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Research and Appropriate Implementation on Vehicle Tracking System Using IOT

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Abstract

The development and implementation of vehicle tracking systems based on Internet of Things (IoT) technology have attracted considerable interest due to the rising demand for effective and secure monitoring solutions. This study investigates the investigation and development of a vehicle monitoring system that utilizes Internet of Things (IoT) capabilities to provide real-time tracking, data collection, and analysis. By combining existing literature, IoT principles, and modern technologies, this study seeks to present a comprehensive and practical method for implementing an effective vehicle tracking system that satisfies the requirements of contemporary fleet management. This document provides a thorough investigation and practical application of a vehicle tracking system utilizing Internet of Things (IoT) technology. The research covers a comprehensive examination of relevant articles and resources regarding vehicle tracking systems and Internet of Things (IoT) applications. It explores into the fundamental principles of IoT and its significance in the context of vehicle tracking. The implementation phase encompasses the creation of a bespoke vehicle tracking system that integrates GPS modules, microcontrollers, wireless communication, and cloud-based data storage to enable real-time tracking and monitoring. The integration of advanced data analytics and machine learning techniques enhances the capabilities of the system, resulting in valuable insights, optimized routing, and predictive maintenance. This integration contributes to improved fleet management. The ethical implications pertaining to the protection of data privacy, security, and compliance to regulatory requirements are carefully taken into account. The results of this study make a valuable contribution to the field of Internet of Things (IoT)-based vehicle tracking systems. Additionally, it provide a practical framework that can be utilized by organizations in search of effective and scalable solutions.

Keywords:

Figure 1: Keywords

Softwarica College of IT & E-commerce | in collaboration with Coventry University

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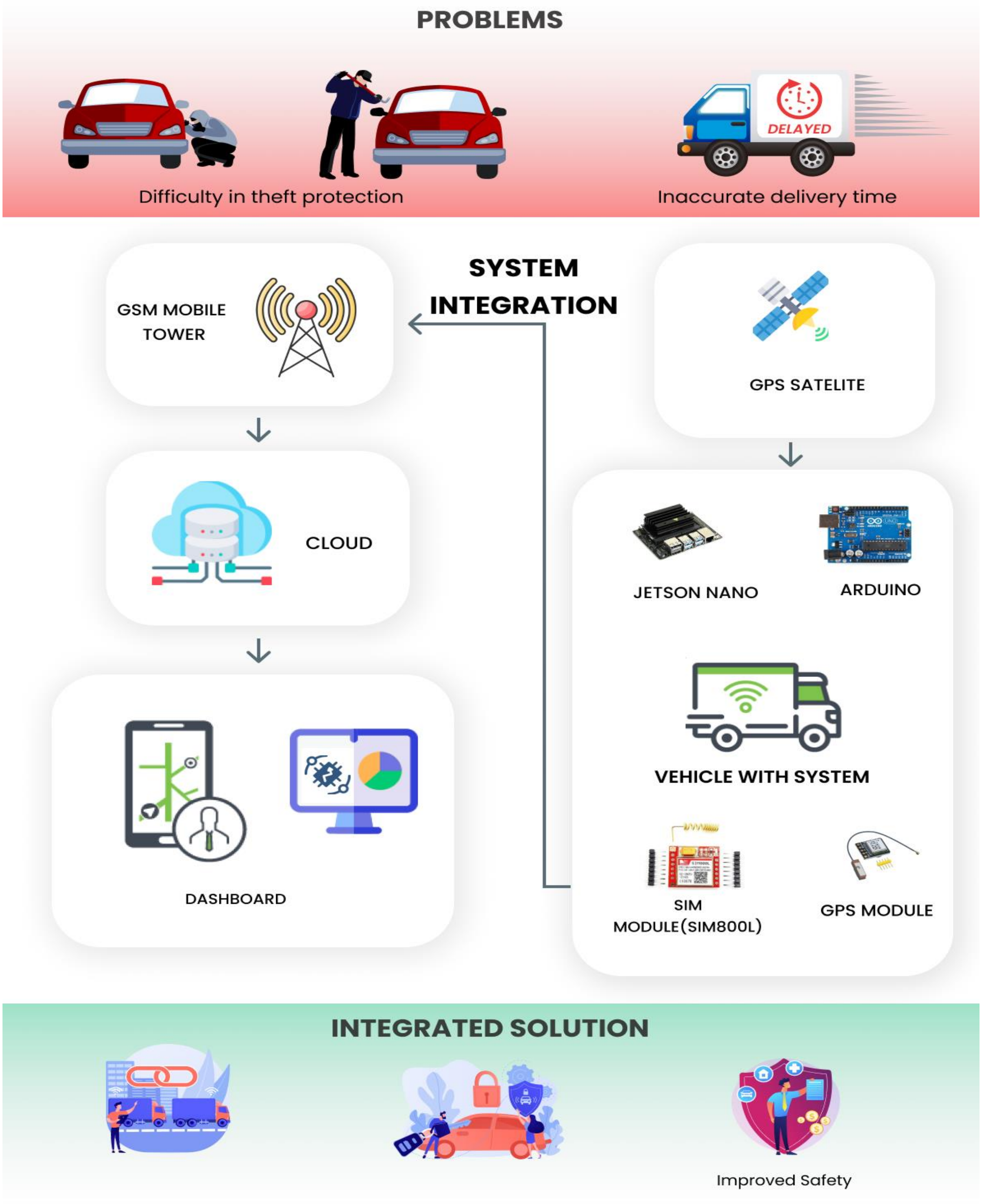
Concept Diagram



Introduction

The rapid expansion of the transportation and logistics industries has resulted in a considerable increase in the demand for effective vehicle monitoring systems that are able to maximize the efficiency of fleet management, improve operational safety, and augment the output of business operations. The landscape of vehicle tracking is undergoing a revolutionary transformation, and one of the most important contributors to this transformation is the integration of latest technology like as the Jetson Nano SIM module and General Packet Radio Service (GPRS) (Zola, 2021).

Figure 2: Introduction on Vehicle tracking System

The Jetson Nano SIM module is a tiny computing platform that is noted for its tremendous capabilities (NVIDIA,2022). It is particularly well-known for its enhanced capabilities in applications involving artificial intelligence and machine learning. Real-time processing of complicated tasks, such as image and video processing, is enabled by the high-performance NVIDIA GPU that this device possesses (Ergin, 2021). This functionality is especially useful in vehicle tracking systems, which place a premium on accurate real-time tracking and monitoring of the vehicles they track. Because of the powerful processing capabilities of the Jetson Nano SIM module, users are able to effortlessly monitor the motions of their vehicles as well as important information such as position and speed.

On the other hand, the technology known as General Packet Radio Service (GPRS) offers a communication channel that is dependable and safe, making it possible to send data across multiple cellular networks without any interruptions (Writer et al., 2022). The Jetson Nano SIM module and the centralized monitoring system are both able to communicate with one another more easily and effectively as a result of the utilization of this technology, which is of critical importance (David ,2022) .Vehicle tracking systems are able to function well and provide fleet managers and vehicle owners with real-time updates when the Jetson Nano SIM module is combined with GPRS.

The adaptability of this integrated system makes it possible to use it in a wide variety of contexts. Fleet managers can make use of it to monitor and control the movements of their vehicles, as well as to increase the efficiency with which they use gasoline and optimize routes. In addition, owners of private automobiles can utilize the system to keep a tight eye on their vehicles, ensuring that they are not being mistreated or stolen in any way by monitoring their locations.

This sophisticated system for tracking vehicles offers a variety of benefits, one of which is the ability to monitor locations in real time. Other key benefits include enhanced levels of operational efficiency and safety as well as increased risk reduction. Fleet managers are able to make more informed decisions more quickly when they constantly monitor the whereabouts of vehicles as well as the performance data in real time (Johnson, 2022). This ultimately results in better resource allocation and lower operating expenses. Enhanced safety features contribute to a safer driving environment and lower the chance of accidents or theft (Kekre, 2021). Some examples of enhanced safety features are real-time alerts for speeding or unauthorized vehicle usage (Kyle, 2022).

This vehicle tracking system that makes use of the Jetson Nano SIM module and GPRS technology is quickly becoming more widespread in use as a direct result of the numerous advantages that it offers. It has become a solution that is sought after by vehicle owners as well as fleet managers who are looking to improve their entire bottom line by optimizing their operations and maximizing their efficiency. Its acceptance rate is continuing to rise, which is cementing its place as a revolutionary and indispensable instrument in the transportation and logistics business. As more companies and individuals become aware of the benefits of this system, the rate of its adoption continues to rise.

Mission and Vision Statement

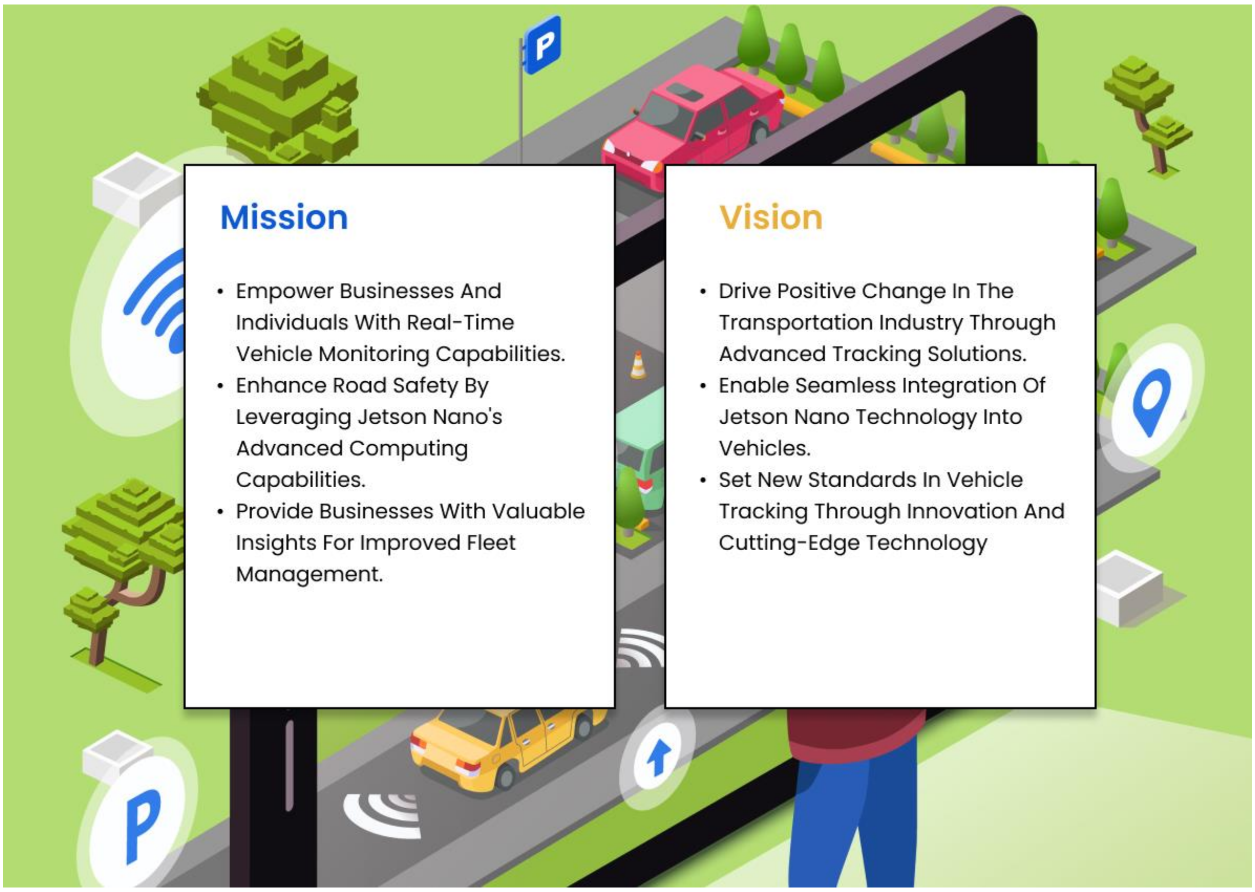


Figure 3: Mission and Vision

Aim

To accurately track the location and movements of vehicles, often in real time.

Figure 4:Aim

Objective

Figure 5 : Objectives

Justification

Nearly every vehicle service and public vehicle in Nepal has problems delivering the right position and seat that is accessible within the vehicle. Passengers will have a more difficult time traveling comfortably as a result of this. The fundamental job of ensuring that the road transportation system is well-organized is what's meant to be referred to as "transportation management," and it's what the phrase "transportation management" alludes to.

In essence, this would require the participation of the general public in the process of making the road economically feasible, sustainable, and organized, all of which will be to our advantage in terms of the means by which we maintain our means of survival. During this historical period, however, the public transportation system was not just unreliable but also inconvenient for a number of different reasons. Because there was a shortage of adequate technology and trained workers, the transportation system had never been updated to improve service for the general population. This prevented the system from being improved. The inefficient management of public transit, which can result in issues such as unwanted traffic and delays in service, has an effect on every industry, including offices and schools, and can generate a wide range of problems. One of the only ways to alter the focus of a society to one that is more developmentally focused is to make changes to the way public transit and automobiles in general function. Transportation is the most important factor in human advancement. It is of the utmost significance to educate oneself on the fundamental requirements of both traffic management and administration of public transit. Educating oneself on these fundamental criteria is of the utmost importance.

Figure 6: justification

The creation of a vehicle monitoring system that will assist in locating the vehicle of interest could be a solution to the problems described above. There are a variety of reasons that make vehicle tracking extremely important in Nepal. These reasons are all interconnected. One of the motivations is to improve people's perceptions of their own safety and security while they are behind the wheel. Through the use of tracking technology, the authorities are able to keep an eye on the whereabouts of vehicles and ensure that they are adhering to all of the rules and regulations of traffic. This has the potential to contribute to a reduction in the number of accidents and incidents that occur on the roads, which will ultimately result in an improvement in the safety of travel for all users. The implementation of vehicle monitoring in Nepal is justifiable for a number of reasons, one of which is the improvement of production and efficiency. Tracking the whereabouts and motions of a company's cars can assist businesses and other organizations in improving their productivity while simultaneously cutting their costs by enabling them to more effectively optimize their travel itineraries and schedules. This can be of the biggest importance for logistic businesses because they rely largely on the efficiency of transportation to move goods and commodities all across the country. This could have a nationwide impact. Lastly, the utilization of technology that tracks vehicles can also help to improve the environmental sustainability of an operation. If the authorities keep an eye on the whereabouts and actions of cars, they will be able to pinpoint specific locations where there is room for advancement in terms of the reduction of emissions and put in place measures that will minimize the impact that transportation has on the environment in its immediate vicinity. Tracking of vehicles is a crucial instrument that can assist in the accomplishment of critical goals in Nepal, including the enhancement of safety and efficiency as well as the promotion of sustainable practices. It has the potential to contribute to the overall prosperity of the nation by helping to make transportation systems more dependable and efficient. This, in turn, could contribute to the general wellness of the nation's transportation networks.

Research Questions

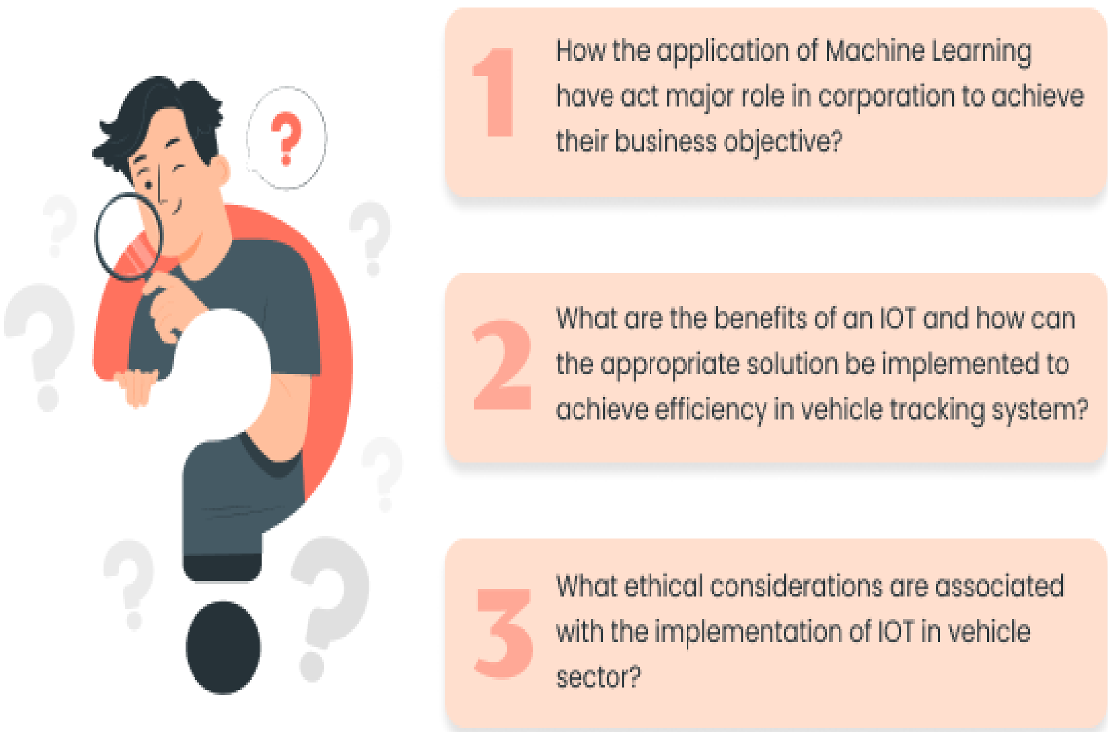


Figure 7 : Research Questions

Scope

Figure 8: Scope

Ethical Considerations

Creating a vehicle tracking system requires rigid ethical considerations, including prioritizing user privacy by implementing strong data security measures and obtaining explicit user consent for data collection and processing (Ethical,2019). In order to cultivate trust and responsibility, open and honest communication regarding the objective, scope, and any hazards associated with the tracking system is absolutely necessary (Silva, 2020). To protect individual identities, anonymization and aggregation of data should be used, and regulations for the retention of data should be explicitly stated to ensure that data is not kept for longer than is necessary given its current and anticipated uses (Chang, 2016). When implementing AI algorithms, bias mitigation measures need to be implemented, and users should have the opportunity to view, amend, and delete their data. They should also have the choice to opt-out of tracking services, which promotes user control and autonomy. Maintaining ethical standards throughout the development and deployment process requires strict adherence to any applicable data protection regulations, as well as extensive public education regarding the capabilities of the technology in question and any accompanying privacy protections (Groth, 2022).

Figure 9: Ethical Considerations

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Literature review

Desk Based research

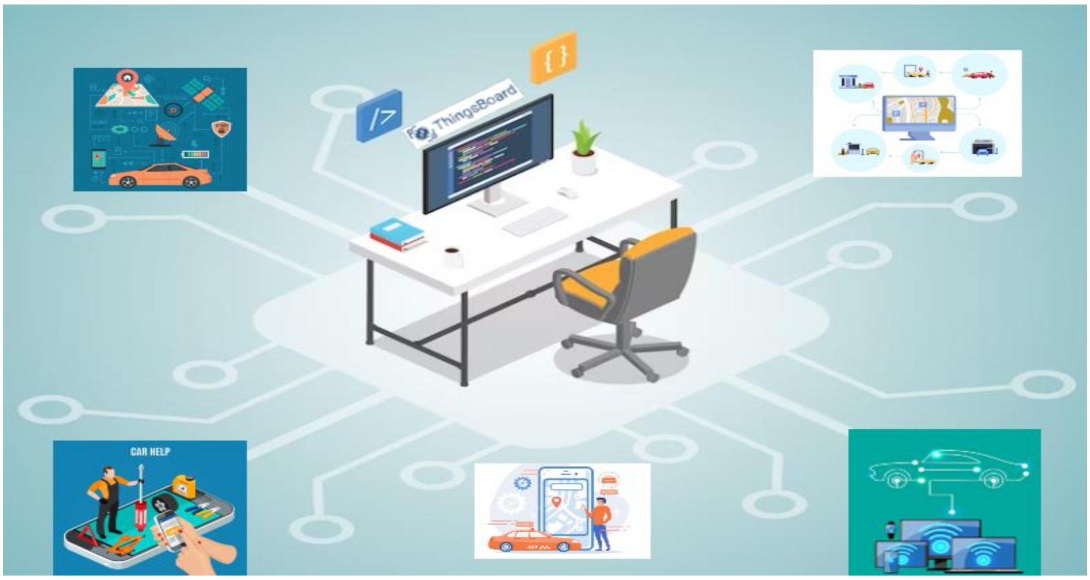

Figure 10: Desk based Research

The investigation of a vehicle tracking system utilizing Jetson Nano can be carried out through the process of conducting a comprehensive examination of the available literature, scholarly articles, technical documentation, and online resources pertaining to the particular subject matter (International Journal of Scientific Research in Science, 2021). " It is recommended that before beginning, one become familiar with the fundamental principles that underlie vehicle tracking systems as well as the specific features supplied by the Jetson Nano platform. This will allow one to get started (Elmanaa et al., 2023). In addition, it is vital to have a good understanding of the capabilities of the device in terms of edge computing as well as its potential for assisting AI processing. It is recommended that research papers, white papers, and case studies be investigated that showcase realistic implementations of vehicle tracking solutions that are based on Jetson Nano technology (Aarab, 2023). It is recommended that a thorough research into the technical prerequisites and specifications that must be met in order to carry out the implementation of the aforementioned system be carried out. The aforementioned components include data storage, communication protocols, camera modules, and GPS receivers. In addition, any existing open-source projects, libraries, and application programming interfaces (APIs) should be investigated in depth to evaluate the extent to which they could be useful in the process of developing the system. It is important to conduct research into the many different artificial intelligence algorithms and computer vision techniques that can be included with Jetson Nano in order to improve the precision of vehicle tracking. In conclusion, when installing a vehicle monitoring system, one should take into consideration the ethical implications, the protection of data privacy, and the adherence to regulatory norms. Guaranteed to be obtained is a full comprehension of the subject matter in preparation for the possibility of its implementation or the conduct of additional study.

Rolls Royce

Rolls-Royce, which is a prominent provider of power systems and services, has been at the forefront of the movement to incorporate Internet of Things (IoT) technology into its products and services in order to improve performance, save costs, and increase efficiency. The company was able to adapt its business model to give value-added services to clients by incorporating IoT, which enables the company to supply customers with real-time data and predictive analytics (Rolls Royce 2019). In this examination of secondary literature, we will investigate how Rolls-Royce has implemented IoT and the benefits that have resulted from this integration. Rolls-Royce has been making improvements to its jet engines, which are one of the company's primary areas of focus, with the use of internet of things (IoT) technology (Abraham,2021). The company is able to gather real-time data on the operation of its engines because it integrates Internet of Things sensors into those engines. This data can then be evaluated to improve fuel economy, lower maintenance costs, and shorten the amount of time that the engines are offline. Rolls-Royce has also developed an artificial intelligence (AI)-based system that it calls Total Care (Buntz, 2023).

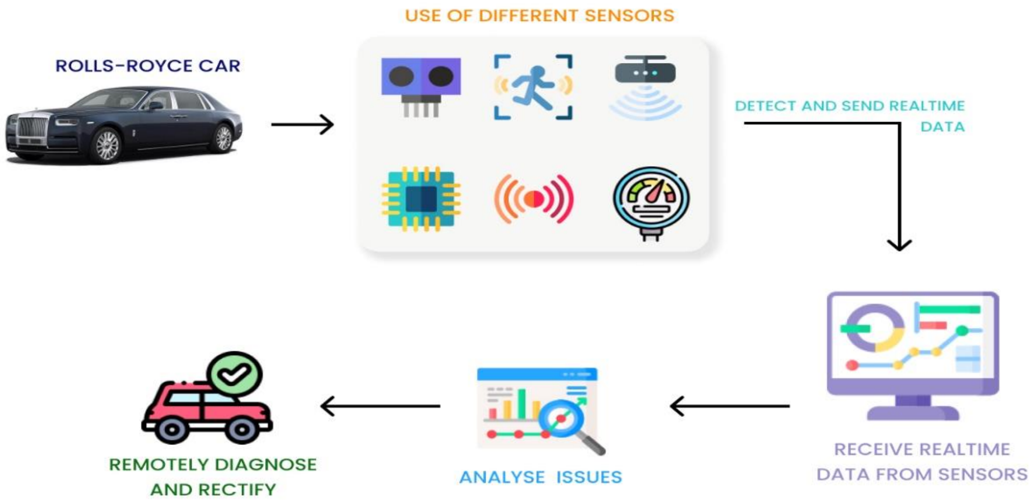

Figure 11: Rolls Royce's IOT implementation

This system makes use of the data obtained from Internet of Things (IoT) sensors to forecast when maintenance is required. This allows Rolls-Royce to schedule maintenance before any severe problems occur. Because they take such a preventative approach to maintenance, the company's customers have benefited from tremendous cost reductions. The Internet of Things (IoT) technology has also been included by Rolls-Royce into its marine goods. MTU Go!, the intelligent asset management system offered by the company, makes use of Internet of Things (IoT) sensors in order to collect information on the operation of the vessel's engine and other essential components (Msmith, 2016). Customers are given the ability to optimize their operations and experience a reduction in expenses thanks to the system's provision of real-time data on fuel usage, emissions, and engine condition. Additionally, the business has developed a remote monitoring system that is known as MTU Go! Remote. This system enables clients to monitor the operation of their boats from any location in the world using the system. Rolls-Royce has integrated internet of things technology not just into its products but also into its services, such as its remote monitoring and diagnostics service referred to as "Care." This service use Internet of Things (IoT) sensors to collect data on the operation of the engine and other essential components. This data is then evaluated in real time to identify any potential problems that may exist (Joshinav, 2018). If a problem is found, the knowledgeable staff of the organization may diagnose and fix it remotely, minimizing the amount of time the clients' systems are unavailable and saving them money. Rolls-Royce has also implemented internet of things technology into the operations of its supply chain. The "Digital Supply Chain" program of the corporation makes use of sensors connected to the internet of things as well as other digital technologies in order to check inventory levels, monitor the performance of equipment, and optimize logistical operations. Because of this, the company is able to shorten its lead times, boost the reliability of its deliveries, and work more efficiently. Rolls-Royce has been able to successfully incorporate Internet of Things (IoT) technology into its products and services. This has made it possible for the company to give clients with value-added services that include real-time data and predictive analytics (Zhong,2019).

The company was able to adapt its business model to become more proactive in its maintenance, hence improving performance and lowering costs. This was made possible by the incorporation of IoT. The company's success and its position as a market leader in the field of power systems and services are both attributable to the effective implementation of IoT, which has contributed to that success.

Amazon

Amazon is one of the world's largest and most successful companies, with a market capitalization of over $1.6 trillion as of September 2021. The success of the company can be attributed in part to the fact that it makes use of cutting-edge technology, such as the Internet of Things (IoT) (Pal et al., 2022). The Internet of Things (IoT) refers to the networking of actual physical items, vehicles, buildings, and other objects that are outfitted with electronics, software, sensors, and network connections that enables them to collect and share data (Amazon,2022). Amazon has been on the front edge of Internet of Things (IoT) innovation, integrating this technology into its whole business strategy to boost productivity, cut expenses, and provide superior service to customers. The Internet of Things (IoT) activities undertaken by the corporation

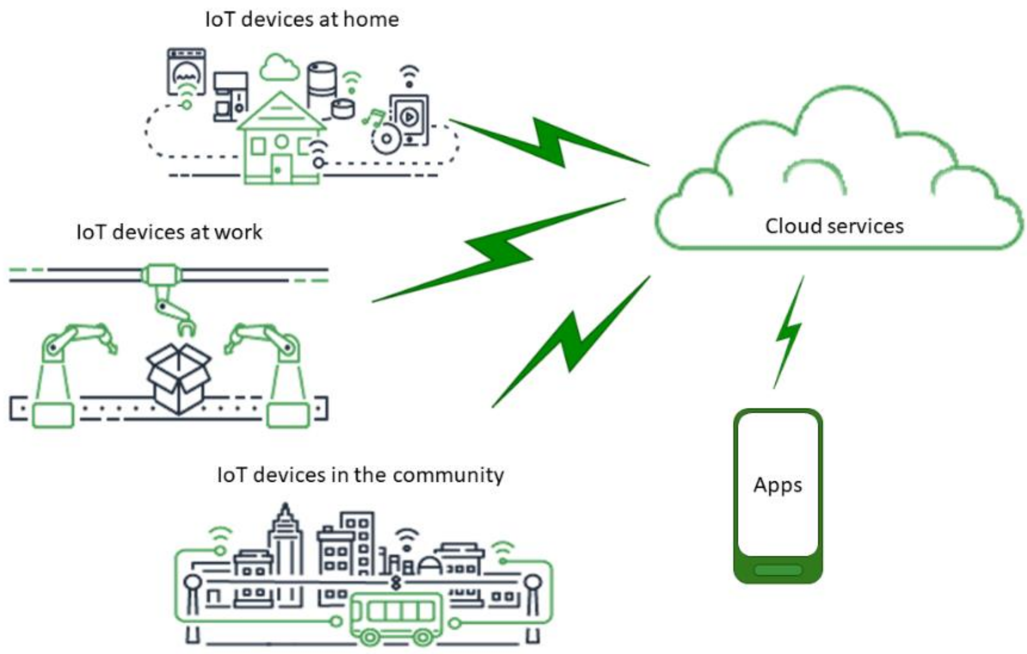

Figure 12: Amazon's IOT implementation

encompass the entirety of its many business divisions, including retail, logistics, and cloud computing. Amazon's AWS IoT has strategically utilized the potential of the Internet of Things (IoT) to propel the company's growth and solidify its position as a technology leader. AWS IoT enables organizations to connect, manage, and analyze a large array of Internet of Things devices and data in a seamless manner by providing a strong and scalable Internet of Things platform. This results in increased operational efficiency and cost optimization for businesses in a variety of different industries. This has not only helped Amazon enhance its existing businesses, but it has also opened up new revenue streams for the company as AWS IoT has become a solution of choice for organizations that are looking to harness the power of IoT for digital transformation.

Amazon has been able to successfully combine internet of things technology with its smart home gadgets, such as the Amazon Echo and Alexa, so establishing an ecosystem that encourages customer loyalty and boosts Amazon's market presence in the market for consumer electronics. These gadgets, which have voice-activated features, give seamless management over Internet of Things (IoT) enabled smart home devices. As a result, user experiences are enhanced, and demand is driven for Amazon's smart home ecosystem.

In addition, AWS IoT has been crucial in improving the efficiency of Amazon's massive network of fulfillment centers, which falls under the purview of the logistics and supply chain sector. Amazon's ability to monitor and track inventory levels, optimize warehouse operations, and ensure timely deliveries are all made possible by the company's usage of IoT sensors and devices. This helps Amazon maintain its reputation as a provider of prompt and dependable service.

The capabilities of AWS IoT go beyond the core product that it provides, which helps to drive innovation and expand the AWS ecosystem. AWS IoT helps businesses to generate useful insights from IoT data, driving data-driven decision-making processes and increasing customer experiences. This is made possible by integration with other AWS services, such as artificial intelligence and machine learning technologies. This integration not only improves Amazon's internal operations, but it also encourages more businesses to embrace AWS services for their Internet of Things (IoT) needs, which ultimately results in the expansion of the company's client base and market reach.

In addition, AWS IoT encourages innovation by supplying organizations and developers with the instruments, resources, and capabilities necessary to prototype, experiment with, and implement Internet of Things solutions. As enterprises work together with Amazon to develop new applications and use cases, the robust partner ecosystem further accelerates IoT adoption, which in turn spurs continued growth in the IoT market.

Amazon's AWS IoT is a service that makes strategic use of the Internet of Things (IoT) in order to expand the company's presence across several industries, improve its already-established businesses, and bring in new consumers for the AWS ecosystem. AWS IoT plays a pivotal role in driving Amazon's continued growth, reinforcing its position as a technology giant, and solidifying its leadership in the internet of things space. It does this by providing a comprehensive internet of things platform; integrating internet of things technology into its consumer electronics; optimizing its supply chain; and fostering innovation.

Coca-Cola

Coca-Cola, one of the most successful beverage businesses in the world, is implementing Internet of Things (IoT) technology in a methodical manner in order to expand its company and improve a variety of areas of its operations. By utilizing IoT, Coca-Cola intends to optimize its production, distribution, and customer engagement processes. This will, in turn, allow the company to strengthen its position in the market while also providing consumers with great experiences. During the manufacturing process, Coca-

Cola uses sensors and other Internet of Things–enabled devices to monitor production lines. This helps the company achieve the highest possible level of efficiency and keep downtime to a minimum. The data that these devices generate in real time enables predictive maintenance, which in turn enables the early identification and resolution of possible equipment issues, which in turn reduces production disruptions and increases overall productivity. In addition, the management of Coca-Cola's supply chain is greatly aided by the Internet of Things. The business is able to receive real-time insights into inventory levels, the states of products, and transportation routes thanks to the incorporation of Internet of Things sensors in delivery vehicles and containers. This method, which is driven by data, improves logistics, cuts down on the cost of transportation, and ensures that goods are delivered to retailers and customers on time.

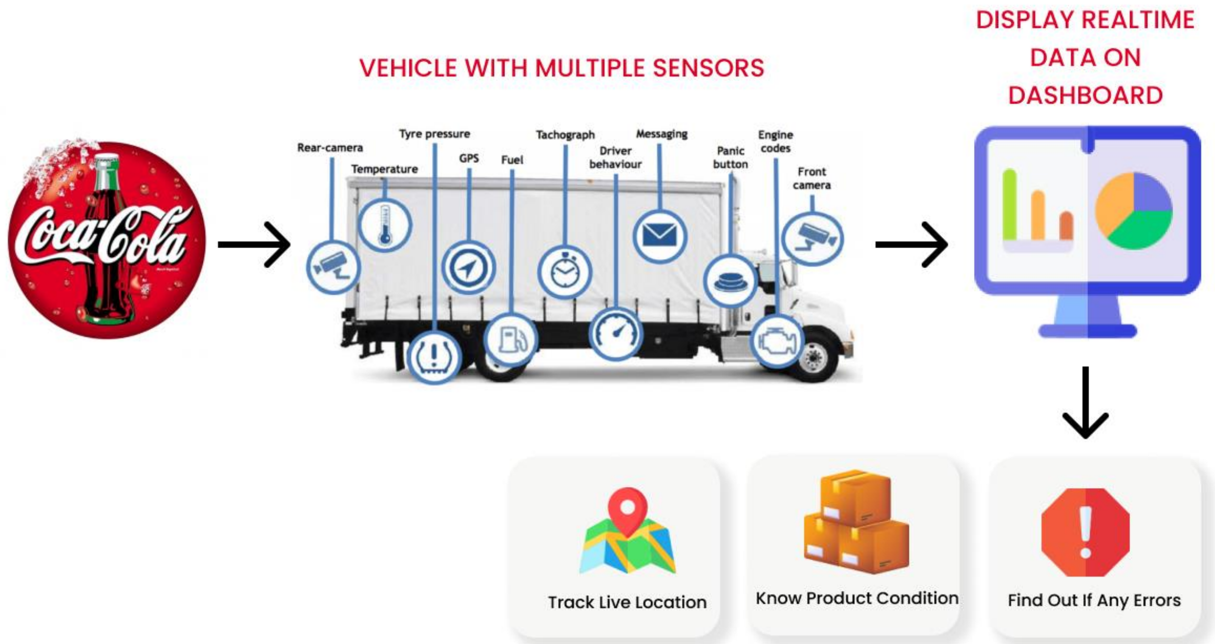

Figure 13: Coca-Cola and its IOT implementation

Coca-Cola employs the internet of things for a variety of purposes, including operational improvements, customer interaction, and marketing campaigns. Consumers can get more tailored experiences from smart vending machines that are connected with internet of things capabilities. These robots are capable of analyzing the preferences of customers as well as their purchasing habits, which enables targeted marketing and product recommendations. In addition, Coca-Cola uses Internet of Things (IoT) technology to power digital signage in order to present commercials that are dynamic and interactive, thereby attracting customers and increasing their commitment to the brand. Data analytics that are driven by the Internet of Things provide Coca-Cola with significant insights about the behavior of consumers, trends in the market, and the success of their products. The formulation of data-backed strategies, the identification of rising market opportunities, and the launch of new product versions that are tailored to specific consumer preferences are all aided by these insights.

Additionally, Coca-Cola places an emphasis on preserving the environment by utilizing IoT. It is possible to optimize resource consumption at production facilities with the help of smart metering and energy management systems. This helps the company reduce its negative impact on the environment and improve its efforts related to corporate social responsibility. In addition, fleet management solutions that are enabled by the internet of things ensure effective maintenance and tracking of delivery trucks, which contributes to a reduction in both operational costs and emissions. Putting an emphasis on sustainability not only appeals to customers who are conscientious about the environment, but it also helps to boost Coca-Cola's reputation as a responsible corporate institution. IoT integration throughout Coca-Cola's manufacturing, supply chain, marketing, and sustainability programs illustrates the company's commitment to leverage innovative technologies for the expansion of its business. Coca-Cola seeks to increase its worldwide market presence, improve customer experiences, and maintain its position as an industry leader in the rapidly transforming beverage business by adopting IoT-driven insights and enhancing operational efficiency. These goals can be accomplished by embracing the Internet of Things.

Tesla

Tesla, which was an early leader in the market for electric vehicles (EVs), is currently leading the way in the incorporation of technologies related to the Internet of Things (IoT) in order to accelerate its business growth and revolutionize the automotive industry. The Internet of Things (IoT) is of critical importance to Tesla's autos because of its capacity to deliver a wide variety of features and capabilities that set them apart from conventional vehicles. The Tesla autos stand out from other types of vehicles due to their unique features and capabilities, which differentiate them from those offered by other manufacturers. Through the incorporation of cutting-edge sensor technologies, cameras, and communication modules into its electric vehicles, Tesla has created a comprehensive Internet of Things (IoT) ecosystem.

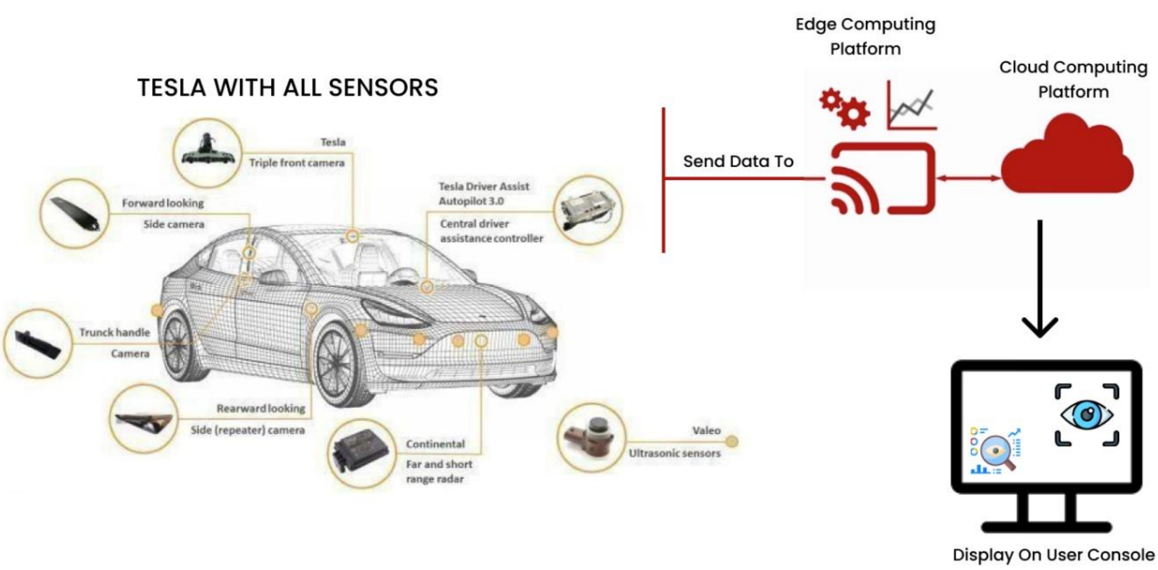

Figure 14: Tesla's IOT implementation

As a direct result of this process, the end product is the production of electric vehicles manufactured by Tesla. The sensors keep an eye on many other aspects of the car, including the condition of the battery, several performance measures, and additional safety features. This ensures that the vehicle is subject to unbroken, real-time surveillance even as it performs at the pinnacle of its potential levels of effectiveness. Over-the-air upgrades are a functionality made possible by the Internet of Things (IoT) that Tesla uses to continuously improve the capabilities of its vehicles and provide new features. Because of this strategy, the long-term viability of Tesla's fleet is practically ensured, and it does so without requiring trips to service facilities or official vehicle recalls. In addition, because Tesla's vehicles are connected to the internet, they are able to gather a significant amount of information regarding driving patterns and general vehicle utilization. This makes it possible for the company to do an analysis on the data described above and draw substantial insights from them. These insights may then be put to use in research and development, product innovations, and the delivery of individualized experiences to customers. In addition, internet of things (IoT) technology is utilized by Tesla's Supercharger network, which is spread out in a strategic manner across the globe. This is done in order to properly monitor and manage the charging infrastructure. Because to this feature, owners of Tesla vehicles are able to charge their vehicles quickly and easily, which not only improves the overall usability of electric vehicles but also helps to increase their wider adoption on a global scale. Through the implementation of a forward-thinking approach that used Internet of Things (IoT) technology, Tesla was able to establish itself as a leader in the competitive automobile sector. In addition to this, the company has established itself as a frontrunner in the fields of environmentally friendly transportation and driverless vehicles. The unconventional application of internet of things technology that Tesla has adopted is largely responsible for the company's ability to differentiate the quality of the products and services it offers in the automotive industry. Tesla is able to maintain its dominant position as the market leader in the electric car business by capitalizing on the opportunities given by the internet of things (IoT). This allows Tesla to continue to lead the market. Because of these characteristics, the company has seen an increase in the area of business it specializes in, has shown an enhanced level of innovation, and has strategically positioned itself for future expansion in the context of environmentally conscious and intelligent transportation.

Development Methodology

Waterfall methodology is a software development life cycle process. It shows a rigid framework for the software development process as a series of steps. The waterfall methodology can provide various advantages for individual projects. One notable advantage lies in its inherent simplicity and clarity, rendering it particularly advantageous for an individual overseeing the entirety of a project. By establishing precise and clearly articulated requirements at the outset, individuals are able to develop a comprehensive and structured plan that outlines the various stages and

milestones of the project, thereby facilitating a systematic and organized approach from initiation to completion. This approach minimizes ambiguity and enables individuals to concentrate on executing each phase in a systematic manner, without being burdened by the intricacies of team coordination and communication typically associated with Agile methodologies.

Figure 15: Waterfall Methodology

The sequential structure of the waterfall model is well-suited to an individual's preferred approach to work. When a single individual assumes responsibility for all facets of a project, the necessity for extensive collaboration and frequent status meetings is reduced. Alternatively, individuals can adopt a systematic approach by carefully progressing through each phase, thereby enhancing their ability to efficiently allocate time and resources. Moreover, in the absence of team dependencies, the process of decision-making can become more streamlined and expeditious, thereby augmenting the overall efficiency of the project.

The waterfall methodology is well-suited for smaller projects characterized by a limited and stable scope, owing to its simplicity and individual-focused approach. The waterfall model is often more suitable for individual projects due to its ability to facilitate easier management and control of the project scope. By establishing a comprehensive comprehension of the project's specifications and limitations from the beginning, the individual can proceed with assurance and a methodical approach, thereby guaranteeing the production of outcomes of superior quality.

An additional benefit of employing the waterfall methodology in individual projects is its provision of a clearly delineated structure for the documentation process. Every phase of the project necessitates the production of distinct deliverables, including documents outlining the requirements, plans for the design, and test cases. Consequently, the individual is able to effectively uphold comprehensive documentation of the project's advancement, thereby ensuring the thorough recording of all facets of the project's evolution. Furthermore, the waterfall methodology may be deemed a suitable option for individual projects in cases where the technology stack and development tools have already been established and are well-known. In these instances, the demand for ongoing experimentation or frequent modifications is reduced, thereby enhancing the value of the structured and sequential characteristics inherent in the waterfall approach. Notwithstanding these benefits, it is imperative for the individual to recognize the constraints of the waterfall methodology. A significant limitation is the absence of adaptability. After the completion of a phase, it becomes difficult to retroactively introduce modifications without causing disruptions to the

overall progression of the development process. This issue can be of considerable importance, particularly when the individual confronts unexpected obstacles or encounters additional criteria during the process.
Moreover, it should be noted that the waterfall methodology may not be optimally suited for projects characterized by uncertain or evolving requirements. Changes can also occur in individual projects, and if the initial requirements are subject to modification, the inflexible nature of the waterfall model can impede adaptability.

The waterfall methodology may be deemed an appropriate selection for individual projects given certain circumstances. The methodology's attributes of simplicity, clarity, and structured approach render it highly suitable for the management of projects that are well-defined and stable, with limited requirements for extensive team collaboration. Moreover, the capacity to uphold thorough documentation can prove to be advantageous for individual project managers. Nevertheless, it is imperative for individuals to thoroughly evaluate the extent, specifications, and prospective modifications of the project prior to selecting the waterfall methodology. Agile methodologies may provide enhanced flexibility and adaptability for the successful execution of projects in situations where requirements are prone to change or when the project involves a more exploratory approach.

Tools, Technology and Integration

Several essential tools are utilized in the creation of an IoT-based vehicle tracking system, with each playing a crucial role at various stages of development.

Figure 16 :Tools

Freepik works as a resource for accessing a wide range of graphics and design elements of superior quality. This facilitates the development of visually captivating user interfaces and icons, thereby enhancing the overall user experience of the tracking application. The user interface of the system is designed and developed in a passive manner, incorporating resources obtained from Freepik in order to ensure intuitive and user-friendly interactions for the end-users.

Visual Studio Code (VS Code) serves as the principal code editor for the vehicle tracking system, facilitating the composition, debugging, and testing of the source code in a non-intrusive manner. The robust capabilities and expansive plugin ecosystem of Visual Studio Code empower developers to operate with heightened efficiency, guaranteeing that the code conforms to established quality standards and remains easily maintainable throughout the entirety of the development process.

GitHub, as a widely utilized version control system, works in a passive manner to facilitate seamless collaboration and efficient code management among team members. The code repository is hosted on the platform GitHub, and contributions are made in a passive manner through the use of pull requests and issue tracking. This setup enables a collaborative development environment, allowing multiple developers to work simultaneously on the project. Additionally, it ensures the smooth maintenance of version control.

Figma, a widely used design tool known for its collaborative features, is actively employed in the process of generating infographic and design mock-ups for the vehicle tracking system. Passive collaboration between designers and developers is effectively supported by Figma's cloud-based platform, enabling them to engage in real-time collaboration and seamlessly integrate design modifications. The mentioned approach optimizes the design-to-development workflow and guarantees that the end result aligns with user expectations and conditions.

Incorporating the ThingsBoard, SIM module, GPS module, Jetson Nano, and Arduino board into a car tracking system combines the strengths of these many technologies to produce a powerful and efficient system. The functions of the various parts of the system are described below.

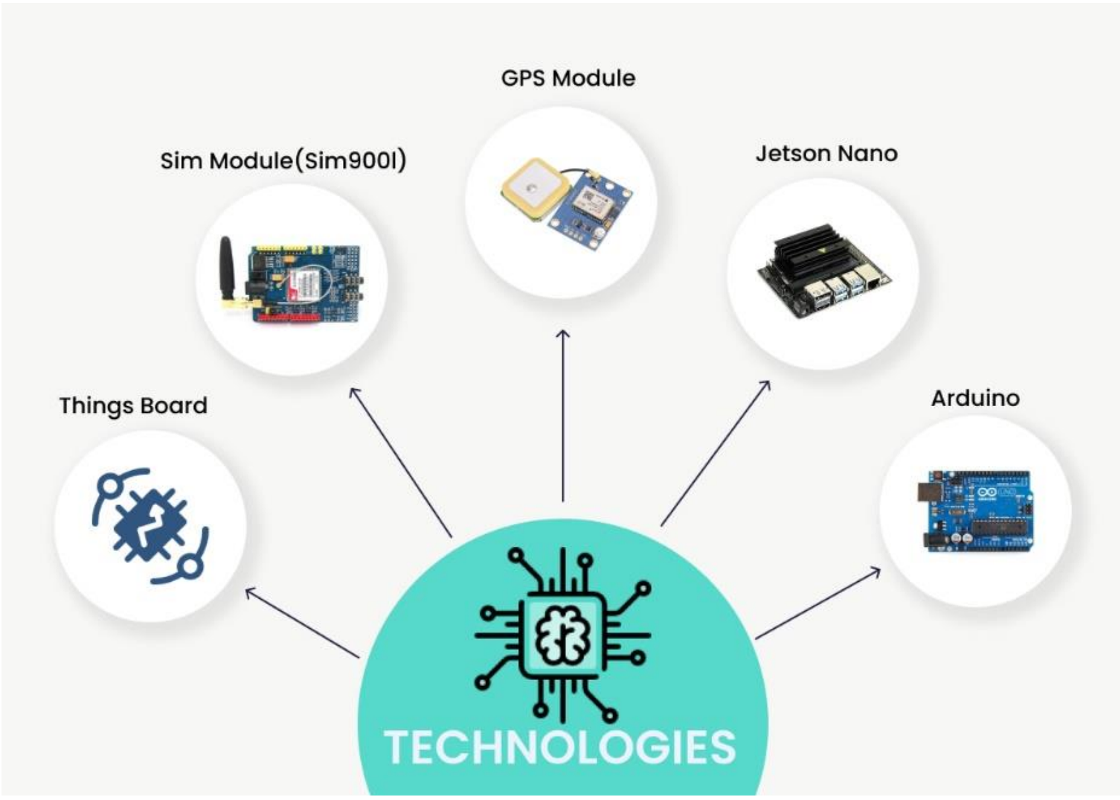

Figure 17: Technologies

The ThingsBoard SIM module allows the tracking system to communicate with the cloud service without any hitches. It acts as an intermediary, sending information gathered by the GPS module and other sensors on to the ThingsBoard cloud for safekeeping and analysis. The SIM module's cellular connectivity makes

the tracking system useful for tracking automobiles across large geographic areas because it is location-independent.
The GPS module is an essential part of a vehicle tracking system since it transmits accurate position updates in real time. It exchanges data with satellites to pinpoint its precise location in space. The ThingsBoard SIM module subsequently uploads this information to the cloud server. The system can track the locations, paths, and speeds of the cars thanks to the GPS information.
The Jetson Nano is an advanced single-board computer that can run AI-capable GPUs, making it ideal for running AI applications and algorithms. The Jetson Nano performs a crucial part in the vehicle tracking system by deciphering the GPS information sent by the SIM module. It can use complex algorithms for planning the best routes, estimating travel times, and analyzing driver habits. And it can use artificial intelligence-based picture identification to help with things like reading road signs and recognizing other nearby items. The system is enhanced by the addition of the Arduino board, which acts as a general-purpose microprocessor. It can handle connecting with sensors and provide a connection between the Jetson Nano and the GPS module. The Arduino board also allows for the connection of other sensors, such as temperature, humidity, and motion, to better understand the surroundings of the car. The Jetson Nano's GPS data can be combined with this information for a more complete picture of the car's location and condition.

Integration

Combining various components, such as a Jetson Nano, a SIM module, a GPS module, and a ThingsBoard, makes it feasible to construct highly effective systems for monitoring automobiles. These systems can be very cost-effective. Because of this, it is now possible to locate vehicles that have been stolen. A piece of edge computing hardware that goes by the name Jetson Nano is the initial component that enters into the process of developing the system. This hardware is known as the Jetson Nano. The name comes from the well-known brand of the product that is being offered for sale. It is able to carry out data processing in real time and make use of artificial intelligence in order to carry out sophisticated vehicle monitoring because it is outfitted with a powerful graphics processing unit (GPU). The combination of these two characteristics enables it to carry out intricate monitoring of the vehicle.
If the Jetson Nano does not have the cellular connectivity that is provided by the SIM module, it will not be able to make contact with external servers or deliver data in real time. Moreover, it will not be able to provide location-based services. This link is necessary for preserving the capability to continuously track and monitor cars, in particular in locations where there is no connectivity to Wi-Fi networks. It is very important to maintain this capability in order to maintain the ability to monitor and follow vehicles.
Because it provides the vehicles with information about their precise whereabouts at any given time, the Global Positioning System (GPS) module is a vital component. In order to enable real-time monitoring and route planning, the Jetson Nano is continually processing data like as GPS coordinates, vehicle speed, and other important telemetry information. This is essential for the operation of the Jetson Nano, which wouldn't be possible without it. ThingsBoard, which is a platform for the Internet of Things, is used to organize and analyze the data that is obtained from the vehicles. This data comes from the various sensors that are installed on the vehicles. The cars are the source of this information. The process of transferring data between the Jetson Nano and the ThingsBoard is carried out via a wireless connection. This connection is established between the two devices. This data interchange may include information

pertaining to GPS and telemetry. ThingsBoard serves as a central server, storing and processing the data, and providing fleet
managers and other stakeholders with an intuitive dashboard that allows them access to real-time updates, insights, and analytics. In addition, ThingsBoard offers a number of other benefits to its users. In addition

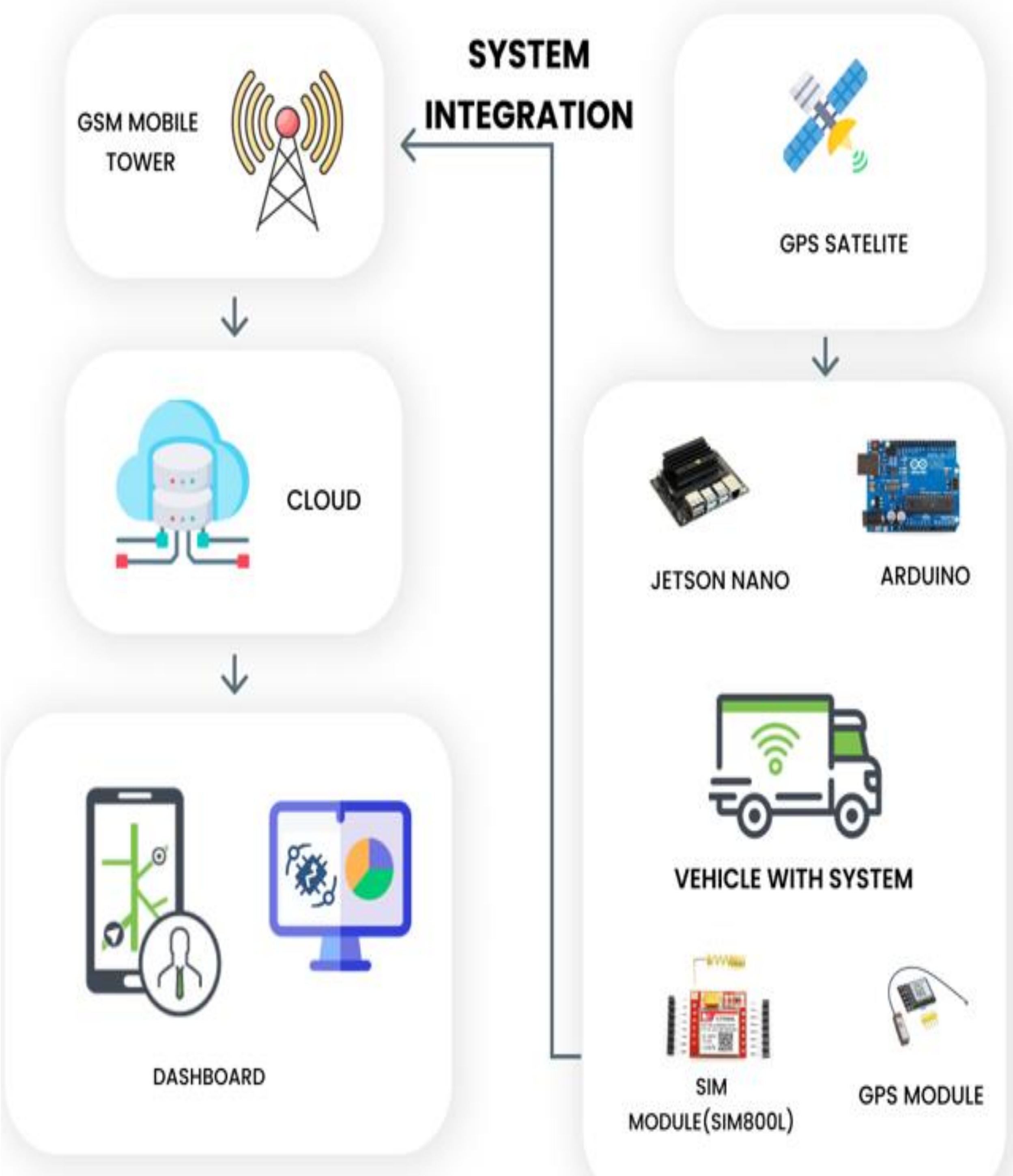

Figure 18 : Integration

to this, ThingsBoard offers a centralized site from which one may view the data being collected. The vehicle tracking system has been synchronized, and as a result, it is now more effective than it has ever been in providing data-driven insights for the purpose of fleet management by means of real-time tracking and remote monitoring. This achievement was previously unattainable. This accomplishment was previously unreachable by any means. It will be much simpler for you to carry out all of the following activities when you have the assistance of a fleet manager, including increasing the effectiveness of routes, keeping track of the condition of cars, and sticking to policies. Utilizing artificial intelligence (AI) algorithms and computer vision could enable the Jetson Nano to do tasks such as object detection, driver behavior analysis, and predictive maintenance. This would allow the capabilities of the Jetson Nano to be expanded even further. These are only some of the many possible outcomes that might be achieved by utilizing this combo. These are just a few examples of the countless different results that are conceivable when applying this combination of factors. These are just a few examples out of a vast number of different potential outcomes that could take place. Because it is able to communicate with other systems, making modifications to the monitoring system in order to make alterations or revisions is both quick and straightforward because to the connectivity that exists between the different systems. One way for keeping the system up to date while yet preserving its adaptability is to implement routine over-the-air upgrades to the system in order to improve its functionality and security. These upgrades can be implemented in order to improve the system overall. This is one of the options that are available to you as a strategy. These improvements are able to be implemented, which will allow for more changes to be made to the system. Some examples of cutting-edge edge computing, networking, and data management technologies that are some examples of technologies that can be included in a system to develop a vehicle monitoring solution that is both extremely effective and immensely intelligent include the Jetson Nano, SIM module, GPS module, and ThingsBoard. These technologies are some examples of technologies that can be included in a system to develop a solution that is both extremely effective and immensely intelligent. The Intel RealSense camera is yet another example of a cutting-edge technology that can be incorporated into a system. This technology can be used for computing, networking, and the administration of data. Other cutting-edge computer, networking, and data management technologies, such as those stated in the previous sentence, are all capable of being incorporated into a system. These technologies include cloud computing, artificial intelligence, and blockchain. Computing in the cloud, computing at the edge, and data management are examples of these technologies. Fleet managers have access to the information they need to make timely, well-informed decisions that enhance operational efficiency and optimize vehicle management, all while decreasing costs and increasing the level of safety within the fleet. These decisions improve operational efficiency and optimize vehicle management. The benefits of these decisions include, among other things, increased operational efficiency and optimized vehicle management.

Technical Specifications

Availability

The vehicle tracking system provides users with a comprehensive solution for the real-time monitoring and management of their fleet or individual vehicles. The system incorporates a sturdy hardware component and is equipped with a high-precision GPS/GNSS module to facilitate precise location tracking, thereby ensuring the accuracy of the positioning data. Communication is enhanced by the utilization of sophisticated cellular or satellite technology, which enables the smooth transmission of data and ensures dependable communication between the tracking device and the centralized platform. The system is designed to accommodate a wide range of power requirements, supporting both battery-operated and vehicle-powered setups. It incorporates power consumption optimizations and backup options to ensure uninterrupted tracking.

Figure 19: Availability

In terms of software capabilities, the vehicle tracking system demonstrates exceptional performance in providing timely updates on the location of vehicles, delivered in real-time and at intervals that can be adjusted according to user preferences. This feature guarantees that users remain consistently informed about the whereabouts of their vehicles. The system's ability to store historical data allows for the comprehensive recording of previous routes and events. Integrated mapping services provide users with numerous advantages, as they effectively enhance visualization by presenting vehicle movements on digital maps. Additionally, these services facilitate the creation of virtual geofences, enabling location-based alerts and notifications. The alerts provided by the system are highly adaptable and encompass a range of events, including instances of exceeding speed limits and breaches of geofences. These alerts can be transmitted through SMS or email, ensuring that users are promptly notified of any significant incidents. In addition, the system provides remote configuration capabilities, enabling users to remotely modify settings and implement firmware updates.

The vehicle tracking system facilitates integration requirements through the utilization of application programming interfaces (APIs), which allow for the smooth integration of tracking data into third-party applications or pre-existing fleet management systems. Moreover, the system offers compatibility with a wide range of fleet management software applications. Maintenance is facilitated by means of firmware updates and troubleshooting guidelines, thereby streamlining the process and minimizing inconvenience. Additionally, users are provided with access to technical support channels to address any potential issues that may arise. The physical design of the tracking device prioritizes practicality and accommodates a range of vehicle types. It offers straightforward installation facilitated by explicit instructions and multiple mounting options. The organization ensures adherence to regulatory compliance, thereby meeting the established standards and certifications within the industry. The system's architecture is specifically designed to accommodate large-scale deployments and efficiently manage a growing fleet, making scalability a fundamental characteristic. The pricing structures provide transparent information regarding the subscription fees, device costs, and any additional service charges. This enables users to make well-informed decisions regarding the deployment and utilization of the system.

Usability

The primary focus of the vehicle tracking system lies in delivering users with a user-friendly and effective interface for effectively managing their vehicles and fleets. The system employs a user-centric design approach, providing a streamlined interface that facilitates seamless navigation of its various features. The dashboard of the system provides users with real-time tracking data presented in a visually appealing and easily comprehensible format. This feature allows users to promptly locate their vehicles and observe their movements through interactive maps. The user interface is expanded to include a mobile application, thereby allowing users to conveniently access important information while on the move. This feature enables prompt responses to events or alerts.

Figure 20 : Usability

The process of establishing and overseeing geofences is facilitated by interactive tools, enabling users to delineate precise areas of significance and promptly receive notifications when vehicles enter or exit these designated zones. The customization feature of the system's alerts enhances usability by enabling users to establish personalized parameters for various alert types, thereby aligning the system with their unique monitoring requirements. The access to historical data is characterized by its smoothness, allowing users to effortlessly retrieve previous routes, stops, and events. This capability proves valuable for conducting performance analysis, optimizing routes, and investigating incidents.

The vehicle tracking system's usability extends beyond the presentation of data, as it incorporates practical tools for managing devices remotely. The addition of new tracking devices, configuration of settings, and remote firmware updates can be easily accomplished by users, thereby obviating the necessity for physical intervention. The reporting and analytics capabilities of the system offer extensive insights into vehicle behavior, driver habits, and fuel efficiency, enabling users to make informed decisions based on data for the purpose of enhancing operations and achieving cost reductions.

Furthermore, the system's comprehensive integration capabilities allow users to establish connections between their tracking data and pre-existing fleet management software as well as other business systems. This facilitates the optimization of operations and the improvement of overall efficiency. Consequently, the vehicle tracking system provides not only immediate and up-to-date information but also enables users to optimize the performance of their fleet, improve safety measures, and ultimately enhance operational efficiency. The vehicle tracking system facilitates efficient and informed decision-making in vehicle asset management by offering a user-friendly interface, interactive mapping, event notifications, and data-driven insights. This technology empowers users to leverage the capabilities of technology while maintaining usability.

Findings

How the application of Internet of Things have act major role in corporation to achieve their business objective?

The emergence of the transformative force known as the Internet of Things (IoT) is being increasingly recognized as playing a pivotal role in aiding corporations to attain their business objectives across a wide array of diverse sectors. Referred to as IoT, this revolutionary concept serves to facilitate the interconnection of commonplace objects and devices, thereby enabling them to communicate and exchange data through the internet. The resulting network of interconnected devices has given rise to a new era characterized by an array of possibilities, where the power of real-time data can be harnessed by corporations to inform decision-making, elevate operational efficiency, and drive innovation.

The ability of IoT to enable corporations to amass and scrutinize an unparalleled volume of real-time data lies at the core of its impact. This influx of data imparts corporations with the capability to derive more profound insights into their operational processes, customer behavior, and prevailing market trends. By harnessing this data, patterns, trends, and anomalies that might otherwise evade detection can be identified. These insights assume the role of a guiding compass, steering corporations towards judicious, strategic decision-making aligned with their overarching business goals. Operational efficiency is immediately optimized through the conduit of this real-time data stream. By means of predictive maintenance, IoT empowers corporations to anticipate the necessity for maintenance in machinery and equipment, thereby curtailing unforeseen downtime and forestalling costly breakdowns. This proactive methodology not only augments efficiency but also extends the operational life of assets. Furthermore, IoT empowers corporations to rationalize their supply chain processes by bestowing real-time visibility into inventory levels, fluctuations in demand, and the status of deliveries. This agility in responding to market shifts translates to reduced inefficiencies and amplified customer satisfaction.

In the domain of manufacturing, IoT has triggered the genesis of smart factories. These intelligently-operated manufacturing facilities are typified by interlinked machinery and devices that communicate and cooperate harmoniously. By harnessing real-time data generated by sensors and devices, these smart factories can optimize production processes, curtail waste, and responsively adapt to shifts in demand. This paradigm shift has not only augmented productivity but has also ushered in cost savings and elevated quality control standards. The insights furnished by IoT have paved the path for tailored customer experiences and inventive business models. As corporations tap into data gleaned from IoT devices, they can tailor their products and services to cater to individual preferences and requisites. This personalized approach not only elevates customer satisfaction but also cultivates the evolution of subscription-based business models, engendering fresh revenue streams and fostering customer loyalty.

The implications of IoT span further into the realm of asset management. Empowered by IoT technology, corporations can remotely oversee and control their physical assets, encompassing machinery, vehicles, and infrastructure. This capability equips corporations to extract optimal value from their assets, diminish operational risks, and minimize losses. The continuous monitoring in real-time guarantees the prompt identification and resolution of potential issues, contributing to both fiscal savings and operational resilience. The integration of IoT into corporate operations transcends mere efficiency and revenue generation – it also amplifies safety and security protocols. By sustaining continuous real-time monitoring of facilities and assets, corporations can avert accidents, unauthorized access, and breaches in security. This heightened vigilance not only safeguards employee well-being and valuable assets but also upholds the corporation's reputation. In summation, the Internet of Things has inaugurated a fresh epoch of business transformation. Through enabling the interconnection of devices and facilitating the accumulation and analysis of real-time data, IoT has evolved into a cornerstone for corporations aiming to realize their business objectives spanning various sectors. The spectrum of its impact extends from augmenting operational efficiency via predictive maintenance and supply chain streamlining to revolutionizing manufacturing and asset management paradigms. The capacity to provide actionable insights, tailored customer experiences, and innovative business models positions corporations at the vanguard of technological progress.

What are the benefits of an IOT and how can the appropriate solution be implemented to achieve efficiency in vehicle tracking system?

The incorporation of Internet of Things (IoT) technology into vehicle tracking systems has been found to be advantageous in multiple ways, according to an in-depth investigation of previously published scholarly works and an in-depth analysis of the topic's implications. These capabilities include the ability to monitor vehicles in real time, precisely determine where they are located geographically, and improve overall fleet management. The passive monitoring of parameters like fuel consumption and engine health can make it easier to perform preventative maintenance on vehicles and optimize their operating costs. This can lead to cost savings. The utilization of sensors and devices that are enabled by the Internet of Things (IoT) makes it possible for the smooth gathering and transmission of data, thereby ensuring that centralized platforms receive an uninterrupted stream of information. In addition, the utilization of cloud-based data storage provides benefits in terms of scalability and accessibility, while at the same time reducing the costs associated with infrastructure. The utilization of Machine Learning algorithms in the analysis of data generated by the Internet of Things (IoT) yields significant insights, which facilitates decision-making based on data and enables predictive analytics for the optimization of routes and enhancement of vehicle performance. These benefits can be attained through the enhancement of vehicle performance and the optimization of routes. It was discovered that the implementation of essential security measures, such as encryption and authentication protocols, was required in order to ensure the protection of sensitive information within the IoT ecosystem. In order for Internet of Things (IoT) technology to be successfully integrated into vehicle tracking systems, it is necessary to conduct an in-depth analysis of the available hardware options, communication protocols, and data management strategies. The development of a resilient Internet of Things (IoT) solution is made possible by the integration of GPS modules, SIM cards, and communication gateways. This solution has the potential to improve the effectiveness of vehicle tracking systems and to make transportation operations safer and more efficient.

The installation of vehicle monitoring systems has resulted in a great many important discoveries as well as practical applications that may be used in everyday life. To begin, companies who implement such systems see improvements in their skills regarding fleet management. The ability to track cars in real time enables more effective route optimization, a reduction in fuel use, and an overall improvement in fleet coordination. Second, the importance of keeping in mind the safety benefits of tracking a vehicle cannot be overstated. The ability to monitor vehicles in real time both assists in the recovery of vehicles that have been stolen or misplaced and works as a deterrent to theft that may otherwise occur. Thirdly, these systems encourage driver accountability because drivers are aware that they are being observed. This leads to improved adherence to the policies of the organization, safer driving behavior, and a reduction in the number of instances in which drivers speed. In addition, vehicle monitoring systems provide accurate forecasts of the projected time of arrival (ETA), which are extremely helpful for companies that rely on timely deliveries or services. Fourthly, the monitoring of vehicle health makes it feasible to perform preventative maintenance, which in turn results in less downtime, fewer failures, and longer vehicle lifespans. Last but not least, clients gain from vehicle monitoring systems since they give transparency in service by providing real-time information on the status of delivery, which ultimately results in an improvement in customer satisfaction. The fleet management system of a delivery company is a useful illustration of how vehicle tracking can be applied in real-world situations. Each delivery vehicle is fitted with a GPS tracking device, which enables it to transmit its whereabouts in real time to a centralized command and control center. The control center keeps track of the precise locations of all of the vehicles throughout the day. This allows them to plan more efficient routes based on real-time traffic information, which in turn saves both time and money. The ability of the customer care agent to access the tracking system and provide an accurate ETA, thereby boosting both transparency and customer satisfaction, is available in the event that a customer makes an inquiry regarding the status of their delivery. In addition, alarms are transmitted to the control center whenever drivers deviate from their allocated routes or exceed the speed limit, which enables the corporation to address any possible concerns that may arise with the conduct of its drivers. The tracking system helps to schedule regular vehicle maintenance, which in turn reduces the likelihood of vehicle breakdowns and ensures that the fleet is always in the best condition possible. In conclusion, vehicle tracking systems provide a multitude of advantages and are an essential component for the effective functioning of a variety of business sectors that are dependent on vehicle fleets for their day-to-day operations .

What ethical consideration are associated with the implementation of IOT in vehicle tracking sector ?

The analysis of relevant literature and case studies has uncovered a number of significant ethical issues that arise during the implementation of Internet of Things (IoT) technologies in the automotive sector. The significance of data privacy and security in the realm of IoT-enabled vehicles was initially acknowledged. The reason for this is that these vehicles collect and transmit significant amounts of personal data, including details such as location, driving behavior, and user preferences. Safeguarding individuals' privacy and mitigating potential harm necessitates the imperative task of ensuring the protection of sensitive information from unauthorized access, data breaches, and misuse. In addition, the ethical quandary surrounding cyberattacks directed at interconnected vehicles raises a significant apprehension. The prioritization of robust cybersecurity measures, such as the incorporation of encryption, authentication, and intrusion detection systems, is crucial in order to effectively reduce the likelihood of malicious exploitation of vehicle systems and the potential jeopardy it poses to the safety of passengers. Moreover, it is essential to highlight the responsibility of ensuring transparency and obtaining informed consent, as it is imperative for individuals using vehicles to have a thorough understanding of data collection processes and their rights regarding data usage. The matter of guaranteeing equitable and unbiased access to Internet of Things (IoT) enabled technologies requires careful consideration, as certain demographic groups or geographic regions may face discrepancies in their capacity to utilize connected vehicle services. This situation has the potential to exacerbate pre-existing inequalities. Furthermore, the ethical implications pertaining to autonomous vehicles and decision-making algorithms were identified, with particular emphasis on the moral dilemmas that arise from inevitable accidents. The establishment of clear guidelines and ethical frameworks is of utmost importance in order to effectively govern the decision-making processes of artificial intelligence (AI) systems in critical situations. This is a fundamental requirement for cultivating public trust and confidence in the technology. The ethical considerations surrounding the integration of Internet of Things (IoT) technology in the Vehicle sector require the establishment of comprehensive regulations, responsible data practices, and continuous monitoring to ensure that the implementation of IoT aligns with ethical principles and societal values.

Limitations

Several limitations were observed in the vehicle tracking system, specifically related to the GPS module Neo 6M. One notable limitation was the less accuracy in delivering longitude and latitude data. The lack of precise location data led to differences in the tracking of the vehicle's position, especially in situations where satellite signals were obstructed or when faced with difficult terrains. As a result, the system experienced a decrease in reliability and real-time monitoring capabilities, thereby hindering its capacity to provide accurate location updates.

Another notable limitation emerged from the implementation of the SIM module 900A within the tracking system. This module experienced network errors, resulting in irregular connectivity problems that disrupted the transmission and reception of data. Consequently, disruptions in communication may result in the delayed or incomplete transmission of data, thereby affecting the system's ability to promptly respond and its overall performance in tracking. Furthermore, it is plausible that the SIM module's elevated power consumption and restricted portability may have contributed to diminished battery longevity in the tracking devices, thereby requiring frequent recharging or replacement. This could potentially pose inconveniences and financial burdens for both users and administrators.

These mentioned limitations presented obstacles to the efficiency and user-friendliness of the vehicle tracking system, thereby requiring precise discussion and potential measures to address these issues throughout the system's creation and implementation phases.

Future Works

Figure 21 : Future Work

In the domain of the future work, numerous exciting possibilities can be investigated for enhancing the vehicle tracking system and its utilization in smartwatches and wearable computing, with a particular emphasis on student tracking. A potential possibility for enhancement relates to the advancement of a Graphical User Interface (GUI) that is more accessible and user-intuitive, specifically for the tracking application. The growing popularity and widespread adoption of smartwatches and wearable devices necessitate the development of an optimized interface that effectively presents concise and pertinent information while ensuring user-friendliness. The integration of interactive visualizations, customizable alerts, and streamlined navigation has the potential to greatly enhance user experience and foster greater acceptance among both students and educators.

Within the domain of smartwatches and wearable computing, there exists a possibility to utilize supplementary sensor data in order to enhance the functionalities of tracking systems. The inclusion of intrinsic sensors, such as heart rate monitors, accelerometers, and GPS modules, within smartwatches can provide significant contextual information to the tracking system. For instance, the utilization of real-time heart rate monitoring can be beneficial in the identification of stressful circumstances during a student's commute or in gaining valuable insights into their physical well-being while traveling in a monitored vehicle. The integration of this technology has the potential to facilitate the creation of intelligent functionalities, such as the automatic generation of notifications to parents or guardians in the event of anomalies being detected. This would effectively contribute to the preservation of students' safety and well-being. The integration of advanced machine learning algorithms and data analytics techniques presents significant potential for the broadening of student tracking capabilities. Through the examination of historical tracking data and the integration of other pertinent datasets, the system possesses the capability to produce prognostic insights. These insights encompass the estimation of anticipated bus arrival times at different stops, as well as the identification of patterns that have the potential to enhance transportation routes and schedules, thereby mitigating waiting periods and congestion. The utilization of a data-driven methodology has the potential to yield a transportation system that is both more efficient and adaptable, thereby affording students a travel experience that is seamless and comfortable.

Furthermore, in light of the growing emphasis on data privacy and security, it is imperative for future research to also examine the deployment of robust security protocols. The implementation of encryption, authentication, and access control mechanisms within the tracking system will play a crucial role in ensuring the protection of sensitive data, including the whereabouts and travel patterns of students. Achieving a harmonious equilibrium between safeguarding data integrity and fulfilling the requirement for instantaneous tracking capabilities will pose a substantial obstacle in this context.

The performance of the vehicle monitoring system can also be revolutionized by adopting latest technology like 5G and edge computing. By harnessing the low latency and high bandwidth capabilities of 5G networks, it becomes possible to achieve real-time tracking updates with unparalleled speed and accuracy. By integrating edge computing capabilities, the system can effectively delegate processing tasks to nearby nodes, thereby mitigating latency and augmenting its overall responsiveness. It is imperative to thoroughly investigate these advanced technologies and comprehend their pragmatic ramifications in order to fully harness the capabilities of the vehicle tracking system on smartwatches and wearable computing within the realm of student tracking.

Conclusion

This thesis successfully explored and implemented a vehicle tracking system using the Internet of Things (IoT) technology, incorporating advanced components such as Jetson Nano, SIM module, and GPS module . The research performed for this study has helped smart transportation infrastructure and real-time vehicle tracking move forward in a big way. By using Jetson Nano's computing power, the system was able to process and analyze data quickly and accurately, so it could keep track of cars. SIM modules made it easy for the tracking devices to talk to the central computer without any problems. This meant that data could be sent continuously, even in remote areas. Also, the GPS module was a key part of giving accurate geolocation information, which made it possible to track all of the vehicle's movements. This might not be new to global market but in Nepalese community this product can be revolutionary in fleet management and logistics.

During the execution process, different problems had to be solved, such as figuring out how to use the least amount of power, making sure data is safe, and making the tracking system easy to use. The fact that these problems were solved shows that using IoT technologies for vehicle tracking uses is possible and useful. As with any technology project, there are still ways to improve and make changes in the future. Adding more sensors to the system and connecting it to other IoT devices can provide useful contextual data that can help people make better decisions and have better user experiences. Also, adding machine learning algorithms for predictive analytics and anomaly detection could make the system smarter and help it handle vehicle operations in a proactive way. The fact that this car tracking system, which uses IoT components like the Jetson Nano, SIM module, and GPS module, was put into place and tested successfully shows how important and useful IoT technologies are in modern transportation solutions. This study lays the groundwork for the continued development and use of smart tracking systems. These systems can change the way vehicles are managed, monitored, and optimized, making transportation systems safer, more efficient, and more sustainable. As the technology landscape changes, more study and collaboration between universities, businesses, and policymakers will be needed to unlock the full potential of IoT-based vehicle tracking systems for the good of society as a whole.

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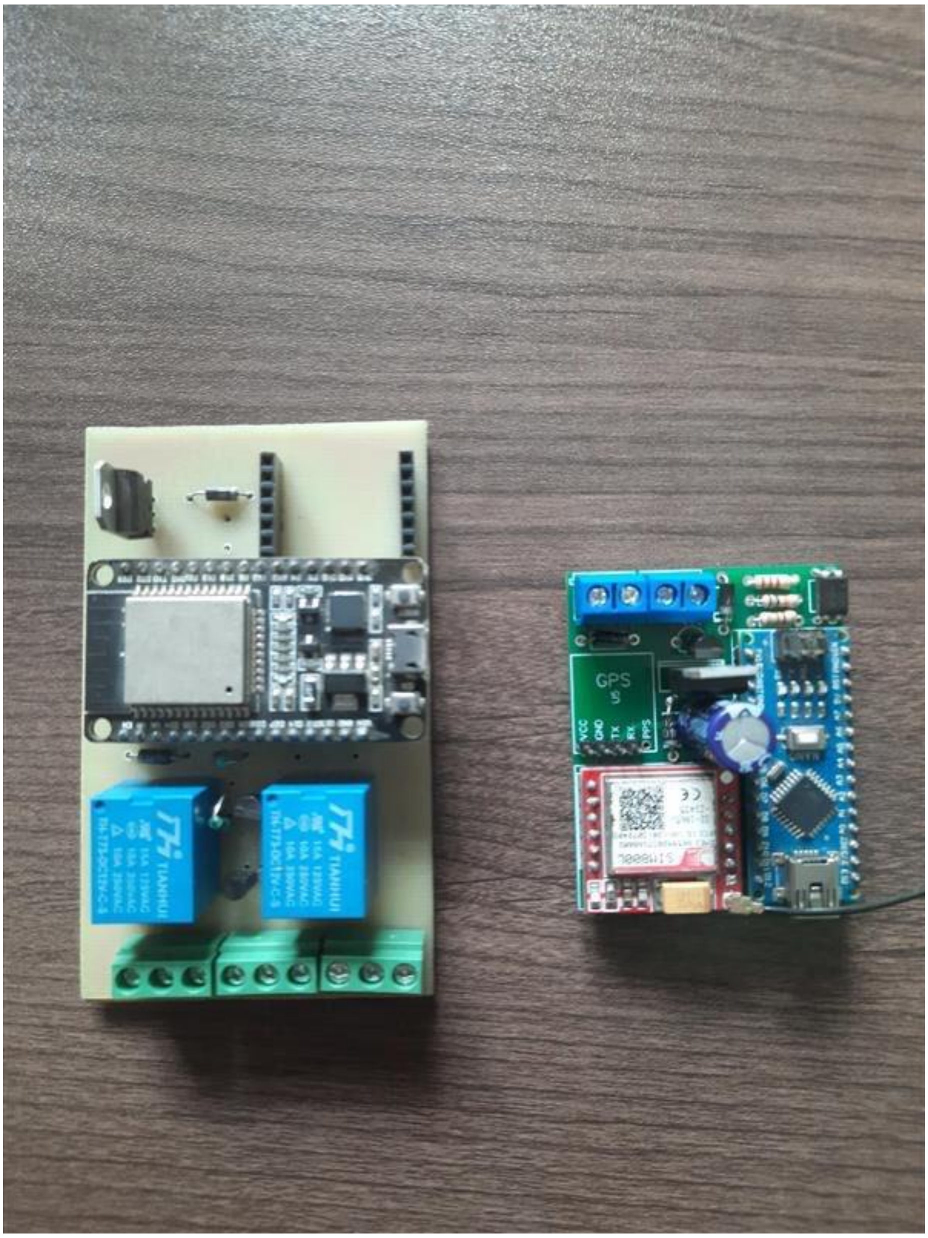
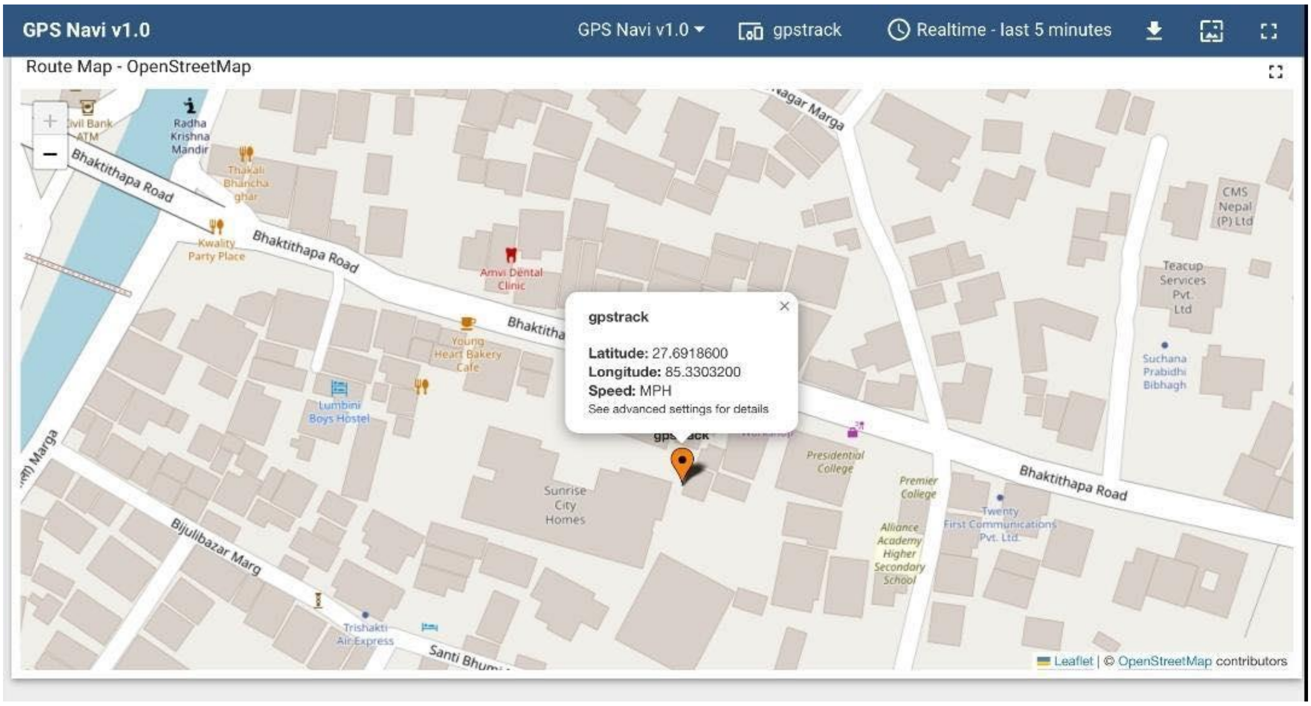
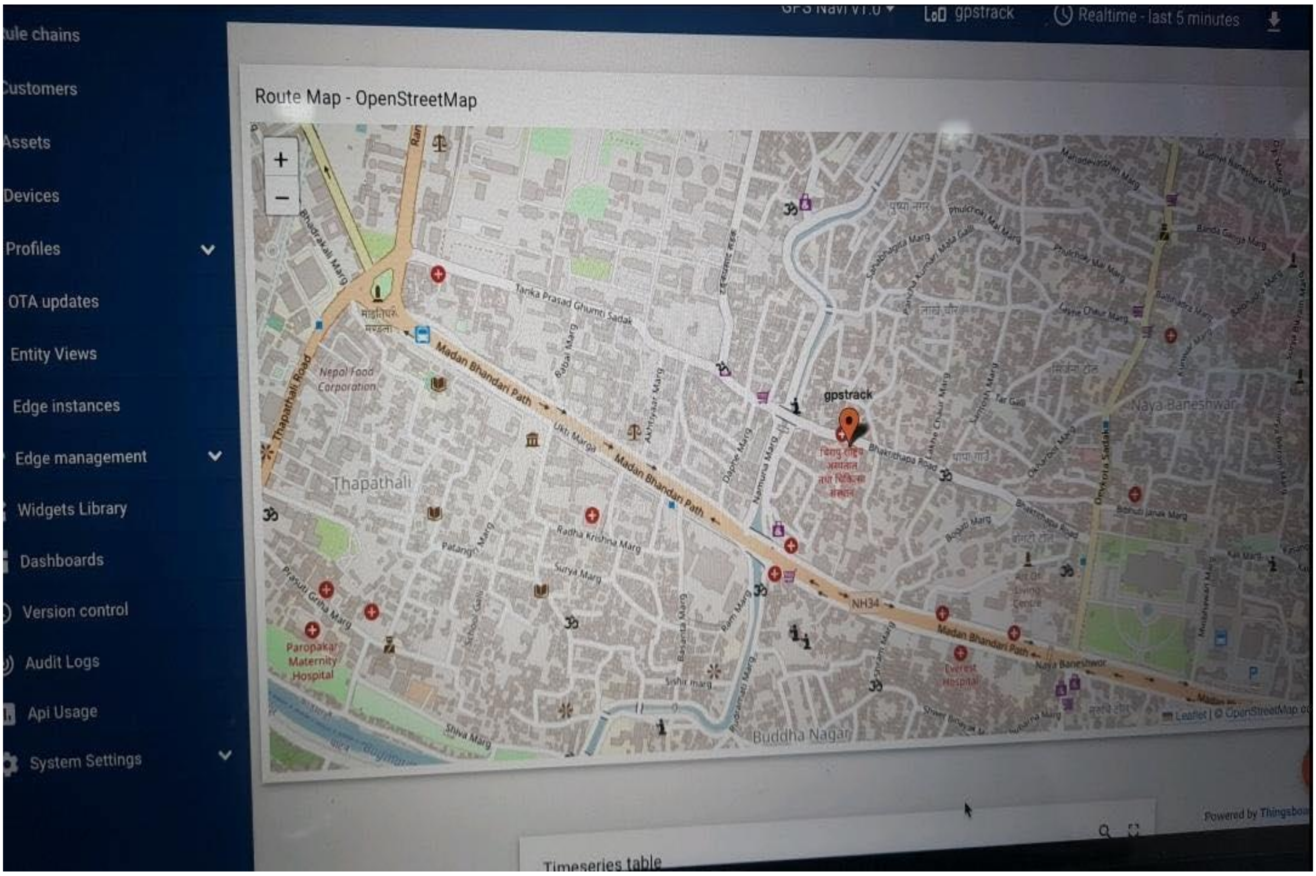
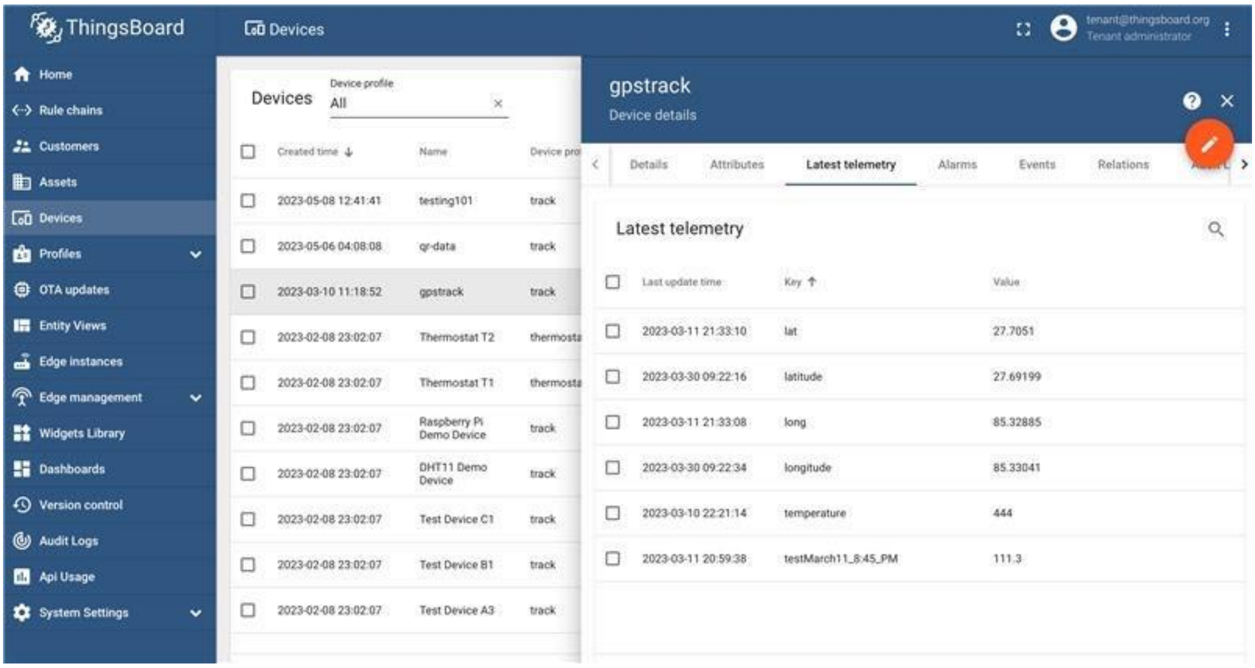
Product Screenshots

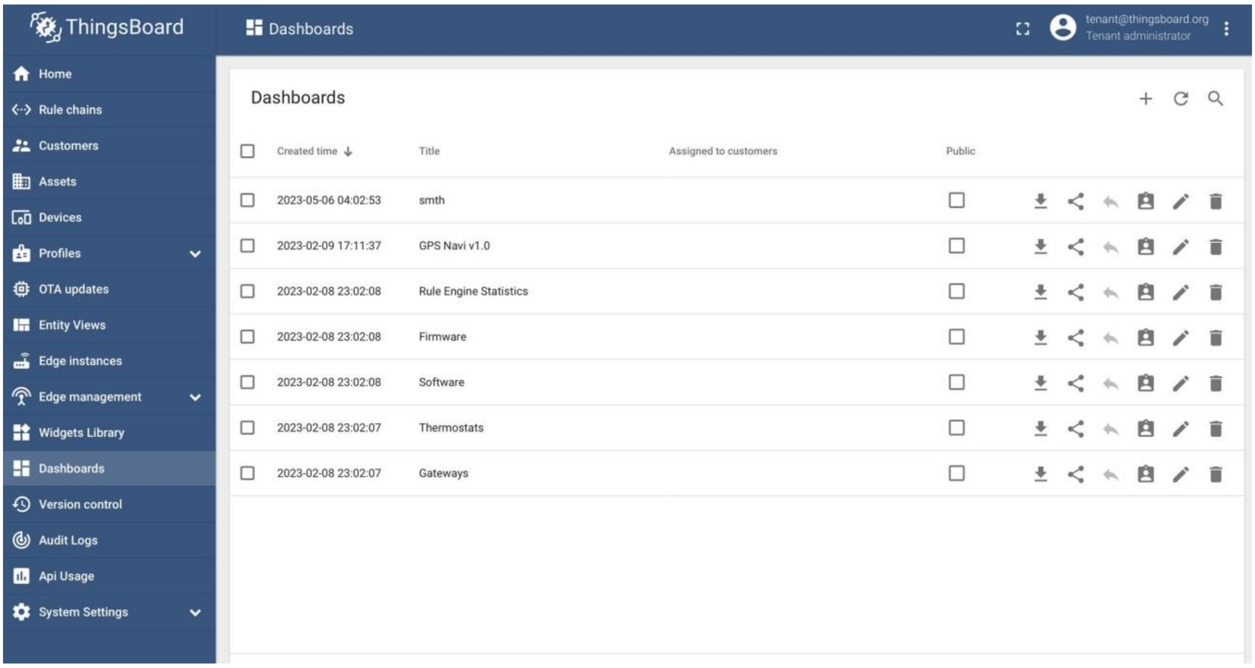



GPS
SIM800L


GPS Navi v1.0
GPS Navi v1.0
gpstrack
Realtime - last 5 minutes
Route Map - OpenStreetMap
Radha Krishna Mandir
Thakali Bhancha ghar
Bhaktithapa Road
Kwality Party Place
Amvi Dental Clinic
Young Heart Bakery Cafe
Lumbini Boys Hostel
Sunrise City Homes
Bijulibazar Marg
Trishakti Air Express
gpstrack
Latitude: 27.6918600
Longitude: 85.3303200
Speed: MPH
See advanced settings for details
Presidential College
Premier College
Alliance Academy Higher Secondary School
Twenty First Communications Pvt. Ltd.
CMS Nepal (P) Ltd
Teacup Services Pvt. Ltd
Suchana Prabidhi Bibhagh
Leaflet | © OpenStreetMap contributors


Customers
Assets
Devices
Profiles
OTA updates
Entity Views
Edge instances
Edge management
Widgets Library
Dashboards
Version control
Audit Logs
Api Usage
System Settings
gpstrack
Realtime - last 5 minutes
Route Map - OpenStreetMap
Madan Bhandari Path
Thapathali
gpstrack
Buddha Nagar
Timeseries table


ThingsBoard
Devices
tenant@thingsboard.org
Tenant administrator
Home
Rule chains
Customers
Assets
Devices
Profiles
OTA updates
Entity Views
Edge instances
Edge management
Widgets Library
Dashboards
Version control
Audit Logs
Api Usage
System Settings
Devices
Device profile
All
Created time
Name
2023-05-08 12:41:41 testing101 track
2023-05-06 04:08:08 qr-data track
2023-03-10 11:18:52 gpstrack track
2023-02-08 23:02:07 Thermostat T2
2023-02-08 23:02:07 Thermostat T1
2023-02-08 23:02:07 Raspberry Pi Demo Device track
2023-02-08 23:02:07 DHT11 Demo Device track
2023-02-08 23:02:07 Test Device C1 track
2023-02-08 23:02:07 Test Device B1 track
2023-02-08 23:02:07 Test Device A3 track
gpstrack
Device details
Details
Attributes
Latest telemetry
Alarms
Events
Relations
Latest telemetry
Last update time
Key
Value
2023-03-11 21:33:10 lat 27.7051
2023-03-30 09:22:16 latitude 27.69199
2023-03-11 21:33:08 long 85.32885
2023-03-30 09:22:34 longitude 85.33041
2023-03-10 22:21:14 temperature 444
2023-03-11 20:59:38 testMarch11_8:45_PM 111.3


ThingsBoard
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Edge instances
Edge management
Widgets Library
Dashboards
Version control
Audit Logs
Api Usage
System Settings
Dashboards
Created time
Title
Assigned to customers
Public
2023-05-06 04:02:53 smth
2023-02-09 17:11:37 GPS Navi v1.0
2023-02-08 23:02:08 Rule Engine Statistics
2023-02-08 23:02:08 Firmware
2023-02-08 23:02:08 Software
2023-02-08 23:02:07 Thermostats
2023-02-08 23:02:07 Gateways

Code Screen-Shot

gpsCode.ino

```
#include <SoftwareSerial.h>
#include <TinyGPS.h>

TinyGPS gps;
SoftwareSerial ss(8, 9);

static void smartdelay(unsigned long ms);
static void print_float(float val, float invalid, int len, int prec);

void setup()
{
  Serial.begin(9600);
  ss.begin(9600);
}


void loop()
{
  float flat, flon;

  gps.f_get_position(&flat, &flon);

  Serial.print("Latitude : ");
  unsigned int a = Serial.print(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
  Serial.print(a);

  Serial.print(" ,Longitude : ");
  unsigned int  b  = Serial.print(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
  Serial.println(b);

  smartdelay(1000);
}

static void smartdelay(unsigned long ms)
{
```

```
static void smartdelay(unsigned long ms)
{
  unsigned long start = millis();
  do
  {
    while (ss.available())
      gps.encode(ss.read());
  } while (millis() - start < ms);
}
```

gpsTracking.ino

```

#define TINY_GSM_MODEM_SIM800

#include <TinyGsmClient.h>
#include <SoftwareSerial.h>
#include "ThingsBoard.h"
#include <TinyGPS.h>

// Your GPRS credentials
// Leave empty, if missing user or pass
const char apn[] = "web";
const char user[] = "";
const char pass[] = "";

#define TOKEN "3uHiDbkkY91rtRxycwUJ"
//#define TOKEN "Q7S0Q1uGjf3kIlRpxgiF"
#define THINGSBOARD_SERVER "http://127.0.0.1/api/v1/gpsTracker"

#define THINGSBOARD_PORT 8080

// Baud rate for debug serial
#define SERIAL_DEBUG_BAUD 115200

// Serial port for GSM shield
SoftwareSerial serialGsm(11,10);  // RX, TX pins for communicating with modem


#ifdef DUMP_AT_COMMANDS
#include <StreamDebugger.h>
StreamDebugger debugger(serialGsm, Serial);
TinyGsm modem(debugger);
#else
  // Initialize GSM modem
TinyGsm modem(serialGsm);
#endif
```

gpsTracking.ino

```
// Initialize GSM client
TinyGsmClient client(modem);

// Initialize ThingsBoard instance
ThingsBoardHttp tb(client, TOKEN, THINGSBOARD_SERVER, THINGSBOARD_PORT);

// Set to true, if modem is connected
bool modemConnected = true;


//GPS Part


TinyGPS gps;
SoftwareSerial ss(9,8);

static void smartdelay(unsigned long ms);

//GPS end

void setup() {
  // Set console baud rate

  Serial.begin(SERIAL_DEBUG_BAUD);
  Serial.println("-------SETUP------");

  // Set GSM module baud rate
  serialGsm.begin(115200);
  delay(3000);

  // Lower baud rate of the modem.
  // This is highly practical for Uno board, since SoftwareSerial there
  // works too slow to receive a modem data.

  serialGsm.write("AT+IPR=9600\r\n");
```

```
  // Lower baud rate of the modem.
  // This is highly practical for Uno board, since SoftwareSerial there
  // works too slow to receive a modem data.

  serialGsm.write("AT+IPR=9600\r\n");
  serialGsm.end();
  serialGsm.begin(9600);

  // Restart takes quite some time
  // To skip it, call init() instead of restart()
  Serial.println(F("Initializing modem..."));
  modem.restart();

  String modemInfo = modem.getModemInfo();
  Serial.print(F("Modem: "));
  Serial.println(modemInfo);

  // Unlock your SIM card with a PIN
  //modem.simUnlock("1234");

  //GPS Software Serial
  ss.begin(9600);
}

void loop() {
  delay(1000);

  if (!modemConnected) {
    Serial.print(F("Waiting for network..."));
    if (!modem.waitForNetwork()) {
      Serial.println(" fail");
      delay(10000);
      return;
    }
    Serial.println(" OK");
```

```
    return;
  }
  Serial.println(" OK");

  Serial.print(F("Connecting to "));
  Serial.print(apn);
  if (!modem.gprsConnect(apn, user, pass)) {
    Serial.println(" fail");
    delay(10000);
    return;
  }

  modemConnected = true;
  Serial.println(" OK");
}



//GPS part for lat and long

float flat, flon;

gps.f_get_position(&flat, &flon);

Serial.print("Latitude : ");
unsigned int latitude = Serial.print(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
Serial.print(latitude);

Serial.print(" ,Longitude : ");
unsigned int longitude = Serial.print(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
Serial.println(longitude);

tb.sendTelemetryFloat("latitude",10);
tb.sendTelemetryFloat("longitude", 20);
```

```
  tb.sendTelemetryFloat("latitude",10);
  tb.sendTelemetryFloat("longitude", 20);

  smartdelay(1000);
}



static void smartdelay(unsigned long ms)
{
  unsigned long start = millis();
  do
  {
    while (ss.available())
      gps.encode(ss.read());
  } while (millis() - start < ms);
}
```