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Global Automotive Threat: How to Stop Hackers from Stealing Cars with Just a VIN Capture

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Abstract **Vehicle theft is a growing global threat, increasingly facilitated by exploiting Vehicle Identification Numbers (VINs) and license plate numbers, exposing vulnerabilities in automotive security systems. This paper examines modern VIN-based cyber threats and security breaches in vehicle identification databases. It proposes an enhanced security framework integrating encryption, blockchain-based VIN authentication, and real-time tracking to prevent unauthorized vehicle access and cloning. The proposed approach enhances traceability, reduces fraud, and strengthens automotive cybersecurity. A proof-of-concept (PoC) demonstrates the feasibility of blockchain integration for VIN protection [1][2]. Highlighting its potential to reduce vehicle theft on a global scale.**

Keywords: **Vehicle Theft, VIN Cloning, License Plate Exploits, Blockchain Security, Automotive Cybersecurity, Data Privacy, Anti-Fraud Measures.**

I. INTRODUCTION

Vehicle theft is a global issue exacerbated by the exploitation of VINs and license plates. Traditionally seen as secure, these identifiers are now common targets for hackers. This paper explores the vulnerabilities of VIN and license plate systems and examines real-world examples of these exploits. It proposes strategies to address the increasing threat to vehicle security [2][3].

II. BACKGROUND

The Vehicle Identification Number (VIN) is a 17-character code given to each vehicle when it was built. It stores critical information, such as the make, model, manufacturing year and engine. VINs are mandatory for registration, insurance, police surveillance, and theft. In addition to the use for which it is designed, VINs serve as a digital signature of the car and as an identification code associated with the car's history and ownership. Each VIN should be unique and no two vehicles will ever share the same id, hence acting as a core method of vehicle identification across the globe.

In a similar way, plates are one of the most common forms of identification in public spaces. License plates issued by government officials are usually printed on the front and back of the vehicle. Such plates are necessary for vehicle tracking, road regulation, toll collection, and parking. In most places, plates are tied to a vehicle's VIN in centralized databases, making it simple for the police and other departments to track vehicle ownership and history.

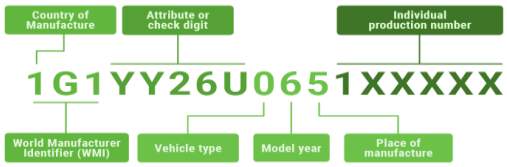

Figure 1 Johnson, A. (2022). Understanding VIN Structure

Even though they play a vital role in car identification and safety, VINs and license plates are also highly susceptible to hacking and deception. The sophistication of newer auto systems, coupled with the increase in the tools and expertise required to rig these identification numbers, have created the opportunity for vehicle theft and fraud. Crime gangs have developed techniques to clone or modify VINs and licence plates, so stolen vehicles can be registered or sold with forged documents. This exploitation is encouraged by the lack of security protection for VINs and license plates, which present great threats to police and automakers. As the global vehicle market continues to grow and cars have grown in value, bypassing VIN and plate systems has become a serious concern. Such thefts have far reaching consequences for both individual car owners and society at large because stolen vehicles are typically associated with gang activity and other crimes. It's critical to get an understanding of the fragility of these critical identification devices to tackle the growing incidence of car theft. [3][5].

Vehicle theft is on the rise despite existing security measures. This might indicate vulnerabilities in VIN-based authentication, rising cyber threats, or flaws in current tracking systems. Figure 2. Shows the uptrend of vehicle theft from year 2010 up to 2021. The variations in vehicle theft across US states with Washington DC reporting the highest rate with 574 thefts per 100,000 residents while Vermont records the lowest with 38 as shown in figure 3.

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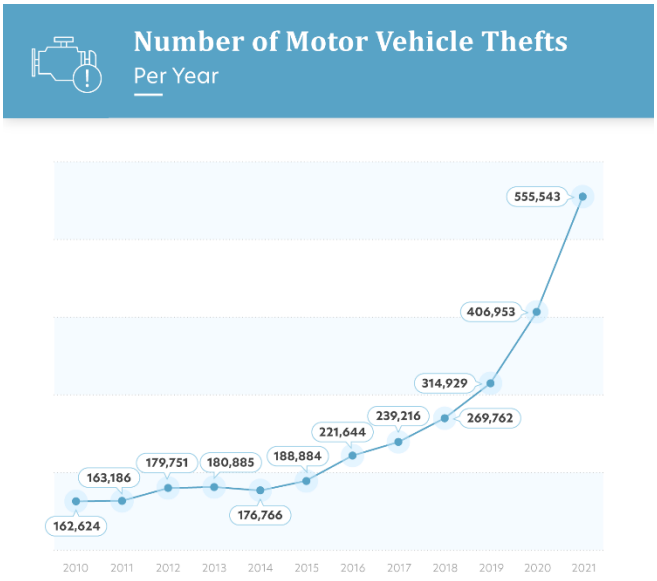

Figure 2: Yearly Motor vehicle theft Graph

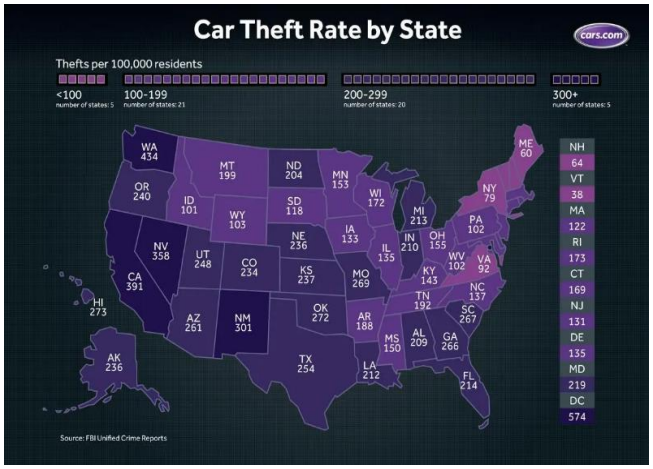

Figure 3 Car Theft Rate by state

III. LITERATURE REVIEW

1. Evolution of Vehicle Theft Technology

Vehicle theft has always existed across the globe and continues to change with the development of cars. Historically, car burglaries were performed through simple break-ins, hot-wiring or the use of simple lockpicking. But since the invention of electronic locks, immobilizers, smart keys, and keyless entry systems, burglars have become increasingly sophisticated. Key cloning and remote hacking has become an big issue in car security over the past few years. attackers can now circumvent conventional key fobs and immobilizers by taking advantage of communication holes in the vehicle's communication system, including the CAN bus. They also exploit keyless entry vulnerabilities, so thieves can easily start a car without a key. [2][6].

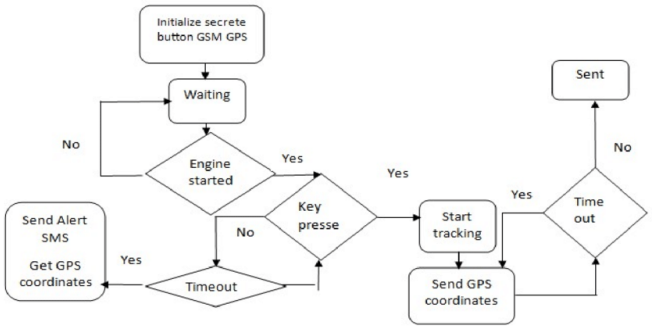

Figure 4 Lee, K., et al. (2021). Evolution of Vehicle Theft Techniques

2. Exploitation of VIN and License Plate Data

Hackers use VINs from windshields to clone keys and bypass security systems. Public and private databases storing vehicle details are also frequent targets of data breaches.Accessing and stealing a car using a VIN is quicker and easier than many would believe. Cybercriminals tap into the Vehicle Identification Number (VIN), which is usually found on a vehicle's windshield. Once they have a car's VIN, they use automated VIN decoders and key programming devices to read the key specifications of it. It enables them to manufacture duplicate physical keys and code electronic fobs or chips that will interface with the car's immobilizer module. In this way, they bypass the vehicle security system and get complete control over the electronic components of the car.
These were initially made for licensed locksmiths to help clients who had lost all of their keys. Unfortunately, these tools are now public domain, which allows hackers to rip off the community by using them to steal cars. True locksmiths search manufacturer databases or approved third party software for the key code associated with a VIN.
This key code tells us the exact cuts and information we need to generate a copy of the key. In older cars that don't have much electronic technology this could be done by merely cutting a key. But some cars these days still need additional

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work, for instance, programming electronics so they can function with the vehicle's immobiliser.
In order to avoid theft, legitimate locksmiths never copy a key without checking ownership of the car. They demand documentation, like proof of registration and identity. A locksmith who omits this verification step is a red flag of fraud or unethical conduct. Even knowingly passing on your VIN or giving it to non-qualified experts makes your vehicle a likely target of theft. The vehicle IDs or Vehicle Identification Numbers, also called License Plate Numbers, are the central tools for car tracking. Vehicle identification numbers are used for registration, insurance and tracking purposes. They include unique information, including make, model, year of production, and specifications of the car. Sadly, VIN cloning is now a primary facilitator of vehicle theft.

The National Insurance Crime Bureau (NICB) reported in 2021 that thieves use VINs and license plates to copy vehicles. They can also copy or falsify papers using a car's VIN, rename it, and market it as a legally registered vehicle. The information is often obtained from public records, dealers, or through hacking into online databases. Sometimes, hackers can access these records through data breaches, hacking, or even from service stations that accidentally leak VIN information in the absence of adequate security measures.
In addition, many vehicle owners or consumers unknowingly provide their VIN and license plate numbers to unscrupulous online platforms that store these details in unprotected databases. This creates a significant risk of data exposure and subsequent theft.
A study by Roberts and Stevenson (2022) highlights that vehicle data leakage from both public and private sources is a serious vulnerability in vehicle theft. The authors note that while databases like Carfax and AutoCheck provide useful services to consumers by tracking vehicle histories, they also make it easy for criminals to gather essential information such as VINs and license plate numbers. Carfax, for instance, pulls information from vehicle service records, insurance claims, auction houses, and law enforcement databases, all of which store detailed vehicle data. These sources, when inadequately protected, become points of vulnerability. [7][8].

3. Current Security Solutions and Challenges

Manufacturers have enacted a number of security measures to prevent car theft. Immobilizers that prevent the engine from starting without a key or fob are standard on almost every car since the 1990s. However, they are not foolproof. According to Lee et al. (2021), older vehicles can still be compromised using OBD-II ports or CAN bus loopholes that enable hackers to bypass security controls and compromise the vehicle's most sensitive systems.
Furthermore, GPS trackers have been touted as a means to identify stolen cars in real time. Systems such as LoJack have been effective in some areas, but not everywhere. Nguyen and Taneja (2020) report that when thieves remove tracking devices or jam their signals, GPS recovery is less effective.
Another potential solution is blockchain-based car registration systems that are currently under consideration for VIN cloning. The blockchain can provide permanent, fully auditable information about who owned and when a vehicle and it will be much harder to tamper with VIN information. However, implementation fees, privacy and scalability remain significant hindrances to adoption. While immobilizers, GPS trackers, and blockchain solutions exist, they face challenges like signal jamming, high costs, and scalability issues [9][10].

4. Data Breaches at Service Centers and Online Platforms

It's hard to put an understatement on how service centers, dealerships and online sites enable vehicle data leaks. According to Zhao et al. (2021), vehicle service companies that have access to VINs, keys, and other private information are the most likely targets for hackers and unauthorised third parties. Generally, these companies do not offer sufficient security to shield the data they hold.
According to Automotive Cybersecurity Research Group (2022), the Automotive Cybersecurity Research group reported on several breaches of data held by vehicle service centers, where stolen VIN, plate numbers, and key codes were made available to hackers. The convenience of access to this kind of information made theft easier, as well as a greater ability for thieves to circumvent vehicle locking mechanisms. Additionally, many online sources let you look up vehicle details based on just a license plate number. Sites like Carfax, AutoCheck and VINcheck offer in-depth reports on the history of the vehicle including accidents, ownership and service records. Such services may be helpful for customers, but can pose a security threat if the information is released to a nefarious party. Attacks, scraping and sharing of information via these sites are a major issue.5. Gaps in Current Research and Technology
Despite advances in vehicle security, research and technology remain far from perfect. For example, although VIN data encryption has been proposed as a way to keep hackers at bay, there is no agreed upon solution to secure VIN data between regions, manufacturers and databases.
The literature also calls for collaborative efforts between automakers, police departments, and private groups to offer a full package — both cutting edge technologies (such as blockchain and encryption) and better regulatory controls against VIN and license plate exploitation. [4][11] Service centers and online vehicle history platforms inadvertently expose VIN and license plate data, making them attractive targets for hackers

Literature Review Summary:
VIN cloning and misuse of license plate information are leading causes of car theft. Flaws in existing vehicle security protocols, such as OBD-II failure and data theft, make it easy for thieves to circumvent anti-theft protections. Data breaches at service centers, dealers, and online platforms aggravate the issue even more by giving valuable vehicle information to unauthenticated parties. We need better collaboration, regulation, and technology solutions to patch these holes and stop them from getting exploited in the future.

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IV. METHODOLOGY

1. Identification of Key Data Sources

To solve the problem of vehicle theft caused by exploiting VIN and license plate information, the first step is to identify where your sensitive vehicle information originates. This includes public databases, such as car registration or law enforcement records where VIN and license plate information is stored; private databases, like Carfax, AutoCheck, and other car history bureaus that consolidate data from dealers, repair shops, and insurance companies; websites and apps that allow users to look up car data using just a plate number; and auto repair shops or dealerships that maintain records and handle vehicle repairs. These key sources and the flow of data between them are critical to identifying the vulnerabilities in the system and understanding how criminals exploit them [3][7]. Identifying vulnerabilities in public and private databases, service centers, and online platforms is the first step toward enhancing security.

2. Evaluation of Current Security Measures

Let's examine some current security controls designed to protect VINs and license plates. This involves verifying encryption—ensuring VIN and license plate numbers are properly encrypted when sent and stored across devices and evaluating whether existing measures provide sufficient protection against unauthorized access. It also includes assessing access controls by determining who has access to sensitive vehicle data and whether service centers and dealerships use effective data protection methods. Additionally, recognizing vulnerabilities is crucial by identifying whether systems that store or process VIN data—such as public databases, service centers, or online platforms—already have exploitable weaknesses. This can involve reviewing existing literature, conducting penetration tests, or auditing affected systems to assess their security status. [8][10]. Assessing encryption methods, access controls, and system vulnerabilities helps pinpoint areas needing improvement.

3. Proposal for Enhanced Data Protection

With the flaws detected in the analysis, it's important to implement additional data security and encryption measures to protect VIN and license plate data. End-to-end encryption should be used to secure VIN and license plate information during storage and transport, ensuring the data remains unreadable if intercepted. Blockchain technology can be introduced to maintain accurate proof-of-possession records for car history, making VIN cloning and unauthorized changes more difficult since altering the blockchain would require computationally impractical efforts. Additionally, multi-factor authentication (MFA) should be adopted for accessing vehicle information, particularly in databases and platforms like Carfax or service centers that store sensitive data [6][9]. Implementing end-to-end encryption, blockchain for VIN data, and multi-factor authentication are recommended to secure vehicle data.

4. Real-time Monitoring and Alerts

An essential element of the proposed solution is to implement real-time vehicle tracking and VIN verification for stolen vehicles. This involves incorporating GPS tracking for high-value or potentially stolen vehicles, enabling quick location and recovery when a vehicle is reported stolen. Real-time VIN verification can be achieved through a decentralized platform that validates VINs during critical moments in a car's lifecycle, such as sales, servicing, or transfers, preventing VIN cloning by cross-referencing a global database [5][11]. Additionally, license plate recognition (LPR) systems can be deployed at strategic checkpoints—such as traffic cameras, gas stations, and toll gates—to compare license plates in real-time against national or international databases to identify cloned plates. Deploying GPS tracking, VIN verification systems, and license plate recognition at checkpoints enables quick recovery of stolen vehicles.

5. Collaboration with Stakeholders

For these solutions to be effective, they must be successfully deployed and standardized through collaboration between law enforcement agencies, vehicle manufacturers, and industry partners. Public-private partnerships are essential for enabling real-time sharing of information between government, manufacturers, and private entities, facilitating quicker detection of stolen vehicles. Universal security protocols should be established with vehicle manufacturers and industry associations to ensure consistent and effective VIN data security across regions and countries. Additionally, all implemented security solutions must comply with data privacy regulations, such as GDPR or CCPA, while remaining robust enough to prevent data theft [1][10]. Standardizing protocols through partnerships between automakers, law enforcement, and regulators is essential for effective implementation.

V. RESULTS

1. Decreased Vehicle Theft Rates

By implementing blockchain-based VIN tracking, car ownership will be locked down and undamaged, and robbers will be unable to modify or duplicate a vehicle's VIN. Through documenting all vehicle registration and ownership information in a decentralized ledger, such a system will ensure that any unauthorized updates to vehicle identification information are immediately flagged. This will reduce the demand for car theft, especially those whose VIN is stolen, thus rendering thefts less attractive to criminals.

In addition, real-time VIN scanning, combined with GPS tracking and LPR will enable stealing vehicles to be identified and recovered more quickly. These will make stolen cars easier to track and locate and reduce the time it takes for the police to seize stolen cars [4][8]. Blockchain-based VIN tracking and GPS monitoring significantly reduce theft rates and facilitate faster recovery.

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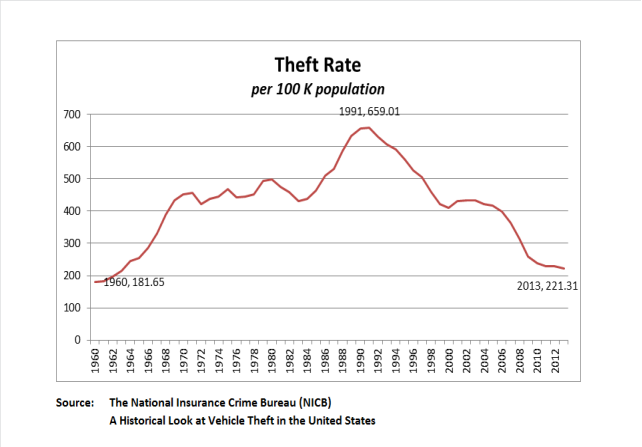

Figure 5: Theft Rate per 100k Graph

2. Improved Traceability

The proposed blockchain integration will also improve the security of stolen vehicles. Since all transaction information (car sales, transfer, registration change, etc.) will be securely backed up to the blockchain, the police, insurers, and vehicle owners will have access to a transparent record of the car's identity. This transparency will make stolen vehicles far less likely to be resold or re-registered undetected. Further, GPS tracking will be connected to blockchain to provide real-time location tracking of vehicles when stolen, which will increase recovery opportunities. This will be particularly beneficial to police because they can monitor where the vehicle is in real time so that it cannot be dismantled and kept in the middle of nowhere Decentralized records ensure transparent vehicle history, deterring resale of stolen vehicles [7][9].

3. Strengthened Data Security

By utilizing AES-256 encryption and the blockchain ledger, personal vehicle information such as VINs, registration numbers, owner's names and addresses will be safely stored and transmitted. This will secure car data from being stolen or manipulated by infected users. Because blockchain is decentralized, there is no single source of failure thereby eliminating massive data breaches and leaks.

Additionally, with multi-factor authentication (MFA) and role-based access controls across service centers, dealerships, and law enforcement, unauthorized access to the data will be reduced. This system will ensure that only registered employees can alter or encrypt sensitive vehicle data, as well as prevent use of VINs and license plates for illicit purposes. AES-256 encryption and blockchain eliminate vulnerabilities associated with centralized data storage [10][11].

4. Benefits to Stakeholders

- Law Enforcement: With increased data availability and real-time tracking, police can find burgled vehicles, trace them back to their owner, and stop them from being sold on the black market. The blockchain network will also offer a secure, transparent vehicle data verification solution that will help officers to detect fraud or theft more effectively.
- Automakers & Service Centres: Automakers and service centres will see an improvement in data security procedures making them less vulnerable to hackers. With the blockchain integration, vehicle registration and record-keeping will be streamlined with one single truth for the vehicle's lifecycle from manufacturing to selling to servicing.
- Consumers: Drivers will be assured that their vehicle ID and ownership information are safe and secure. As a result of real-time VIN verification and GPS-driven vehicle recovery, consumers will be better off reclaiming their car when they are stolen.
- Insurers: Insurers will experience increased data integrity and availability. The blockchain technology ensures that claims are processed with proven, tamper-resistant counterparties. Automakers, insurers, law enforcement, and consumers benefit from improved data security and theft prevention.

5. Demonstration & Pilot Testing

An internal PoC for the blockchain-based VIN verification mechanism was created and run under virtual conditions. In the PoC, vehicle transactions (such as transfer of ownership and registration) were all simulated and tracked on a private blockchain network. Initial findings indicate that the system effectively monitors and validates car ownership at any given moment, avoiding unauthorised modifications to vehicle id information. Future stages of the PoC will involve partnering with industry partners to expand the system to real-world situations and validate its scalability. In addition, experiments on the real-time tracking algorithm with GPS-equipped cars showed an increase in the speed and effectiveness of stolen vehicle recovery. The system was able to track where stolen cars went in real-time and alert the police minutes after the car was stolen

The combination of blockchain, better encryption, and real-time VIN recognition is a revolutionary technology to prevent vehicle theft across the globe. By making vehicle identification information secure, tamperproof, and traceable, the solution will not only reduce theft rates but will also strengthen the entire automotive ecosystem. These projected benefits to stakeholders – from police officers to consumers – are testament to how the system could revolutionize vehicle data security and anti-theft protection around the world.

public blockchains, which are completely transparent, this information could fall into the hands of unauthorized people. This issue can be mitigated by creating permissioned blockchains, where access is controlled by only authorized participants (for example, police agencies, automakers, service stations). Further, Zero-knowledge proofs (ZKPs) could validate vehicle data without revealing the secretive data, thus maintaining privacy. Implementing permissioned blockchains and zero-knowledge proofs addresses privacy issues [10].

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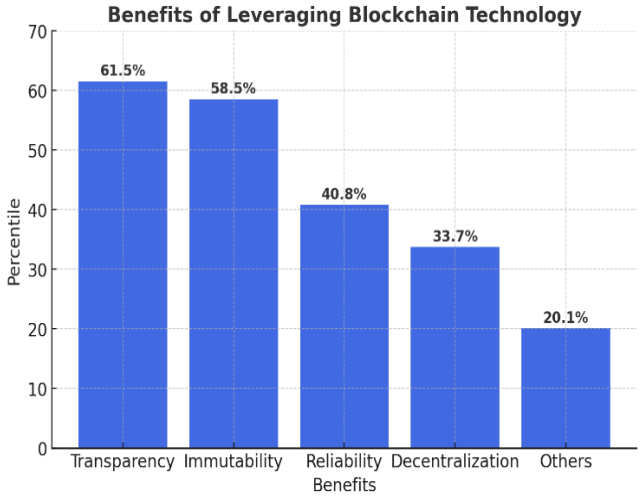

Figure 6 Roberts, L., and Stevenson, M. (2022). Impact of Blockchain on Vehicle Theft Rates

VI. DISCUSSION

1. Scalability of Blockchain Technology

One of the biggest issues associated with bringing blockchain technology across the globe is its scalability. Although the PoC proved it is possible to record VINs on blockchain, we don't yet know how the platform will handle the volume of registrations, transfers of ownership and updates in real time. Blockchain's transaction speed could become a major hindrance if not sufficiently
addressed. In order to mitigate this, future work might look into layer 2 or better consensus algorithms, like PoS or DPoS to scale while remaining secure and decentralized [7][9]. Efforts to enhance blockchain's capacity for large-scale adoption must continue

2. Privacy Concerns

Despite the open and foolproof nature of blockchain, it may be vulnerable to privacy breaches if private vehicle data (such as owner data) is published to the blockchain. On

3. Industry Adoption Challenges

For this approach to work, there needs to be strong stakeholder involvement. Automakers, regulators, law enforcement agencies, insurance carriers, and repair shops will have to agree to standardize data formats and verification processes. Resistance to change and implementation costs may prove to be major barriers to adoption. Thus, it will be critical to create a global standard for blockchain integration and data exchange.

Second, getting all vehicles (both old and new) to join the system will require a phase of transition, in which older vehicles may be dropped off or replaced by non-invasive solutions. It will be important to include automotive stakeholders and regulatory agencies in regulations and compliance conversations if we are to overcome these obstacles [5][11]. Global standardization and collaboration among stakeholders are required for seamless integration.

4. Legal and Regulatory Issues

Any advancements in car security are going to come under regulatory fire. Vehicle registration, data privacy and blockchain use vary by jurisdiction. It'll be a challenge to coordinate the solution with these standards and obtain government approvals. We also need global standardization so that the blockchain system can function across borders because vehicle theft is transnational. Regulators will also have to consider the means by which smart contracts on the blockchain can be triggered when disputes occur or fraud happens, such as theft or fake signing. Creating a legal regime that will acknowledge blockchain transactions as
legally irrevocable will be critical to the implementation of this solution.

Scheme	Blockchain Type	Consensus Network Type	Security Features		
			Authorisation	Confidentiality	Integrity
[12]	Public/Permissioned	Trusted	√	× [1]	× [1]
[16]	Public	Trusted	√	×	×
[19]	Permissioned	Trusted	×	×	×
[15]	Permissioned	Trusted	√	×	√
CRA[3] *	Permissioned	Trusted/Untrusted	√	√	√

[1] The scheme depends on the deployed database to support the mentioned security feature. * CRA[3]: our

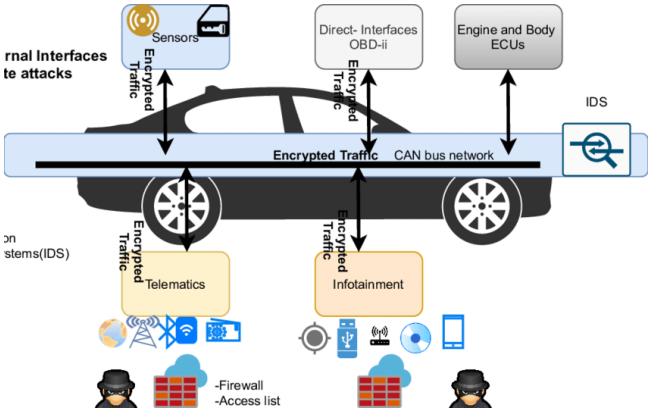

Figure 7 Privacy and Security Architecture

5. Future Research Directions

While the solution sounds promising, there is still much to be researched on several fronts:

• Advanced Vehicle Tracking Systems: Beyond VIN verification, real-time GPS tracking paired with geofencing may further enhance the ability to identify stolen cars and notify the police as soon as the vehicle crosses a pre-defined boundary.

• Decentralized Identity Systems: Decentralized identity systems might allow car owners to take greater ownership over their personal data and make sure only designated individuals can view or change their information.

• AI and Machine Learning to Prevent Fraud: Having AI algorithms which employ machine learning to spot patterns of vehicle fraud or VIN tampering would add an extra level

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of security. This would thereby make it possible to detect malicious processes on the system.

• Regional Integration and International Adoption: Future research should aim to establish global models for blockchain use in the automotive space to help exchange vehicle data across borders and prevent cross-regional theft.

6. Long-term Impacts

Over time, blockchain-based VIN verification and data protection could reshape the entire automotive supply chain. Consumers will have more peace of mind knowing their vehicle is more secure because the information stored in your car cannot be tampered with. Police will have a robust, open vehicle tracking system to locate stolen vehicles, making the recovery faster and reducing vehicle re-sale in black markets. Liability and fraud risks will be reduced for automakers as ownership and histories of vehicles will be safely tracked. Insurance carriers will also benefit from improved records, making claims more efficient and insurance fraud less likely.

VII. CONCLUSION

This paper demonstrates how blockchain, encryption, and real-time monitoring can combat VIN and license plate exploitation. While challenges remain, the proposed solutions pave the way for safer automotive ecosystems [2][6]. Future research should focus on scaling technology, enhancing privacy, and fostering collaboration [8][9].

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