International Scientific Journal of Engineering and Management ISSN: 2583-6129
Volume: 03 Issue: 04 | April – 2024 DOI: 10.55041/ISJEM01446
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

Telematics – Evolution of Stolen Vehicle Tracking Solutions in Automotive Engineering

Suresh Sureddi
ssureddi@gmail.com

Abstract: The automotive industry has transformed drastically over the past two decades with the advancements in IoT, connectivity and Artificial intelligence (AI). Among the connectivity features, technologies for stolen vehicle tracking are continuously evolving as the battle between the car thieves and those committed to protect the vehicle theft is ongoing. This article first details the evolution of stolen vehicle tracking technologies, provides insights into the one of the typical early architectures of Stolen vehicle tracking system using GPS + GSM+ Immobilization technique and then provides the details of latest security technologies like IoT and LPWAN to recover stolen vehicles.

Keywords: Connected Vehicles, Stolen vehicle Tracking, GPS (Global Positioning System), GSM (Global System for Mobile), Internet of Things (IoT), Connectivity, CAN (Controller Area Network), TCU (Telematics Control Unit), Artificial Intelligence.

Introduction:

In 1990s, Telematics systems combined telecommunications and informatics to provide a range of services which include emergency assistance and navigation. GM's OnStar was one of the early systems to offer features like automatic crash notification using GPS and GSM technologies. GPS (Global Positioning System) car tracking systems utilize a network of satellites orbiting the earth to determine the precise location of the vehicle. Later, these technologies are extended to remotely block the stolen vehicle from ignition by using immobilization technique **[1]** (Blocking the engine from ignition). This GPS tracking system revolutionized the stolen vehicle recovery. However, the thieves soon learnt to disable GPS devices. Also, the satellite signals reception was not good in some areas which disrupted the tracking of the vehicle. To address this limitation, the combination of cellular and Wi-Fi technology was introduced to track vehicles, but it was again conquered by thieves with the use of signal jammers to disrupt cellular and Wi-Fi communications. Now, a new IOT based LPWAN technology is gaining attention for its efficacy in stolen vehicle tracking **[2].** This article starts with detailing the system details of legacy Stolen vehicle tracking system using GPS, GSM and Immobilization logic and then provides details about the advanced promising technologies like IoT, LPWAN and AI.

GPS-GSM based Stolen vehicle system architecture:

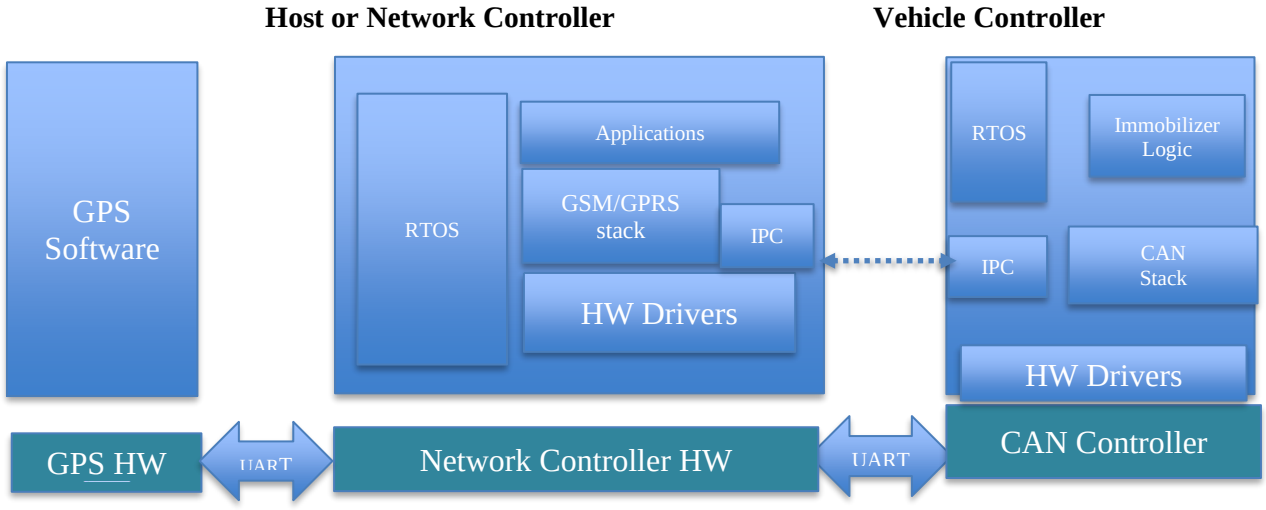

Fig 1: TCU -Typical System architecture of SVT using GPS, GSM and Immobilizer

In early 21st century, systems were built based on GSM and GPRS. Typically, a dual controller architecture was followed by most of these systems. One being the host controller which hosts the GSM/GPRS SW and handles the core connectivity functionality through the cellular network and the 2nd controller is an IO controller which is primarily responsible for interaction with other modules in the vehicle over the Controller Area Network. These two controllers exchange information through an inter processor communication (IPC) protocol over the serial HW interface.

GPS chip runs the GPS software to calculate position, heading and speed of the vehicle and provides this information to the host/network controller for further processing and transmission to the control (Service) center.

Geofencing: This is one of the GPS features which helps TCU to send notifications to the control center when vehicle enter/exits set areas. **[1]**

RTOs (Real time operating systems): Each controller hosts its own RTOs for scheduling and synchronization of tasks.

Vehicle controller hosts vehicle diagnostics in addition to the CAN stack. The combination of vehicle controller functionality and host controller functionality achieve the objective of stolen vehicle tracking and blocking functionality.

Immobilizer: Upon request of the Service Center, the unit activates an immobilizer, which blocks the stolen vehicle by disabling the starter engine. The command to immobilize is not executed while the car is driving but is deferred until the ignition is turned off for a certain period.

Typical interaction between TSP and TCU to achieve stolen vehicle blocking functionality.

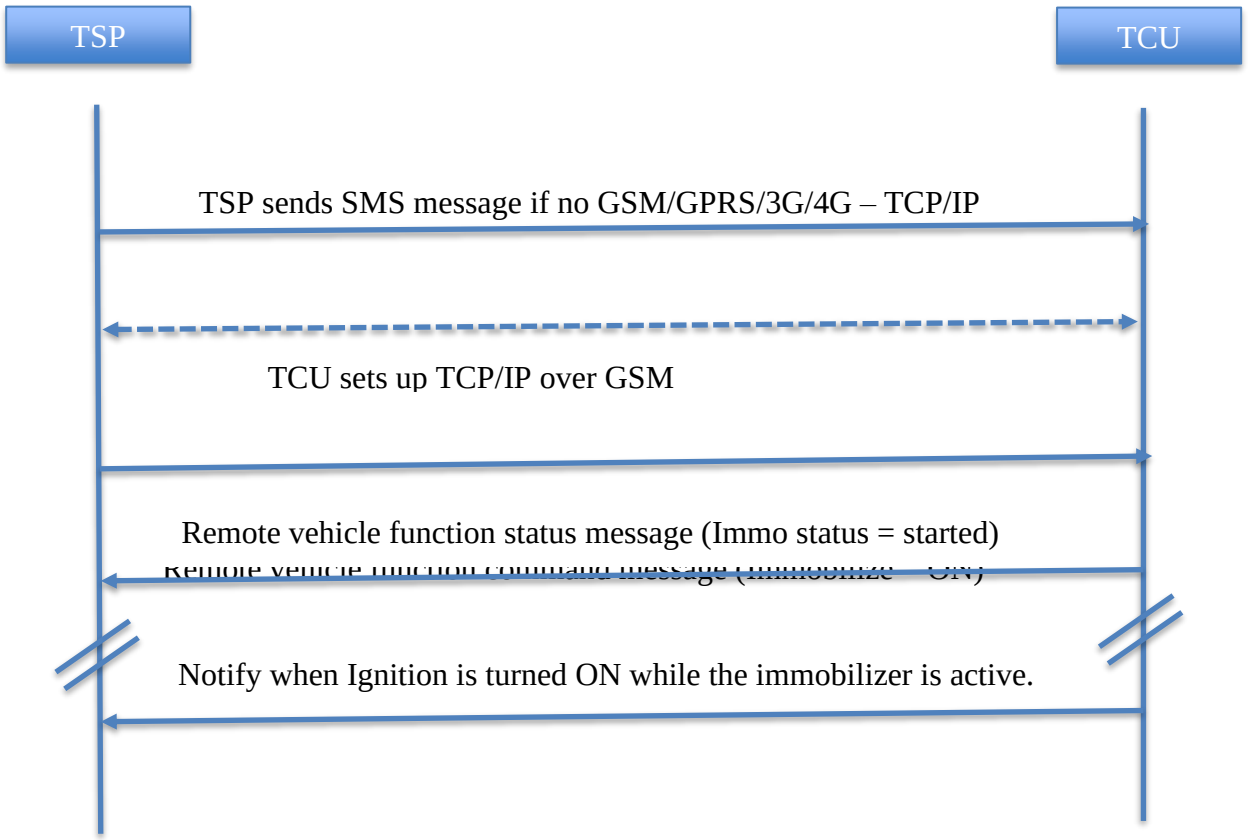

Figure 2: TCU and TSP message sequence for blocking the stolen vehicle.

As shown in above sequence, TCU in the vehicle doesn't immediately block the stolen vehicle after receiving a command from the service center to block the engine. TCU activities the immobilization function and blocks the engine in next ignition which helps to recover the stolen vehicle.

These GPS+GSM based technologies are further advanced to make the system more robust. For example, alternate methods were proposed in case of GPS failure in areas like tunnels and dense urban areas where the GPS reception quality was poor. In one study **[3]**, vehicle positioning system using GSM technology was proposed. According to this study, In GSM, every base station transmits specific network data to the mobile devices. Using this data and applying special techniques, it is possible to calculate a mobile devices location (embedded in the vehicle) with reasonable accuracy. In this network-based approach (a.k.a. Network overlay system), position is calculated by the base transceiver station [BTS] using triangulation and multilateration of incoming radio signals. Position fixing using network-based techniques requires full access to sensitive network information and thus this service can only be provided by cellular network providers. Another drawback of this approach is that it requires specialized hardware and software to be installed in base stations for acquiring AOA and TOA/UTDOA (Time of Arrival/Uplink Time of Arrival). This study concluded that it is not a cost-effective solution and hence it is not a better solution than a device-based approach (i.e., GPS based solution).

One more study **[4]** is performed in 2018 based on Time series prediction algorithm, which can be used in case of the failing GPS. This algorithm takes a series of inputs of latitude and longitude values and predicts the path. A machine learning algorithm is considered to create a prediction model. Also, the comparison of static path values

which are already stored in the database with the dynamic values (taken run time) is made and an alert message is sent to notify any major deviation.

In another study **[5]**, where prototype is performed using Arduino uno microcontroller, Wi-Fi ESP -8266, GPS NEO-6M, switch, DC motor and cloud-based IoT POC platform – Thing speak, proved that cost effective Vehicle anti-theft solution can be accomplished using cloud based IoT solution. Thing Speak is an open data and API platform(IoT POC) which permits data collection, storage and analysis. They considered 5-layer IoT architecture to gather and transform the raw data into useful and readable information.

In another study **[6],** a similar IoT based PoC as mentioned in [5] is performed, with a few differences. One of them being, Raspberry Pi 4 was recommended over Arduino microcontroller due to speed and accuracy even though Arduino is flexible and cost-effective microcontroller. Also, Freeboard was considered which is an HTML-based platform that allows data to be displayed using user customized different layouts. Using freeboard, vehicle location data can be created and visualized from different devices and variety of open APIs.

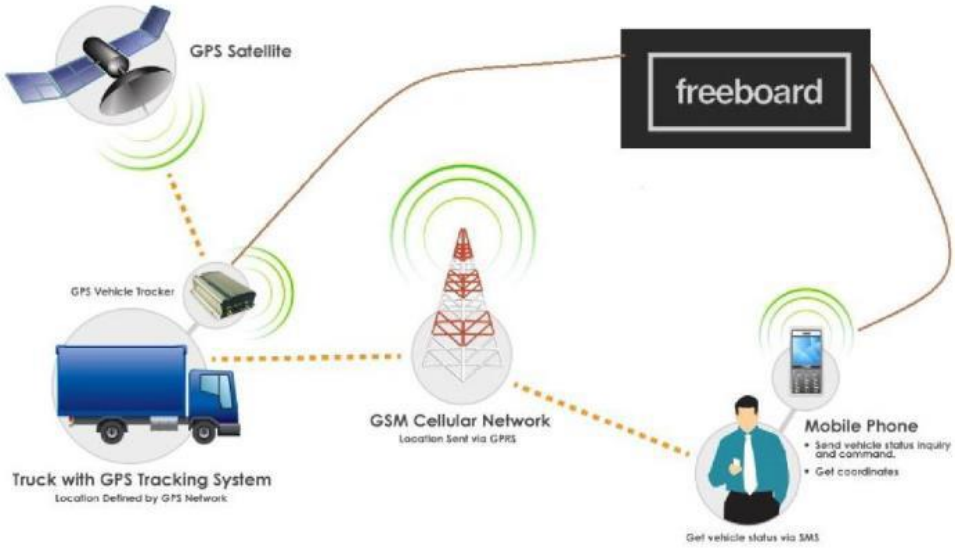

Figure 3: Vehicle tracking system using IoT - Courtesy [7]

While GPS car tracking systems are highly effective, they are not without challenges. Privacy concerns are at the forefront, as the constant tracking of a vehicle's location could be seen as invasive. Moreover, sophisticated thieves have begun using GPS jammers and other technology to evade detection, prompting a continuous cycle of innovation to counteract these measures **[7].** With emerging technologies such as AI (Artificial Intelligence) and machine learning being integrated into GPS tracking systems, enhancing the predictive capabilities to prevent theft proactively, these systems are looking promising. Also, the GPS Trackers have become smaller, more discreet and easier to hide in vehicle components compared to the traditional hardware intense architectures.**[1]**

In one article **[8]**, counter measures for signal jamming, such as biometric technology, radio frequency identification, and ultrasonic sensors were mentioned. But the cost, the potential failure of electronic components and the amount of time needed for installation out weights the benefits and become a barrier for technology adoption. According to this article, IoT devices can provide one solution which will emit signals in different regions. These less expensive and long-life battery devices can be placed in multiple spots within the vehicle, rendering the detection of the device by a thief complex.

Many modern vehicles come equipped with GPS tracking capabilities, either as a standard feature or as part of an optional package. These systems are integrated into the vehicle's onboard navigation or telematics system, providing

not only theft protection but also a range of connectivity features like emergency assistance, fuel consumption, vehicle diagnostics, driver behavior analysis and more.
Also, the car manufacturers are now integrating sophisticated security features, such as biometric authentication systems such as fingerprint and facial recognition. This not only improves security but provides convenience for owners **[1].**

Considering the limitation of traditional GPS systems which can be jammed and disabled by tech savvy criminals, one article **[2]** proposes a LPWAN (Low Power Wide area network). Unlike GPS and Wi-Fi, LPWAN technology remains undetectable and is less prone to interference.

Conclusion:

GPS tracking systems have revolutionized vehicle security. It provides accurate location and tracking and remote immobilization. These GPS+GSM based systems have been further expanded to integrate with cloud computing to make stolen vehicle tracking systems as part of the IoT. These blending traditional deterrents with cutting-edge technology represent a significant leap forward in auto theft protection. As these tracking systems become more integrated with other technologies like artificial intelligence, machine learning and 5G, the hope is that auto theft will become increasingly difficult, protecting not just individual vehicles but also contributing to the safety and security of communities at large. However, as this technology evolves, so too will the methods employed by thieves, ensuring that the battle against auto theft will remain a dynamic challenge.
Car manufacturers are also integrating other sophisticated security features, such as onboard cameras and surveillance systems, biometric authentication systems such as fingerprint and facial recognition. This not only gives additional security but provides convenience for owners.
In fight against vehicle theft, multiple and diversified security technologies to be relied upon by the manufacturers and stakeholders because thieves adapt quickly and find ways to evade them.

References:

[1] DCB Editorial, Aug 18, 2023: Evolution of Vehicle Security: From Locks to GPS Trackers.
https://dailycarblog.com/2023/08/evolution-of-vehicle-security-from-locks-to-gps-trackers/
[2] Gareth Mitchell, 30 Dec 2023**,** Implementing IoT for recovering stolen vehicles.
https://www.iotinsider.com/iot-insights/implementing-iot-for-recovering-stolen-vehicle/
[3] Huq S., Md. Mostafizur Rahman Mozumdar, Md. Manirul Islam, Bayzid Ghani, Mohammad Shihabul Haque, Dec 2006, A Telematics Application for Stolen Vehicle Recovery Using On-Device Position Fixing
[4] Dhanya M, Vol.8 (2018) No. 6 ISSN: 2088-5334 Anti-Theft Vehicle Tracking System Using GPS and Location Prediction
[5] Utkarsha, Keshav Kumar Jhab, Jun 2021, Vehicle Anti-Theft Tracking System Based on Internet of Thing (IoT)
[6] Baravkar Deepak Sanjay1, Ghogare Shivraj Hanumant2, Hole Mrunal Madhav3, Mehak Bhat4, Prof. Poonam Deodar, Jan 2022, A Survey on Vehicle Tracking System using IoT.
[7] Surfside Washington news, 26 mar 2024, The Evolution of Auto Theft protection: Navigating the New Era with GPS car tracking.
[8] Avnet Silica, May 30, 2021, IoT in Stolen Vehicle Recovery: It's a Steal!
https://my.avnet.com/silica/resources/article/iot-in-stolen-vehicle-recovery-its-a-steal/