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CLOUD BASED VEHICLE TRACKING SYSTEM

A PROJECT REPORT

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ABSTRACT

The need for a vehicle tracking system in real-time is growing continuously due to the increase of the theft cases. This type of system needs to transmit large data with a huge number of HTTP request to the server to keep tracking and monitoring the vehicle in real- time, this will made the expenditure extremely high every month for transmitting the information of the tracked vehicles to the server, therefor this expenditure needs to be reduced by reducing the data size that transmits to the servers. This paper shows an integrated car/vehicle tracking system in real-time to track car/vehicle anywhere in the world at any time. This system is mainly divided into two parts: vehicle tracking part and monitoring part. Tracking part is represented by installation the electronic devices in the vehicle using Arduino UNO and SIM7100C 4G modem, which will send the coordinates to the Azure cloud SQL Database and through web Application the coordinates will be received and shown in real time on a map.

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Chapter 1: Introduction

1.1 Inspiration

The fundamental inspiration driving this undertaking is security of vehicles. The need of constant global positioning frameworks considerably expanded because of expansion in robbery cases. Traditional global positioning frameworks needs to communicate enormous measure of information to the server to continue following and checking of the vehicle progressively. This persistent circle of following and checking, makes expenses an excessive lot. Accordingly, the consumption should be chopped somewhere near lessening the information size that should be sent to the server.

Thus, cloud based vehicle global positioning framework should be introduced that can follow vehicle continuously from anyplace all over the planet. We can sort it into two principal parts:
1)Tracking Part
2)Monitoring Part

Following part comprises of establishment of the electronic gadgets in the vehicle utilizing Arduino UNO and SIM7100C 4G module. The directions will be sent by means of 4G. The observing part is in cloud and will get arranges and shows on map utilizing web application. The crucial commitment of this part is advancing information since directions will be sent when the vehicle is moving. Consequently, it will save cost.

1.2 Presentation

In vehicle crisis cases like robbery, mishap, taking, and breakdown, a prompt reaction is required, and the principal activity required is to track down the vehicle. To find a vehicle there are a few strategies that can be utilized to restricted the vehicle like Global position framework (GPS) or the cell organization. Be that as it may, the GPS procedure utilized a ton of energy and consume huge measure of force. Yet, as long as the vehicle has a battery that can't consider being an issue any longer.

The GPS global positioning framework utilized the GPS innovation to decide exact place of the vehicle, that area of the vehicle can be found when the GPS is appended to the vehicle. Global positioning framework might find a taken or lost vehicle by following and observing it, that could prompt capture vehicle's hoodlums. Cheats might sell the vehicle as one section or could sell it as extra parts. In this way, we want a productive global positioning framework with successful expense and quick sending.

The GPS must be worked at constantly persistently and that could prompt imagine an answer that assuming the driver might cut the force of the GPS. On the opposite side of such frameworks, there ought to be an administrator who can actually look at the driver's geographic area progressively by showing the directions on a guide utilizing a PC or cell phone or some other gadget as long as it has a web association with continue to screen the vehicle.

The server that gets the information sent from the vehicle can be a typical server with only one head that checking the guide or could be in the cloud which implies that can impart the data in connected data set to other administrators or clients, the cloud furnishes the guides anyplace and whenever with huge capacity. Cloud based servers give dependability, adaptability, versatility, openness. The primary commitment of this paper is diminishing the quantity of HTTP demand sent from Arduino and lessens the size of the data that 4G module shipped off the distant server. Additionally, this work has added more security for the data about vehicle by utilizing 4G association.

1.3 Scope

This is most likely the question on each entrepreneur's or alternately the board's brain who has known about a vehicle global positioning framework. In the event that you oversee or possess an organization with countless vehicles, for example, a taxi organization, a planned operations organization, or a conveyance organization, a vehicle global positioning framework is a significant speculation that permits you to see where your vehicles are consistently, give more precise conveyance or get times for clients, and further develop vehicle security.

It likewise permits you to see the courses that the drivers have taken. A worker driving an organization vehicle outfitted with a GPS checking gadget can never mislead you about his situation or course since you can follow him consistently.

The project`s aim is to develop a cloud based broad system which can provide a complete solution of vehicles theft cases and other security-related problems. The solution will also include a web app which can be accessible from anywhere in the world.

Pakistan car production and sales
Number of vehicles ('000)

Figures do not include production and sales by companies that are not members of the association
Source: Pakistan Automotive Manufacturers Association

FT

Figure 1: Pakistan' s car production and sales

The number of car sales have surged in an enormous way in the world. Car sales are also increasing in Pakistan day by day. In 2021, auto sales surged by around 31.5% in Pakistan.
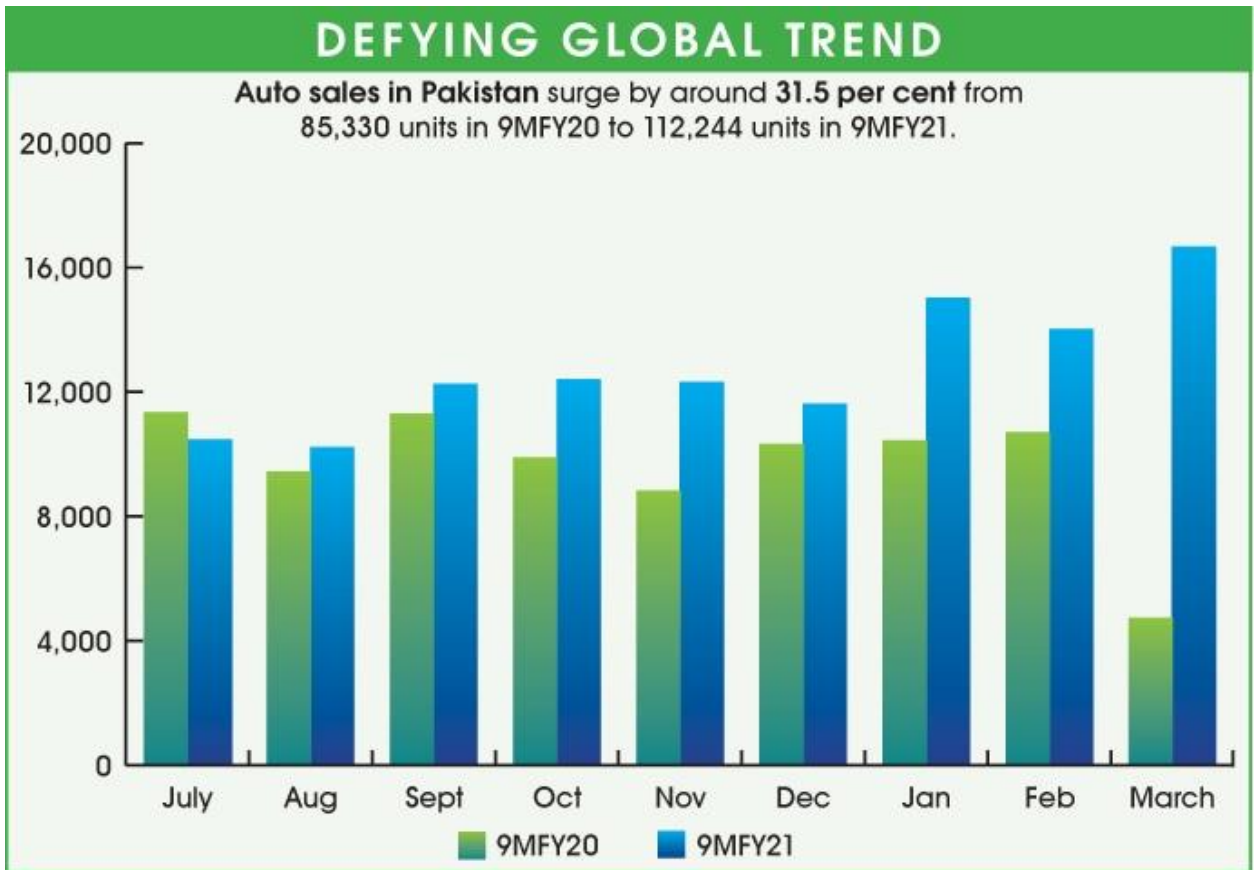
Figure 2: Defying global trend

The scope of the project can be defined in terms of the following objectives:

- The utilization of a Cloud based tracker allows commercial vehicles such as trucks, buses, logistics, and construction equipment to be tracked and monitored. As the number of business vehicles on the road grows, so will the use of this tracking system.

Figure 3: GPS tracking

- The worldwide vehicle tracking market is anticipated to reach $15,957.5 million by 2025, up from $4,765.0 million in 2017. From 2018 to 2025, the market is supposed to develop at a 19.9% yearly speed.

Figure 4: GPS navigation

- The revenue earned from the deals of the whole solution, which includes hardware, software, and other subscription fees linked with the tracking and data reporting technology, is referred to as the Vehicle Tracking Systems Market.

Figure 5: Vehicle tracking system market

- If you manage or own a company with a large number of vehicles, such as a taxi company, a coordinated factors company, or a delivery company, a vehicle tracking system is a profitable investment that allows you to see where your vehicles are at all times.

Figure 6: GPS user level diagram

- By knowing where your vehicles are and where they've been, a reliable and easy to-utilize vehicle monitoring solution might upgrade your productivity and lower your working expenses. Our system can detect real time coordinates of the vehicle.
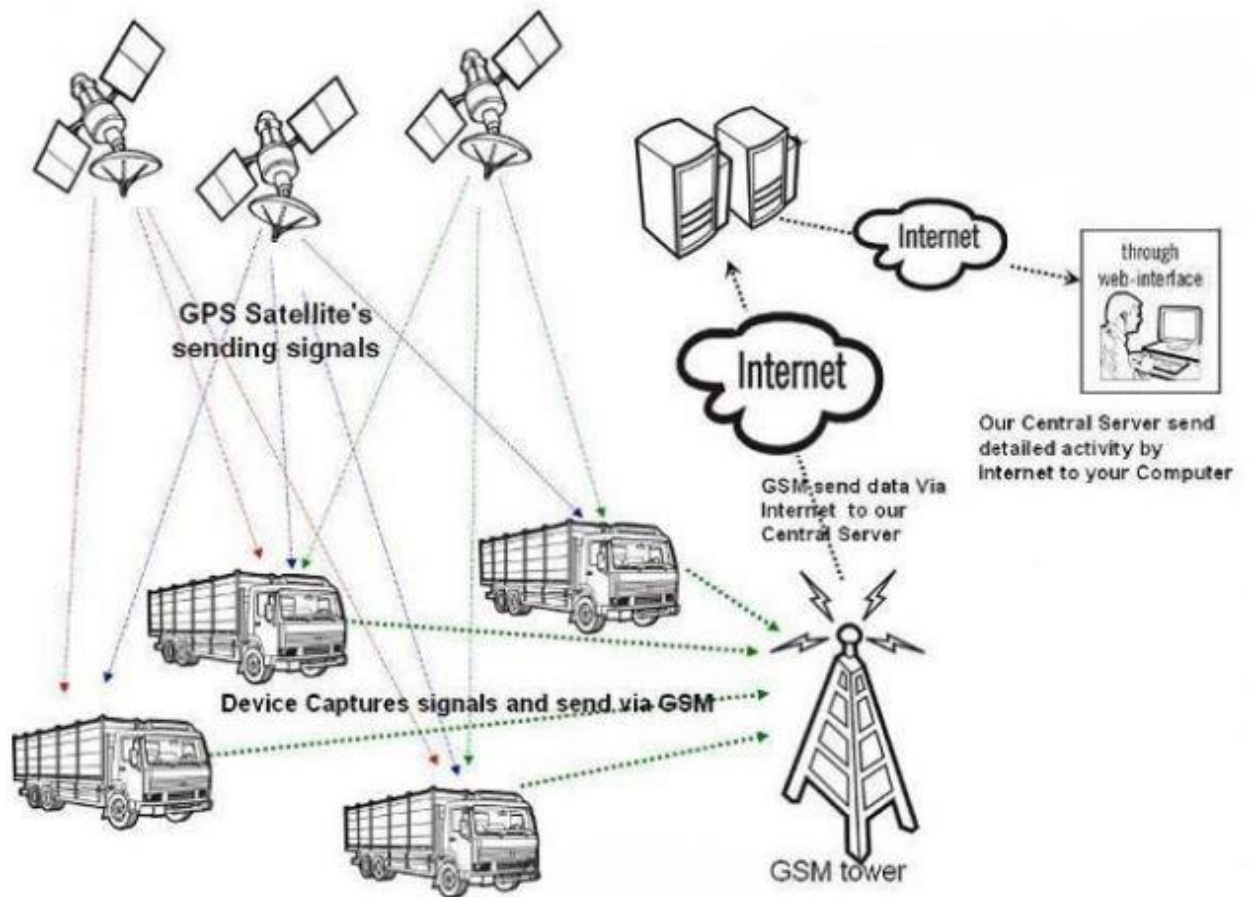
Figure 7: GPS tracking system level diagram

Chapter 2: Literature Review

There has been a lot of work done recently on vehicle tracking due to the increasing vehicle theft cases and other security related issues in every part of the world. Research on real-time vehicle tracking and speed limits devices have gained more speed due to the advancements and developments in the areas of Cloud Computing and Internet of Things and their capabilities to act as an anti-theft systems.

To locate a vehicle there are some ways that can be used to localize the vehicle like Global position system (GPS) or the cellular network. However, the GPS technique is considered to use a lot of energy and consume large amount of power. But till the time, the vehicle has a battery that cannot consider being a problem. The GPS and GSM/ GPRS tracking system consumes the GPS technology to determine exact location of the vehicle, that location of the vehicle can be found when the GPS is attached to the vehicle/system.

10 Cities with the Most Car Thefts (2022)

Motor Vehicle Thefts per 100,000 residents

Source: Insurify analysis of the National Insurance Crime Bureau's Hot Spots Report. Correlations only.
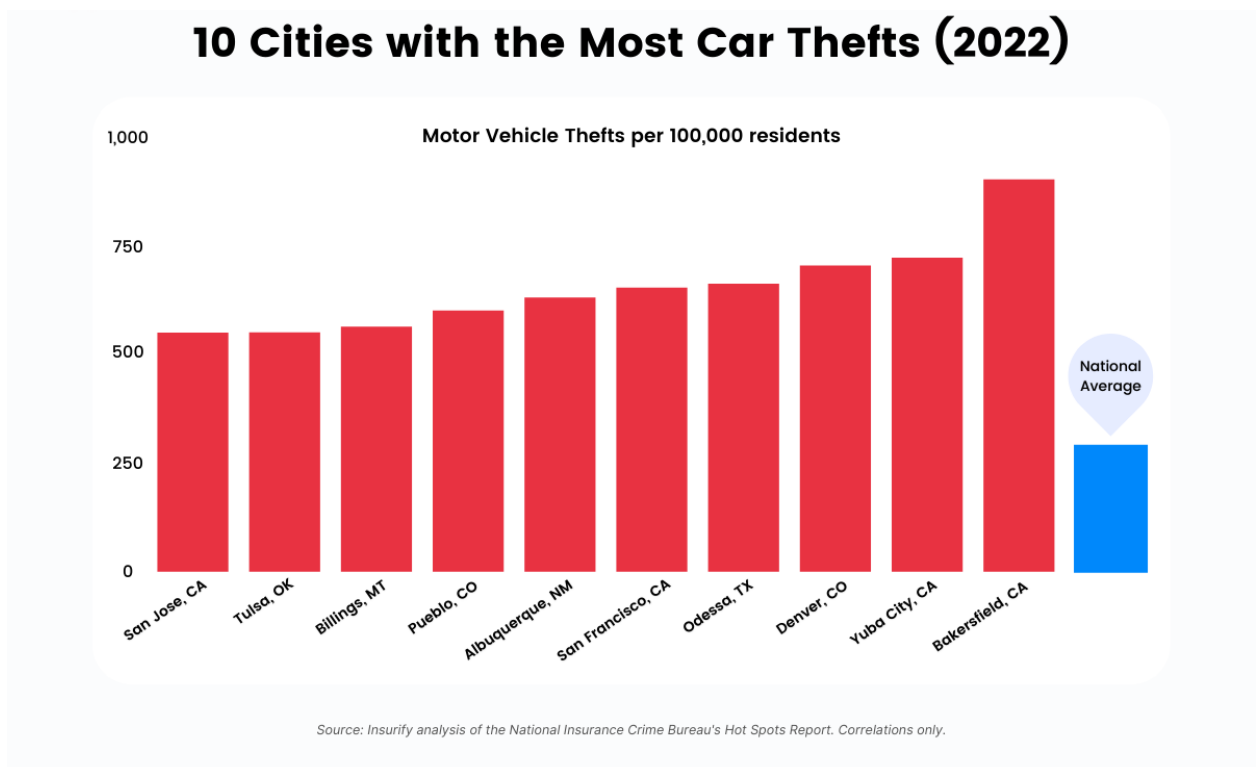
Figure 8: Cities with the most car thefts

2.1 Global Positioning System (GPS)
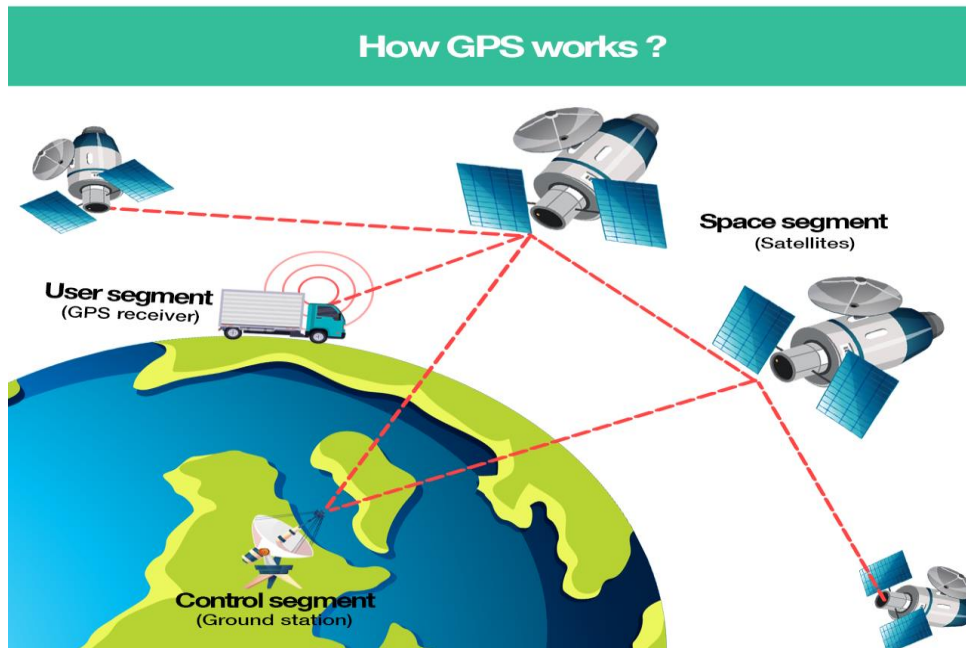
Figure 9: How GPS works?

GPS is a system composed of a network of 24 satellites of the US. The satellites occasionally discharge radio signal to GPS receivers. The GPS receiver receives the signal from no less than three satellites using triangular methods to find two-dimensions, or four satellites to compute three dimensions (latitude, longitude and altitude) [1].

2.2 Google Map

Is a version of Google Earth it's free software to provide map by satellite image, the programming language of Google Map is KML (keyhole mark-up language). It is used to demonstrate lines and pins materials.

2.3 Global System for Mobile Communication (GSM)

GSM is a standard developed by the European telecommunication standards institute

(ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones, first deployed in Finland in July 1991[2]. As of 2014 it has become the default global standard for mobile communications - with over (90%) market share, operating in over 219 countries and territories.

2.4 Subscriber Identity Module (SIM)

SIM is a separable savvy card considered one of the critical elements of GSM, SIM card containing the client's membership data and telephone directory. This permits the client to hold data in the wake of exchanging handsets. Then again, the client can likewise change administrators while holding the handset essentially by changing SIM, the design of GSM organization.
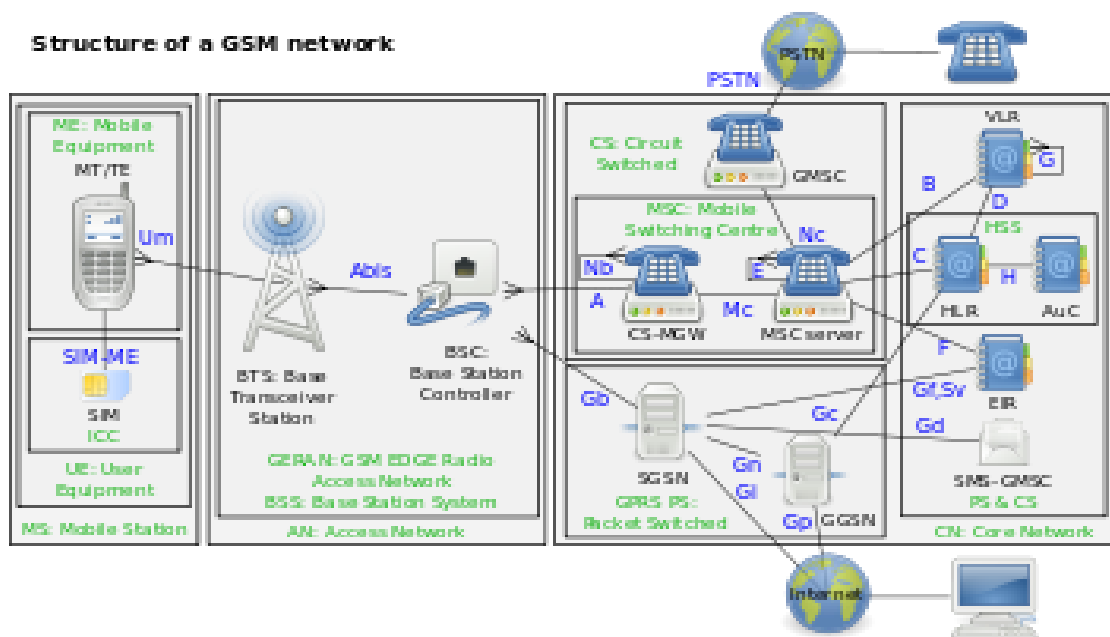
Figure 10: Structure of a GSM network

2.5 General Packet Radio Service (GPRS)

GPRS was initially normalized by European media transmission standard Institute (ETSI). Thus the 3GPP grew third-age (3G) UMTS norms followed by fourth-age (4G) LTE (long haul development) high level principles, which don't shape part of the ETSI GSM standard [3].
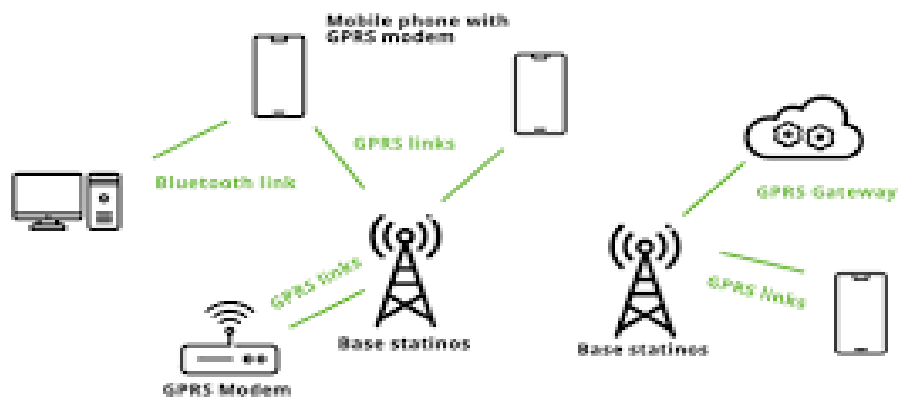
Figure 11: GPRS

2.6 Arduino
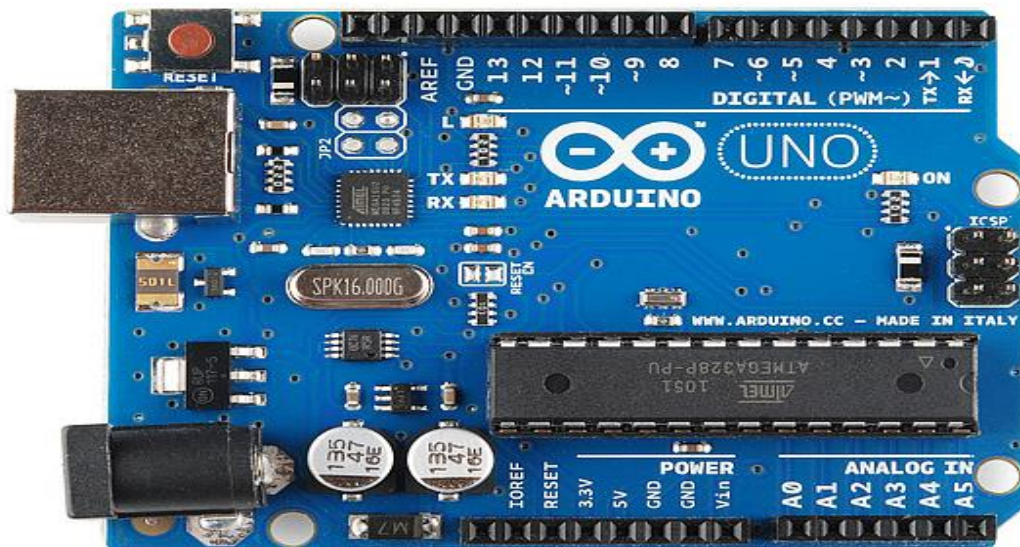
Figure 12: Arduino Structure

Is an open-source PC equipment and programming organization, venture and client local area that plans and produces microcontroller-based packs for building computerized

gadgets and intuitive items that can detect and control the actual world.

The venture depends on a group of microcontroller board plans produced fundamentally by Smart Projects in Italy, and furthermore by a few different sellers, utilizing different 8-cycle Atmel AVR microcontrollers or 32-bit Atmel ARM processors [4]. These frameworks give sets of advanced and simple I/O sticks that can be communicated to different extension sheets ("safeguards") and different circuits. The sheets highlight sequential interchanges interfaces, remembering USB for certain models, for stacking programs from PCs. For programming the microcontrollers, the Arduino stage gives an incorporated improvement climate (IDE) in view of the Processing project, which incorporates support for C, C++ and Java programming dialects.

The principal Arduino was presented in 2005, expecting to give a reasonable and simple way for learners and experts to establish gadgets that communicate with their current circumstance utilizing sensors and actuators Common instances of such gadgets planned for novice specialists incorporate straightforward robots indoor regulators, and movement identifiers. Arduino sheets are accessible monetarily in preassembled structure, or as DIY packs. The equipment plan determinations are straightforwardly accessible, permitting the Arduino sheets to be fabricated by anybody. Adafruit Industries[5] assessed in mid-2011 that north of 300,000 authority Arduino had been financially created, and in 2013 that 700,000 authority sheets were in clients' hands.

2.7 Arduino Advantages

It's straightforward and available client experience; Arduino has been utilized in a great many various ventures and applications. The Arduino programming is not difficult to-use for different devices, yet easy to use and adaptable enough for cutting edge clients. It runs on Mac, Windows, and Linux. Instructors and understudies use it to construct minimal expense logical instruments, to demonstrate science and physical science standards, or to get everything rolling with programming and mechanical technology. Creators and draftsmen assemble intuitive models, performers and specialists use it for establishments and to try different things with new instruments. Creators, obviously, use it to fabricate large numbers of the activities showed at the Maker Faire, for instance. Arduino is a critical device to learn new things. Anybody -

youngsters, specialists, craftsmen, software engineers - can begin dabbling simply adhering to the bit by bit directions of a unit, or sharing thoughts online with different individuals from the Arduino community.

There are numerous other micro controllers and micro controller stages accessible for actual figuring. Parallax Basic Stamp, Net media's BX-24, Fidgets, MIT's Handy board, and numerous others offer comparative usefulness. These devices take the muddled subtleties of micro controller programming and envelop it with a simple to-utilize bundle. Arduino likewise improves on the most common way of working with microcontrollers, however it offers some benefit for educators, understudies, and intrigued beginners over different frameworks:

Cheap - Arduino sheets are moderately reasonable contrasted with other micro controller stages. The most affordable rendition of the Arduino module can be gathered the hard way, and, surprisingly, the pre-collected Arduino modules cost under $50.

Cross-stage - The Arduino Software works perfectly on Windows, Macintosh OSX, and Linux working frameworks. Most micro controller frameworks are restricted to Windows.

Basic, clear programming climate - The Arduino Software (IDE) is not difficult to-use for novices, yet adaptable enough for cutting edge clients to exploit too. For educators, it's helpfully founded on the Processing programming climate, so understudies figuring out how to program in that climate will be know all about how the Arduino IDE functions.

Open source and extensible programming - The Arduino programming is distributed as open source devices, accessible for expansion by experienced developers. The language can be extended through C++ libraries, and individuals needing to comprehend the specialized subtleties can take the jump from Arduino to the AVR C programming language on which it's based. Essentially, you can add AVR-C code straightforwardly into your Arduino programs assuming that you need to.

Open source and extensible equipment - The plans of the Arduino sheets are distributed under a Creative Commons permit, so experienced circuit fashioners can make their own form of the module, broadening it and further developing it. Indeed, even generally unpracticed clients can assemble the bread board adaptation of the module to comprehend how it functions and set aside cash.

To know more about Arduino vs other microcontrollers, see [6].

2.8 SIM7100C LTE Module:

Figure 13: SIM 7100 LTE Module

SIMCom demonstrates an ultra rigid and reliable wireless module SIM7100C [7], which works on Qualcomm MDM9215 multiplemode LTE platform. SIM7100C is a all-to-all multi-band TDD-LTE/FDD-LTE/TD SCDMA/WCDMA/GSM/GNSS SMT type module designed with very strong processors integrating application core:ARMv7 Cortex™ A5(1GHz), dual Telecom core (Up to 500Mhz), allowing customers to get benefit from small dimensions and cheaper product solutions. It has very strong extension working capability with rich interfaces including UART, USB2.0, SPI, I2C, PCM, etc. With abundant application capabilities like TCP/UDP/FTP/FTPS/HTTP/HTTPS/SMTP/POP3 and MMS, the module gives much elasticity and easiness of integration for customer's applications.

General features:

Four-Band TDD-LTE B38/B39/B40/B41

Tri-Band FDD-LTE B1/B3/B7

Dual-Band TD-SCDMA B34/B39

Dual-Band UMTS/HSDPA/HSPA+ B1/B5

Tri-Band GSM/GPRS/EDGE 850/900/1800 MHz

Control Via AT Commands

Supply voltage range: 3.4V~ 4.2V

Operation temperature: -40ºC to +85ºC

Dimension: 30 X 30X 2.9 mm

Weight: 5.7g

GNSS gpsOne Gen 8B;standalone;assisted,XTRA

Specifications for Data transfer:

	UPlilnk up to	Downlink up to
TDD-LTE/FDD-LTE	50Mbps	100Mbps
TD-HSDPA/HUUPA	2.2Mbps	2.8Mbps
TD-SCDMA	128kbps	384kbps
HSPA+_	11Mbps	42Mbps
UMTS-	384Kbps	384Kbps
EDGE Class	MAX.236.8Kbps(DL)	MAX 236.8Kbps(UL)
GPRS	MAX 85.6Kbps(DL)	MAX 85.6Kbps(UL)

CSD-GSM data rate 14.4Kbps
WCDMA data rate 57.6Kbps
WCDMA 64Kbps CSD for video call

Interfaces:

USB2.0

UART

SIM card

SPI

I2C

Keypad(5*5)

Constant current sink

GPIO
RTC
ADC
PCM
SDIO

2.9 Global positioning framework:

Global positioning framework is vital in our life; such countless various arrangements have proposed show as related work cry:

The minimal expense vehicle following and observing framework is introduced to track and screen vehicle status that are involved by specific party for specific purposes, and to give area and time data anyplace on the planet. The proposed framework comprises of in-vehicle GPS collector, GSM modems and micro controller GPS module safeguard is utilized to follow and find the place of the vehicle, and the GSM for sending advance notice message to the proprietor of the vehicle and inserted regulator.
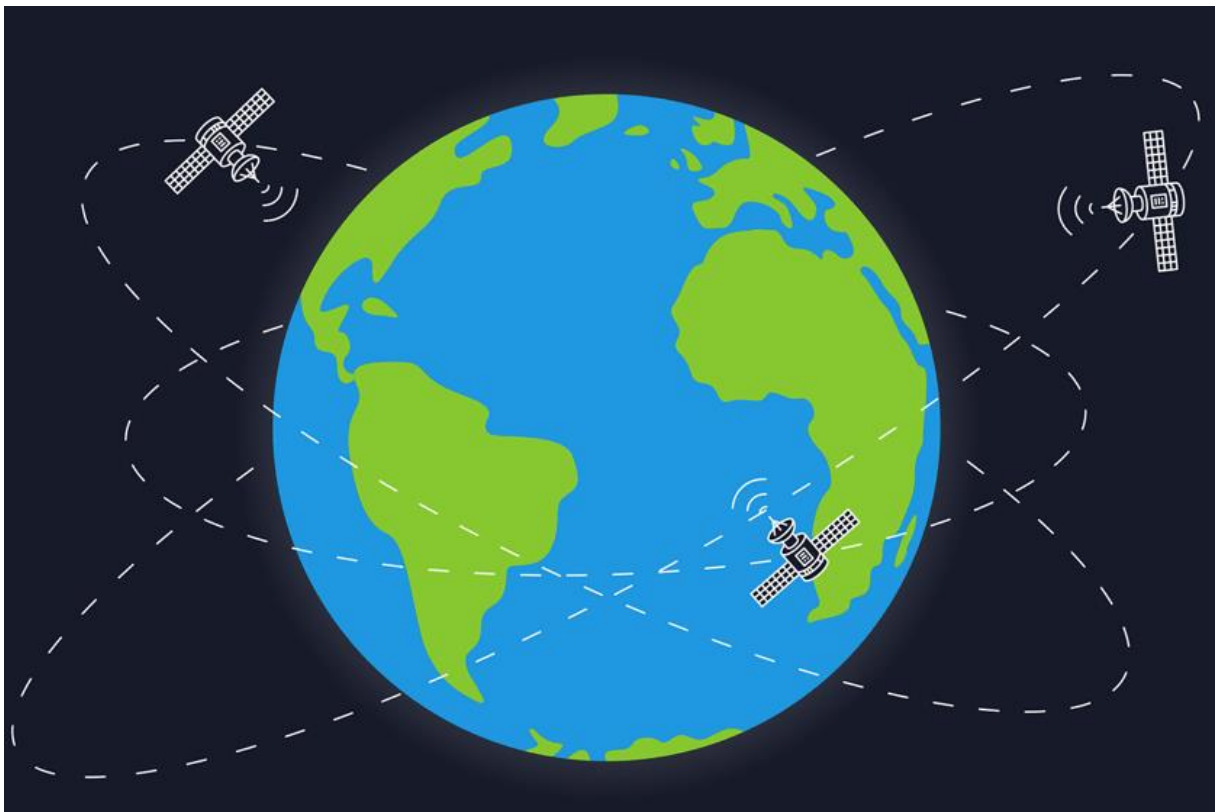

Figure 14: Global Positioning Framework

Google Maps used to show the ongoing area of the vehicle and typically find gadget position with the assistance of organization. the client simply send one message to the vehicle and the vehicle's portable will send you the ongoing area of vehicle as web connection and client needs to tap on a connection and that connection goes to Google guide and will show the ongoing area of vehicle.

In spite of the fact that utilizing SMS innovation which it's advantageous approach to moving and getting information, and it is modest innovation, however the web administration isn't accessible at the entire time, so an android telephone application can be helpful for getting information without web.
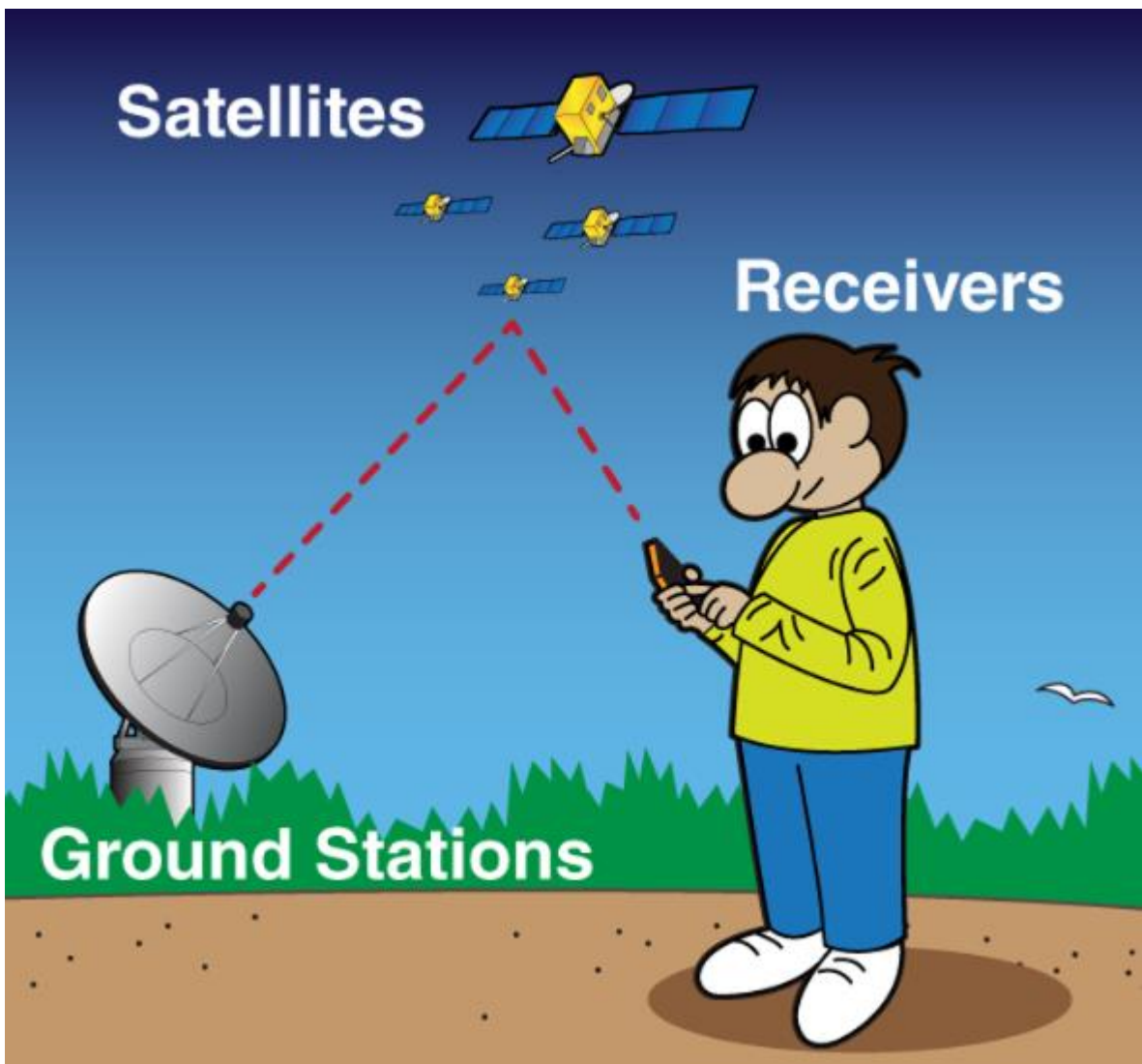

Figure 15: Informaton network through satellites

The framework presents a GPS and GSM based vehicle global positioning framework that

furnishes the proprietor with full security and track of the resource. GSM/GPS innovation utilized for security purposes, though the robbery counteraction framework given by Android application. The point proposed is to execute small scale model by utilizing a solitary chip micro controller in the vehicle. The framework implanted in the vehicle, comprise of a GSM modem, GPS beneficiary, control hand-off, current sensor and Micro controller.

The framework permits clients to follow the position, speed, water level, motor level and various boundaries. The proprietor simply needs to send a SMS and the global positioning framework introduced inside the vehicle will answer soon. Client can stop the bike when the vehicle under burglary by android application. In this framework GPS, GSM is communicated with atmega162 v micro controller and 16x4 LCD show is utilized to show a message to the client. The web to follow the vehicle on web, and an android application for advanced cell to follow the vehicles on Google Maps without need of web. That framework shows and presented the customary existing global positioning frameworks regarding cost, administrations, dependability and control.

Despite the fact that of robbery counteraction and control presented by this framework and SMS innovation, yet the proprietor need quite a while to get his vehicle.

Vehicle global positioning framework in light of Google map and cell phone application:

The proposed framework is utilized Google earth and cell phone application to follow the vehicle whenever and to tackle different issues that looked in this metropolitan life transportation. The framework proposed a vehicle global positioning framework utilizing GPS/GSM/GPRS innovation and a Smartphone application to offer better support and financially savvy answer for clients. GPS is mounting on the vehicle which gives current area and it is transport by GSM alongside different boundaries as SMS to the recipient. Micro controller is utilized to peruse specific motor boundaries from car information port, processes the GPS data and to send this information to the server utilizing GSM modem by SMS. Cell phone application to track and screen a vehicle area got from the framework in-vehicle GPS beacon constrained by a microcontroller. In this proposed framework a vehicle area and all data are naturally put on Google map subsequent to handling utilizing Smartphone application. Hence, clients will actually want to constantly screen a moving vehicle on request.

2.10 Tracking system using GPS technology

The proposed "Mixture GPS-GSM" framework assists the police with automobiling circulation and burglary alert; it's pre-owned SMS to follow the vehicle, and utilized "kalman" channel to address the ongoing position. While

in other proposed frameworks The Google Maps API is utilized to show the vehicle on the guide in the Smartphone application, besides the framework will find focus by the utilization of a Web application which that it require web server to run. This global positioning framework screens all danger and dangers, utilized for security, remote observing transportation and other field, and ready message to cell phone for distant data. Likewise this approach presents minimal expense answer for car position and valuable on account of vehicle robbery circumstance. Despite the fact that of utilizing cell phone or Google map on web to follow the vehicle, yet the web isn't accessible at the entire opportunity to follow the vehicle. In this manner, disconnected android application can be valuable for following and anti theft circumstances.
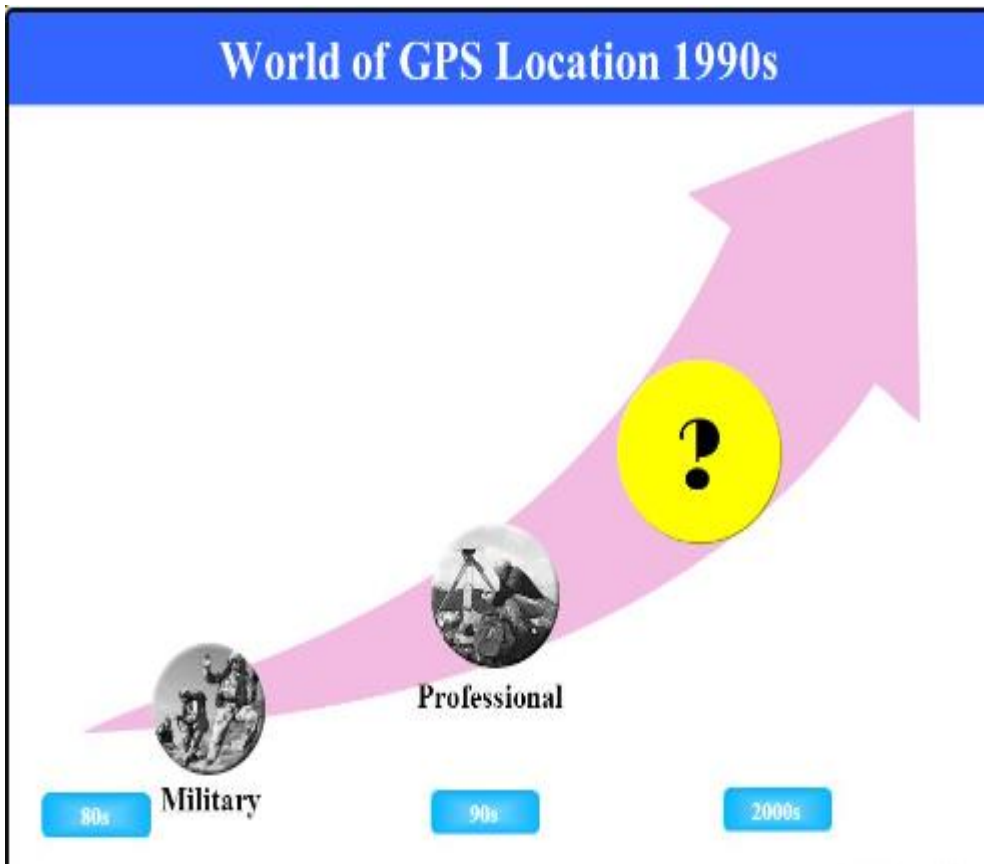

Figure 16: GPS uses in 90's

The propose framework will give the specific area of vehicle with distance among client and vehicle.

The associations are putting cash in checking and following vehicles targeting further developing administrations and guaranteeing the security in freights transports. Communicating Side contains GPS, GSM and GPRS usefulness which is preload in a PDA . The framework contains single android portable that is furnished with GPS and GSM modems alongside processor that is introduced in vehicle. The framework permits those organizations to screen the voyaged courses through a web client that utilizing Google Maps API and shows colors on the guide to demonstrate if the gadgets on course.

As per study GLONASS [8] and GALILEO [9] gives more precision than GPS yet their recipient costs extremely high, see COMPARISON in [10] . GPS is the best innovation thinking about its accessibility and cost, on the grounds that each Android telephone has inbuilt GPS beneficiary. In this manner there is no need of buying a different GPS recipient for each client.

"I.A. H. Eltoum and M. Bouhorma" [11] have proposed object pointed toward fostering a speed based framework for area following that will be more helpful for clients and more solid. This framework put the thought of the organization administration and expanding the exactness in Smartphone's. It is base of creating application in Android and it has been intended to work with the reuse of parts and permit the parts to be supplanted by clients , and utilized Linux bit proceeds as a reflection layer between the equipment and Android programming. This approach concentrates on the constant area following and control framework that can follow the objective situation at all time and places as expected by the client, and enhanced confinement framework relying upon the incorporation of GPS and GPRS/3G techniques.

This approach involves Android application for greater unwavering quality, and utilized the speed condition to expand the precision of following; the issue of utilizing GPS is that it's not effective in the space which is loaded with tall structures, because of those Wi-Fi signals proposed to supplant GPS.

"Z. Liu, A. Zhang" and **"S. Li"** [12] have proposed a vehicle following and burglary counteraction framework utilizing GPS/GSM and SMS innovation. They involved RFID module as regulator to turn ON and OFF. At the point when the vehicle is taken, the vibration sensors and pyro electric infrared sensors mounted inside the vehicle are set off "pyro electric to ensure it's brought about by human variables", then, at that point, GSM module will send the area data acquired by GPS module to the proprietor's cell phone. SMS Control Protocol to

locking the vehicle, opening the vehicle and slicing of fuel as indicated by the substance of the short message.

This approach worked by RFID module, GPS stores the scope and longitude data gathered in E2PROM chip. GPS module working autonomously is that the precision of the information got each time is ensured. GSM reports the data to dominate control module, which can effectively lock and open the vehicle.

Albeit this framework can be exceptionally helpful when the vehicle is taken, utilizing SMS to stop the vehicle, however it's wasteful to control the vehicle, accordingly an android application with web server can be successful answer for stop the vehicle.

"T. Selvamurugan" presents an answer framework to tackle the issue of vehicle burglary and mishap because of over speed, liquor intoxicated by driver. This proposed framework has been intended for following and observing of the vehicle utilizing ARM processor and give successful and continuous vehicle area utilizing GPS and GSM. The framework utilized geographic positions and time data from the worldwide Positioning Satellites. The model has been broadly tried, in actuality, circumstances and exploratory outcomes are extremely uplifting for drivers and owners. Plan and Implementation of vehicle following and observing utilizing GPS and ARM processors to keep away from vehicle impact and lessen gridlocks out and about simultaneously speed of the vehicle likewise has been monitored.

Albeit this approach present effective carry out to decide speed utilizing accelerometer, which that gives high exactness in speed, and utilized ARM processor, yet it requires some expense.

"V. H. KomalBhujbal and Bhakti Kulkarni" have proposed "Following Location and Speed of Vehicles: Using GPS on Android Platform". They present a framework that gives following administrations utilizing "Orion Easy track" gadget which is a GPS/GSM/GPRS module, and they utilized Google guides to show the last refreshed position of the multitude of client's vehicles as a picture that addresses the ongoing area of a chose vehicle. This framework joins the establishment of an electronic gadget in a vehicle, with programming essentially at one functional base to empower the proprietor or an outsider to find the vehicles position, speed, stops, developments, and gathering information from the field and convey it to the foundation of activity.

In this approach a SMS notices are shipped off the client's mobile phone in the event of Over-

Speeding, Enter/Exit a Geo-wall region "virtual edge for a certifiable geographic region", Car Stops/Moves and Car Alarm going on. The proposed GPS framework is partitioned into three principal parts: the Server, the Client applications, and the GPS beacon. The vital component is to give to the administrator is tracking down the area and speed of the vehicle[12]. This approach is separated into three fundamental parts: Server, Client applications, and Orion gadget, working incorporated together, that is empowering overseeing of area, speed and explicit limit.

"J. R. Mahalingam T. also, Shunmuganathan K.L" managed idea of global positioning framework in view of distributed computing foundation. Distributed computing is Internet-based registering, by which shared assets, programming, and data are given to PCs and different gadgets on request. This framework is executed in android for giving portability and easy to use. The data is communicated to Tracking server utilizing GSM/GPRS modem on GSM network by utilizing SMS or utilizing direct TCP/IP association with Tracking server through GPRS.

This approach has impediment of utilizing customized web server, in light of the stockpiling limit is restricted, keeping up with is excessively extreme, backing up information or moving to another new server is troublesome and human connection point is required each time Installing another server and keeping up with costs high.

"A. P. SumitRai" has proposed a methodology for following utilizing Google map application. The framework executed utilizing GPS and GSM unit to gathering the information from the field and deliverers it to the server from where it will be gotten by android application. The vehicle's area can be seen on Google maps in android application utilizing web. GPS will give the longitude and scope values and that values has been sent to the server (open GPS server) utilizing GSM module, and the longitude and scope worth will be transferred on the server, then the client will ready to get the constant area of the vehicle and show it on Google map utilizing android application and internet. This approach is exceptionally helpful on account of utilizing android and "open gps" server to store and deal with information, the issue of utilizing that it's not productive in disconnected frameworks.

"S. S. T. Mahadevaiah K G, Abhishek V, Rakshith P R and Ashish N Koushik" have proposed vehicle global positioning framework utilized GPS and GSM. They utilized SMS innovation to control the vehicle, which can be switched off by just with a straightforward SMS

utilizing micro controller to stop motor engine. This framework comprises of an android based far off vehicle separating framework will give viable, continuous vehicle area, planning and detailing this data worth and add by working fair and square of administration gave. The proposed framework utilized geographic position and time data from the Global Positioning Satellites, GSM and SMS innovation for remote information transmission. Vehicle data can be seen on electronic guides through the Internet or particular programming. Vehicle global positioning frameworks are likewise famous in shopper vehicles as a robbery counteraction and recovery gadget and utilized in different applications when vehicle is taken, field administration the board and it utilized for food conveyance and vehicle rentals companies.

Despite the fact that of utilizing GPS and an android application to give security framework more than other framework , and gives a decent control of vehicle, however this approach can be control of one vehicle not armada of vehicles .consequently, Server is valuable to control of armada of vehicles.

"K. S Om Prakash" has proposed framework to follow the development of vehicle's area whenever. The framework gives minimal expense arrangement extremely less Hardware parts which are less expensive and open by everybody. This framework carried out unit utilizing GPS module to get geological directions from satellites and GSM/GPRS module to send the GPS information to the web server. It likewise utilized TCP server to store the GPS information containing the area data.

2.11 Cloud Technology

Figure 17: Cloud Technology

The "Cloud" [13] term refers to those servers that can be accessed using the internet, and also the softwares, databases etc that run on those servers. In all over the world Cloud Servers are located in the data centers.

"Cloud Computing"[14] is the delivery of computing services which includes storage, servers, networking, databases, software, analytics, and intelligence over the Internet "the cloud" to offer faster innovation, flexible resources, and economies of scale. You typically pay only for cloud services you use, helping you lower your operating costs, run your infrastructure more efficiently, and scale as your business needs change.

"Cloud Computing" is used, so that users or companies don't have to manage the physical servers themselves or run software application on their local server.

The users can access the same applications and files deployed on the cloud from almost any device, because storage and computing does not take place in the local server, it takes place in the data center. Therefore, for the businesses, it is beneficial to switch to cloud because it removes many overheads and some IT costs: for example they no longer have to maintain and update their servers, because cloud vendors will be doing that.

There are three different ways to deploy cloud services [15] :
- Public Cloud

- Private Cloud
- Hybrid Cloud

Public Clouds are owned and operated by the third party cloud service providers. Which deliver the computing services over the internet. While **Private cloud** refers to cloud computing resources used exclusively by the organization or a single business. It can be physically located in company's onsite datacenter. **Hybrid cloud** merges the both clouds, the public and the private clouds, they are bound together by the technology that allows data and applications to be shared between them.

MS Azure cloud is the example of the public cloud that will be used in this project.

Table 1: Public cloud vs Private cloud vs Hybrid cloud

Public Cloud	Private Cloud	Hybrid Cloud
No maintenance costs	Dedicated, secure	Policy-driven deployment
High scalability, flexibility	Regulation compliant	High scalability, flexibility
Reduced complexity	Customizable	Minimal security risks
Flexible pricing	High scalability	Workload diversity supports high reliability
Agile for innovation	Efficient	Improved security
Potential for high TCO	Expensive with high TCO	Potential for high TCO
Decreased security and availability	Minimal mobile access	Compatibility and integration
Minimal control	Limiting infrastructure	Added complexity

Benefits	Drawbacks

There are three main types of cloud computing services [16] :

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

Software as a Service is the method which delivers the applications over the internet, which can be on demand and probably on subscription basis. Users connect to the application over the internet, mostly with their web browsers on their PC, Tablet or phone. While **Platform as a Service** is method of delivering the cloud computing services which supplies an on-demand

environment for developing, testing, managing and delivering the software applications. **Infrastructure as a Service** is the most basic type of cloud computing services. It provides the services of renting the IT infrastructure such as servers, Virtual Machines, storage, Operating systems and networks etc. It is based on pay-as-you-go basis.

Table 2:IaaS vs PaaS v SaaS
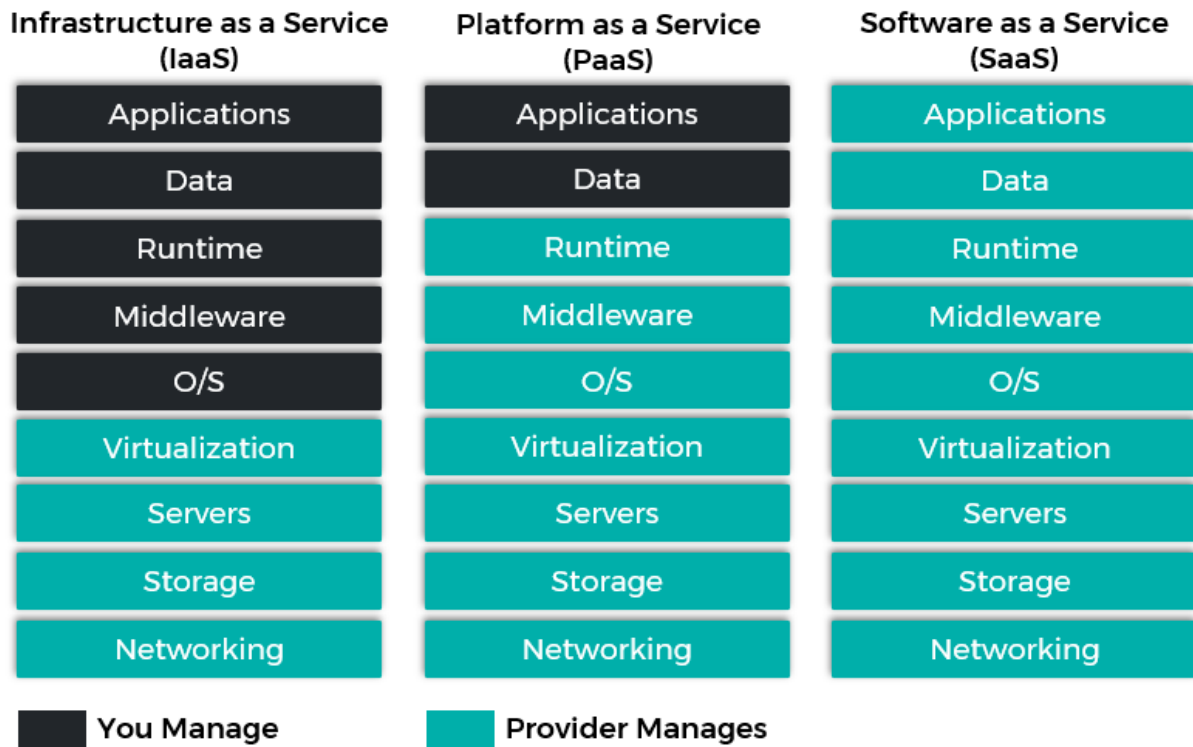
MS Azure SQL Database comes under the category of Platform as a Service (PaaS).

As for this project, **MS Azure Cloud** is used to store the data coming from the device that would be installed in the car. The data will be saved in the **SQL Database** resource deployed on the Azure Cloud.

2.12 Web Technology

Figure 18: Web Technology

Web Technology refers to the various tools and techniques that are utilized in the process of communication between different types of devices over the internet. A web browser is used to access web pages. Web browsers can be defined as programs that display text, data, pictures, animation, and video on the Internet. Hyperlinked resources on the World Wide Web can be accessed using software interfaces provided by Web browsers.

Creation of websites or web development has been classified into two ways:
- Frontend Development.
- Backend Development.

2.13 Front end Development

Figure 19: Front end development

The part which is directly accessed by the user is called "Front end". It is also called the "Client Side" of an application. Front end can be built using languages/frameworks such as HTML, CSS, and JavaScript or React JS or Django etc.Usually, web browsers receive HTML, CSS and JavaScript files to run on the user machine.

In the project, HTML,CSS, and JavaScript is used for the Frontend Development. A library named "Bootstrap" is also used to make the web application responsive.

2.14 Back end Development
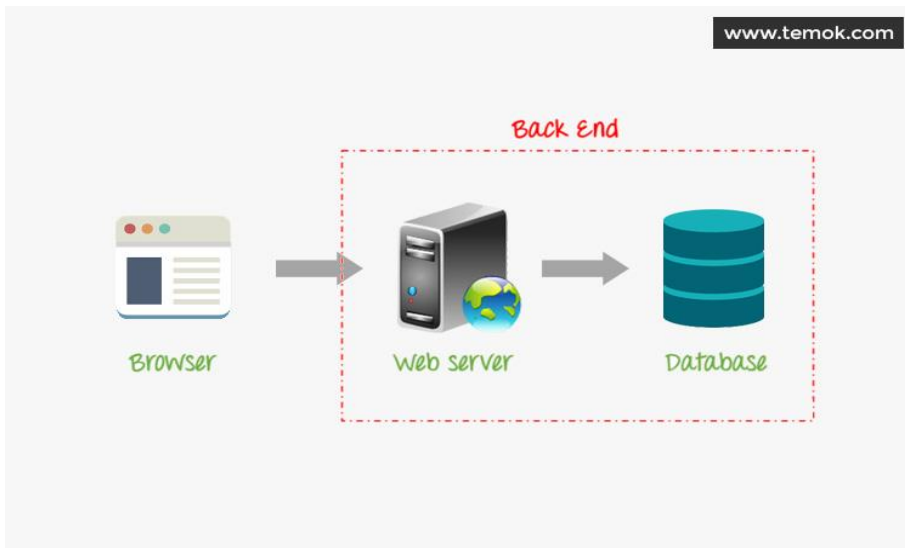
Figure 20: Back end development

Back end is the part which cannot be accessed by the user because it is a server side of a website. Therefore, it cannot be directly contacted by the users.So, the code in it does not run on the user machine, it runs on the server. It is mainly used to store and arrange the data. Back end can be built by using languages/frameworks such as Node JS, PHP, Python, Ruby etc.

In this project, Node JS is used for the Backend Development. Library named as "Mysql" is also used to interact with the database of the Azure Cloud.

2.15 API
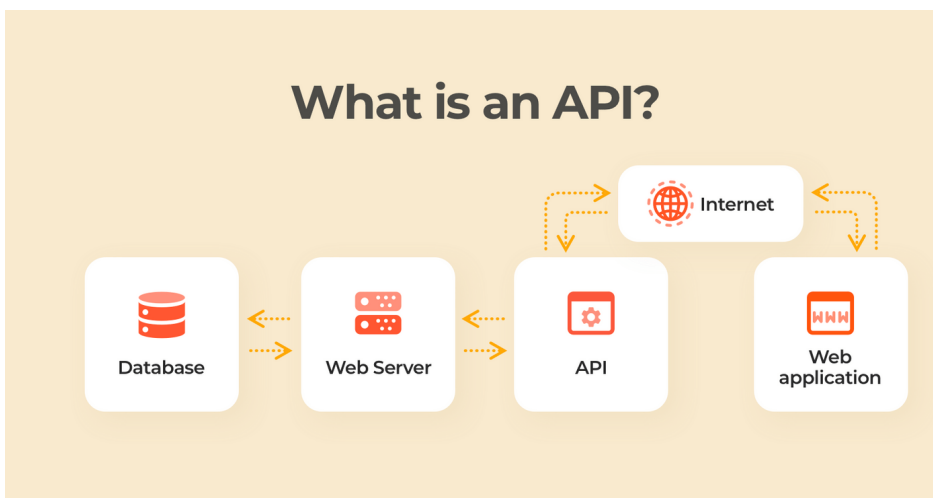
Figure 21: API structure

API stands for Application Programming Interface. Application in the context of APIs means that any software with a unique function. While Interface can be thought as a contract of any service between the two applications. This contract describes that how the two applications can communicate with each other using some requests and their responses. Information based on the developers can use requests and responses can be found in that API documentation.

In the context of Web, the Web API can be defined as an API between web server and the web browser.

There are four different ways that APIs can work which depends upon when and why they were created.

- SOAP API
- RPC API
- Websocket API
- REST API

Probably, the most used and popular is **REST API**, which stands for **Representative State Transfer**. In this type of API, the client sends requset to server as data. The client input is used by the server to start internal functions and returns the output data back to the client. **REST** defines a set of functions like GET, POST, PUT, DELETE etc. That can be used by the clients to access server data. Clients and servers exchange data using **HTTP**.

In this project, the **REST API** is used by the **Node JS** Application framework known as **Express JS**.

For more information on Web Technology, see [17].

Chapter 3: Related Products and Solutions

In order to track vehicles for security purposes, there has been a lot of work done on the development of vehicle tracking systems.

3.1 Trakom

An ultimate application for parents/guardians that guarantees security and well-being of children on the way , it tracks the live location of transport, computerized participation, voice notifications and correspondence from school [18] .

- Realtime location of school transport
- Opportune notice/SMS
- Precise attendance of children
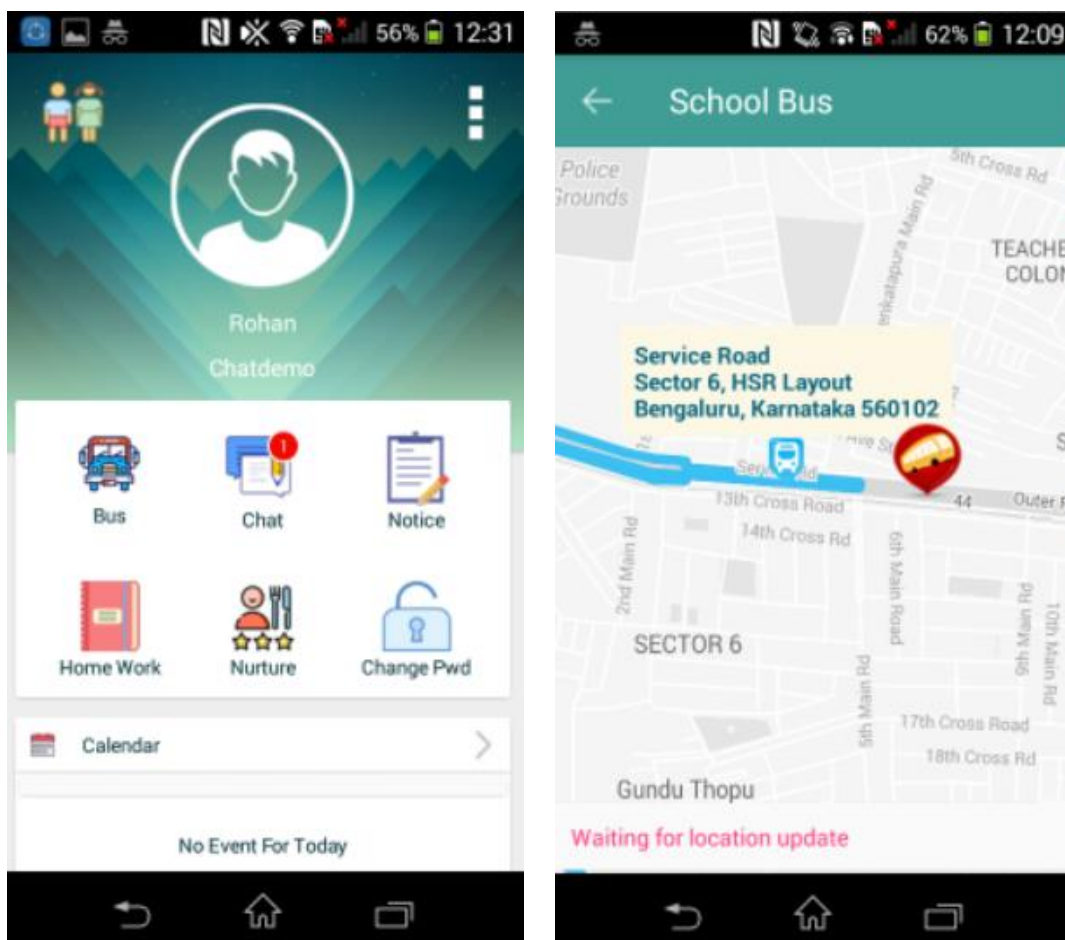
Figure 22: Front-end of Trakom

3.2 Bouncie

Bouncie, launched in 2017, is a GPS tracking device designed for the vehicles to help drivers stay safe and aware [19] . The device plugs into the OBD2 (on-board diagnostics) port in the vehicle and gives real-time notifications and driving data. Authorities can see their car's location and trip details like speed, driving habits, and accident notifications.
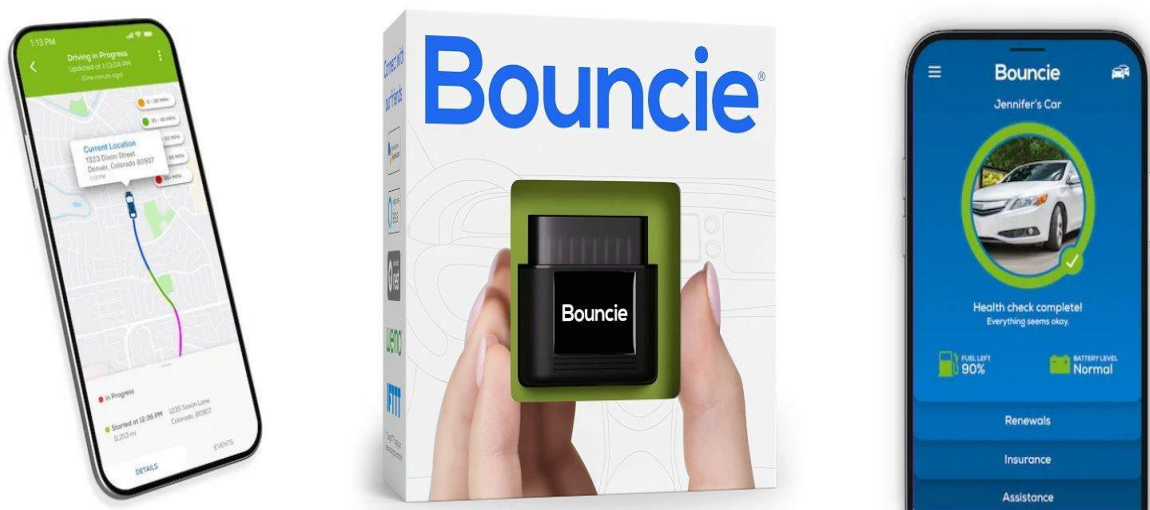
Figure 23: Bouncie structure diagram

3.3 Vyncs Pro 4G+

Vyncs Pro 4G+ is Vyncs Basic 4G+ with 20 seconds GPS tests (shipped off your record together like clockwork) and Live Map Auto Refresh (map consequently reviving as new GPS information comes in). Vyncs Fleet 4G+ is the fleet variant of Vyncs with many elements for business fleets and backing for in excess of 5 vehicles.

Figure 24: Vyncs Pro 4G+

3.4 E-Tracking solutions

It provides a wide range of vehicle and assets tracking and fleet management systems in Pakistan at competitive prices with reliable infrastructure and services. Currently they provide their services in 60+ cities with 3500+ vehicles currently using their services.

Figure 25: E-Tracking solutions

3.5 V-tracking

Vehicle Tracking (Pvt.) Ltd. was established with the sole point of offering security answers to individual vehicle proprietors and a much expected required relief to the Banking Industry. V-Tracking brings unequaled aptitude and observation facilities by using SMS, GPRS and Voice Communication stages that empower ongoing following. Vehicle Tracking Pvt. Ltd. was granted VTS permit by Pakistan Telecommunication Authority in August 2004.

Figure 26: V-tracking

3.6 AskTech (Pvt) Ltd. (AskTrack)

Ask Track [20] was established with the sole point of offering security answers for the vehicle proprietors. A turnkey arrangement that guarantees a cheap but totally dependable and familiar correspondence framework for proficient vehicle following. ASK Track being a genuine local player with tasks all over Pakistan has laid out an unmistakable marketpresence. Ask Track is assisting its clients with dozing better realizing that we are cautious 24×7! With the arrangements from Ask Track, for example, Stolen Vehicle Services, Fleet Management Solutions, Safe Transport Environment Project and e-Solutions, following your vehicle is somewhat away! Our insight and mastery limits the gamble of burglary as well as provides our clients with an inner serenity as now they never fail to focus on what genuinely is theirs with Ask Track!

Figure 27: Ask Track

Ask Track also offers a fleet management system. It is a modern and dependable system that

permits you to oversee vehicles and drivers with accuracy and increment efficiency while setting aside time and cash.

Ask track also has a Mobile Application with engine controls on Android & IPhone with easy and customer friendly interface.

3.7 Crescent Tracking

Crescent tracking has been established to fill the hole on the lookout for a capable organization to give a really GPS/GSM-GPRS security arrangement which is adaptable versatile in broadened conditions that incorporate cutting edge programmed vehicle and individual area frameworks.
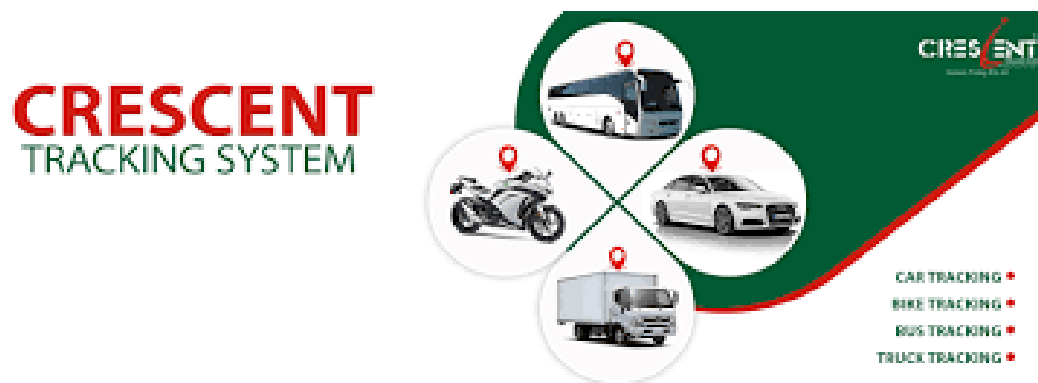
Figure 28: Crescent Tracking

3.8 Alpha Track

Alpha Track Pvt Ltd was consolidated in the year 2012 under the Companies Act 2017 managed by Security and Exchange Commission Pakistan (SECP). It is authorized by Pakistan Telecommunication Authority (PTA) to work across every one of the urban areas in Pakistan. It consistently endeavor to become one of the most outstanding following organizations in the country.

It has over 7500 clients in a simple consequence of our diligent effort and quality administrations.

The group uses GPS, GSM, and satellite innovation to follow your vehicle precisely anyplace in Pakistan. The business area (both private and public) is guaranteeing the security, fuel checking, and following all the while with the assistance of the high level administrations given

by Alpha Track.

Figure 29: Alpha Track fleet management

How does our project stand out from other products?

There are a number of factors that stand out our project from other companies that provide tracking services. Our project is Cloud based that distinguishes it from in-house servers. A comparison of these two is given below.

3.9 In-house servers

Table 3: In-house servers Pros & Cons

Pros	Cons
Gives you actual command over your backup	Requires a capital interest in equipment and framework.
Keeps basic information in-house. No outsider approaches your data.	Needs space in your office for a rack or server room/storeroom, notwithstanding devoted IT support.
Don't bother depending on an Internet association for admittance to information.	Might be more powerless to information misfortune during catastrophe circumstances because of its in-house area. How frequently you take the information offsite will reflect how much information you'll lose in a crisis.
Can be more practical for little to average sized companies.	No uptime or recuperation time ensures.
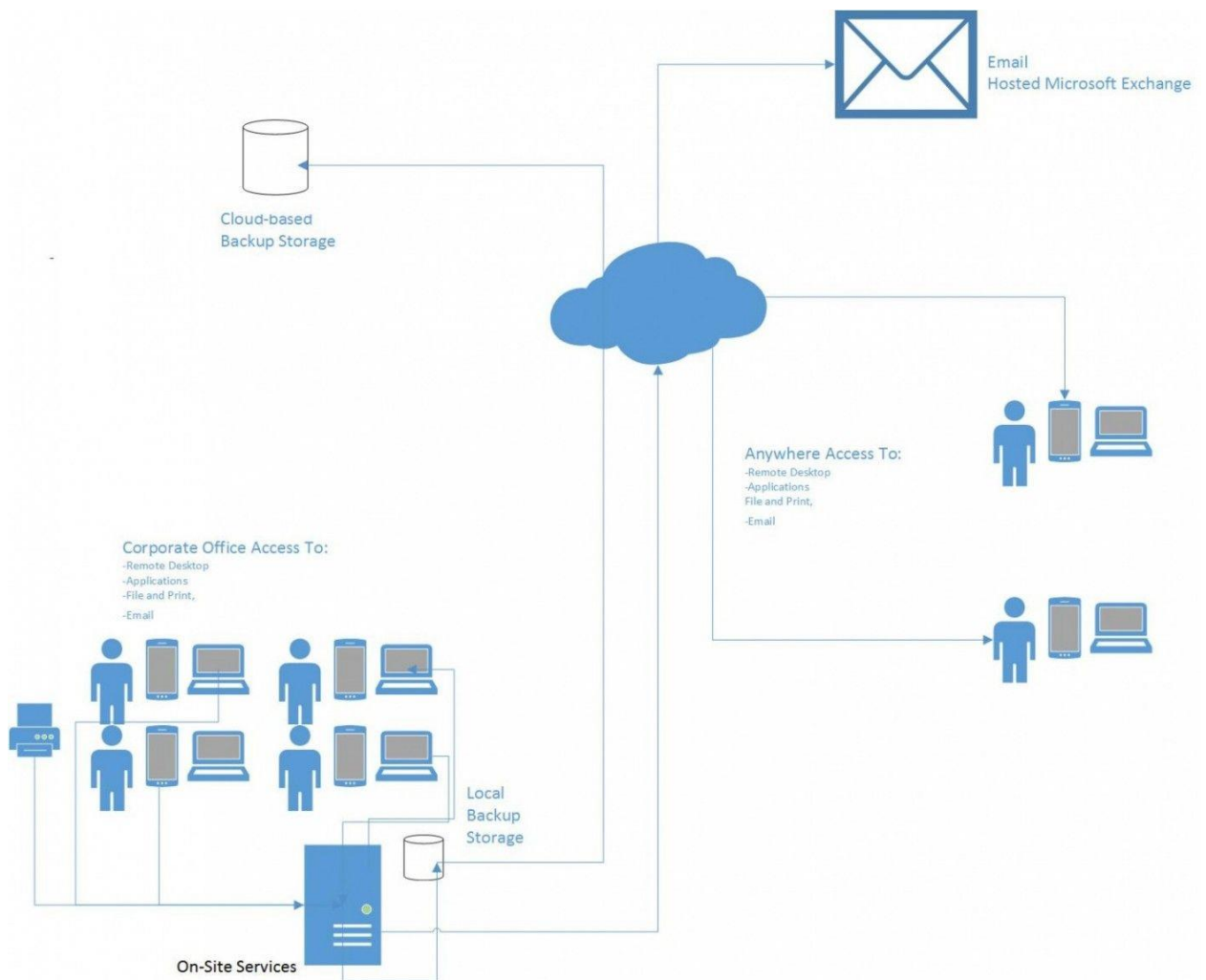
Figure 30: In-house servers structure diagram

3.10 Cloud Servers

Table 4: Cloud Servers Pros & Cons

Pros	Cons
No requirement for on location equipment or capital costs. Appropriate to more modest organizations that might grow out of capacity excessively fast.	The expenses of the information recuperation could offset the advantages for organizations that are not as reliant upon uptime and moment recuperation.
Capacity can be added on a case by case basis. Arrangements are many times on-request, so you just compensation for what you need.	Organization might have a breaking point to information that can be put away in the cloud because of capacity accessibility and cost.
Reinforcement and reestablish can be started from anyplace, utilizing any PC, tablet, or smartphone.	If the Internet goes down your ally or on your cloud supplier's side, you will not approach any of your data.
Information can be upheld in the cloud as routinely as 15-minute stretches, limiting information misfortunes in catastrophe circumstances. Little informational collection recuperation time is gotten to the next level.	Full information recuperation could demonstrate extremely tedious and effective on frameworks. Nonetheless, on the off chance that a Datto is utilized, recuperation can happen in minutes.
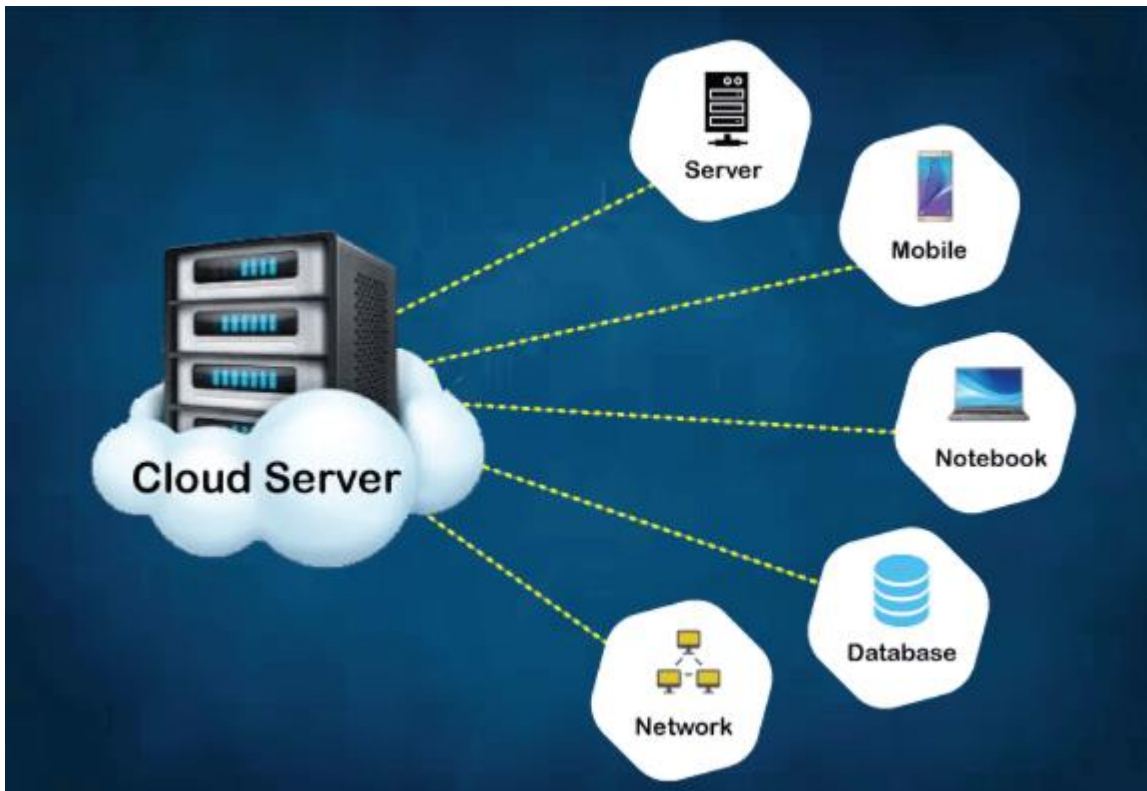
Figure 31: Cloud servers

Chapter 04: Design / Implementation

4.1 System Level Diagram
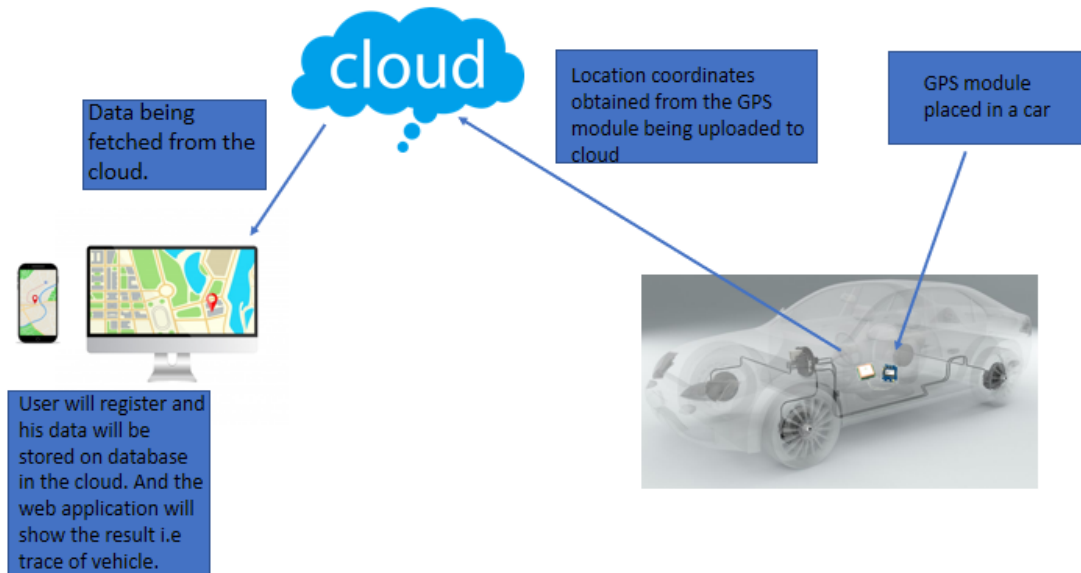
Figure 32: System level diagram

The hardware would be installed in vehicle. Coordinates of the vehicle would be fetched by Arduino from the module and by using 4G it would send the coordinates to the SQL SERVER in the MS AZURE CLOUD.

The Web Application is created, which can be accessed by the Authenticated user, which fetches the coordinates from the SQL SERVER in the MS Azure Cloud to show the location of the vehicle using Azure Maps.

4.2 Hardware Design

There are two hardware designs in the project.

- For testing purpose

- For Implementation of the project

4.3 Testing Hardware:
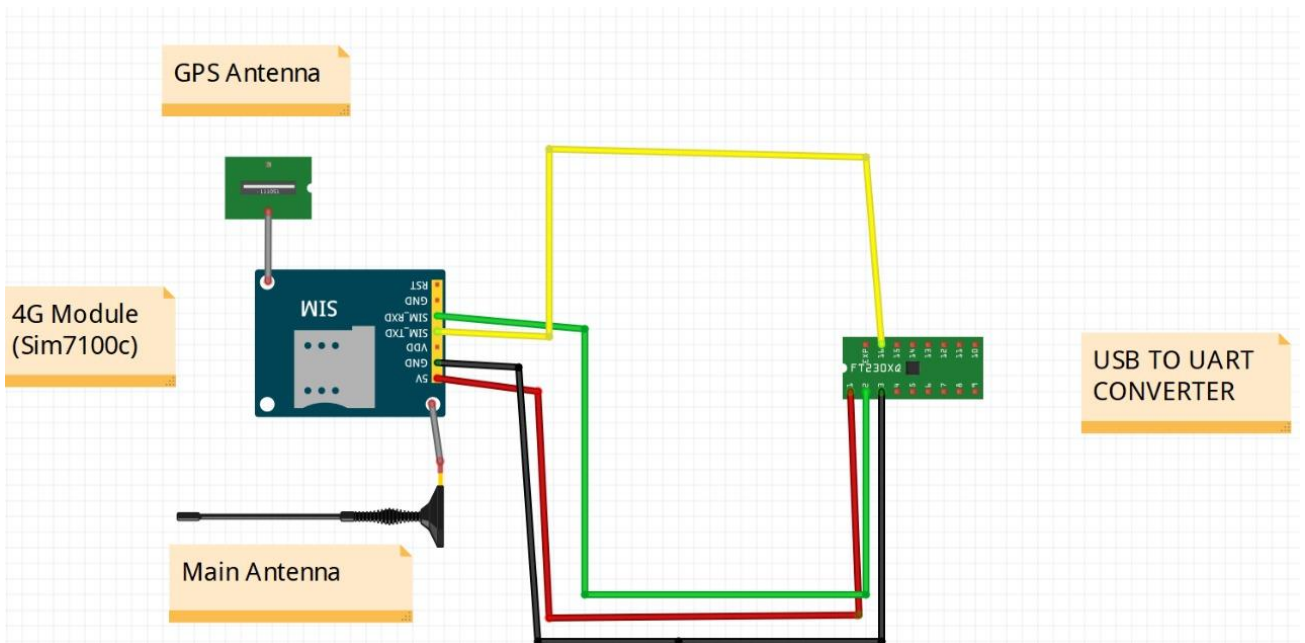
Figure 33: Testing Hardware

We are using above hardware in order to test module that whether it is working or not. Module is connected to PC using USB TO UART converter. We are using a software named **"PuTTY"** so that PC can serially communicate with the module. We test the module using basic AT commands such as **"AT"**, which in reply will prompt an **"Ok"**.

4.4 Implementation Hardware
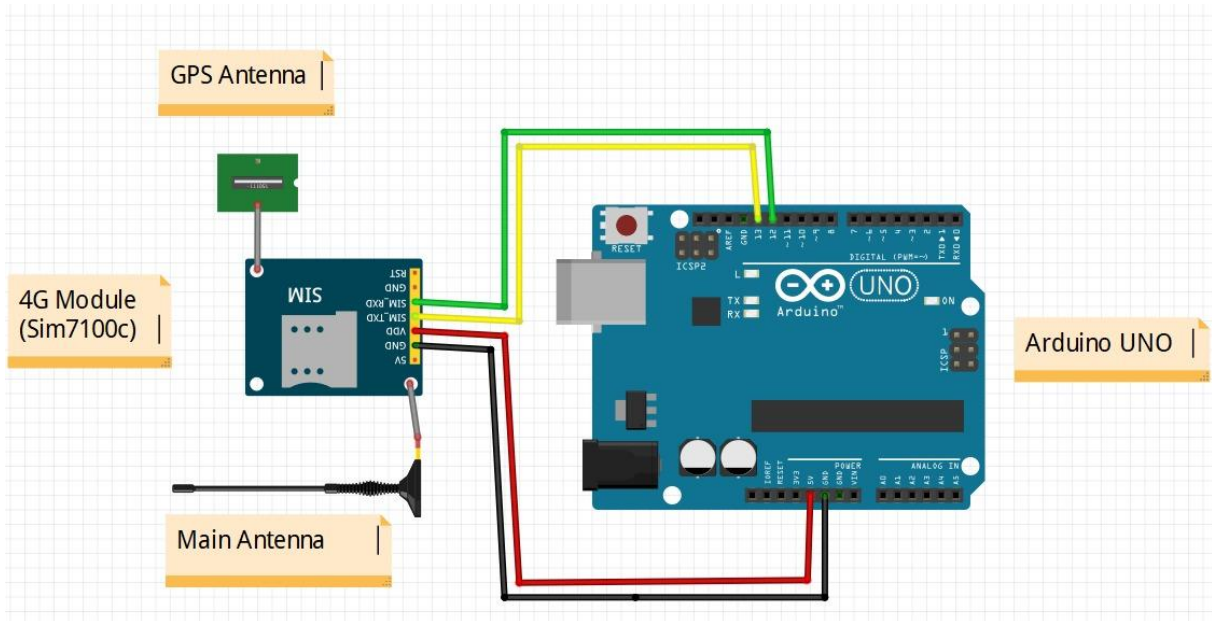
Figure 34: Implementation Hardware

We are using this hardware for the implementation of the project. We are connecting to two antennas to the module, the first one is the main antenna used for the 4G and the other one is the GPS antenna. The TX and RX ports of the module are connected to the port 11 and 12 of the Arduino. And then the Arduino is connected to 5v of the power supply (not shown in the image above).

4.5 Database ERD Diagram
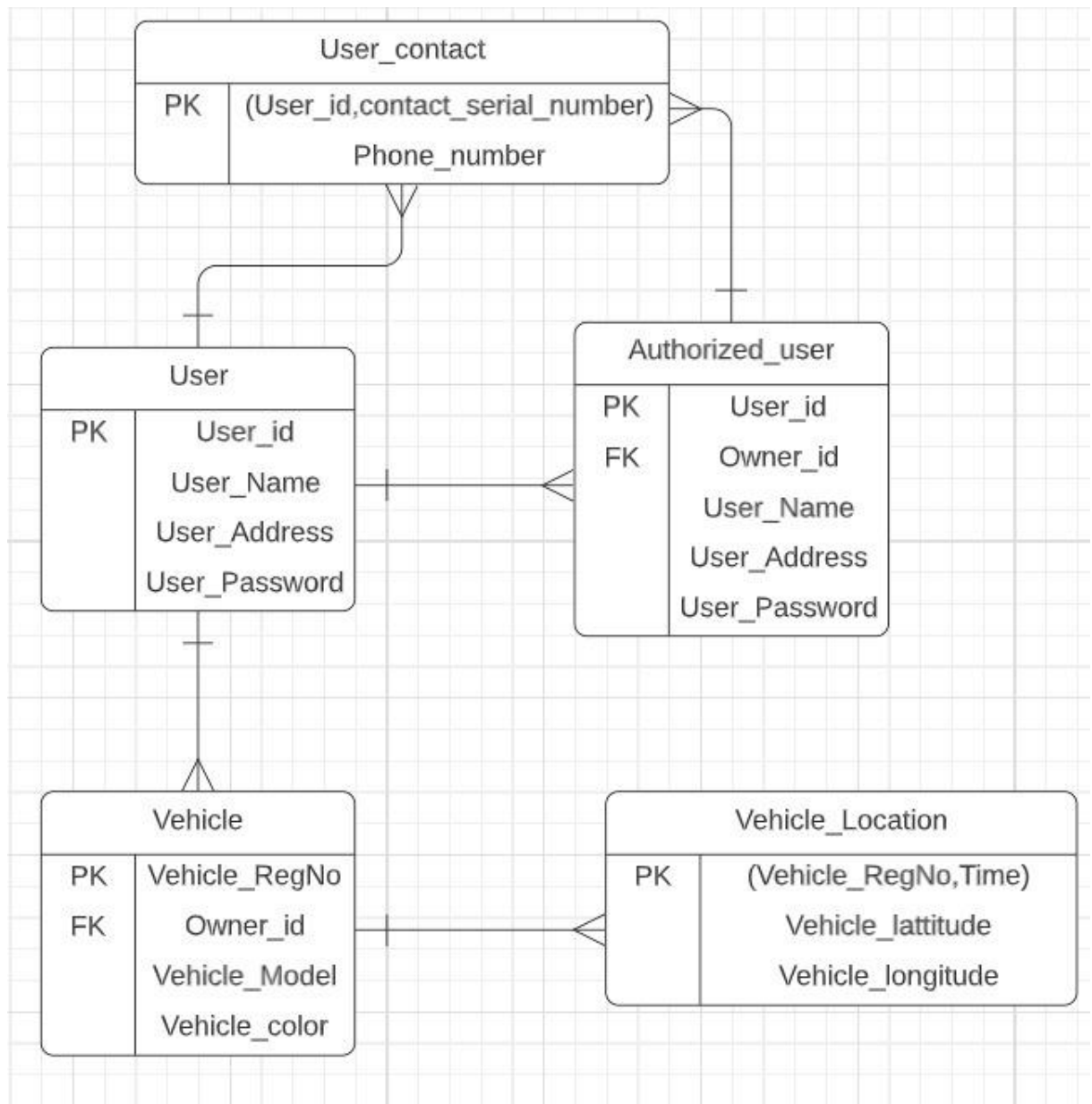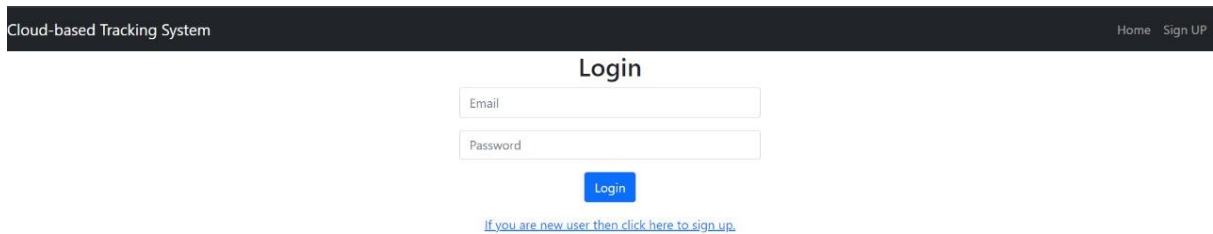
Figure 35: Database ERD Diagram

User table is made so that user's credentials can be saved in it. While authorized user is made so that a user can authorize other users to track his/her car. User contact contains phone numbers of the user. Vehicle contains information about the vehicle of the owner. While Vehicle_Location contains info about location of the vehicle in a particular time.

4.6 Sign in page

The sign in page is made for verifying the credentials of the user, so that he/she can use the services of tracking the vehicle.

It is made by using HTML, CSS and library named 'Bootstrap'.

Figure 36: Sign in page

4.7 Sign up page

The sign-up page is made for saving the credentials of the user, so that he/she can use the services of tracking the vehicle.

It is made by using HTML, CSS and library named 'Bootstrap'.

Figure 37: Sign up page

CHAPTER 5: TESTING AND RESULT

5.1 Checking some 'AT' commands

First of all, before doing anything we have to check whether the module is in working condition or not. For that we have to connect it to PC using UART to USB Converter as shown in Figure 4.2. For testing we have to use the list of commands called 'AT commands' which can verify the working of the module. Here are some the commands that verifies working of the module.

Figure 38: Checking AT commands (1)

57

Figure 39: Checking AT commands (2)

Figure 40: Checking AT commands (3)

As it is clear from the Figure 5.1,5.2 and 5.3 that if we send any 'AT command' to the module, in reply it says 'OK' and then does some functionality which is specific to the command. The 'OK' reply means that module is in perfectly working condition. After 'OK' reply we can add SIM to the module and then we can use the internet.

5.2 Transferring data to ThinkSpeak server

For checking the and controlling the transmission of the data, we have to send it somewhere where we can monitor it, so for that we are using ThinkSpeak server, from which we can see and monitor the data that has been sent to it.

The commands that are used in this transferring are:

- AT + CIPMUX
- AT + CSTT
- AT + CIPSTART
- AT + CIPSEND
- AT + CIPSHUT
- AT + CIICR
- AT + CIFSR

AT + CIPMUX:

To initiate multiple connections.

AT + CSTT:

To set the APN of the current network.

AT + CIPSTART:

To initiate TCP connection with the ThinkSpeak server.

AT + CIPSEND:

For sending data to TCP connection of the ThinkSpeak Server.

AT + CIPSHUT:

To close the TCP connection with the ThinkSpeak Server.

AT + CIICR:

To set the GPRS connection.

AT + CIFSR:

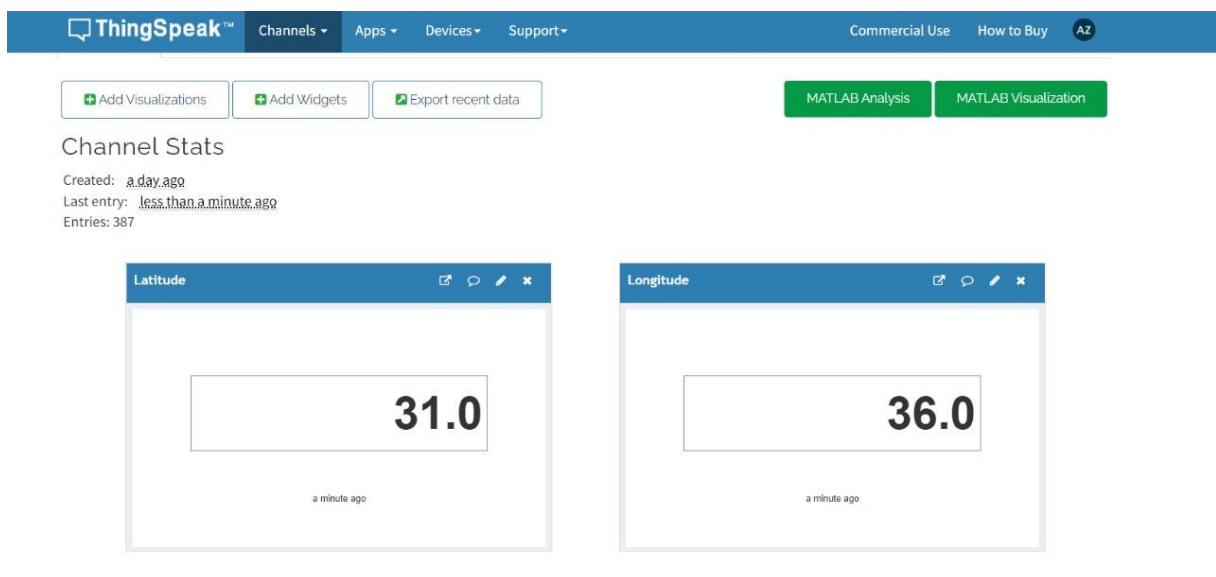To get the local IP Address of the module.

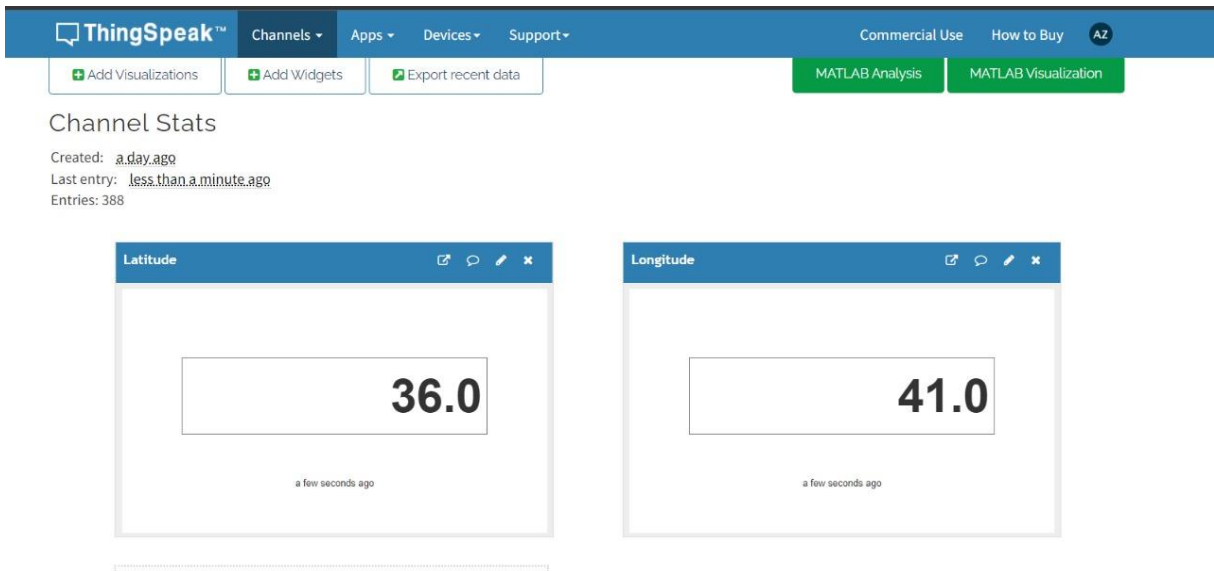*Figure 41: Transferring data to ThingSpeak server (1)*

60

Figure 42: Transferring data to ThingSpeak server (2)

In these figures we are sending some random coordinates to it, so that we can verify the data that has been sent.

5.3 Receiving coordinates from GPS module and sending it to ThinkSpeak server

As shown in the above section, we succeeded in transferring the random data (for testing purpose) to the ThinkSpeak server, now we are sending the gps coordinates from the module itself. But to do that, we have done some programming in order to decode the Lattitude and Longitude from 'NMEA (National Marine Electronics Association) sentences' using built in Arduino library 'TinyGPS' , which is used for extracting the required field (Lattitude and Longitude in this case).
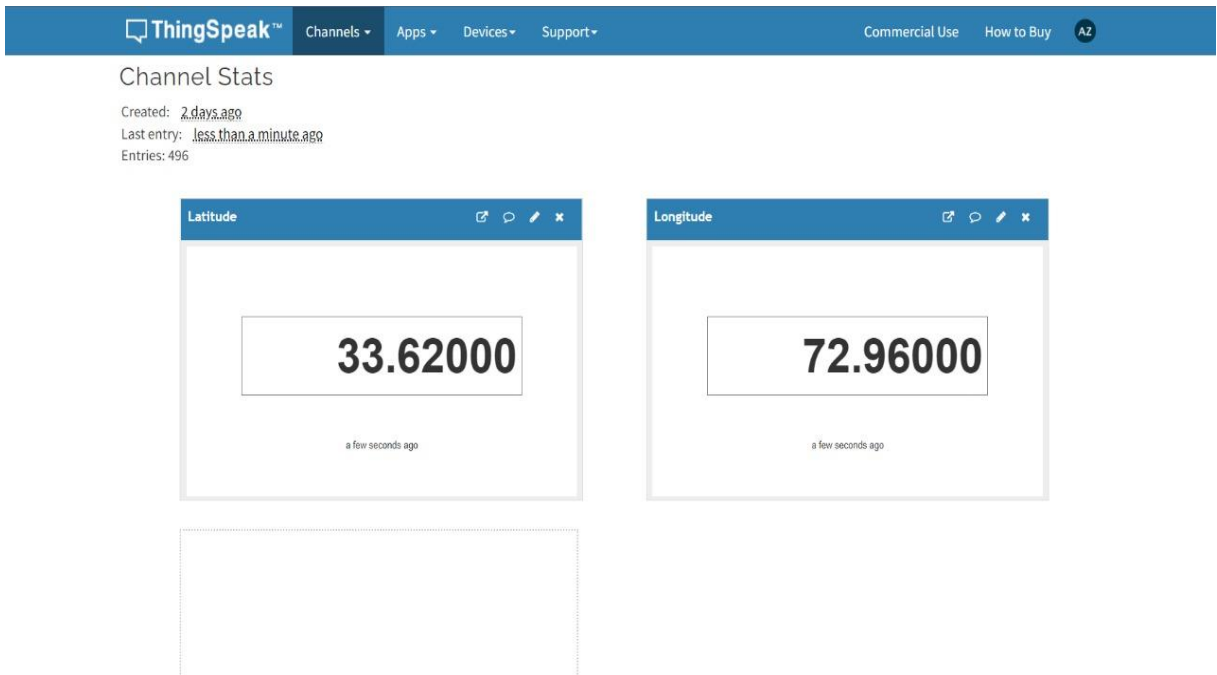
Figure 43: Transferring data to ThingSpeak server (3)

5.4 Sending the coordinates to the Azure Cloud Database

We are using IOT HUB in this case, IoT Hub is a Platform-as-a-Services (PaaS) managed service, hosted in the cloud, that acts as a central message hub for bi-directional communication between an IoT application and the devices it manages. So, we can connect it to Arduino using its API KEY. And from there we can send it to Azure Stream Analytics, which is used for streaming real time data and then to the SQL Database of the cloud.
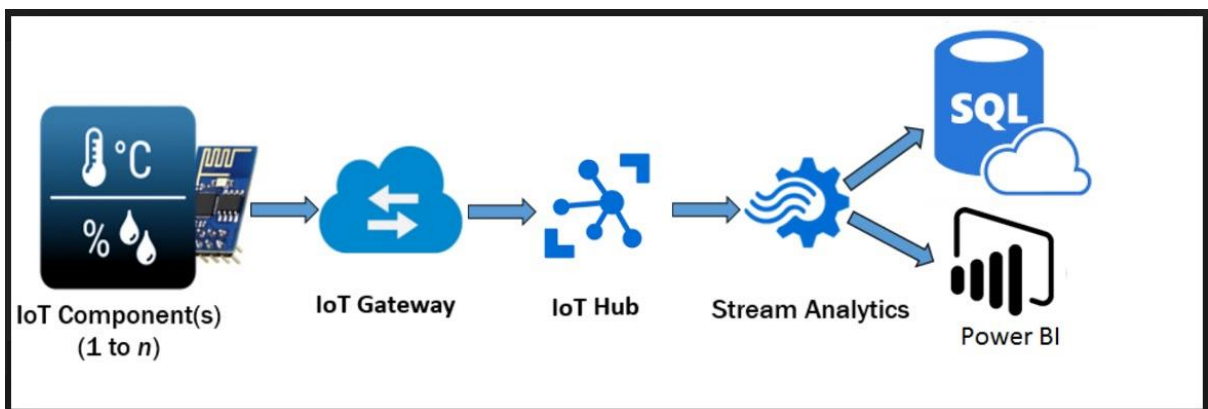

Figure 44: Sending coordinates to Azure cloud

5.5 Showing the location on the map in Realtime

At the end, we repeatedly fetch data from SQL Sever of Azure using Rest Services and display it on the map in Realtime.
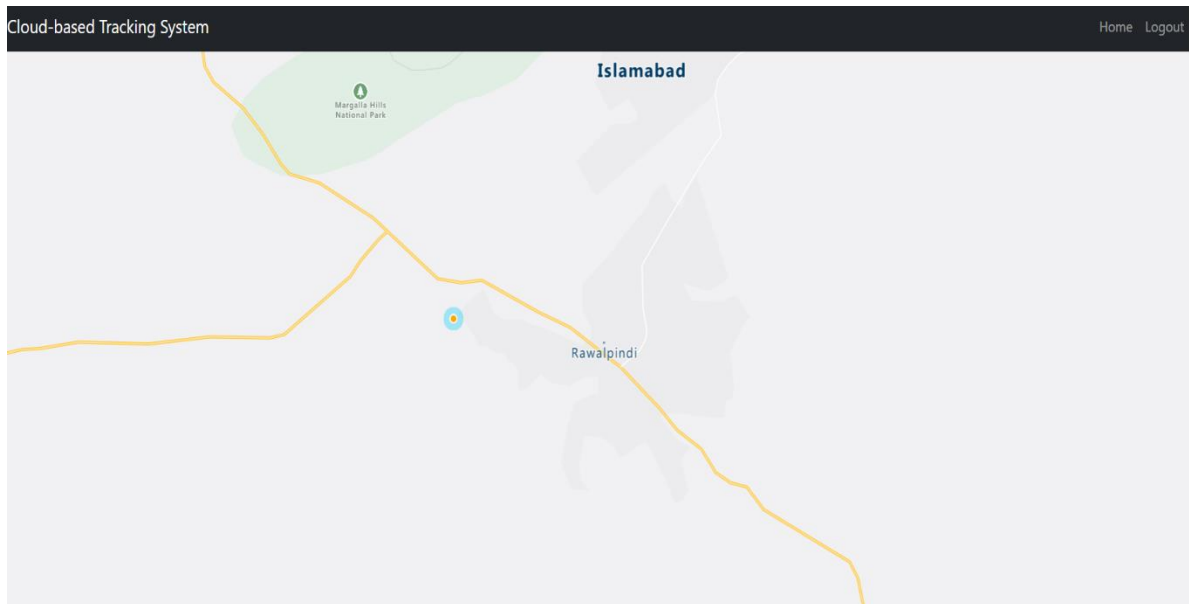

Figure 45: Showing location on the map

Chapter 6: Conclusion and Future Prospects

6.1 Conclusion

The project developed a device which can send the location of the vehicle to the cloud. It repeatedly sends the location to the cloud. A web Application was also developed, which continually fetches the coordinates from the cloud (for showing it in Realtime), for the authenticated users. Then the coordinates are being displayed on the azure map in Realtime.

6.2 Future Prospects

The project has great prospects in the future. As a complete product there are multiple new ways to make it even better and provide more development work. Many of the planned improvements could not be implemented due to time constraints. We hope that these recommendations will be taken with a positive outlook and will be worked on with great zeal.

An organizational version of the device can be developed which can serve the purpose of tracking of vehicles to avoid any financial loss. Moreover, has also a great potential of scalability as in near future, the need of cloud based trackers will only increase.

References

[1] How does the GPS Technology work https://spaceplace.nasa.gov/gps/en/

[2] Understanding and working of GSM https://www.electronics-notes.com/articles/connectivity/2g-gsm/network-architecture.php

[3] Differences between GPRS, 3G and 4G https://howtotechnaija.com/differences-between-gprs-edge-3g-hsdpa-hspa-4glte/

[4] Arduino UNO Processor Datasheet https://www.alldatasheet.com/view.jsp?Searchword=Atmega328p&gclid=CjwKCAjwnZaVBhA6EiwAVVyv9IOq_kg9BTv5-rDj5LDxixrjkKtYPzFNBtbEVH5bLzqsTS_igsMZ0xoCFrgQAvD_BwE

[5] More about Adafruit Company https://en.wikipedia.org/wiki/Adafruit_Industries

[6] Arduino vs other microcontrollers https://robotronicspro.blogspot.com/2014/09/why-arduino-is-preferred-over.html

[7] Sim7100 Datasheet https://datasheet.lcsc.com/lcsc/1804162215_SIMCom-Wireless-Solutions-SIM7100C-PCIEA_C126265.pdf

[8] More about GLONASS https://www.gps.gov/systems/gnss/

[9] More about GALILEO https://galileognss.eu/

[10] GLONASS vs GALILEO VS GPS https://expertworldtravel.com/gps-vs-glonass-vs-galileo/

[11] Velocity based tracking and local- ization system using smartphones with gps and gprs/3g   https://staff-old.najah.edu/sites/default/files/_Public_Transportation_Management_System_based_on_GPSWiFi_and_Open_Street_Maps.pdf

[12] Research on long-distance high-altitude transport vehicle tracking system based on Beidou satellite positioning and RFID, Urban housing, vol. 28, no. 09, pp. 224–226, 2021.

[13-16] For more about Cloud and Cloud Computing and its services https://www.cloudflare.com/learning/cloud/what-is-the-cloud/

[17] Web Technologies for developers https://developer.mozilla.org/en-US/docs/Web

[18] See more of Trakom https://www.astiinfotech.com/Trakom

[19] See more of Bouncie https://www.bouncie.com/

[20] See more of Ask Tech https://www.asktech.com.pk/