards for Producing Data

Compensation for data production is made through the purchase of data by consumers on AMO Market. However, rewards are not determined based exclusively on demand and supply. Rather, valuation of data is based on various elements in the purchase process. Determining rewards based on data valuation and transaction is a central principle for the healthy operation of AMO Market. It is the basis for self-regulation within the Market to ensure that only high quality data is circulated, and to adjust and stabilize the value of AMO Coin.

3.5.2 Rewards for Participating as Node

Participation as AMO Nodes increases the reliability of the AMO Blockchain and contributes to the growth of AMO Market. Therefore, AMO Coin is given as a reward. Additional compensation is given to Nodes with contributions to AMO Peer Storage, and the amount of compensation is determined through assessment of contribution to AMO Blockchain and Market.

3.5.3 Rewards for Block Generation

AMO Blockchain utilizes the DPoS (Delegated Proof-of-Stake) algorithm as a consensus model for quick and efficient block generation. Nodes that acquire stakes with more than a set amount of AMO Coin will be able to select a representative node. The number of representative nodes in AMO Blockchain is not fixed, but rather the number of representatives will change according to how many nodes are necessary in order to optimize the speed of block generation while maintaining stability.

AMO Platform measures and discloses information on contributions to AMO Blockchain in order to support the process of a fair and open representative selection process. Contribution information includes the volume and quantity of data transactions, AMO Coin balance, average amount of storage during a set time period, and contribution of the transactions. This information allows transparency for voters in the selection, reducing the risks of malicious nodes being selected.

New AMO block generation will be operated by AMO Coin Management System within the platform, and AMO Platform's operation policy is determined by the community of market participants. After the new block has been generated, AMO Coin will be paid to the representative node and the voter node that generated the block, and a portion will be used for blockchain operation. The voter node compensation will be facilitated by AMO Coin Management System with the representative node.

Chapter 4. Service Examples

Listed below are various use-cases for car data with a thriving AMO Market. However, note that the objective of the AMO project is not to launch the services themselves. Instead, the aim of AMO is to provide an environment in which such services may be implemented and continuously upgraded.

- Lifecycle management services including the exchange of car parts
- Prediction of car faults and safety improvement
- Prevention of counterfeit or theft of cars and car parts
- Analysis of car accidents
- Customization of car insurance plans
- Trustworthy P2P sale of used cars
- P2P sale of electricity for car charging
- Location information services for available car charging and parking lots
- Music and video streaming and billing
- Simultaneous content streaming experience in multiple vehicles
- Local Dynamic Map (LDM) services
- Open participation for bounty for car data users
- Secure monitoring for car-related personal information
- In-car or connected car commerce/payments

The following sections will describe how the services listed above can be supported by AMO Market, supporting various activities in the automotive industry.

4.1 Car Maintenance Services

Through In-Car Data collected by AMO Data Collector™ along with processed car data provided by gas stations, automobile repair shops, and other service providers, AMO Market facilitates the maintenance of a car throughout its lifecycle.

For example, in the context of purchasing a used car, plenty of asset movement is involved, making the tracking and management difficult. In fact, the transfer of car ownership involves the sharing of information with multiple stakeholders, including auto manufacturers, insurance companies, used car dealerships, car registration offices, and auto repair shops. When processed car data (vehicle damage, servicing or inspection records, etc.) from auto manufacturers, auto repair shops and other service providers is stored on AMO Blockchain and therefore reliable and tamper-proof, there can be great savings in time and effort during the purchase process. In this way, car users are able enjoy security when purchasing used cars and data-backed guidance when repairing their cars. At the same time, by providing User Data, insurance companies, auto repair shops and other services are able to capitalize on new business opportunities to offer value-added services such as timely repairs or replacement of parts.

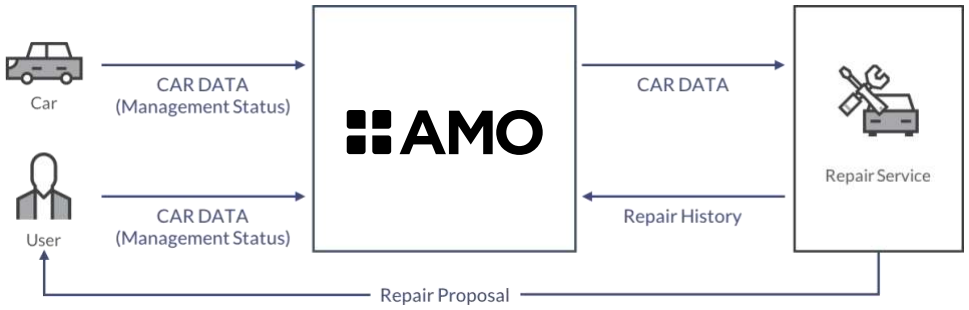


Figure 20. *Car Maintenance Services*

4.2 Car Accident Analysis Services

AMO Market collects data internally and externally generated by the vehicle. In the event of an accident, data generated from the car's sensors will be stored on the AMO Blockchain Peer Storage. With guaranteed data integrity, this information can be used as legal evidence in conjunction with black box (event data recorder, EDR) data. Data obtained during the accident can be used to create simulations and investigate the cause of the accident.

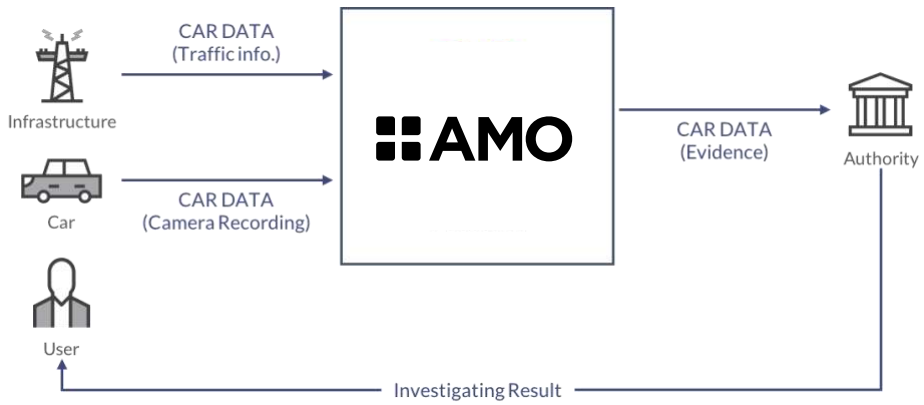


Figure 21. *Car Accident Analysis Services*

4.3 Accurate Insurance Rate Calculation Services

Insurance service providers determine car insurance rates based on the driver's driving history and adjust discounts based on rating factors and the number of accidents. Presently, car insurance providers request customers to provide information about their mileage, car model, black box use, and more, to be factored into the insurance rate. Unlike the existing model, AMO Market does not require manual input of information. Instead, all information about the car model, registration year, mileage and more is gathered and stored on the AMO Blockchain. Using this car data as reference, insurance companies could offer more accurate and customized insurance plans that reflect drivers' driving patterns.

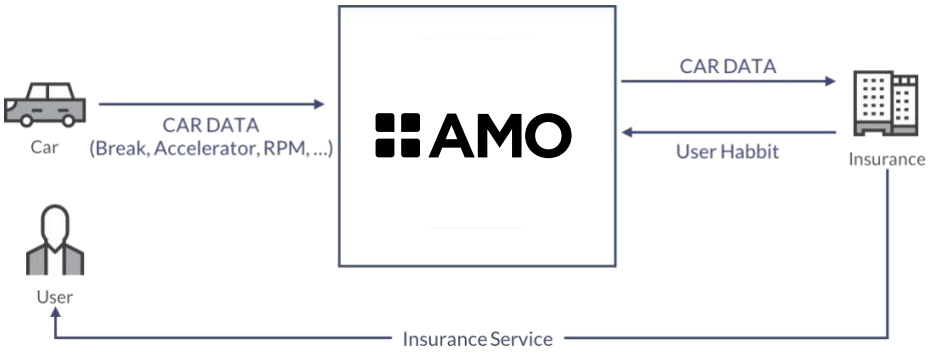


Figure 25 *Accurate Insurance Rate Calculation Services*

4.4 Car Charging and Parking Services

Many people will have had the experience of driving around the block several times in search of a parking lot or an electric charging station. Services linked to charging stations and parking lot availability can be created and implemented using the information about these stations and parking lots in AMO Market. Service providers related to charging stations or parking lot statuses can assist their customers to the nearest location if there is a shortage of electricity or a need for parking while on the road.

This can be taken one step further with the establishment of peer-to-peer (P2P) electricity trading. Unlike existing methods of having to use electricity from a central agency, users could utilize a buyer-seller matching direct deal service, which would use AMO Market to pair the buyer to the seller, and to manage the state of charge and location-related information.

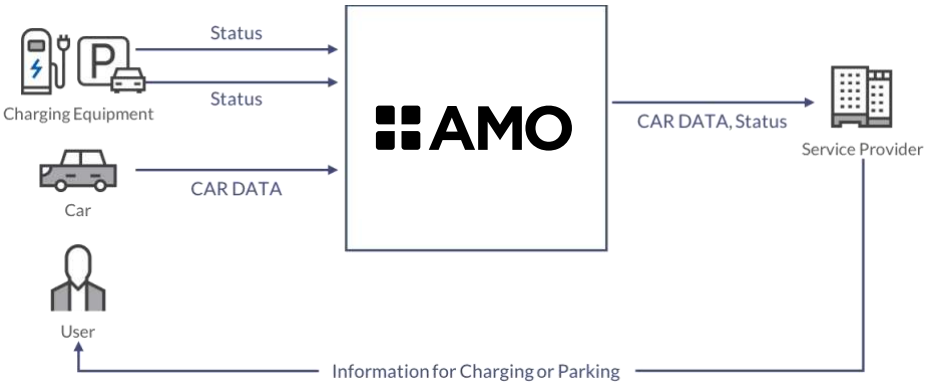


Figure 26. *Car Charging and Parking Services*

4.5 Music and Video Streaming Services

Advancements in autonomous vehicle technology have fueled interest in the potential of in-car entertainment, with many predicting future cars will primarily serve as platforms for entertainment. AMO Market can provide car users real-time access to various media content including movies and music.

Figure 27 *Music and Video Streaming Services*

4.6 Local Dynamic Map Service

AMO Market can provide drivers with access to Local Dynamic Maps (LDMs), which feature more detailed and up-to-date information about traffic conditions than typical traffic maps. All data gathered from active car sensors and V2X communications will be stored on AMO Blockchain to gather information about the car's external environment. Service providers can use this information to generate an even more accurate depiction of the driving environment and deliver this information to cars, car users, service providers, and all other market participants.

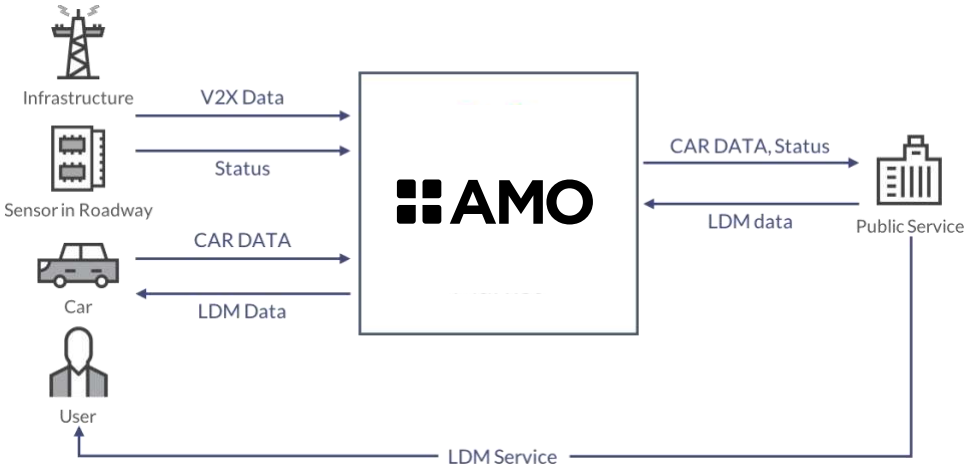


Figure 28. *Local Dynamic Map Service*

4.7 Secure Monitoring of Personal Information

Smartphones users are by now accustomed to receiving numerous notifications on their devices regarding the use of personal information and access to data. This should also be the case with cars that communicate with the outside environment, especially since some car data may contain personal information. AMO Market encrypts all stored personal data and does not allow any use of the data without the driver's permission. Participants can personally monitor and control the use of their data since use of the data without the consent of the car user is prohibited, and all history of rights and permissions is recorded.

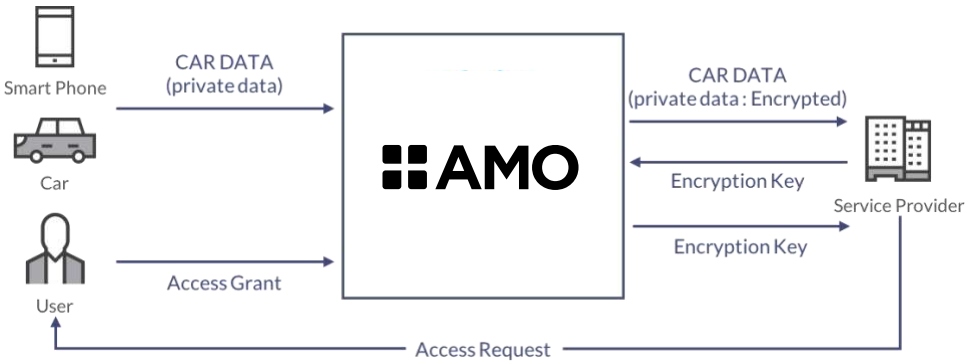


Figure 22. *Secure Monitoring of Personal Information*

4.8 Data Mobility Service

One of the types of data recorded in AMO Market is User Data, which includes subscriptions to content. If the car user uses a car/ride-sharing service, purchases a new car, or uses a car belonging to another person, this user can easily move over such data from one car to another through a simple authentication process.

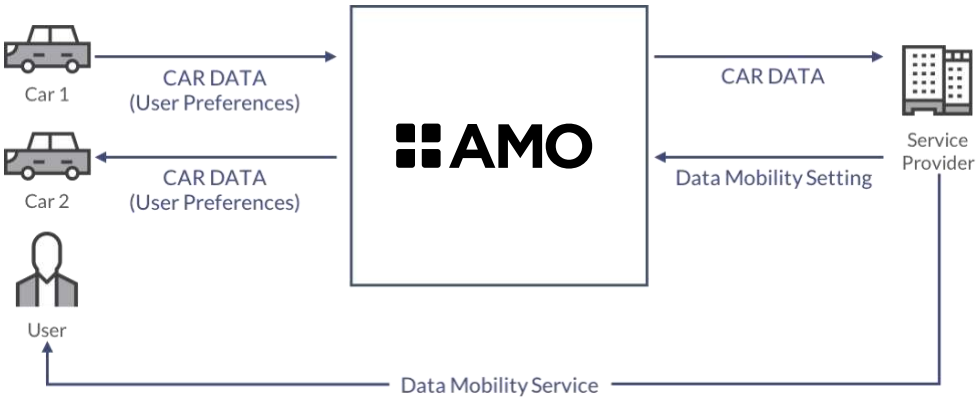


Figure 30. *Data Mobility Service*

4.9 Open Participation for Bounty

As AMO Market grows and the number of participants increase, the types of data that purchasers want to buy may also diversify. This may lead to instances where consumers may not be able to find the type of data they want. If this is the case, consumers may offer a bounty for the type of data they desire, and invite other data producers to generate the data. In this case, ownership of the data will be subject to bilateral agreement between the parties.

After recording the amount of bounty, the type of data requested, and the ownership of the data, a smart contract is signed, allowing the buyer to quickly and efficiently obtain quality data. The data producer in this situation is able to get additional compensation, and previously unavailable data is now created, allowing for further growth of AMO Market.

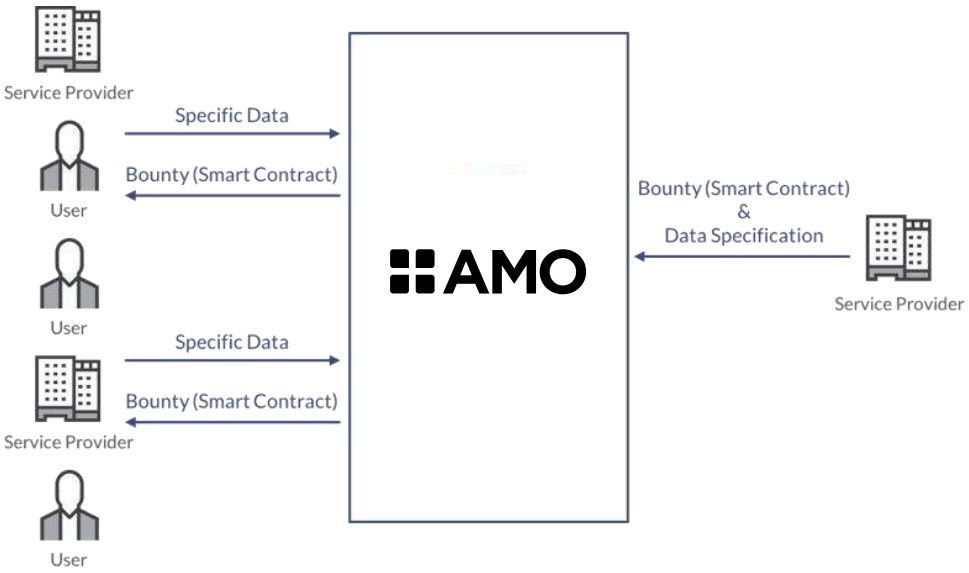


Figure 31. *Open Participation for Bounty*

Chapter 5. Reverse ICO

Collection of car data requires expertise and experience in multiple fields like embedded technology, mobile technology, server technology, and security. Especially in the processing of sensitive data like personal information that is vulnerable to breach attempts, deep knowledge in encryption and de-identification technology is needed.

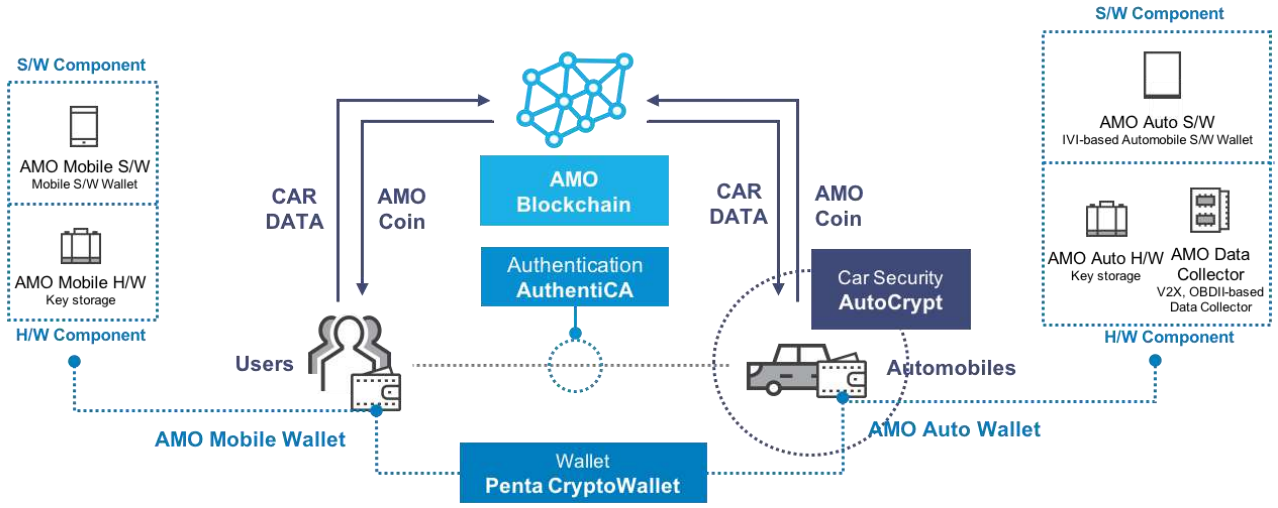


Figure 32. *Expertise and security in car data collection*

Even after collecting car data, it's imperative to design, implement and operate a security system for data transactions and the coin economy system.

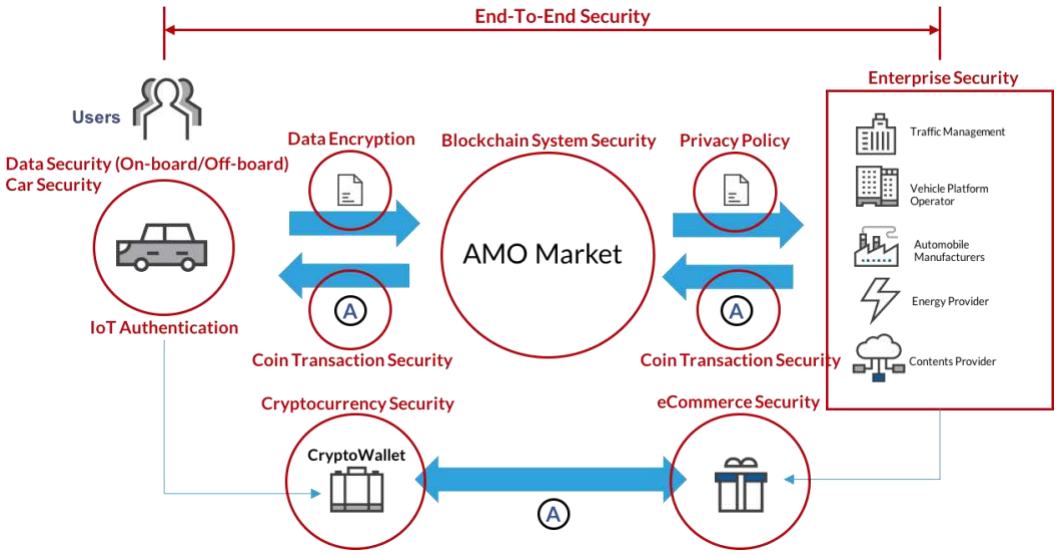


Figure 23. *Security elements for data transaction in the market*

The issues surrounding car data and existing car ICOs can be resolved with Penta Security Systems' AutoCrypt®, AuthentiCA®, and Penta CryptoWallet™.

AutoCrypt®
AuthentiCA® + Blockchain
Penta CryptoWallet™

AutoCrypt®	• Able to collect all data: V2X, In-Car Data, User Data • In conjunction with Penta CryptoWallet™, AMO Auto Wallet™ works as an in-car blockchain client as well as a wallet
AuthentiCA®	• AMO CA works as a PKI for the mutual authentication of IT systems used by different market participants • Encryption provided to enable market participants to grant permissions for data • Encryption key provided to allow for data encryption and de-identification
Penta CryptoWallet™	• AMO Mobile Wallet™ released with features like data collection, community involvement, transaction, and blockchain client. • Various additional functions for future AMO Coin economy expansion

Table 3. **Utilization of Penta Security Systems technologies**

5.1 AutoCrypt®

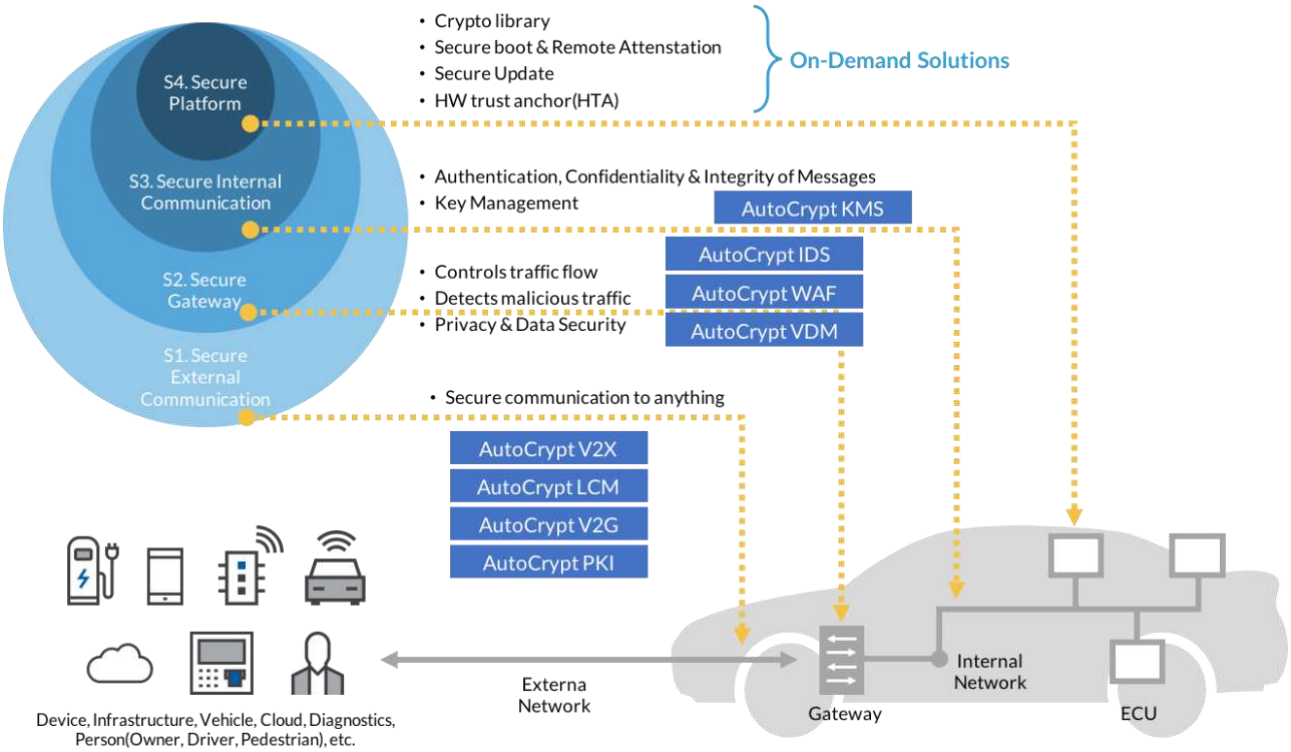


Figure 24. *Components of AutoCrypt®*

AutoCrypt® is a security solution for connected cars, autonomous vehicles, and smart cars. Launched in 2015 as Korea's first dedicated car security solution, work on developing AutoCrypt® actually began in 2007 as an on-demand security solution for auto part and car manufacturers. The technology required for comprehensive automotive security can be divided into four major categories, and AutoCrypt® offers the following:

1. Securing communication between car and external devices: Provision of encryption and authentication for external communications through the public key encryption.
2. Secure gateway to protect the electrical and electronic systems(E/E): Provision of detection capabilities and controls for data traffic flows in order to defend against incoming cyberattacks, as well as necessary data security and privacy to protect outgoing data transmitted to external devices.
3. Secure communication for car's internal network: Provision of necessary security and key management technology to enable encryption and authentication between ECUs in car's internal network.
4. Security for ECUs: Provision of Secure Boot and Remote Attestation capabilities to create safe operational environment for ECUs. Secure updates for ECU software and firmware are also provided, leveraging Hardware Trust Anchors (HTAs) like TPM to enhance the security of such technologies.

In the AMO Market, security is required for sharing car data and receiving processed car data. AutoCrypt® through AMO Market provides the necessary security technology for creating more convenient and secure cars.

2007.	Security between Vehicle and Diagnostic Device
2011.	Security between Vehicle and Nomadic(mobile) Device
2012.	Security for Patrol Car Fleet Management
2013.	V2X Security over DSRC (WAVE)
2014.	Mobile Telematics Security (consulting)
	VDMS (Vehicle Data Monitoring System) Security
2015.	AutoCrypt® Launched
	Advanced Firewall for Vehicle
2016.	Security for C-ITS Testbed (Daejeon-Sejong)
	(Cooperative Intelligent Transportation System)
2017.	Security for Electricity Vehicle Charging System
	Enhancement to C-ITS Testbed (Daejeon-Sejong)
	Security for C-ARS Testbed (Yeoju)
	(Cooperative Automated Driving Roadway System)
	Security for K-City (Hwaseong)
	(Korea Autonomous Mobility City)
2018.	Scheduled Highway C-ITS Deployments (2018~2020, Plan)

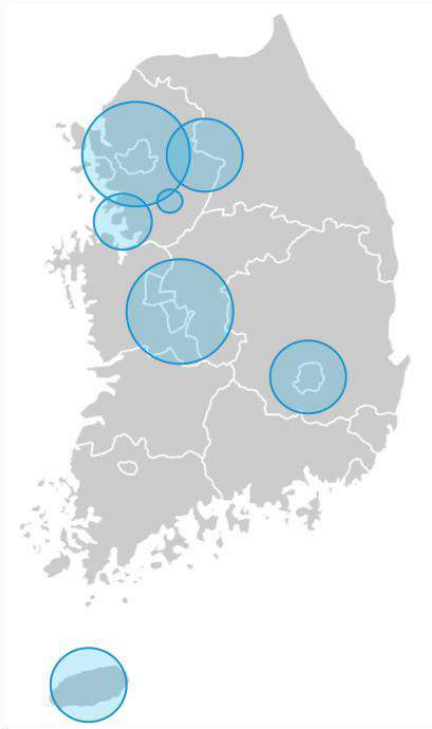


Figure 25. *AutoCrypt® History*

5.2 AuthentiCA®

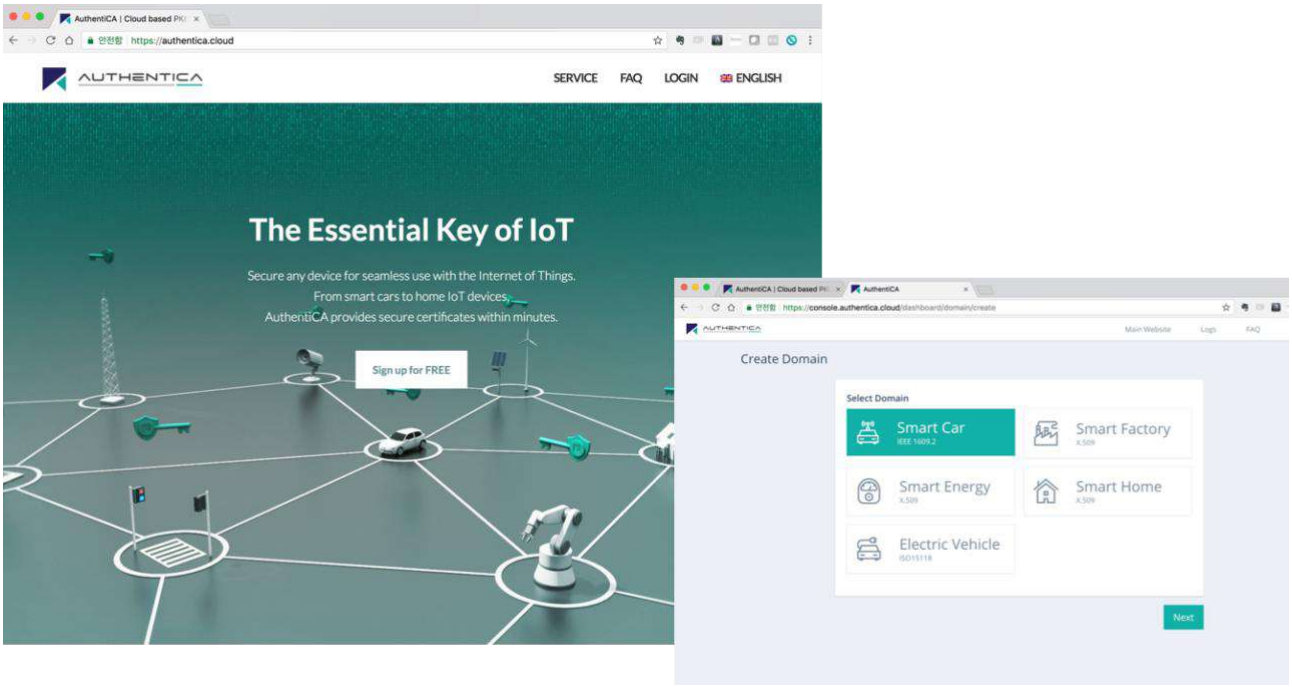


Figure 26. *AuthentiCA® service screen capture: https://authentica.cloud*

The Internet-of-Things, or IoT, is the technological network of large-scale devices like smart cars, smart factories, smart grids, smart homes, and handheld devices like wearables and sensors. However, regardless of the size of IoT devices, the priority needs to be in securing the communications between the device and the service server. Secure communications can be implemented through authentication and encryption of confidential data between the two entities. But even encryption can only occur after authentication, making authentication the key and foundational technology in IoT.

AuthentiCA® is a cloud-based certificate authority service that allows users to easily create, sign, and manage keys and certificates for creating a secure IoT environment. Since it is compatible with Microsoft's Azure IoT Suite, users of Microsoft's cloud platform Azure can conveniently utilize the IoT security technology provided by AuthentiCA®.

AMO Market participants use keys and certificates issued by AMO CA (AuthentiCA® technology optimized for AMO Market) for authentication to support secure trade of car data.

5.3 Penta CryptoWallet™

Figure 27. *Penta CryptoWallet™ in three form factors*

Cryptocurrency has attracted great interest for its potential to transform existing online business models and contribute to the development of new online-to-offline (O2O) business opportunities. In reality, the industry has been struggling with setbacks following high-profile security incidents involving cryptocurrency exchanges and hacks targeting wallet providers.

Many existing digital wallets either only provide storage for keys required for cryptocurrency or lack secure options for network connections, which has left numerous wallets vulnerable to attacks. Penta CryptoWallet™ securely manages the entire lifecycle of encryption keys that are used in cryptocurrency transactions. It is also compatible with various electronic money transfer services and provides secure storage and transaction of electronic money.

The technology behind Penta CryptoWallet™ will be optimized for use in AMO Market to develop AMO Mobile Wallet™ and AMO Auto Wallet™. In addition to functioning as cryptocurrency wallets that facilitate AMO Coin transactions, they will serve as AMO Nodes that participate in the AMO Blockchain.

Chapter 6. Roadmap

In order to establish AMO Market after the ICO, development and service launches will happen in stages according to the road map. The roadmap has been designed to facilitate the functional participation and smooth interaction of market participants. The roadmap is subject to change as the benefits of participation expand and AMO Market grows.

2018.05
- Public sale and token distribution

2018.3Q
- AMO Mobile Wallet v1 Launch (AMO Token Transfer)
- AMO CA v1 Launch (Beta)

2019.1Q
- Testnet Launch (AMO Blockchain Beta Launch)
- AMO Data Collector Launch
- AMO Mobile Wallet v2 Launch (Communication with Data Collector)
- AMO CA v2 Launch
- CAR DATA Open Specifications Release

2019.2Q
- AMO Auto Wallet v1 Launch
- AMO Mobile Wallet v3 Launch (Communication with Auto Wallet/Testnet)
- AMO Foundation Established

2019.3Q
- Mainnet Launch (AMO Blockchain v1 Launch)
- AMO SDK v1 Launch
- AMO CA v3 Launch
- AMO Asia Expo Open

2020.1Q
- AMO Auto Wallet v2 Launch (Communication with Mainnet)
- AMO SDK v2 Launch
- Payment using AMO Wallet

2020.3Q
- AMO Client for Service Provider v1 Launch (AMO Data Manager, GUI for SDK)

2020.4Q
- AMO Blockchain v2 Launch
- AMO World Expo Open

2021.2Q
- AMO Blockchain v3 Launch

Chapter 7. Team Members & Advisors

The AMO Team consists of experts in their respective fields with the ability to turn the vision of AMO into a reality.

SangGyoo Sim

CEO
- Creator of AutoCrypt
- Ph.D & M.S., POSTECH
- R&D Engineer, Samsung Electronics
- Adjunct Prof. in Dongduk Women's University
- Adjunct Prof. in Soonchunhyang University
- Head of Penta IoT Convergence Lab
- 15+ years experience in IT & Security

Daniel ES Kim

CSO
- Creator of D'Amo
- B.S., POSTECH
- Chief Technology Officer, Penta Security Systems
- 20+ years experience in IT & Security

DS Kim

CTO
- M.S., POSTECH
- Cloudbric Co-Founder
- XBrain Founding Memeber & Advisor
- 20+ years experience in IT & Security

KyungMoon Nam

Head of Strategy
- WebCash
- 15+ years of experience in IT

Erik Tan

Head of Operations
- B.A., University of Wales
- Senior Manager, Certis CISCO
- Senior Manager, LHN Group
- 10+ years experience in IT

Jaeson Yoo

Chief Evangelist
- B.A., Occidental College
- Principal Consultant, Cooper21 Consulting LLC.
- 15+ years experience in business development

SungKyoon Chung

Head of R&D
- Creator of Penta CryptoWallet
- M.S., POSTECH
- Founder of GRock Information
- 15+ years experience in IT & Security

Advisors

Gilles Delfassy

Board of Directors at ON Semiconductor

Gilles Delfassy is a member of the Board of Directors of ON Semiconductor, Cavendish Kinetics Inc., and e-Lichens S.A, and Chairman of the Board of Kalray S.A.. He started his career with Texas Instruments and created and led the Smartphone Semiconductor business of TI, growing it to a five-billion-dollar operation. He was Senior VP and Executive Officer of TI until 2007. From 2009 to 2012 he was President and CEO of ST-Ericsson.

Chance Du

General Partner at Coefficient Ventures

Chance Du is Founding Partner at Coefficient Ventures, a multi-strategy crypto fund with presence in North America, Asia, and Europe. Her passion and knowledge for decentralized governance protocol has led her to speak about blockchain technology at leading industry conferences including the Stanford Cryptocurrency Exchange conference, De/Centralize 2018 Singapore, Ether Denver, Google Female Founders Summit, and Fintech Silicon Valley among many others.

Seokwoo Lee

Founder and CEO of Penta Security Systems

Lee founded Penta Security Systems, a Korean IT-security firm, in 1997. The company quickly globalized its operations, entering Japan, the United States, and Singapore. Lee transformed the company by diversifying its technologies and advancements from WAF to IoT security technologies. In 2010 He was awarded by (ISC)²® with the Information Security Leadership Achievements award. In addition to co-founding xBrain, he is also adjunct professor at POSTECH as well as the founding chairman of POSTECH's Association of POSTECH Grown Companies.

Kazunari Miyazaki

Head of NEC Venture Fund, Director of BIGLOBE

Kazunari Miyazaki is the former head of the NEC Venture Fund and Director of BIGLOBE , the Yahoo of Japan. Since its beginning in July 1996, BIGLOBE has expanded the services offered beyond ISP connection services to extend to portal sites, broadband content and numerous other Internet services. Miyazaki has 10+years of experience in M&A, accounting and finance, supporting portfolio companies, conceptualizing and identifying market needs, and implementing result-oriented strategies.

Carol Streitberger Brighton

President and Owner, CSBrighton Consulting

Carol Brighton is President of CSBrighton Consulting, specializing in advising high-tech companies in Europe and the US and helping to pave the way for successful and profitable acquisitions. Formerly the Group VP of Corporate Internal Communication for STMicroelectronics in Switzerland, Brighton's expertise in communications and investor relations also comes from a career as Vice-President of Global Communication for ST-Ericsson and previous work in Texas Instruments.

YoungHa Kim

Former CEO, Samsung Electronics China

YoungHa Kim spent over three decades at Samsung Electronics, focusing on the Chinese market. His previous appointments as the head of the Beijing, Hong Kong, and Shanghai branches before being elected the CEO of Samsung Electronics China in 2011 were due to his business acumen and his ability to achieve financial results for the company. He has been credited with developing strong retail sales networks in China, bringing Samsung mobile phones to hold the top market share position in the country from 2013 onward. Retired in 2015, Kim is currently Professor at Dankook University.

Bonghan Brian Cho

Founder and CEO of Equalkey Corp., Korea

Dr. Cho is the founder and CEO of Equalkey Corp., an AI firm focusing on transforming education using an innovative and systematic approach. He is also a member of the Board of Directors of DBS Group Holdings Ltd and DBS Bank Ltd. Previous appointments included Executive VP and CIO for Samsung Fire & Marine Insurance, Deputy CEO and CIO for Hana Financial Holdings, and CTO of the Next Banking Generation System at KB Kookmin Bank. Cho holds a Ph.D and M.S. in Computer Science, specializing in AI. Cho has also received recognition for his contributions to the software industry with the Republic of Korea President Award.

Teddy Hyunwoong Kim

Co-Founder of Gridwiz, Chief of R&D Center & EV Dept.

Teddy Kim co-founded Gridwiz, a company specializing in solutions that economically manage customers' energy consumptions. Gridwiz's Distributed Resource (DR) solution is considered the number one solution in the industry, and Gridwiz provides solution packages for DR, Distributed Energy Resource (DER), Smart Factory, and Electric Vehicle (EV) charging infrastructure. He also currently heads the R&D center the Electric Vehicle department as the resident expert in ISO/IEC 15118 standardization (wired and wireless V2G communication). He is a specialist on Distributed Energy Resource (DER) including EV application.

Gu-Min Jeong

Professor, Kookmin University

Jeong is a Professor at the School of Electrical Engineering,and also a chair of mirror committee for ISO TC22 SC31/32 in KATS , and of the IT convergence committee of KAMA. He is also a chair of the Infineon Center (funded by Infineon, Germany) and the Hyundai Odin Center, both at Kookmin University. His previous appointments include his positions as Advisory Professor for Samsung Electronics regarding IoT and In 2016, Advisory Professor for NAVER regarding smart cars and autonomous driving, and Visiting Associate Professor of ICS, UC Irvine, CA, USA. Before joining Kookmin University, he co-founded NeoMtel and was a manager at SK Telecom.

Huy Kang Kim

Associate Professor, Department of Cyber Defense, Korea University

Professor Kim is currently an Associate Professor in the Department of Cyber Defense and Graduate School of Information Security at Korea University. His main research areas include data-driven security (e.g., fraud detection system, intrusion detection system in vehicles, and user behavior analytic system). His previous appointments include leading the KAIST UNIX Society (KUS), Technical Director and Head of Information Security of NCSOFT, and founder of A3 Security Consulting, the first ever information security consulting firm in Korea.

Chapter 8. Legal Issues

The AMO team has written this whitepaper for reference only in order to provide more information about the AMO Blockchain. The whitepaper is not written to advise investment in the AMO team or the blockchain. The whitepaper is written "as-is," in other words, it was written with current status in mind, meaning it may be subject to changes in the future.

Additionally, the AMO team does not make any warranty statements or guarantees of any kind with respect to this whitepaper, and will not assume legal responsibility. For example, the AMO team does not guarantee that (i) the whitepaper is based on legitimate rights and does not infringe on third party rights, (ii) the white paper is commercially valuable or useful, (iii) the whitepaper is suitable for achieving a specific agenda and (iv) there is no error in the content of the whitepaper. The range of liability and responsibility is not limited to the aforementioned examples.

If referring to the whitepaper in any way to make a decision or to take action, the consequences thereof will be the responsibility of the reader, and not the AMO team. For example, in case of any damages, monetary loss, harm, or debt, the AMO team will not compensate or indemnify in any way.

References

- Cyber Security and Resilience of smart cars:

  https://www.enisa.europa.eu/publications/cyber-security-and-resilience-of-smart-cars/
- Federal Automated Vehicles Policy - September 2016:

  https://www.transportation.gov/AV/federal-automated-vehicles-policy-september-2016/
- Testing automated vehicle technologies in public:

  https://www.gov.uk/government/publications/automated-vehicle-technologies-testing-code-of-practice
- Sens. Markey, Blumenthal Introduce Legislation to Protect Drivers from Auto Security, Privacy Risks with Standards & "Cyber Dashboard" Rating System:

  http://www.markey.senate.gov/news/press-releases/sens-markey-blumenthal-introduce-legislation-to-protect-drivers-from-auto-security-privacy-risks-with-standards-and-cyber-dashboard-rating-system
- Million lines of code:

  http://www.informationisbeautiful.net/visualizations/million-lines-of-code/
- Connected car report 2016: Opportunities, risk, and turmoil on the road to autonomous vehicles:

  https://www.strategyand.pwc.com/reports/connected-car-2016-study (2016.09)
- Service Fabric Customer Profile: BMW Technology Corporation:

  https://blogs.msdn.microsoft.com/azureservicefabric/2016/08/24/service-fabric-customer-profile-bmw-technology-corporation/
- Monetizing car data - New service business opportunities to create new customer benefits:

  https://www.mckinsey.com/~/media/McKinsey/Industries/Automotive%20and%20Assembly/Our%20Insights/Monetizing%20car%20data/Monetizing-car-data.ashx
- Cybersecurity Guidebook for Cyber-Physical Vehicle Systems J3061 :

  https://www.sae.org/standards/content/j3061/
- U.S. DoT chooses SAE J3016 for vehicle-autonomy policy guidance :

  http://articles.sae.org/15021/
- ISO 15118-1: General information and use-case definition[4] :

  https://www.iso.org/standard/55365.html
- ISO 15118-2: Network and application protocol requirements[5]:

  https://www.iso.org/standard/55366.html
- ISO 15118-3: Physical and data link layer requirements[6]:

  https://www.iso.org/standard/59675.html
- ISO 15118-4: Network and application protocol conformance test[7]:

  https://www.iso.org/standard/55366.html
- ISO/FDIS 15118-5: Physical and data link layer conformance test[8] :

https://www.iso.org/standard/61725.html

- ISO/DIS 15118-6: General information and use-case definition for wireless communication[9] :

  https://www.iso.org/search/x/query/15118-6

- ISO/CD 15118-7: Network and application protocol requirements for wireless communication[10] :

  https://joinup.ec.europa.eu/solution/isoiec-15118-7-road-vehicles-vehicle-grid-communication-interface-part-7-network-and/about

- ISO/FDIS 15118-8: Physical layer and data link layer requirements for wireless communication[11]:

  https://www.iso.org/standard/62984.html

- IEEE Std 1609.2-2016 (Revision of IEEE Std 1609.2-2013) - IEEE Standard for Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages:

  https://standards.ieee.org/findstds/standard/1609.2-2016.html

- Design and Implementation of IEEE Std 1609.2 Message Encoder/Decoder for Vehicular Communication Security:

  http://www.cseric.or.kr/literature/ser_view.php?searchCate=literature&SnxGubun=INEN&mode=total&gu=INKO051A0&cmd=qryview&SnxIndxNum=195047&rownum=2&f1=KW&q1=WAVE

- Road vehicles — Functional safety — Part 1: Vocabulary :

  https://www.iso.org/obp/ui/#iso:std:iso:26262:-1:ed-1:v1:en

- The Automotive Standard ISO 26262, the innovative driver for enhanced safety assessment & technology for motor cars :

  https://ac.els-cdn.com/S1877705812031244/1-s2.0-S1877705812031244-main.pdf?_tid=9b6b6ae1-1b1f-4060-86cc-35f582c1bef5&acdnat=1523670019_5a6e2ef4e9fa6acf1756ee22a018914c

- Cyber security Guide book for Cyber-physical Vehicle System :

  https://webstore.ansi.org/RecordDetail.aspx?sku=SAE+J+3061-2016+(SAE+J3061-2016)

- Connected Car: Vehicle Platforms Increasingly Use Smartphone Connectivity:

  https://www.gartner.com/doc/3838867/connected-car-vehicle-platforms-increasingly