

# SAFETY FOR SCHOOL BUSES USING RFID TECHNOLOGY

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# Safety for Children at Bus Stop

a RFID-based for children



1 - Students step into the bus



2 - Students step into the wrong bus



3 - Students being absent in the bus



4 - Students have left the bus



5 - Students have left the bus at the wrong station



6 - Students been left behind in the bus

# Objectives & Scope

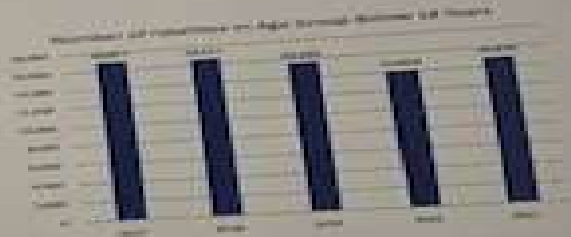
- It will facilitate the movement of school children during their boarding and alighting to and from the school bus in a secure and safer way.
- To develop appropriate standards/ specifications of BIS for *Safety of School Bus including boarding/ alighting of students and Tracking / Monitoring of the school bus*

### Children Killed in Road Accidents in India

The data from the ADSI reports of NCRB shows the number of children killed in road accidents in the last five years in India. The number decreased from 2017 to 2020 but increased in 2021. According to the report, **40 children are killed per day in road accidents in India, and 77,820 lives lost in the last five years.**

#### Children Killed in Road Accidents in India

Year	Number of Fatalities in Age Group Below 18 Years
2017	16,877
2018	16,511
2019	15,533
2020	14,024
2021	14,875



Source: ADSI 2021, 2020, 2019, 2018 & 2017, NCRB, Govt of India. (<https://ncrb.gov.in/en/ADSI-2021>)

There is a need for age-disaggregated data, which will help to understand the effectiveness of the measures required for safety of children and inputs for policy making.

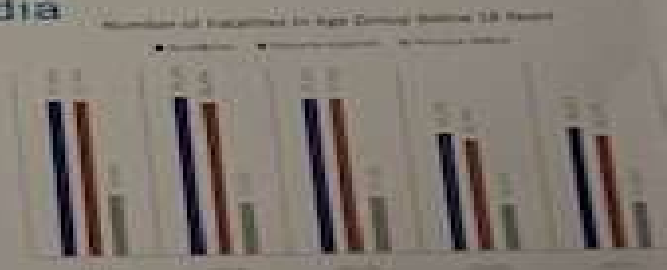
### Road Accidents Near Schools/ Colleges/ Educational Institutions

The following data of ADSI, NCRB shows the number of accidents near schools, colleges and educational institutions in India and the number of persons killed and injured in those accidents.

The data reveals the importance of implementing School Zone effectively near all schools to improve safety for children around and traveling to schools. There is a need for disaggregated data collection focusing on schools and its analysis and presentation for a better understanding of safety with children's perspective.

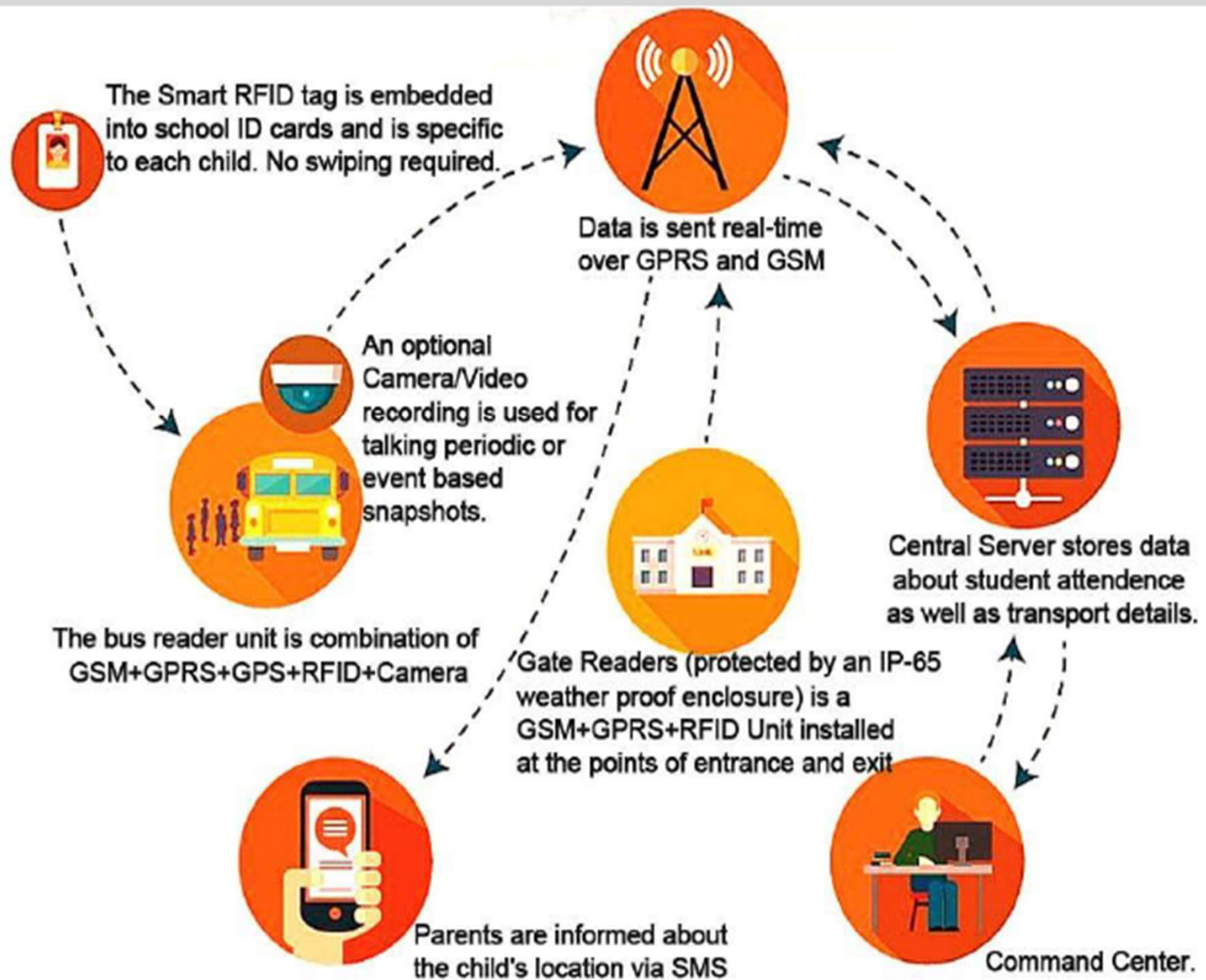
### Road Accidents, Persons Injured and Died near Schools/ Colleges/ Educational Institutions in India

Year	Accidents	Persons Injured	Persons Killed
2017	37,848	37,754	14,836
2018	38,285	36,854	12,535
2019	37,143	37,050	13,185
2020	28,226	26,404	10,845
2021	28,873	26,976	11,032

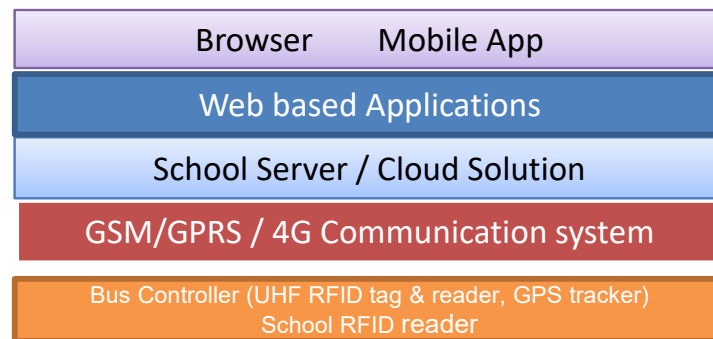
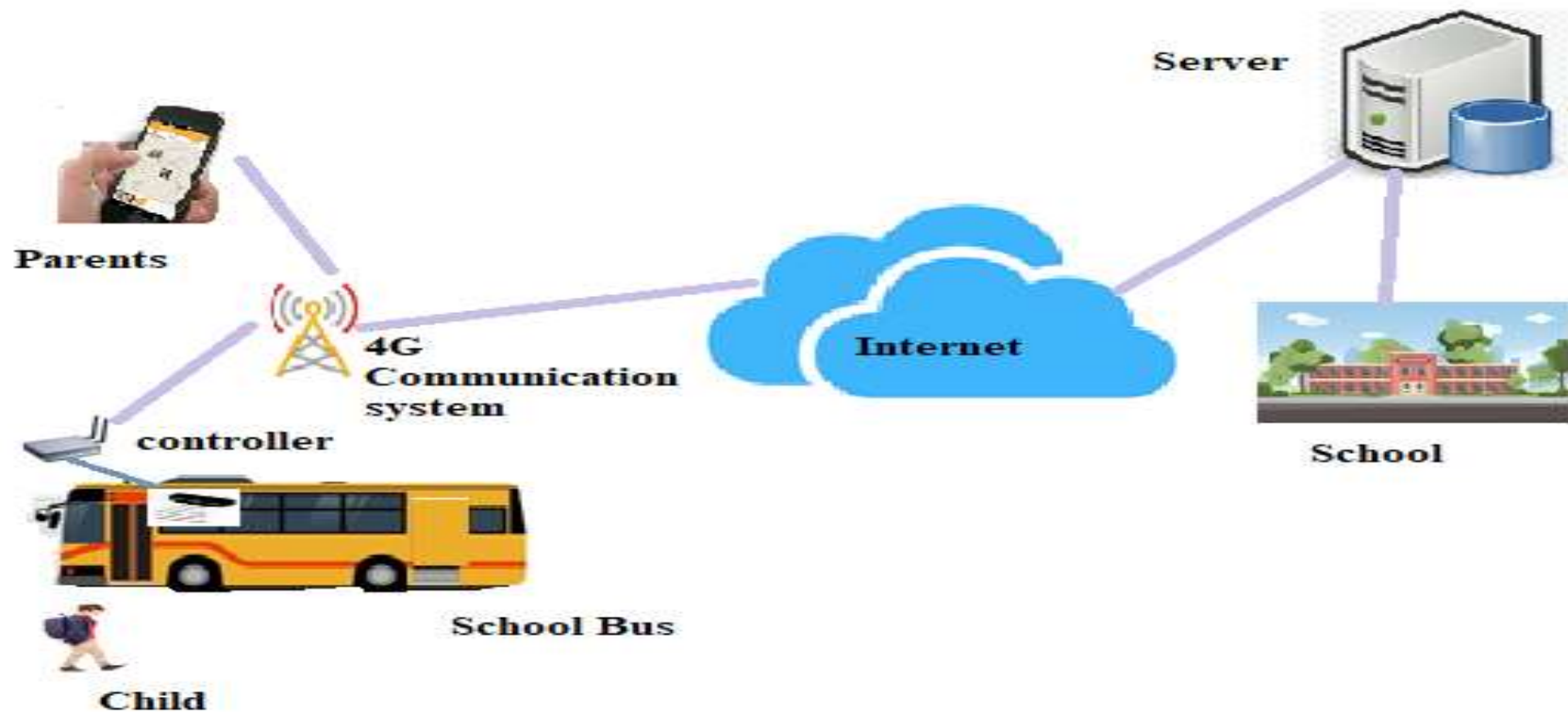


Source: ADSI 2021, 2020, 2019, 2018 & 2017, NCRB, Govt of India. (<https://ncrb.gov.in/en/ADSI-2020/>)

# How It works centrally?



# communication architecture diagram



Dissemination of Information/  
Communication System

# System Architecture

The system architecture comprises four main components such as the on-board/in-school RFID Tracking System, on-board/in-school controller (RFID system, GPS, and 4G using **MQTT** -is the de facto standard for machine-to-machine communication), -Backend Server with web based applications and mobile app.

The system consists of the subsystems:

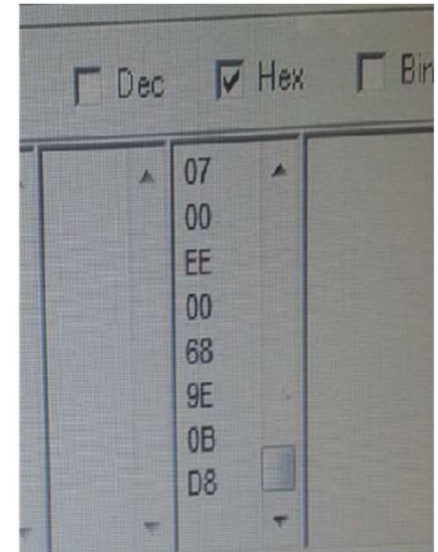
Back-end - The back end system installed in the school

In-bus - The monitoring and tracking system installed each school bus

Tracking units - The RFID units carried by each student or staff which shall be tracked by the system

Remote monitoring software - The tracking software (mobile app) used by parents or any other authorise person

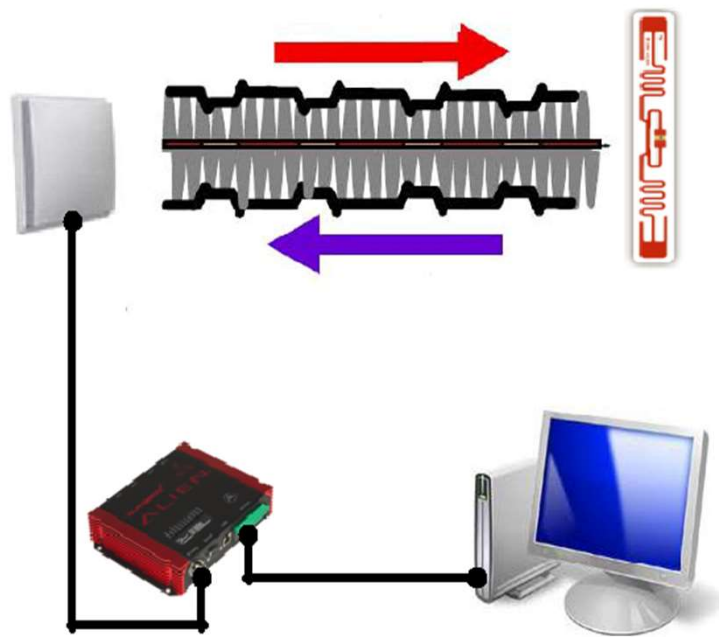
# Reader, microcontroller and GSM Modem



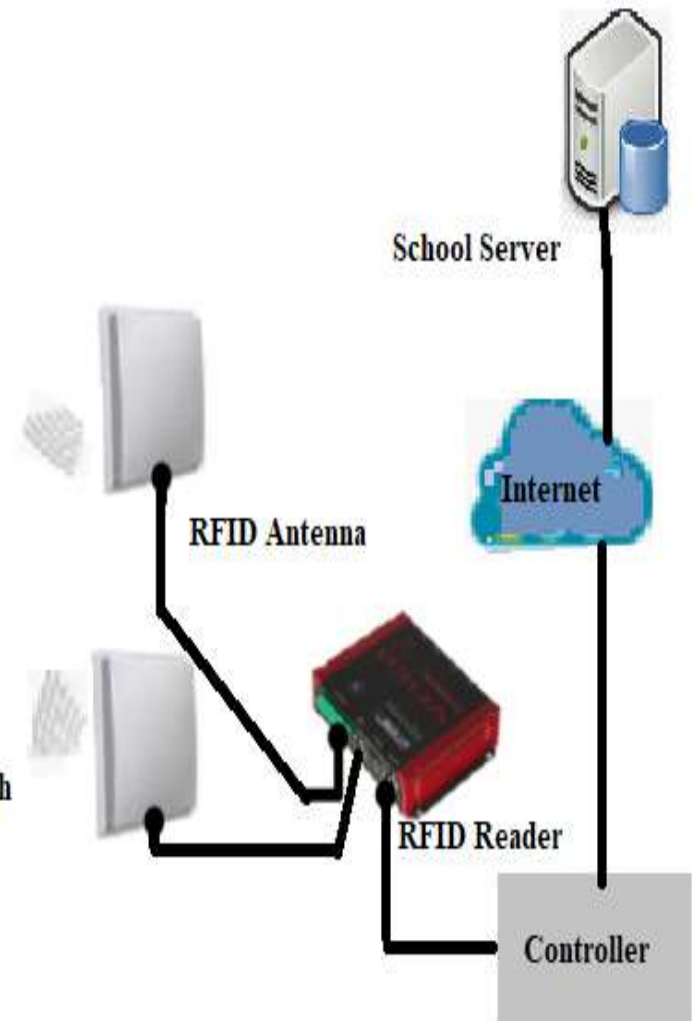
Testing the RFID Tag RFID Reader

Reader, micro controller and GSM Modem.

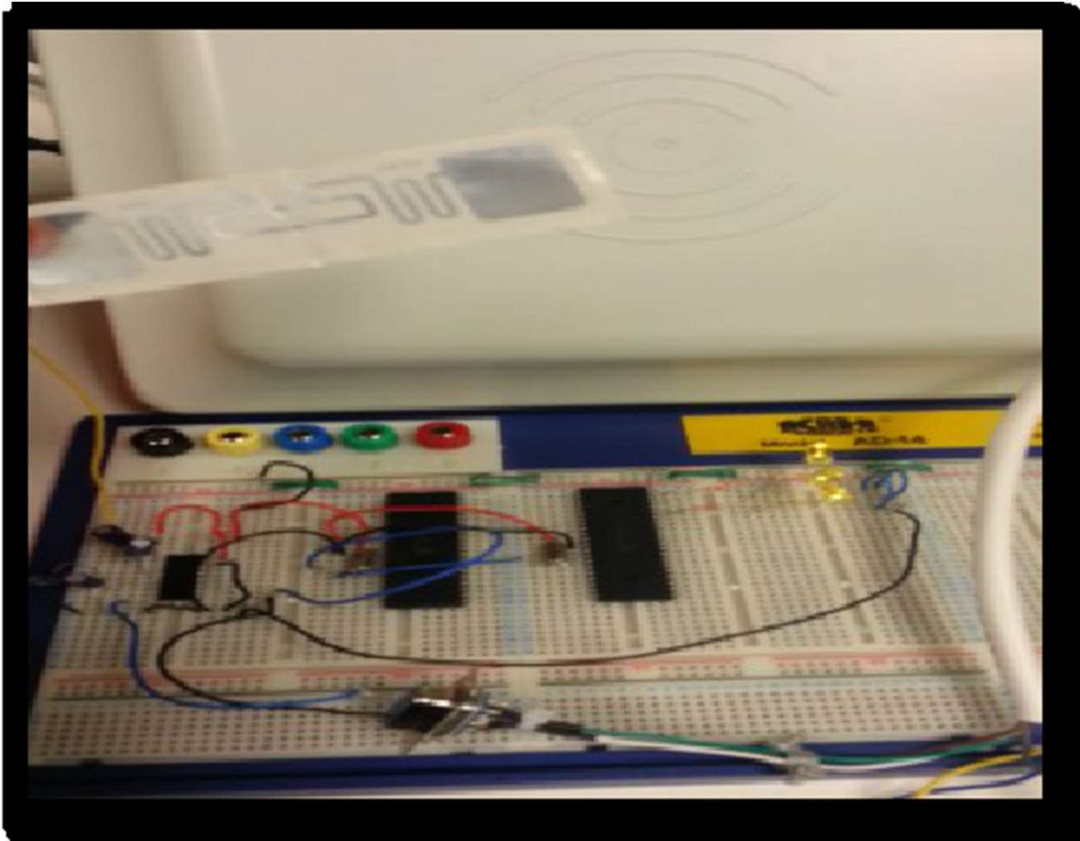




Student ID card with UHF RFID tag



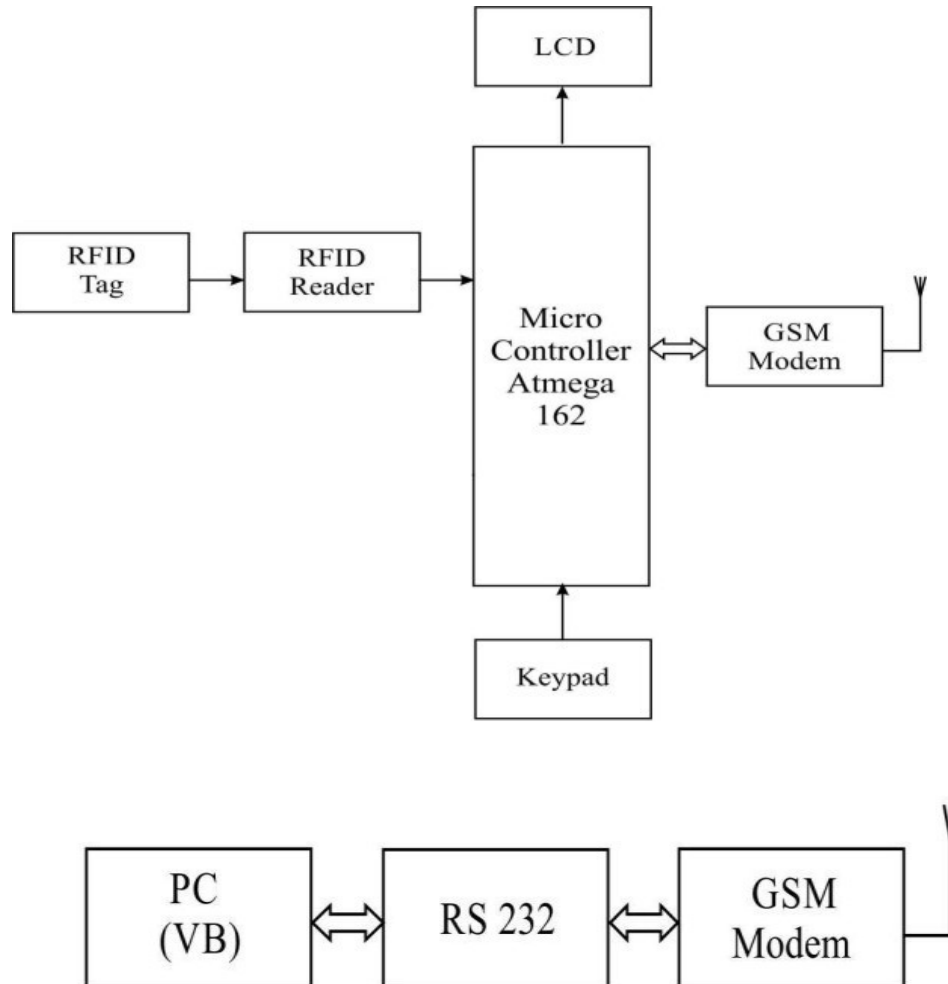
## Reader-microcontroller interface circuit



ATmega32 microcontroller is used to interface the reader and the GSM modem in the bus unit for data exchange

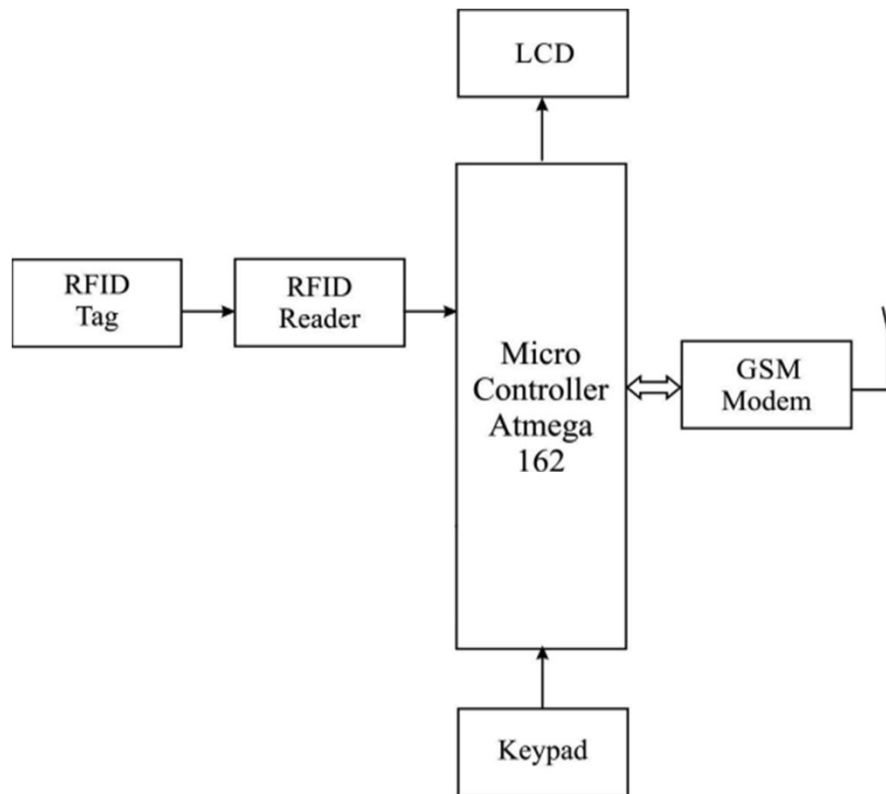


# The bus unit Architecture



- The bus unit will consist of the following components.
  - RFID Tag
  - RFID Reader
  - LCD
  - GPRS & GSM Modem
  - Microcontroller Atmega 162
  - GPS
  - Keypad
  - Ultrasonic Sensor
  - Buzzer

# School unit's Architecture



- School unit consists of the following components:
- 1. RFID Tag
- 2. RFID Reader
- 3. LCD
- 4. GSM Modem
- 5. Microcontroller Atmega 162
- 6. Keypad
- 7. GSM Modem
- 8. RS 232
- 9. PC (VB)

# Functional

- **Requirements:**
- The system shall meet the following requirements
- Each student shall carry an ID card (hung around the neck) or RFID tag to be embedded in their school bag. . This card shall contain an embedded RFID tag (passive RFID). It shall also have student information printed on it as per school norms. The card shall be PVC and have rectangular form factor.
- Each such card has a global unique ID (tag number) defined by the manufacturer. The child's tag shall be mapped to her school unique ID and this data shall be initialised at the workstation in the school and saved in the school server. This shall be downloaded in the bus OBU as well.
- The RFID reader along with Antena mounted at the bus entry shall record the presence of the tag in the detection zone (door).
- The CCTVs cameras shall be positioned in such a way the bus door as well as entire inside of the bus is recorded. The camera shall be able to record clearly in low light conditions. The recordings are saved in the recorder placed at the driver dashboard. The cameras shall have in-built mic to record surrounding audio). The recorder shall have memory for at least 7 days of recording.
- The OBU shall capture the RFID information regarding the detection of card / tag ID in the detection zone. An LCD screen mounted at the driver dashboard as well as in the inner part of the bus just opposite to wall behind driver's cabin shall display the student/staff name and count. LCD shall also display other information like warnings (door open) and information messages, if any,
- The school system (workstation) shall have a GUI based map to show location of each bus. It shall also display through visual and audio alarm any alarm event. Alarm events shall be configurable and may include bus stopping for unusual amount of time, bus going off-route (geo-fencing) and status of other sensors, if connected ( emergency switch pressed, over speed, driving with door open etc)
- A mobile app (Android and iOS or any other standard) shall inform the parents of the bus location and boarding/alighting of their child, only authorised persons (through login and password) shall be able to view the status of only their child.
- The bus RFID system shall run on bus battery.
- The bus system shall have auto diagnostics to report any component failure.
- The system shall inform the school if any child boards a wrong bus.
- The children's ID . bus ton any other data shall be downloaded by the server to each bus OBU.

## Process:

- The children/staff board the bus in the school. Each passenger has an ID card with embedded ID
- The RFID reader reads the card and updates the OBU.
- The OBU records this as a transaction and displays child's name on the LCD display along with a count with and audio beep.
- Once all children have boarded, the driver verifies the display count with headcount.
- When the bus leaves the school, it is tracked via GPS and the position is sent over GSM/GPRS network to school server where it is shown in real time on the workstation GUI map.
- The parents can also see the bus location through mobile app.
- When the bus stops at designated stop, the students of that stop alight from the bus. The RFID reader senses the tags and records it in the system. It also compares the actual students alighting with the pre-stored information as to how many students should be alighting based on boarding and bus-stop data. If any child does not alight (child sleeping), the system shall alarm the driver through the LCD via visual and audio alarm.
- It shall be possible to the boarding/alighting status of the child to her parents through the app as well as SMS.
- Similar process shall be adopted when the bus goes out to pick up children in the morning,

The system shall comply with Automotive Industry Standard 140 (AIS 140) , a set of standards published by ARAI (Automotive) for vehicle tracking system, camera surveillance system, and emergency request button

The system must be able to overcome the following limitations

- Avoid multiple readings of the tag if a child frequently crosses the activation zone, say, going in and out of bus at school, getting into activation zone while in a moving bus, as the activation zone shall only detect presence of tag and not direction.
- RFID reader should not read beyond the specified activation zone,

# Business rules for School Bus Children Safety

- Business rules

The business rules of the database of the system may be mentioned as under:

A child can be in only one bus, but a bus may have many children.

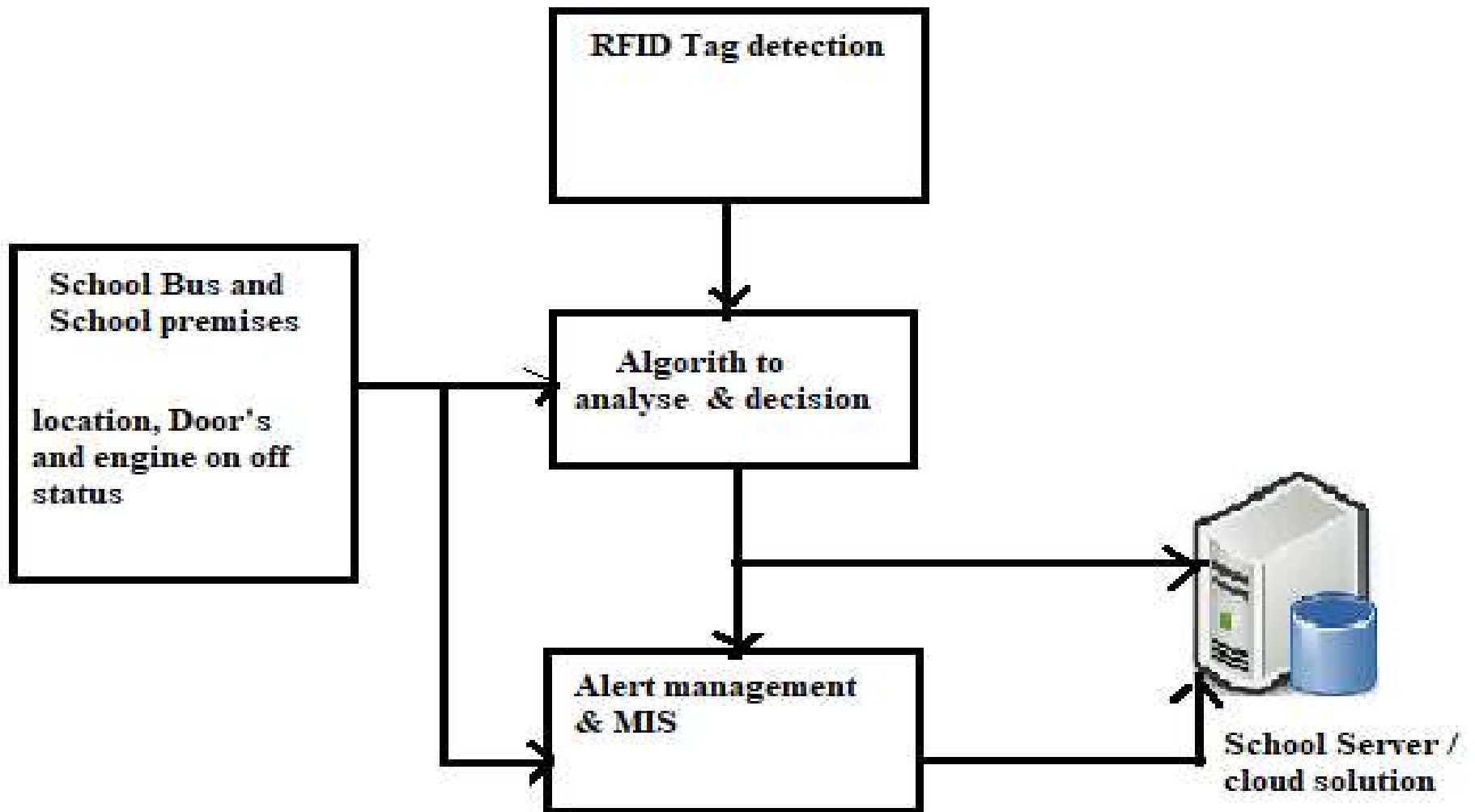
A child has one or many relatives.

A relative may have many children registered at the school.

A bus may be driven by one or more drivers, but a driver can drive only one bus.

A child may have many attendance records, but an attendance record has one child.

# Student tracking module diagram





- **Student tracking module**
- This module will identify the children ID tags, who boarded the school bus and retrieve the data stored using two RFID antennas installed in school bus and through radio frequency details fetched by RFID reader fitted in controller installed in school buses
  
- **Controller module**
- This module manages different hardware components through RFID tracking algorithms, tracking school bus application, communication through GSM/GPRS or 4 G using MQTT. This system will be able to collect various and useful information, such as to the current school bus location, emergency, the bus driving behaviors and the list of children who left or stepped into the school bus.
  
- 
- **School Admin module**
- This module will filter and analyze data processed from controller module and track in real-time the current locations of children and school buses, check the locations against defined Geo-fences areas, generate comprehensive alerts, notifications and reports, and so on.
  
- 
- **End-Users module**
- This module will be depended on the end users, i.e. school authorities, transport authorities, and/or parents. This will allow access School Admin module through web portals, mobile applications, and mail/SMS in a pre-defined defined format.

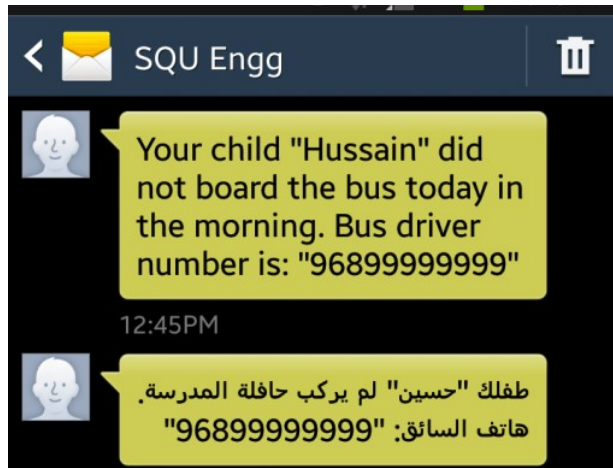
# School Children Tracking



## School Children Tracking System

Your children are safe with us

#	Relative Name	Relative Type	Phone Number	Student Name	Bus ID
1	Shaikha Al-Jahdhami	Aunt	96897252277	Mohammed Al Jahdhami	b0002
2	Shaikha Al-Jahdhami	Aunt	96897252277	Ilaf Al-Jahdhami	b0002
3	Salim Al-Jahdhami	Father	96896339229	Mohammed Al Jahdhami	b0002
4	Salim Al-Jahdhami	Father	96896339229	Ilaf Al-Jahdhami	b0002
5	Alya Al-Lawati	Mother	96899356218	Hussain Al-Lawati	b0001
6	Anwaar Al-Lawati	Aunt	96892592019	Areej Al-Lawati	b0001
7	Anwaar Al-Lawati	Aunt	96892592019	Taha Al-Lawati	b0001
8	Ala Al-Lawati	Father	96898050105	Areej Al-Lawati	b0001



# Addition of New Information

Message sent to parents

First name:	<input type="text" value="Anwar"/>	Last name:	<input type="text" value="Al-Lawati"/>
Address:	<input type="text" value="Muscat"/>	Phone:	<input type="text" value="96890590019"/>
relation:	<input type="text" value="Aunt"/>	Language:	<input type="text" value="English"/>
student info:			
First Name:	<input type="text" value="Areej"/>	Sname:	<input type="text" value="Ala"/>
Last Name:	<input type="text" value="Al-Lawati"/>	gender:	<input type="text" value="Female"/>
Home Phone:	<input type="text"/>	Address:	<input type="text" value="Muscat"/>
ID:	<input type="text" value="300104"/>	serial number:	<input type="text"/>

# **GSM Modem**

## **interfacing with the reader and Microcontroller**

- **GSM Modem**

### **GSM Modem**

GSM, is a Global System for Mobile communications, widely used & governs cell phone technology. Cell phones becomes active and functional with a cell phone service carrier's GSM network by identifying and selecting for cell phone towers in the nearby area. Global system for mobile communication (GSM has been accepted as globally standard system for digital cellular.

ATmega162 microcontroller is used to interface the reader and the GSM modem in the bus unit for data exchanging. The reader communicates with microcontroller using serial communication interface RS232

# Communication between Two Modems

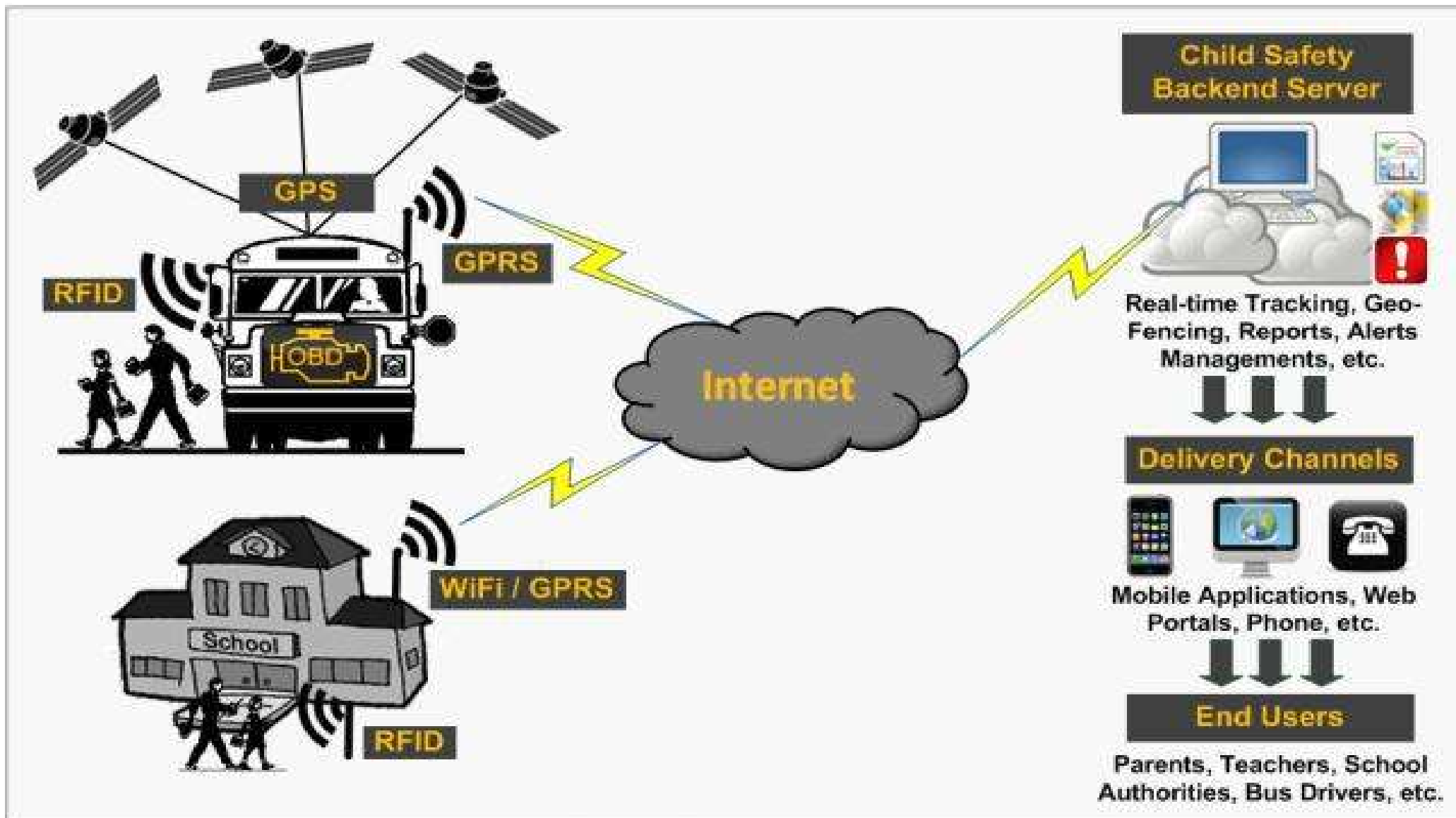
- **Communication between Two Modems**

## **Communication between Two Modems**

Two TMAS GSM/GPRS modems are designed for transferring the data from the bus unit to the school unit. One of modems is placed in the bus unit to send SMS which contains the tag serial numbers to another GSM modem in the school

Then, one GSM modem was connected with the AVR microcontroller (AtMega168) using RS232. The microcontroller has the AT commands.

# Overall System Architecture for school Children Safety



# IN-SCHOOL SMART GATEWAY

- **A. *RFID Tracking Module***

- 
- This module is responsible for reading raw RFID measurements from the RFID reader and antennas and to detect in real-time the RFID tags, and thus the children, that have left or step into the bus or the school.

- 
- **B. *Bus Monitoring Module***

- 
- This module is responsible for tracking in real-time the current bus location as well as the bus driving behaviors. In particular, the following driving events are continuously monitored, and the related alerts are automatically sent to the Child Safety Backend Server: bus over-speeding, hard acceleration, and hard braking.

- 
- **C. *Over-The-Air (OTA) Gateway Protocol***

- 
- This module is mainly responsible for the configuration and management of the Smart Gateways. In particular, this OTA protocol will enable the Bus Operator to remotely manage the deployed in-bus and/or in-school smart gateways by sending new configuration parameters, firmware versions and commands through SMS messages. Moreover, this module will allow the smart gateways to send urgent alerts and notifications to the Child Safety Backend Server, in particular in case of unavailable or stable Internet connectivity.

# IN-SCHOOL SMART GATEWAY

- ***D. Machine-to-Machine (M2M) Communication Protocol***
- This module is responsible for connecting wirelessly the smart gateways to the Internet and thus to the remote Child Safety Backend Servers. This module implements a two-way M2M communication protocol which will be in charge of 1) sending all tracking and sensors information, notifications and alerts to the remote Servers; and 2) receiving all the gateway parameters (e.g. firmware, software modules configuration parameters, etc.) and assigned tasks (e.g. list of assigned children, list of RFID tag IDs to detect, etc.) from the same servers.
- 
- ***E. Local Database***
- 
- This module is responsible for buffering all the related smart gateway configuration parameters, software modules inputs and outputs and tracking information



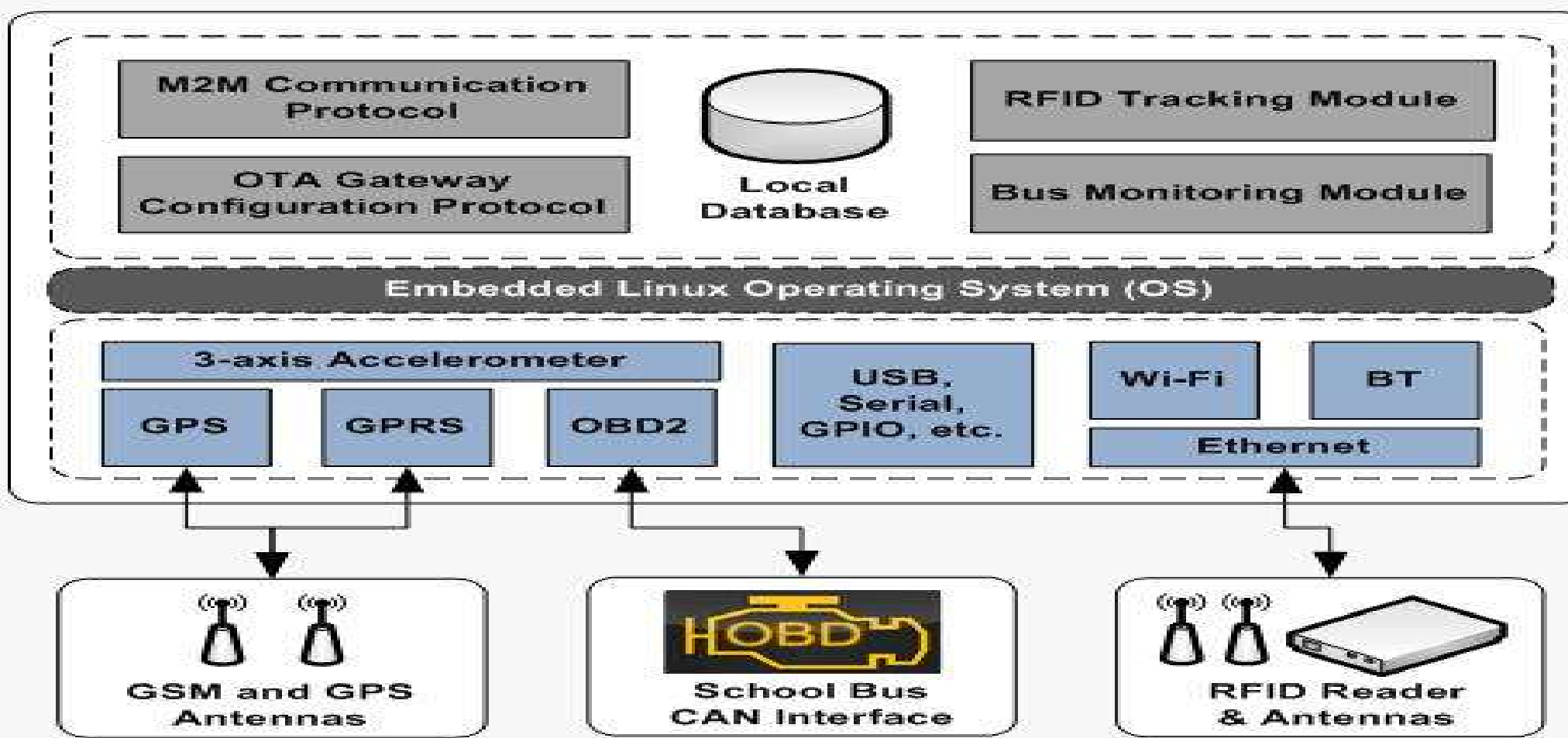
# ***The System Web-based Application***

## ***The System Web-based Application***

The database-driven web-based application should be able to manipulate the system, update, and query the database. Two options can be exercised to log into the website, as a parent or as an administrator.

The administrator can add, modify, delete or view information about students and their relatives, buses and drivers. On the other hand, each parent can see the status of his/her children if they board/leave the bus in the morning and afternoon. It will comprise of displaying the details of the students, relatives separately, inserting new information , deleting/updating existing information

# Smart Gateway Hardware and Software Components

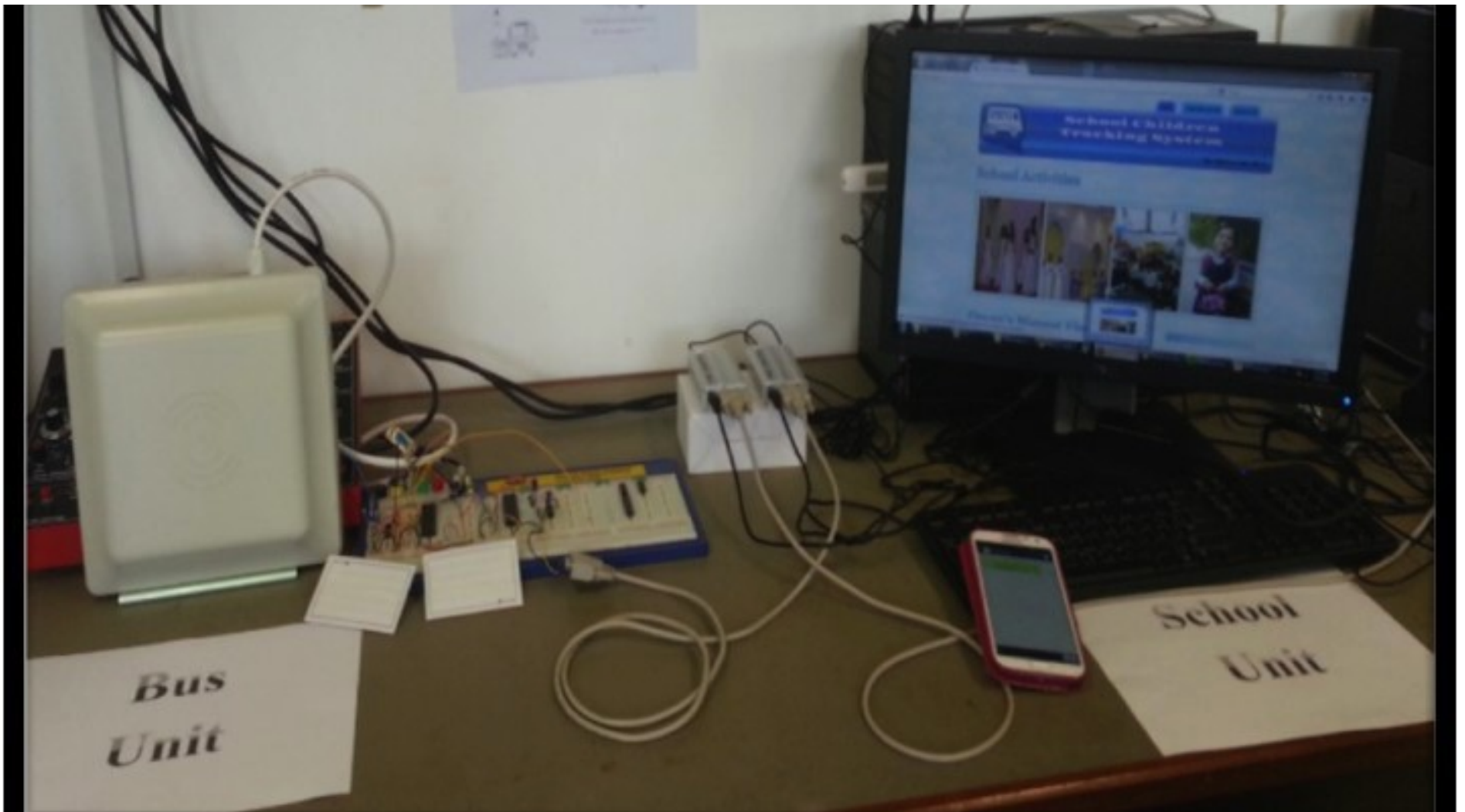


OTA (over the air) provides operators with a more a cost-effective means to enable remote interaction without the expense of manually reconfiguring cards,

. OBD systems give the vehicle owner or repair technician access to the status of the various vehicle subsystems.

A Controller Area Network (CAN bus) is a robust vehicle bus standard designed to allow microcontrollers and devices to communicate with each other in applications without a host computer

# Experimental Set up



# CONCLUSIONS

- RFID tracking technology is a practical option for monitoring and tracking the children's safety during their trips to and from school on school busses