1 . Scope of the project

1.1 Background

The operation of an Autonomous Vehicle(AV) takes place without the driver's direct input, and the driver is not obliged to pay attention to the road at all times or It can happen that AV is running without the driver all the time. In order to facilitate traffic safety, roadside assistance, traffic congestion avoidance, and remote monitoring, autonomous vehicles communicate with one another. The condition that an autonomous vehicle (AV) do no worse than a human is one of the most challenging problems to solve. One of such challenges is to detect an Emergency Vehicle(EV) and reorganise themselves to make way for EV to pass through them. Human drivers can easily detect by hearing and seeing EV . Autonomous vehicles struggle when it comes to identifying emergency vehicles and taking appropriate action.

1.2 Project Aim and Objectives

1.2.1 Aim

To model and simulate Intelligent traffic system(ITS) where AVs are integrated with 5G technologies and are able to detect and make way for emergency vehicle.

1.2.1 Objectives

1. AV’s need to register themselves to the Intelligent Traffic System based on 5G and fog computing.
2. AV’s are communicating with each other through 5G data plane (through 5G NR and UPF)
3. Autonomous Vehicles(AV) need to properly detect approaching Emergency Vehicle(EV) which is using visual warning lights to convey urgency of their destination.
4. When AV could not “see” an emergency vehicle due to obstacles like building or other vehicles, it should have the awareness of EV by “hearing” siren sounds using audio microphone for siren recognition or awareness of whole traffic using Intelligent Traffic System(ITS).
5. Emergency vehicles used by intruders for illegal purposes. These vehicles possess the same visual warning lights and siren and depict themselves as the legitimate emergency vehicles. Hence, these fake vehicles pose a serious challenge

to AVs on the road who got fooled by giving way to them. AVs should be able to verify the authenticity of an Emergency Vehicle.
6. Autonomous vehicles as well as ITS need to properly localise the position and direction of an Emergency Vehicle(EV).
7. AVs should coordinate among themselves , re-organize , clear the lane of EV and to yield the way to EV.

1.2.2. Project Deliverables

1. Modelled Autonomous Vehicles(AV) connected to Intelligent Traffic System(ITS) software using 5G technology(open source).
2. Deep learning model to detect Emergency Vehicle siren sound and detect light sources used by EV.
3. AVs with the help of ITS are able to reorganise themselves to make way for EV.

2. Literature Review

2.1 Introduction

The development of new technologies, such as high-speed networks, decentralised storage systems, edge computing and 5G has made driverless car possible which require highly reliable low-latency communications. 5G can satisfy the requirements of Autonomous Vehicles since 5G provides very high speed and very low latency[1].

2.2 5G

5G technology is being used for applications that require highly reliable low-latency communications. 5G can be used to satisfy the requirements of Autonomous vehicles because it offers speed offer speed upto 10 Gbps with incredibly low latency of 1 ms[1] . 5G is best suited to make driving autonomous as it can supports delay sensitive autonomous vehicles(URLLC) which requires very less error-bit rates. 5G also provide latency requirements of autonomous vehicles by providing more bandwidth(eMBB) and achieve the speed in Gigabits. 5G also improve connectivity among autonomous vehicles(mMTC) [13] . Figure 1 shows Emergency vehicle detection using 5G [7].

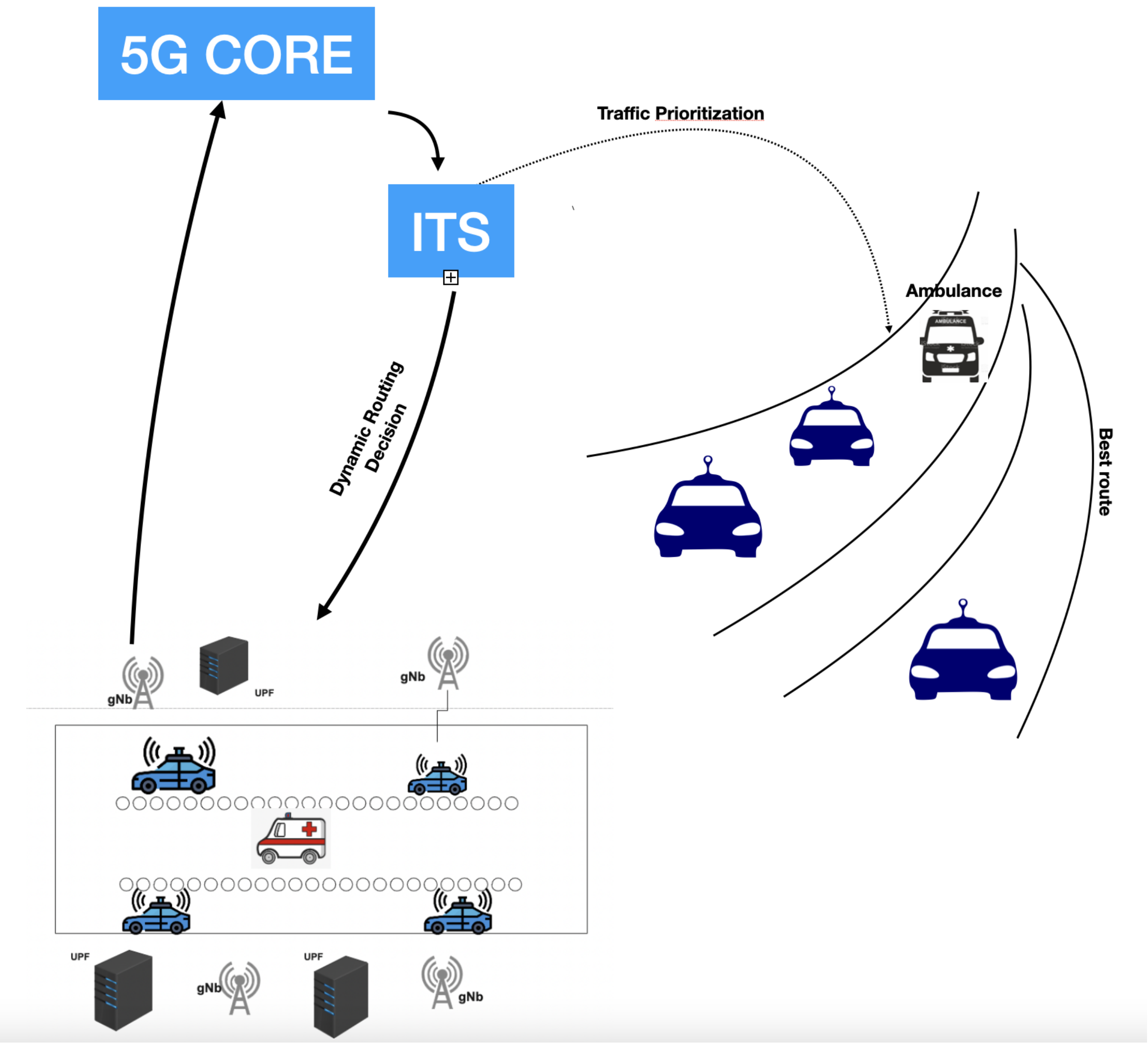


Figure 1 shows Emergency vehicle detection using 5G.

2.3 Fog Computing

Technology advancements in fog computing facilitate access to vehicle data. Fog nodes which use fog computing technologies have recently been built. Better environmental information and other vehicles information is provided by these nodes, which also aid in inter- and intra-vehicle communication. The fog nodes analyse the collected data and also collect crowd-sourced data from the AVs. [2] provides a technique for adjusting network slicing for vehicular fog-RANs.

2.4 Emergency Vehicle detection

[3] gives the overview of Autonomous Vehicles sensor. AVs used a variety of sensors, including radar, LiDAR, cameras, and ultrasonic, to sense and analyse its surroundings. [4] developed method to detect emergency vehicle by AVs. Sensors and GPS are used by AV to collect and evaluate images or feed frames and sensor data about its immediate surroundings, such as approaching vehicles, parked automobiles, trees, buildings, etc. These feed frames are fed to the deep learning module. Deep learning module identify a set of light sources from this image based on one or more templates. These templates are created using vivid colours, various feature combinations, or just light colours. These templates change the image that was shot into a certain colour space so that hues like orange, yellow, blue, and red can stand out more.By examining the relative spatial configuration of the light sources and the determining that these light sources are flashing, it determines that these light sources belong to EV. AVs examine a light source's flash pattern and compare it to one or more classifiers to determine whether these light sources belong to a specific type of EV. Light sources that exhibit false positives for sun glare, one or more hues that are not related to colours associated with emergency vehicles, or light sources that are not associated with electric vehicles based on geographic location dara are all discarded by AVs. A group of light sources is filtered by AVs if it demonstrates one or more traits linked to prospective emergency vehicles. Therefore, it manoeuvres the AVs to yield in response to the specified specific emergency vehicle based on the assessment that the two or more light sources are linked with the particular type of emergency vehicle.

In addition to vision-based detection, AVs require auditory detection to detect the existence of emergency vehicles and their relative positions to AVs. [5] offer a unique approach that uses just two inexpensive microphones to collect data on actual sirens and deploy models.Two microphones is installed at rear end of AV. This microphone is connected to the onboard computing unit. The audio signals were collected from the microphone channels and preprocessed.In the pre-processing stage, band-pass filter removed noise from the frequency range. The database is then populated with these processed noise data and visual data from step1 for model training.The pre-processed signals are passed to a neural network model. Model outputs the presence of siren, their direction and distance from the AV.

2.5. Intelligent Transport System(ITS)

ITS is a communication system that connect several AVs for the exchange of vital information such as traffic, congestion, and road conditions through cellular network. Autonomous and connected vehicles (ACVs) are one of the key elements of the ITS. ITS has encountered some difficulties with autonomous cars with regard to emergency vehicle identification , localization and precise path prediction. These obstructions of course cause traffic and safety issues. AVs exchange information with signals and respond correctly to the environment. [6] suggested a deep learning model in a ITS using 5G to handle the problems caused by autonomous cars. Long short term memory(LSTM) networks are given data from natural driving and a driving trajectory dataset. The probability matrix for each intention to change lanes is calculated using the softmax function. [7] shows Illustration of ITS using 5G shown in the Figure 1. [7] have mentioned that there is vehicle-to-vehicle (V2V) and vehicle-to-everything (V2X) communications using 5G. With V2X, the AVs communicate to each other providing live information to each other. With V2X, AVs have better view to warn all AVs that an emergency vehicle was coming.

The position and intent of each AV are communicated. Instead of attempting to predict the movements of other vehicles, the autonomous vehicle AI can use this information to directly determine the location, direction, and speed of nearby vehicles. Figure 1 shows the general architecture of Intelligent Transport system[7].

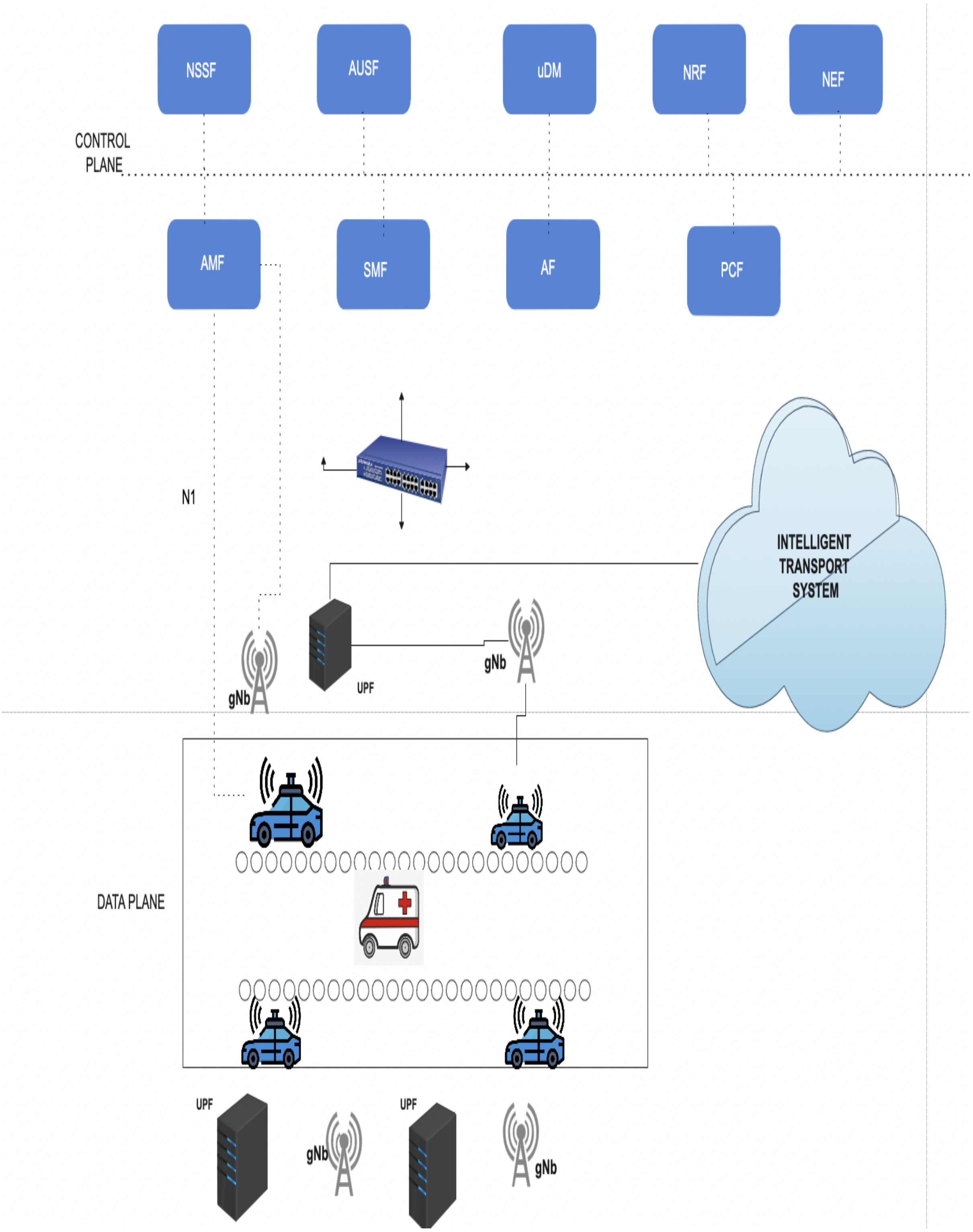


Figure 2. Intelligent Transport System (ITS)

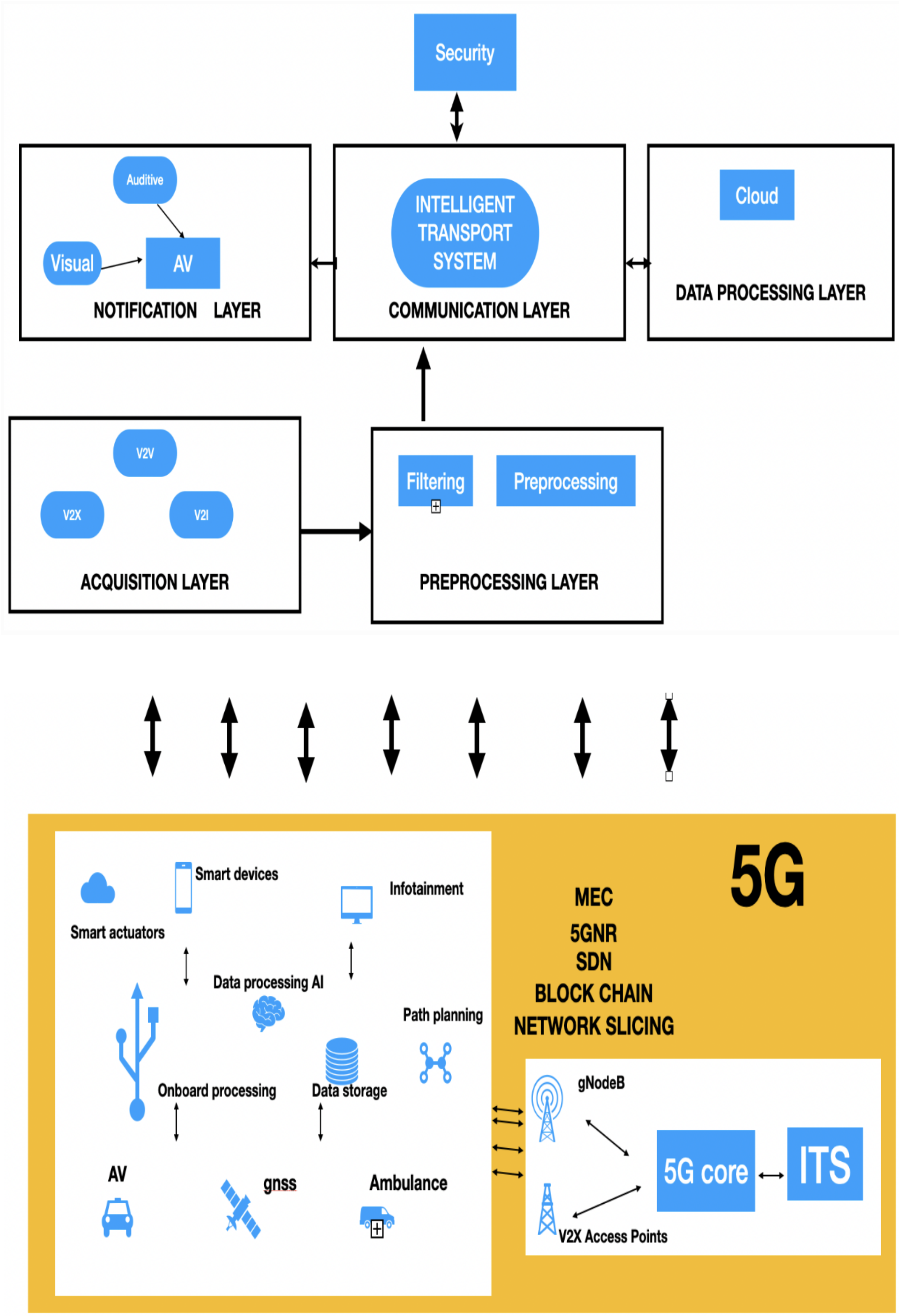


Figure 3. shows the general architecture of Intelligent Transport system

The other benefit is that using V2V, the other vehicles can communicate their sensor data, extending the range of each vehicle's sensors. With the communication channel providing inter-vehicle intent and extended sensor range, multiple vehicles can coordinate on a highway and travel closely together. Platooning improves traffic flow and can save fuel. The key will be to incorporate the positional data from the other vehicles into the route planning AI software. Using a communication infrastructure (core network), autonomous vehicles will be able to exchange data like traffic, congestion, and road conditions with one another.
[10] provide inter-vehicular connectivity which enables traffic safety, roadside assistance, driving efficiency, remote monitoring, traffic congestion avoidance, maintenance, and system failures . Self driving cars are configured with variety of sensors which communicate using 5G NR and 5G Core network. [9] propose communication system in which self driving cars are configured with variety of sensors and they are communicating using 5G NR and 5G Core network. Network is divided into two groups . First vehicles which have on-board sensor units and the other is gNodeB and other communication infrastructure.

The on-board units of the self driving cars are made up of sensors that aid in the detection of objects as well as obstacles within their specific range. There will be multiple sensors installed in Autonomous vehicles(AV). Ultrasonic sensors will be used for range within 5 metres for detecting objects nearby . Front camera, back camera, radars and LiDAR sensors are used for detection of Lane and objects, collection of high speed collision avoidance and detection of emergency vehicles[11]. Sensors on the vehicle gathers information from other vehicles and environment. Using this data, global route is determined , For determining the best possible route, the communication system uses sensors data from vehicles and traffic. based on these data and route, ITS issue commands[7] . Detection sensors is used which identifies various features in and around the environment. Ambient sensors monitor the environment and back scatter provided the perception of outside world [7].

AVs interconnected through 5G share crucial information about the environments, road blockages, traffic conditions with each other. If a malicious AV enters into the network, it poses serious security issues to the AVs. A malicious AV post wrong information about the environment, can get access to private information about the vehicles such as its location, path, modify the information shared by other AVs, etc.

2.6 Blockchain

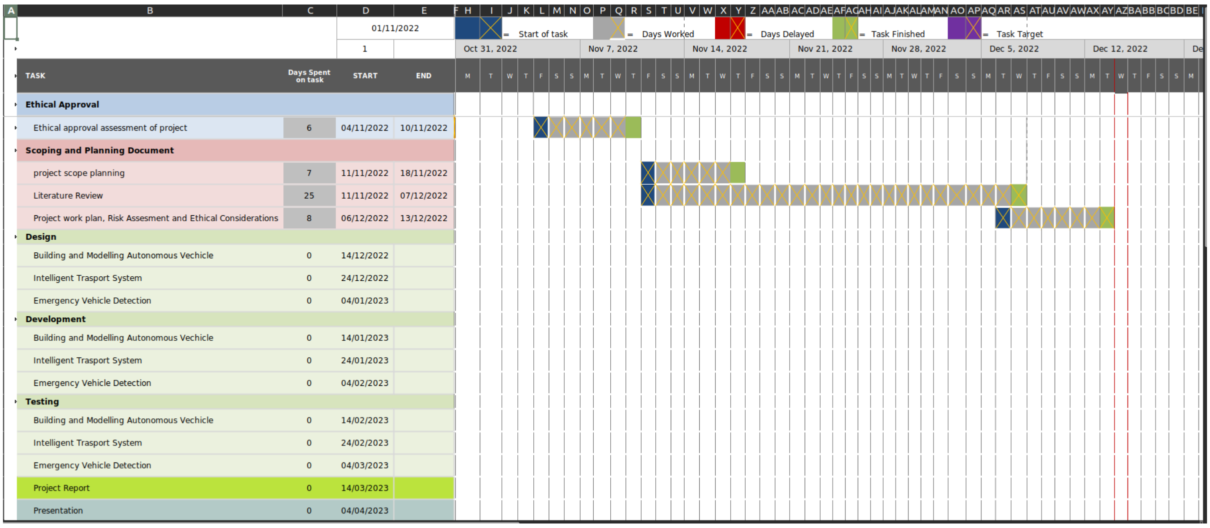
[8] proposed a hybrid blockchain architecture that consists of local directed acyclic graph and permissioned blockchain that is run by the vehicles for reliable and secured data sharing in 5G network. With blockchain integrated with 5G, only trusted vehicles enter into the network. For communication systems based on 5G, blockchain ensures trust-based message propagation that assess the data sent by AVs. Only reliable automobiles access the vehicular networks thanks to blockchain. Through its immutable feature, blockchain also guarantees the confidentiality and privacy of the cars' sensitive data[12].

2.7 Summary and links to current project

AVs will be communicating with each other using 5G . ITS will be developed which will be used to connect each AVS with each other , deconjust traffic, make informed decision about traffic. Emergency vehicle will be detected by AV and will be reorganised to give way to EV with help of ITS.

3. Project Work Plan, Risk Assessment and Ethical Considerations

3.1 Tasks, milestones and timeline



TASK	Days Spent on task	START	END
Ethical Approval			
Ethical approval assessment of project	6	04/11/2022	10/11/2022
Scoping and Planning Document			
project scope planning	7	11/11/2022	18/11/2022
Literature Review	25	11/11/2022	07/12/2022
Project work plan, Risk Assesment and Ethical Considerations	8	06/12/2022	13/12/2022
Design			
Building and Modelling Autonomous Vechicle	0	14/12/2022	
Intelligent Trasport System	0	24/12/2022	
Emergency Vehicle Detection	0	04/01/2023	
Development			
Building and Modelling Autonomous Vechicle	0	14/01/2023	
Intelligent Trasport System	0	24/01/2023	
Emergency Vehicle Detection	0	04/02/2023	
Testing			
Building and Modelling Autonomous Vechicle	0	14/02/2023	
Intelligent Trasport System	0	24/02/2023	
Emergency Vehicle Detection	0	04/03/2023	
Project Report	0	14/03/2023	
Presentation	0	04/04/2023	

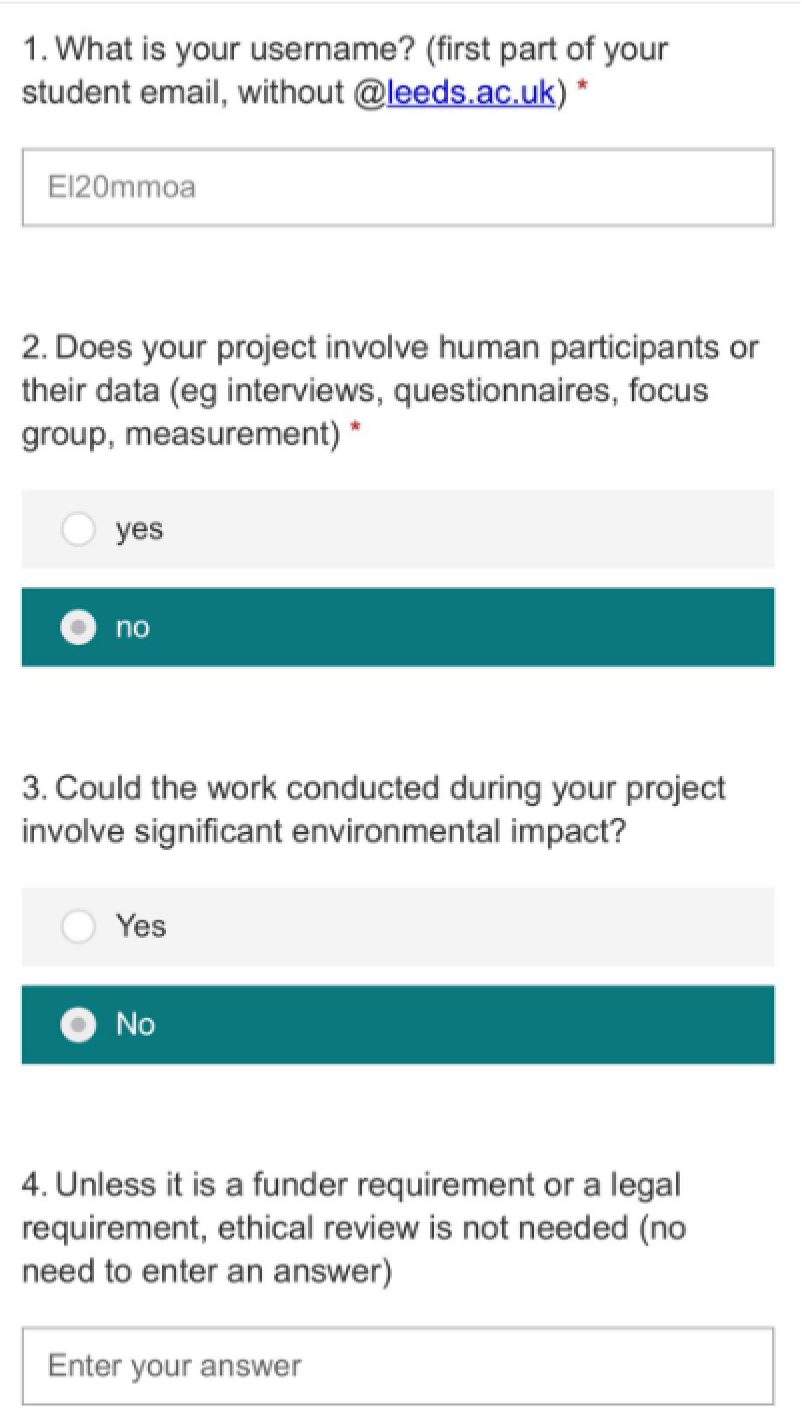
3.2 Project Risk assessment

Strengths	**Weaknesses**
● Previous experience in developing similar projects. ● Familiarity with the development environment. ● Previous work has been done on this platform(architectural knowledge). ● Multi-part solution with many independent modules to show progress. ● Trending technlogies ● Software development is already underway.	● Limited development time ● Unpredictably long software development times ● Limited availability of 5G band frequency. ● ITS code development and debugging are exceedingly challenging tasks. ● Making a test setup could be challenging.

Opportunities	**Threats**
● Current lack of solutions for implementing Intelligent Traffic System and Emergency Vehicle Detection by Autonomous Vehicles. ● We can publish this in a high impact factor research paper.	● This is a hot topic right now. Someone already has a solution they can put into practice.

3.3 Ethical Considerations

Making certain that the project's objectives and scope are not misrepresented is a crucial aspect of ethics. Checking for prejudice or exclusion, correctness, giving credit to collaborators of open source code of 5G , and exchanging code or completed projects in return will be priority.I will address each specific objectives comprehensively. The conclusions of the project will correlate to the objectives given and the results. I will not be coercing anyone to participate in this project. I will not doing any type of persuasion or deception in attempting to gain an individual's trust. I will be using consent form as an agreement of trust between the researcher and the participants.The confidentiality of the information supplied by project and the anonymity of respondents will be respected



1. What is your username? (first part of your student email, without @leeds.ac.uk) *

El20mmoa

2. Does your project involve human participants or their data (eg interviews, questionnaires, focus group, measurement) *

○ yes

● no

3. Could the work conducted during your project involve significant environmental impact?

○ Yes

● No

4. Unless it is a funder requirement or a legal requirement, ethical review is not needed (no need to enter an answer)

Enter your answer

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