

IoT Enabled School Bus Management System

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Abstract: Internet Of Things is one of the very fastest leading trend in the world at present. This technology has connected various objects with sensors and software and has made a huge impact on the society where everything is now becoming digitized. These technologies have caused various changes in both hardware as well as software and can be utilised by both the trends as per the requirements. It is a technology that helps to connect a device to any real object and can be helpful to maintain the data through a huge network by establishing communication between the device and the users. This technology is very much favourable to huge organisations as it establishes automation and also reduces the labour costs. Various applications of the Internet of things have benefitted a huge community of businessmen, consumers as well as the government. All the applications of IoT was taken into consideration for building up the entire project. Bus tracking as well as the database management of the students of the school is the main aim behind the School Bus Management System.

Keywords: Internet of Things, Authentication, Access Control, Google Maps, Sockets, Webhooks.

I. INTRODUCTION

Internet of Things (IoT) is an emerging technology in the world that has created a huge community among the developers and has been very successful towards digitization. Usually, IoT is very useful in different applications, by using the sensors as well as the other IoT devices that helps to connect any real world entity or object with the software, so that those applications can be accessible with a very few clicks. Few examples of the businesses where IoT is used are home automation, manufacturing, transportations etc. All the applications of IoT are used so that the real world related issues can be solved and all the entities can be automated. IoT can be of great use in huge scale businesses such as to maintain the traffic congestion, to provide services to the city, for the economic development of the people as well as the society, involvement of various citizens of the society and to ensure the safety and the security of the appliances. The emerging smart societies have also embedded various IoT sensors into the physical entities such as water signals, elevator's entrance, street lights, etc.

The application of Granting Access Control and Authentication will be of greater use while dealing with the IoT based application. The application dealing with API based access controls are helpful to manage the authorized users to securely access the data reducing the chances of attacks. The authentication based on the JWT's deals with verifying the identity of a particular user who requests access and grants access after complete verification as well as validation. Access control in these API refers to the ability to bind the access to the information stored in the database.

Date of Submission: 25 April 2023

Date of Acceptance: 20 June 2023

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This allows companies to ensure the security of their information that helps to minimize the risk.

The access control is managed through authentication processes which can include passwords, PINs, and different multi-factor authentications.

There are different types of Access Control that can be implemented at an organization that authorize the access to only the verified users. Access control prevents sensitive data, such client information, from getting into the wrong hands. It is a distinctive part of the contemporary zero trust security architecture, which makes use of several techniques to validate network access.

Authentication is used to make sure a person is who they say they are by the process of complete verification as well as the validation. A way of authentication is commonly used by various applications to secure access to an application or its data. Authentication protects priceless possessions and, in the information age, monitor computer systems as well as data to provide integrity to the same. The most popular forms of authentication are setting strong passwords and the security questions. Card-based authentication, retinal scanning, voice recognition, and fingerprint authentication are further ways to provide authentication to any application. The user or computer must authenticate their identity to the server or client during authentication to have the access for the requested document.

Google maps is currently a web mapping technology that is being used a lot for navigation purposes. Google maps is a service which has a lot of stored information regarding the geographical regions and sites worldwide. Generally, Google map is used for road maps, wherein it guides the traveller for the route to a destination that an individual is searching with an

estimated time of arrival, preferred route as per the application, distance of the location, congestion on the roads, expense of the particular road by adding the cost of the tolls if any, etc. Google maps provide us more than just the listed information.

It also views the satellite as well as the aerial view of various locations. Javascript is one of the extensively used technologies by Google maps. This web service also makes use of the protocol buffers in order to transfer the data present as per the requirement of the user instead of using JSON, so as to enhance the performance of the web service. Google maps, when combined together with IoT, can ensure the presence of a physical entity in the digital world. For example, the navigation of the route of the vehicle can be monitored through the web application.

Sockets is a type of communication network node that is created among two programs that are running on a network. It acts as a bridge as it is used to establish a relationship between the client program i.e., the frontend as well as the server program i.e., the backend of any application. These javascript based sockets allow the user to connect to any server and also permits the exchange of data with this server. It provides functionalities that enable it to connect with a remote system through the TCP/IP network.

A webhook is an event driven API that performs a specific function while responding to a trigger. The function that has to be performed by the webhook on the provided trigger is set initially. The triggers, here, include clicking on a button, submitting a form, receiving any information, duration of the day etc. A few examples of webhooks are: automatic uploads on Twitter or any other site during a particular time of the day, flashing the light of a doorbell as soon as it rings, etc. Webhook forwards the data in the actual time, whenever the incident occurs. There are various services or applications where the information of the actual time matters and benefits to the business. It also prevents traffic congestion on the module by not involving any sort of communication when no event has happened.

In this paper, we focus on Internet of Things and the different applications such as Authentication as well as Access Controls for the security purpose to maintain the integrity of the data, Google Maps for the purpose of navigation that the school bus will be travelling, Sockets to ensure a relationship between the web service as well as the servers and Webhooks to ensure the real time functionalities as well as the response to a trigger.

II. RELATED WORK

This particular section illustrates the various research efforts that have regularly been carried out in due course of time to ensure the working of the IoT to provide a digital platform to the users by using the hardware devices as the sensors connecting those in the software to make them available online. The different keywords that have been used in the specification of these research areas can be used to create a platform that can track the location of the school bus and can notify the parents regarding the status of the school bus and can suggest alternate ways to achieve the same.

Anne HH. Ngu et al made a survey in [1] entitled “IoT Middleware: A Survey on Issues and Enabling Technologies”. The work in this paper focused on explaining a comprehension for the challenges of the systems of the IoT middleware. They analyzed various architectures of the IoT middleware system and the major challenges that were faced while those systems were being developed. They also provided two solutions in those IoT service discoveries. They believed in various trending security techniques such as cryptography, design based privacy etc.

Leeza Singla et al made a survey in [2] entitled “GPS Based Bus Tracking System”. The work in this paper focused on providing a detailed study of the GPS system that is used in tracking the location of the bus. It provides various modules such as bus module, passenger module, server module, distance calculation as well as the prediction of the arrival time when the bus is expected to reach its required destination. The GPS coordinates are decided by the satellite and are therefore supposedly accurate. It also predicts the average velocity of the bus with which it is travelling.

Khalid Ammar et al made a survey in [3] entitled “A Real-time School Bus Tracking and Monitoring System”. The work in this paper discussed the issues that were faced by the students as well as the parents which led to the idea of such a system. Their system included various elements such as the design parameter, on-board tracking unit to ensure if the student has on boarded on the school bus, the on-board unit software, tracking server with the SMS service as well as the on-board unit interaction to access the location of the school bus, boarding status from the school, approaching towards the home location, clearance check as well as website development.

Ilker Korkmaz et al made a survey in [4] entitled “A Smart School Bus Tracking System”. The work in this paper is focused on to ease the life of children and their parents by removing the problems that are faced by them for school transportations. The design as well as the implementation in this paper includes the following system architecture, system design, allocation of various routes, system implementation, GUI's of the mobile applications.

Megha Dewan et al made a survey in [5] entitled “IOT Based Smart Vehical Monitoring and Tracking System”. The work in this paper is based upon the Vehicular Ad-hoc Network to ensure the road safeties. It predicts the probability of accident by observing the nearby condition of the traffic that is near the sensed vehicle. The components of this system are Arduino, Ultrasonic Sensor, Vibration Sensor, GSM as well as GPS. The proposed model in this paper also generated Collision Avoidance, Accident Detection, Vehicle Theft Detection.

Abdullah H. Alquhali et al proposed a model in [6] entitled “IOT Based Real Time Vehicle Tracking System” The work done in this paper implemented the tracking of the vehicle as well as the anti-theft system so as to prevent any sort of theft to the vehicle and grab the location of the vehicle in case of any

theft to the registered number of the vehicle. This paper shows the sub elements of the model that are implemented as Arduino Uno R3, SIM900A GSM/GPRS Module, GY-NEO6MV2 GPS Module, Liquid Crystal Display, Software Components, ThingSpeak, Freeboard as well as Arduino IDE. Shubham Jain et al proposed a model in [7] entitled “Application Based Bus Tracking System”. The work done in this paper focused on triple functions of an application for students going to their school or colleges. Their proposed work included System Prototype, Preprocessing, Geographic location and Kalman Filter. This system was served on the web as well as the android application. It also determined if the driver followed the speed limits and monitored the behaviour of the driver.

III.CRITICAL ANALYSIS

The below added table shows the recent work that is done in the areas of our research with the advantages as well as the disadvantages of the research papers that have been discussed. This tabular study allows us to compare the research papers together so that they can be used accordingly in our proposed model.

TABLE 1: Summary of related work that includes a brief information regarding all the literature surveys

Paper	Author	Advantage	Disadvantage	Technology Discussed
[1]	Anne H. Ngu, Mario Gutierrez, Vangelis Metsis, Surya Nepal, Quan Z. Sheng.	It completed with a detailed study of the IoT Middleware System and provided two solutions while addressing key challenges in IoT Middleware System.	It believed that a lot more privacy techniques were installed in the IoT systems but the paper lacked the knowledge for the same.	Hydra, GSN, Google Fit, Xively, Paraimpu, Calvin, Node-RED and Ptolemy Accessor Host.
[2]	Leeza Singla, Parteek Bhatia.	The accuracy of the system coordinates is high as it takes the coordinates using the satellite, predicts the speed of the vehicle and mentions the traffic conditions during that part of the day.	The reliability of this system depends upon the GPRS facilities. The internet availability is a must, without the internet availability the system is a failure.	Android, GPS, GSM, Location Based Services, Clustering and Artificial Neural Network.

[3]	Khalid Ammar, Mohammad Jalmoud, Abdulrasull Boushehri, Khalid Fakhro	Their proposed system contributes towards the safety of the students as well as notify the parents and the admin in case of any mishap.	Their system lacked a temperature sensor, security camera, traffic congestion, pollution sensor as well as noise sensor to prevent accidents related to these issues.	School bus management system, real-time bus tracking, SMS server, GPS, GSM and RFID Reader.
[4]	Ilker Korkmaz, Alp Camci, Cihangir Cengiz, Dogan Dirik, Emre Cekci, Fatih Mehmet Akbaba	The system provides all the status of the approaching as well as the drop off of the school bus to each member of the family.	The system lacked the usage of different API's to provide various routes that could be followed to avoid congestion.	Web Application, Mobile Application, Bus Tracking, IoT devices, Rest API.
[5]	Megha Dewan, Alok Agarwal	The location of the vehicle could be monitored from anywhere in the world. SVMTS has been used so as to block the vehicle in the theft condition.	The system is deficient of the graphical representations so that the accidents can be prevented beforehand.	Arduino, Ultrasonic Sensor, Vibration Sensor, GPS, GSM and LCD Display
[6]	Abdullah H. Alquhali, Mardeni Roslee, Mohamad Y. Alias, Khalid S. Mohamad	The algorithm used can predict the time of arrival with 100 percent accuracy. The data is regularly stored and transferred to the monitoring server for further analysis.	The reliability of the system decreased while the GPS tracker was transported from an outdoor location to somewhere in the basement parking area. It cannot notify the parents about the route of the bus.	Vehicles Tracking, IoT, ThingSpeak, Smart Device and GPS.
[7]	Shubham Jain, Adarsh Trivedi, Shweta Sharma	This system could be used for time estimation as well as to retrieve the theft vehicle. It can also monitor the behaviour of the bus driver.	The system is not a cross platform compatible system and didn't work properly in the real-time monitoring features.	API, Kalman Filter, Web Server as well as Google Maps

IV.PROJECT IMPLEMENTATION

This is how our web application for the School Bus Management System will look like. The UI for the complete project after the implementation of the above mentioned algorithms has been depicted in this particular section.

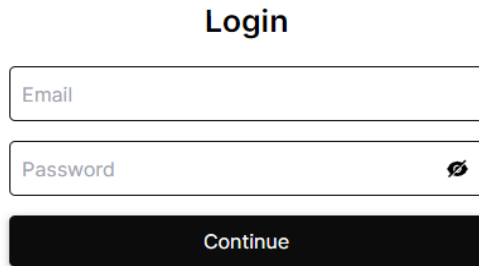


Figure 1. Login Page

The above figure shows the login page for our web application that will be the landing page. As soon as the URL is entered or clicked, it will be the very first page to appear on the screen of the user or the admin. The password will be encrypted and the access will be provided after complete verification as well as validation.



Figure 2. Home Page

Home page of the website is shown above, whenever any user will login , the user will be navigated to the home page.

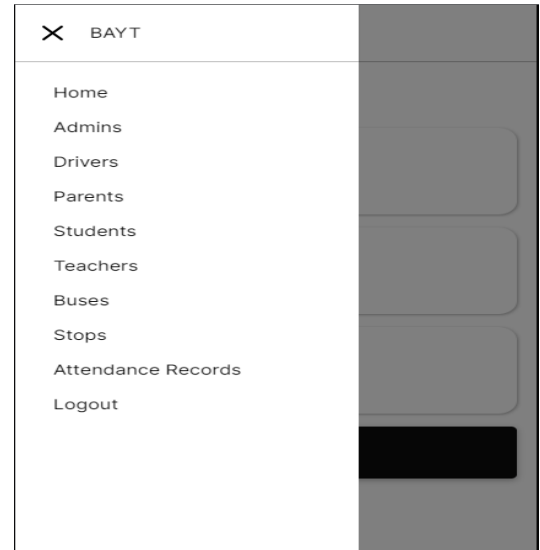


Figure. 3. Admin's Portal

The Admin portal serves as a centralized platform to manage and oversee various aspects of the system. It also Welcomes you ,the first page when you login.

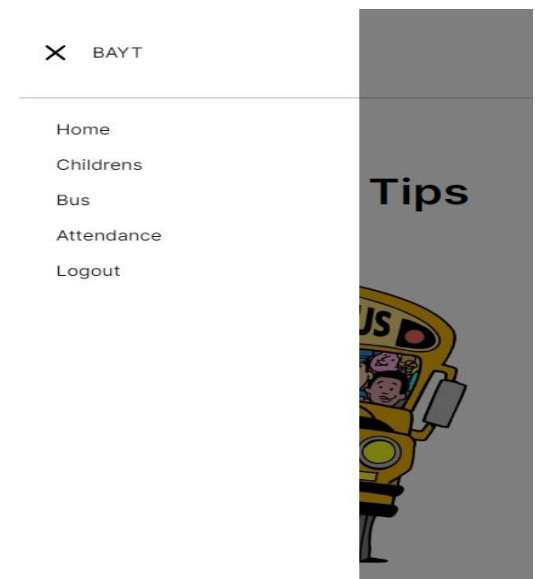


Figure. 4. Parent's Portal

The Parent Portal serves as a platform to manage and oversee various aspects of the parent. Parent can view the attendance record of their children and can track the bus live location through the portal.

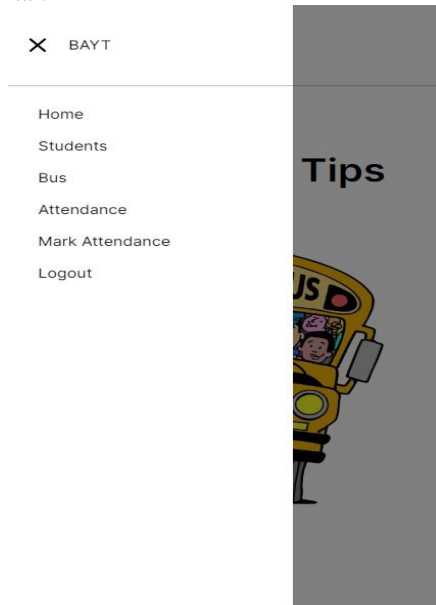


Figure. 5. Teacher's Portal

The Teacher Portal serves as a centralized platform to manage and oversee various aspects of a teacher. It also contains the data regarding the students assigned to the teacher. Teachers can mark the attendance of the students while boarding and deboarding the bus.

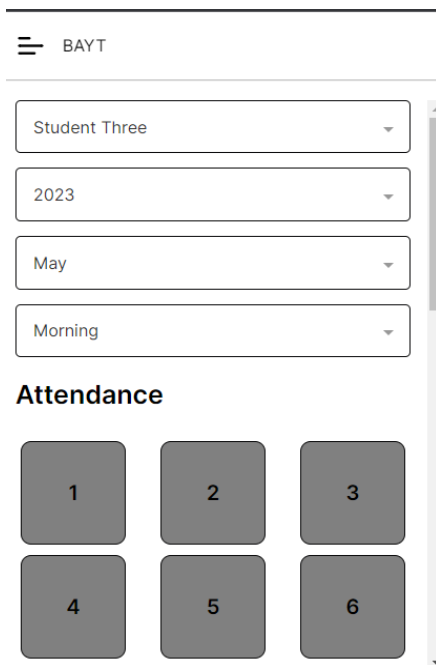


Figure. 6. Attendance Records

The Attendance Record will contain the attendance of all the students. The admin can view the record for all the students whereas the teacher's and the parent's can view the attendance record for their respective students.

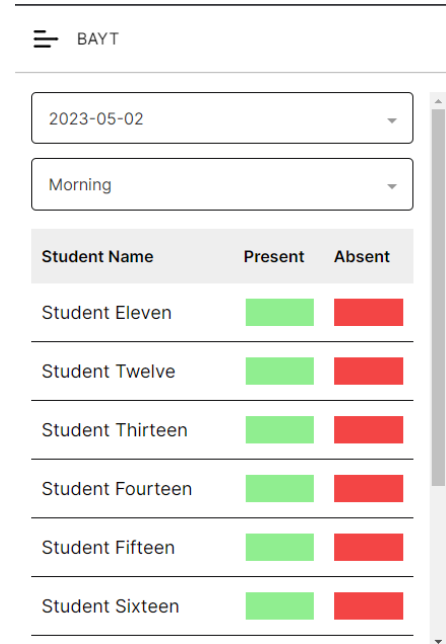


Figure. 7. Mark Attendance

The Attendance Page would be useful to mark the attendance of the student while the student is boarding the bus or being dropped off by the bus. The attendance could be marked only by the teacher who is in-charge of the bus duty on that route, that particular day.

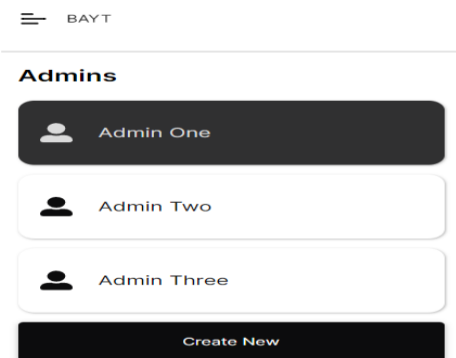


Figure. 8. Admin's Page

The Admin's Page can be seen by the admin. The admin can view the complete details of the admin's. He can also add new admin in the list and can also remove them from the existing list.

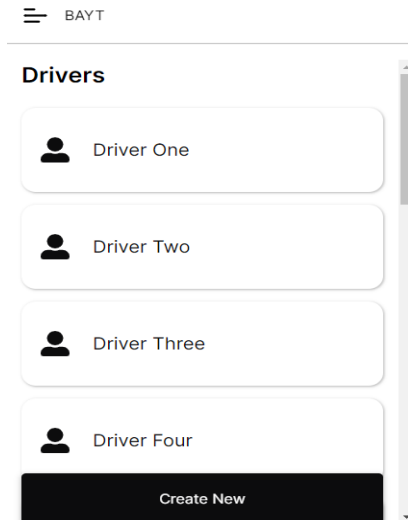


Figure. 9. Driver's Page

The Driver's Page can be seen by the admin. The admin can view the complete details of the drivers. He can also add new drivers in the list and can also remove them from the existing list.

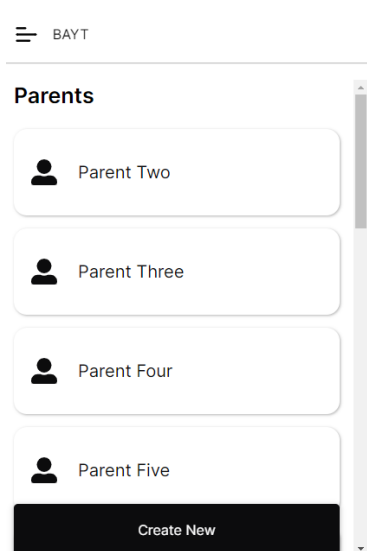


Figure. 10. Parent's Page

The Parent's Page can be seen by the admin. The admin can view the complete details of the parents. He can also add new

parents in the list and can also remove them from the existing list.

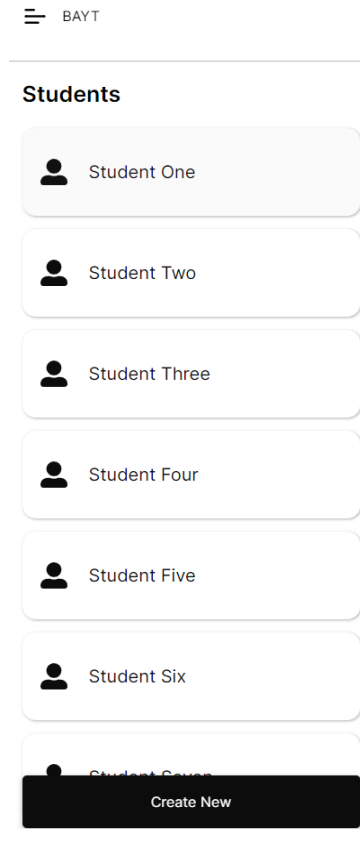


Figure. 11. Student's Page

The Student's Page can be seen by the admin. The admin can view the complete details of the students. He can also add new students in the list and can also remove them from the existing list.

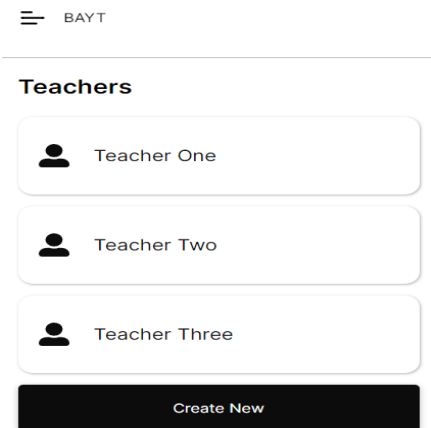


Figure. 12. Teacher's Page

The Teacher's Page can be seen by the admin. The admin can view the complete details of the teacher's. He can also add new teachers in the list and can also remove them from the existing list.

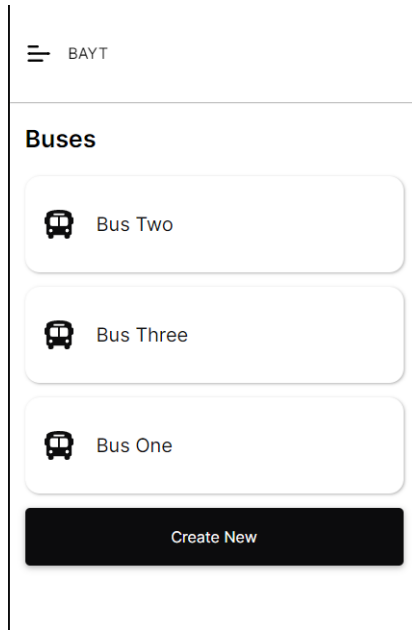


Figure. 13. Buses Page

The Buses Page can be seen by the admin. The admin can view the complete details of the buses. He can also add new buses in the list and can also remove them from the existing list.

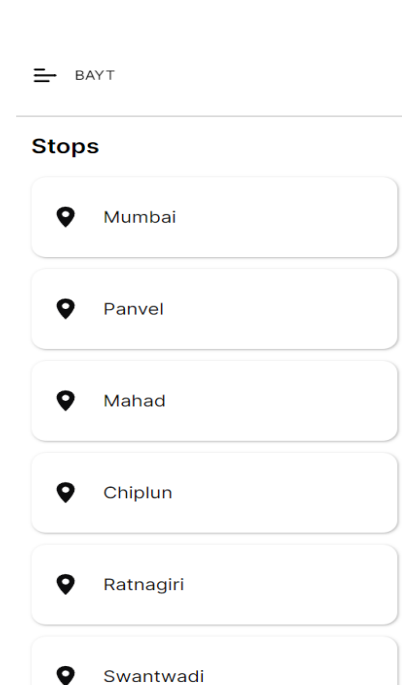


Figure. 14. Stops Page

The stops page can be seen by the admin. The admin can view the complete details of the stops. He can also add new stops in the list and can also remove them from the existing list.

V. FUTURE WORK

All these research papers helped us to have a much better understanding towards the basic idea behind these applications. We aim to build a web portal in the future using all these information that we have studied and reviewed so far that we could gather from all the research papers about applications of IoT including authentication as well as access control, sockets as well as webhooks and Google maps. The web portal will be managing the student database, wherein the student's attendance shall be marked. It will also notify the parents about the on-boarding as well as the drop off of their child, the minute they take the bus. The parents can also navigate the location of the bus that can prevent last minute hassle for the parents. This web portal will benefit a huge portion of the working parents and its regular use will be a step towards creating an entire digitized environment.

ADMIN	TEACHERS	PARENTS
View all Buses and their stops.	Can view attendance of students	View all their childrens details
Add new buses and stops	Can mark attendance of students during morning and evening for the current day.	View attendance of their child
Track buses live location	View bus details and track live location.	View bus details of their child
View all users such as Drivers, Parents, Teachers, and Students	Can deboard the student whenever they leave the bus.	Track live location of any child's bus
Add new Users	View all students details that belong to the same bus as teacher.	Gets notified of every event

Figure. 15. System Design which comprises the different modules that have been referred to in the implementation of the project.

VI. CONCLUSION

In this paper, we have reviewed several ways to track down the location of any vehicle using different applications of IoT as well as various other API's that can fit the requirement of a fast-changing as well as the dynamic environment i.e., a portal for a school management that could track down the location of the bus and can be beneficial for the parents as well as the school management.

Since, the child's security and well-being are one of the greatest concerns of every parent, we chose this project to lighten the burden from their shoulders so as to ensure that they are well aware of the exact location of their child. We have chosen Google maps to extract the accurate location and the coordinates of the bus to notify the parents or the guardians about the bus's expected time of arrival. Additionally, we will be making use of the sockets to connect the client program with the server program as well as webhooks in response to a trigger. Since, the distribution of privileges is best handled with Role Based Access Control Models (RBAC), we have chosen RBAC to handle the large distributions of the same. The portal will be a great success towards managing the traffic while marking the presence of the student. It will be of great benefit for all the parents specially the ones that are working to appropriately manage their timings and easy pick-up and drop off of their child.

[7] S. Jain, A. Trivedi and S. Sharma, "Application Based Bus Tracking System," 2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon), Faridabad, India, 2019, pp. 152-154, doi: 10.1109/COMITCon.2019.8862254.

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