Essen RFID
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ESSEN

UAE Ministry of Interior pilot project for RFID-based SCHOOLBUS/STUDENT TRACKING SYSTEM

Safe, secure and verified school bus transportation

School bus route tracking and live data transmission through GPRS

Automated tracking of students boarding and exiting from the school bus and SMS alerts to parents

Covers all contingencies in student pick-up and drop

TECHNOLOGY

Solution:
EPC Gen2 compliant
personnel tracking solution
GPS based remote vehicle tracking

Tag Type:
Personna™ UHF Passive

Reader/Antenna:
Xtenna Hybrid™
Xtenna Proximity™
Strada™

Method:
Multiple Tracking via Integrated
Reader/Antenna modules
Vehicle Tracking via On-board
Tracking device

Integration Platform:
 RFID Middleware:
  Xtenna™ WebToolkit
  Xtenna™ Studio
 Application: Essen RFID's
  Student Tracking System
 Database: SQL Server 2005 Exp. ed.

Tag Manufacturer/Supplier:
Essen RFID, with US based chip inlay

Reader/Antenna Manufacturer:
Essen RFID, with US based module

Systems Integrator:
Essen RFID

For further details contact:

Essen RFID
24-B, Jolly Maker II
Nariman Point
Mumbai 400021 India
www.essenrfid.com

Xtenna™
Integrated RFID Antenna/Reader

INSIDE:

CASE STUDY

KEY REQUIREMENTS:

Concerns regarding the safety of children on their way to school and back home prompted the Ministry of Interior, United Arab Emirates to examine solutions that gave the school authorities as well as parents live information about whether their children had reached school safely, were within the school premises and whether they had returned home safely. This was considered of great importance in order to prevent young school children having to fend for themselves under high outdoor temperatures in case of missed pick-ups and drops at bus stops, with working parents being unaware of the situation.

Main challenges in implementation:
- Identifying children boarding school buses and verifying the boarding time and place of each student into the bus.
- Locating and verifying the disembarking point and time for each student.
- Sending message updates to parents that their children have safely reached school or home.
- Alerting the bus driver if any student tries to board the wrong school bus.
- Alerting the bus driver if any student is left behind in the bus.
- Alert to driver if bus has been replaced for any reason.
- Alert to new driver if any driver is absent.
- Monitoring the live location and path of each school bus on its daily trips.

SOLUTION:

Essen RFID suggested the use of RFID technology for tracking students entering or exiting the school bus and confirming their entry into the school premises. Along with this, a GPS based vehicle tracking solution was proposed that allowed remote tracking of current location of school buses by the school authorities. Automated RFID identification of student tags is combined with GPS location of the bus at each pick-up/drop-off point to ensure accurate and safe boarding and disembarking by the children, along with instant, automated SMS alerts to parents, school administrators and bus drivers.

IMPLEMENTATION:

A PERSONNA™ RFID tag is issued to each student as an identity card. Similar tagged ID cards are also issued to each bus driver. A Xtenna Proximity™ reader is used for registering tags into the database. Xtenna Hybrid™ antenna-readers configured to be remotely programmable through Wi-Fi are mounted at the door of each school bus. Controller devices are installed in each bus, which interface with the mounted RFID reader. A Strada™ vehicle tracking device is also attached to this controller, which communicates with the central server located in the school.

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Each school bus is also issued a tablet device that displays alert messages for the bus driver and the bus assistant on its screen.

An Indicator Panel is also mounted into the dashboard of the bus, which displays the following status through LED lights to the bus driver:

1. Controller On: This is displayed through its LED indicator light.

2. Error Restart: In case of system error, this LED indicator light enables the driver to immediately notify the administrator.

3. Server Connected: This indicator is on when the controller has established connectivity with the server.

4. Door Open: This LED is on whenever the bus door is open.

5. Geo-Fence: This LED is turned on when the bus reaches within the geo-fenced area of a marked bus stop.

6. Trip Selector: These LED lights indicate the status of the current trip as either a pick-up or drop trip.

7. End Trip: This indicates the current trip has ended.

The system deploys various software interfaces as follows:

1. SQL Server as the server database for storing data.

2. Web Server to host the web services.

3. My SQL database to store local data.

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Flow Diagram:
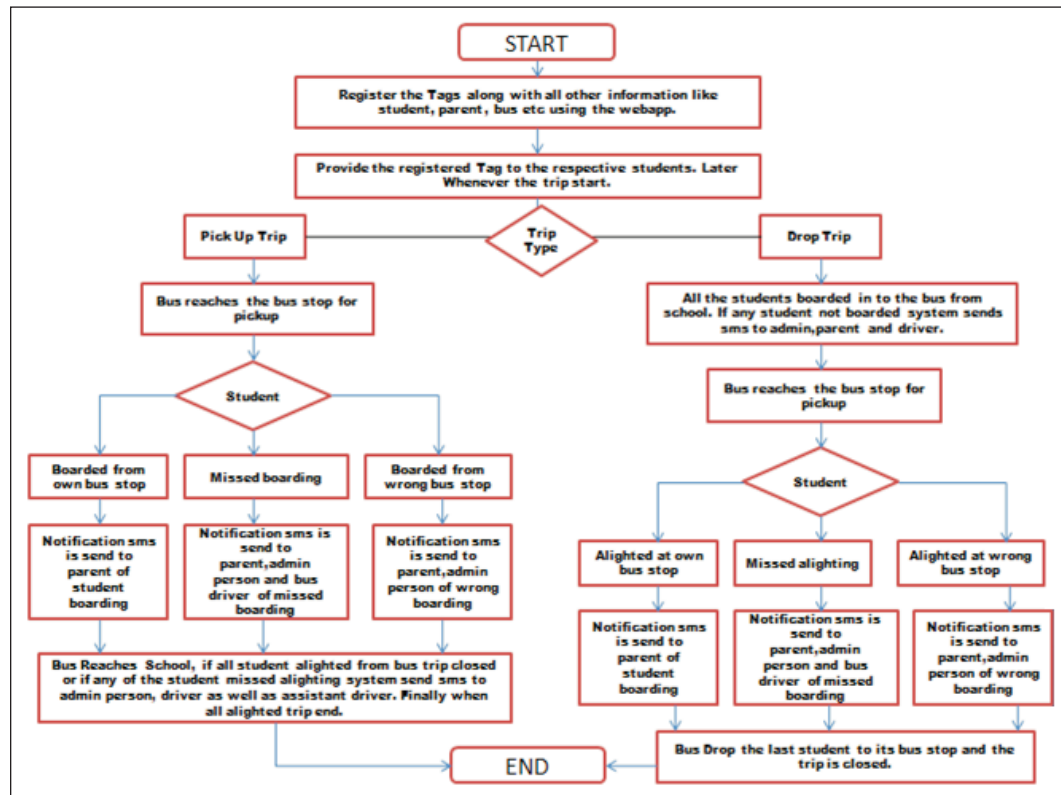
WORKING:

Essen RFID's SchoolBus-Student Tracking system deploys the following main modules:

1. Registration Module
2. Mapping Module
3. Dashboard

Registration Module:

This module is used for registering students, parents, bus drivers and other important information into the database. The main masters in this module are:

1. **Student Master:**
   Information regarding each student is entered into the database from the master record of the school. This data consists of student's address, age, class year, etc.

   Data of new students is also collected and entered into the school master and database, as and when a new student takes admission in the school.

   Each individual student data is associated with a PERSONNA™ tag issued to the student.

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2. Parent Master:

This master is used to register data regarding parents such as name, address, mobile phone number, etc. During registration, the option of SMS alerts to parents can also be selected.

3. Bus Master:

This is used to register the buses available for pick-up and drop for the students. During registration, bus details such as bus license number, bus VIN number, controller IP (placed inside the bus), etc. are entered into the database.

A Strada™ vehicle tracking device is attached to the controller. This device precisely gives out live GPS co-ordinates of the school bus, which are utilized for exact pick-up and drop-off along the route. This also enables real time location of the bus along its route and its tracking by the administrator on a map.

4. Route Master:
   This master is used to register the route for both pick-up and drop. During registration, the type of route i.e. pick-up or drop, route name and route code are entered.

5. Bus-stop Master:
   Here, the various bus-stops available for pick-ups and drops are registered into the database. During registration, the GPS location for each bus stop is also entered.

6. Driver Master:

This master registers the bus drivers available to the school into the database, along with their details such as their name, driving license number, category, mobile phone number, etc.

Each individual driver data is associated with a PERSONNA™ RFID tag that is issued to the bus driver as an ID card.
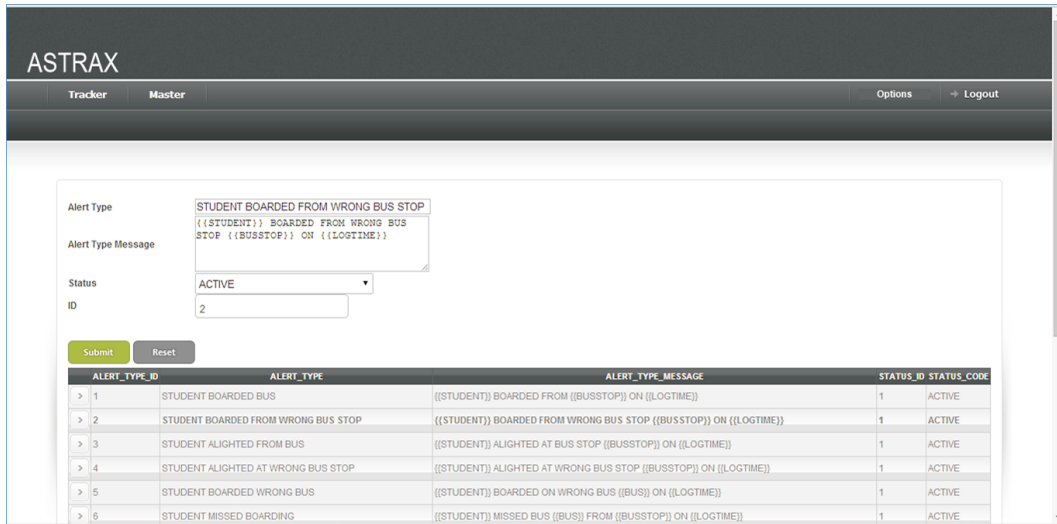
7. Alert Message Master:

This is used to register the various standardized alert messages that will be sent as an SMS to parents and to the system administrator, for various boarding and disembarking conditions during student pick-up and drop bus trips.

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Mapping Module:

This module is used to establish relationship between the data in various masters, such as associating students to their parents, students to their designated bus stop, buses to routes, etc. in the database.

When a RFID tag is read at any location during a trip, the system maintains background transactions to link these associated entities in the database during the entire process.

1. Student-Parent Mapping:
   This is used to associate each registered student to his/her registered parents or guardians. A particular student can be mapped with at most three parents/guardians at a time.
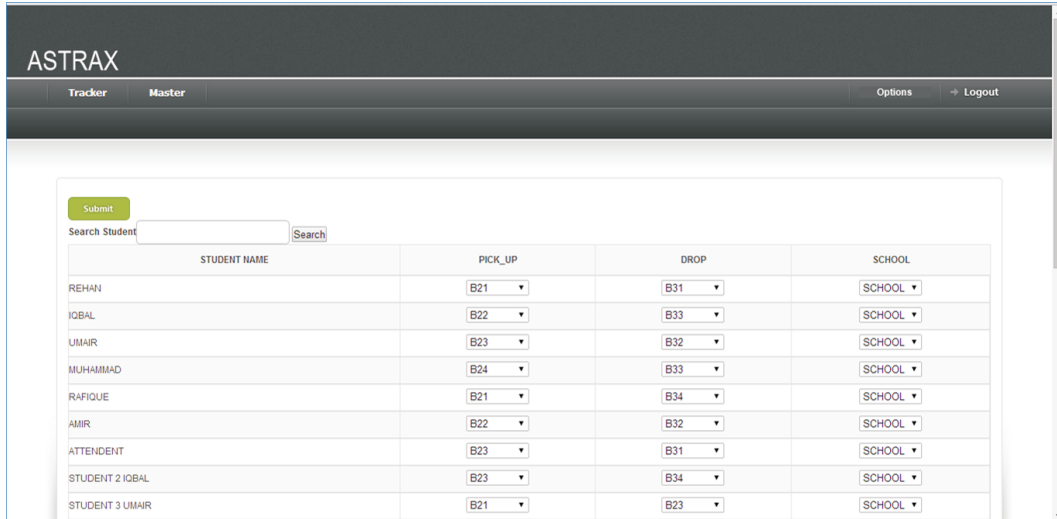
2. Student-Bus Stop Mapping:
   This is used to map each student with his/her respective bus stop for pick-up as well as drop-off by the school bus.

3. Route-Bus Stop Mapping:
   This is used to add various bus stops already registered in the master to a bus route.

4. Bus-Route Mapping:
   This maps available buses to a particular route in the system. A route can be mapped to multiple buses for pick-up and drop.

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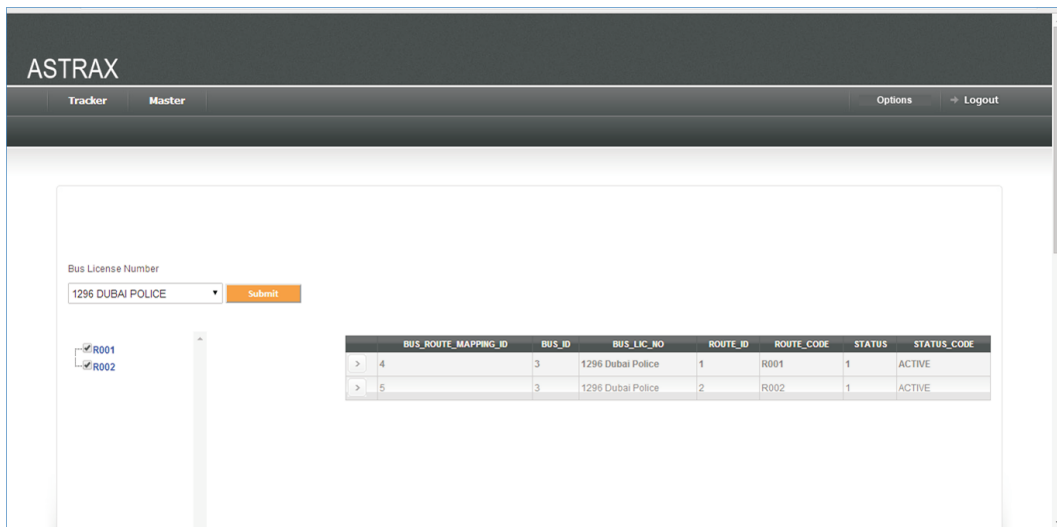
5. Driver-Route Mapping:

This maps a driver to his assigned bus route so that he gets route-specific alerts. If a driver is absent, then a new driver is assigned to the route and gets all alerts associated with that route.

Dashboard:

Dashboards are used to show the current status of buses, their route and the overall view of the students inside the bus.

1. Bus Tracking:

This dashboard is used to provide a live and updated overview of each school bus on its designated trip. This information will include the total number of students mapped with the bus, the number of students currently inside the bus, the current bus route, and the current live position of the bus on that route. Driver details for the particular bus trip are also displayed on the screen for easy reference.
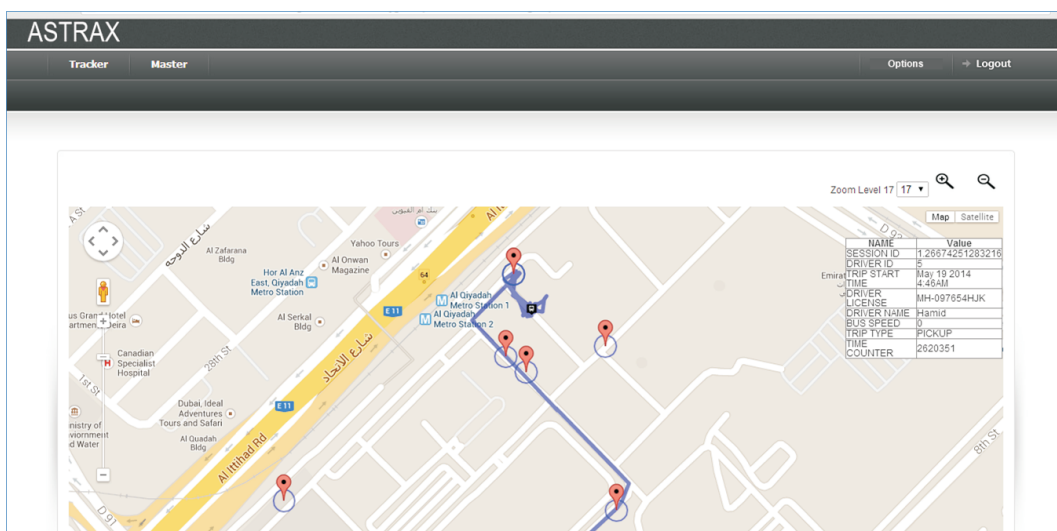
CASE STUDY

2. View Points:

    This dashboard is used to view all the registered bus stops on the map with their respective geo-fenced area.
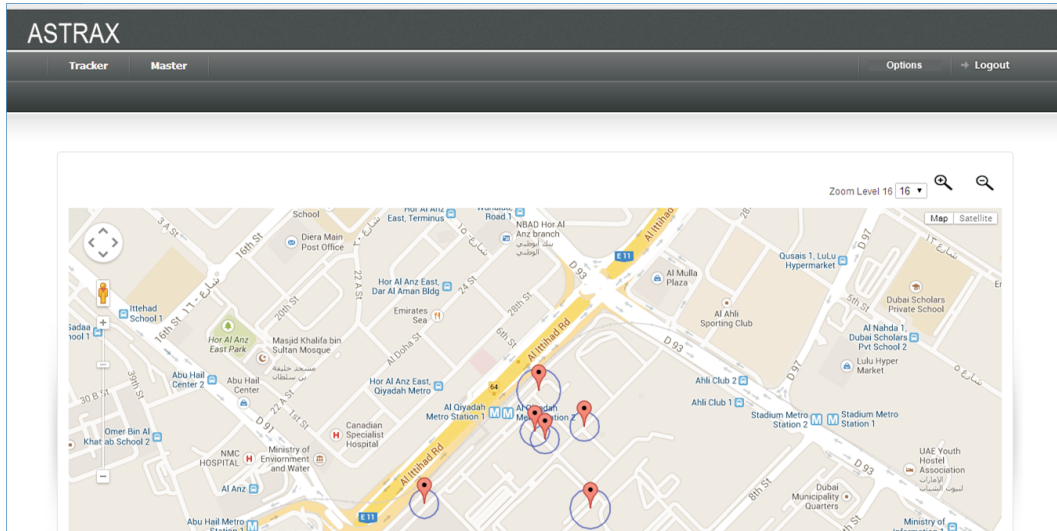
3. View Images:

    This dashboard acts as a remote rear-view for the school bus when it is in reverse motion, in order to safeguard school children who may be standing behind the bus unknown to the driver. At this time, the RFID reader mounted at the rear of the bus will be activated and start reading. If any student tag ID is detected, a camera is triggered and the student photo captured by the camera is sent to the server and an alert beep is started in the bus. Through the web application, the image can be viewed and the student's name also obtained along with the date and time.

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Working Process:

1. **Tracking the student entering/exiting the bus:**
   Each student wears a RFID-enabled ID card containing a PERSONNA™ tag. When a student's tag ID is read by the twin antennas of Xtenna Hybrid™, if the tag is detected first by antenna A and then by antenna B, this indicates that the student has entered the bus. If the tag is detected first by antenna B and then by antenna A, then this indicates that the student is exiting from the bus.

2. **Student picked up by school bus:**
   Xtenna Hybrid™ on the bus entrance checks if the student is registered for that particular bus route. If the tag ID is not found then a pop up alert is displayed, whereas if the registered ID is found then the system is updated along with co-ordinates from the Strada™ vehicle tracking device. This confirmation of pick-up with location name, date and time is also sent via SMS to the parent. If a child registered for pick-up is not found then the parent gets an alert message that the child has missed the stop and has not boarded the school bus.

3. **Student reaching school:**
   When the bus reaches school, the Xtenna Hybrid™ on the bus registers the student exiting the bus by detecting his tag first with antenna B and then with antenna A, and a corresponding entry is made into the system data. The system then automatically sends a confirmation SMS to the parent indicating that their child has reached school safely, along with the time of arrival.

4. **Student boarding the wrong bus when leaving school:**
   If a student tries to board the wrong bus when leaving school for home, then the Xtenna Hybrid™ on the bus detects the student's tag ID as not assigned to that bus route and pops up an alert on the screen. This alerts the bus driver who prevents the child from getting into the wrong bus.

5. **Student dropped off from school at destination:**
   The student is dropped off at his destination mapped with the exact GPS co-ordinates obtained by Strada™ and registered in the database. At drop-off, the exiting student's tag ID is read by the Xtenna Hybrid™ on the bus and a confirmation SMS is sent to the parent with location name, date and time of drop-off.

6. **Student remains inside bus:**
   If a student is not dropped off and is still in the school bus, then the driver gets an alert that the child is still remaining in the bus.

7. **Bus replacement:**
   If a particular school bus is not available because of maintenance or any other reason, then the driver assigned to that bus will receive a SMS alert that he has been assigned a replacement bus. However his assigned route remains unchanged. The change takes place at the backend server where the new bus will be associated with the route of the old bus.

8. **Driver replacement:**
   If a particular driver is absent, then the replacement driver will receive a SMS alert regarding the bus assigned to him, and all data and alerts associated for that bus route will now be sent to him.

9. **Bus has not reached in time:**
   The Strada™ tracking device sends GPS co-ordinates of the moving bus to the central server database. The system administrator can select each school bus for tracking and viewing its current position on its route in real time. Thus there is strict monitoring of the bus as to its schedule and whether it is having any stoppage or is running late. SMS updates or alerts can also be sent to parents if required.

Tracking Scenarios - Indicator Panel and SMS Alerts:

   Pick-up Trips:

1. The bus driver's RFID tag is read identifying him as the assigned driver for the particular bus trip.

2. The driver starts the pick-up trip using the Trip Selector on the Indicator panel on the bus. The Pick-up LED will glow to indicate that the trip has started.

3. When the bus reaches the first pick-up bus stop, the Geo-Fence LED will glow on the Indicator panel when he brings the bus to a halt within the pre-defined geo-fenced area for that bus stop.

4. **Normal Scenario:** The student boards the bus from his/her designated bus stop. The RFID reader on the bus reads the student's tag ID and the system sends a confirmation SMS to the parent that their child has boarded the school bus.
   e.g. SMS: Umair boarded from Bus Stop BS1 on 23-05-2014 08:00 AM

5. **Normal Scenario:** When the bus reaches school, the RFID reader on the bus reads the student's tag ID as he/she alights from the bus. The system sends a confirmation SMS to the parent that their child has reached school.
   e.g. SMS: Umair alighted at School bus stop on 23-05-2014 09:00 AM

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6. **Alert Scenario:** The student boards the bus from the wrong bus stop. The RFID reader on the bus reads the student's tag ID and the system sends an alert SMS to the parent and to the system administrator.
   e.g. SMS: Umair boarded from Wrong Bus Stop BS2 on 23-05-2014 08:00 AM

7. **Alert Scenario:** The student boards the wrong bus at the bus stop. The RFID reader on the bus reads the student's tag ID and the system sends an alert SMS to the parent, the system administrator, as well as the bus driver.
   e.g. SMS: Umair boarded Wrong Bus DB-07-JK-2460 on 23-05-2014 08:00 AM

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8. **Alert Scenario:** The student misses boarding the bus at his/her assigned bus stop. The system sends a missed boarding alert SMS to the bus driver and his assistant as well as to the child's parent.
    e.g. SMS: Umair missed bus DB -04-JK-2135 on 23-05-2014 08:00 AM

9. **Alert Scenario:** The student is picked up from outside the geo-fenced area. The system generates a boarding alert SMS to the parent as well as the system administrator specifying the exact latitude and longitude of the student boarding location.
    e.g. SMS: Umair boarded from outside bus stop area at 25.271139, 55.307485 on 23-05-2014 08:00 AM
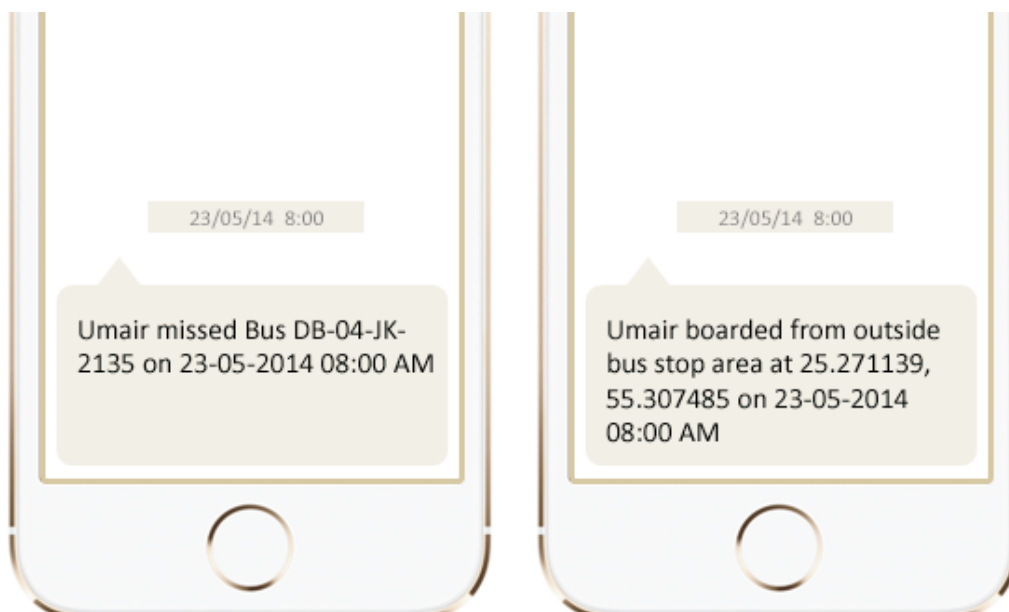
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10. **Alert Scenario:** The student boards the wrong bus and from the wrong bus stop. The RFID reader on the bus reads the student's tag ID and the system sends an alert SMS to the bus driver and driver's assistant, the parent as well as to the system administrator.

e.g. SMS: Umair boarded from Wrong Bus Stop BS2 in Wrong Bus DB-07-JK-2460 on 23-05-2014 08:00 AM

23/05/14 8:00

Umair boarded from Wrong Bus Stop BS2 in Wrong Bus DB-07-JK-2460 on 23-05-2014 08:00 AM

11. **Alert Scenario:** The student is unable to continue to school due to health reasons. The bus assistant informs parents that the child is alighting at the next bus stop.

e.g. SMS: Umair will be alighted at Bus Stop BS2 due to his health problem.
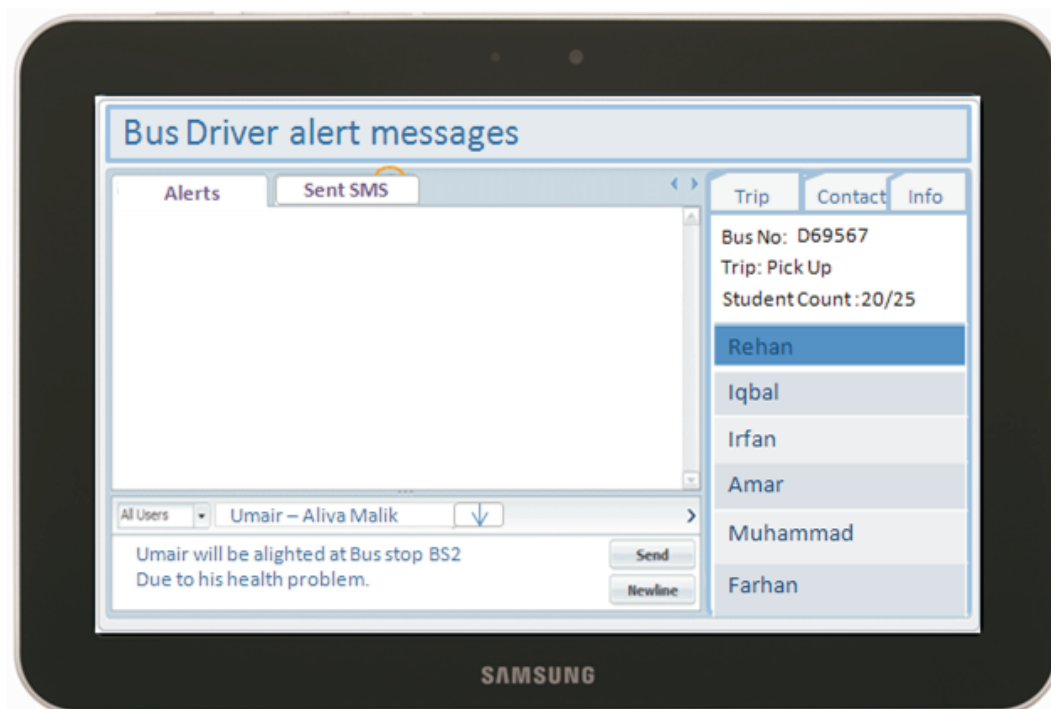
12. **Alert Scenario:** The driver ends the pick-up trip and a student is still remaining inside the bus. The system generates a student left in bus alert for the driver, bus assistant and the system administrator.

e.g. SMS: Umair left in Bus DB-07-JK-2460 on 23-05-2014 09:00 AM

13. After all students have alighted from the bus, the driver ends the trip using the Trip Selector on the Indicator panel on the bus before starting a new trip.

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Drop Trips:

1. The bus driver's RFID tag is read identifying him as the assigned driver for the particular bus trip.

2. The driver starts the drop trip using the Trip Selector on the Indicator panel on the bus. The Drop LED will glow to indicate that the trip has started.

3. Students board the school bus to return home.

4. **Normal Scenario:** The student boards the return bus at the school bus stop. The RFID reader on the bus reads the student's tag ID and the system sends a confirmation SMS to his/her parent.
    e.g. SMS: Umair boarded from School Bus Stop on 23-05-2014 03:00 PM

5. **Normal Scenario:** The student alights at his designated drop bus stop. The RFID reader on the bus reads the student's tag ID as he/she alights from the bus. The system sends a confirmation SMS to the parent that their child has alighted at his/her bus stop.
    e.g. SMS: Umair alighted at Bus Stop BS1 on 23-05-2014 04:00 PM

<table>
<tr><td>

3:01

VM- SCHOOLDU

23/05/14 3:00

Umair boarded from School Bus Stop on 23-05-2014 03:00 PM

</td><td>

4:01

VM- SCHOOLDU

23/05/14 4:00

Umair alighted at Bus Stop BS1 on 23-05-2014 04:00 PM

</td></tr>
</table>

6. **Alert Scenario:** The student misses boarding the return bus at the school. The system generates a missed boarding alert for the parents and the administrator.
    e.g. SMS: Umair missed bus DB-07-JK-2460 on 23-05-2014 03:00 PM

7. **Alert Scenario:** The student alights at an earlier bus stop. The RFID reader on the bus reads the student's tag ID as he/she alights from the bus. The system sends an alert SMS to the parent that their child has alighted at the wrong bus stop.
    e.g. SMS: Umair alighted at Wrong Bus Stop BS2 on 23-05-2014 04:00 PM

8. **Alert Scenario:** The student misses his designated drop bus stop and alights at a later bus stop. When the designated drop is missed, the system sends an alert to the driver, bus assistant and the administrator. When the student alights at the next bus stop, the RFID reader on the bus reads the student's tag ID as he/she alights from the bus. The system sends an alert SMS to the parent that their child has alighted at the wrong bus stop.
    e.g. SMS: Umair missed Bus Stop BS1 and alighted at Wrong Bus Stop BS3 on 23-05-2014 04:00 PM

9. **Alert Scenario:** The student alights outside the geo-fenced area of his/her designated bus stop. The system generates a drop-off alert SMS to the parent as well as the system administrator specifying the exact latitude and longitude of the student alighting location.
    e.g. SMS: Umair alighted outside bus stop area at 25.271139, 55.307485 on 23-05-2014 04:00 PM

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23/05/14 4:00

Umair missed Bus Stop BS1 and alighted at Wrong Bus Stop BS3 on 23-05-2014 04:00 PM

23/05/14 4:00

Umair alighted outside bus stop area at 25.271139, 55.307485 on 23-05-2014 04:00 PM
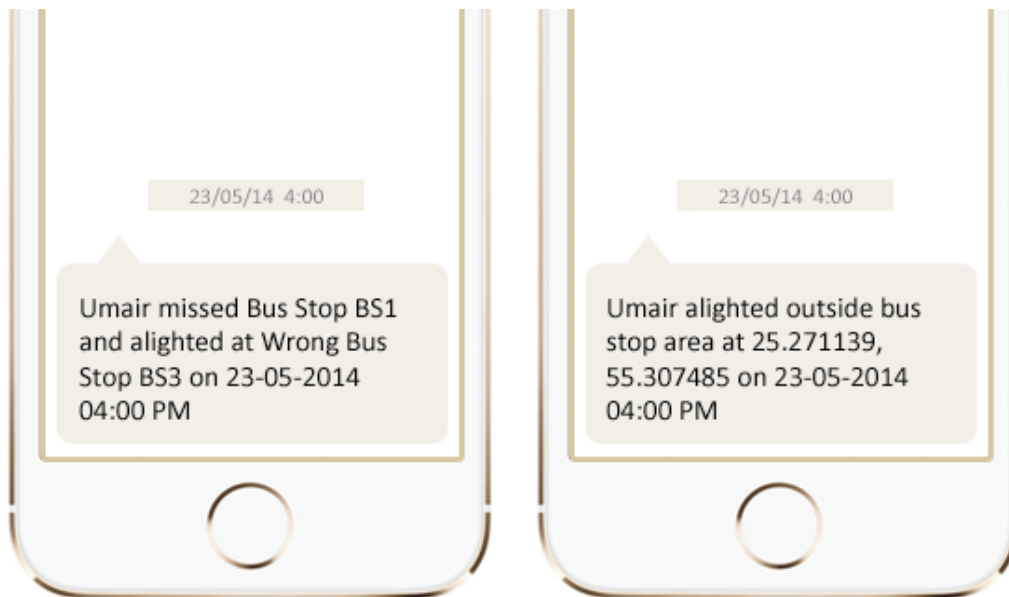
10. **Alert Scenario:** The driver ends the drop trip and a student is still remaining inside the bus. The system generates a student left in bus alert for the driver, bus assistant and the system administrator.
   e.g. SMS: Umair left in Bus DB-07-JK-2460 on 23-05-2014 04:00 PM

Bus Driver alert messages

| Alerts | Sent SMS | | Trip | Contact | Info |

Umair left in bus DB2460 on 23-05-2014 04:00 PM

Bus No: D69567
Trip: Drop
Student Count : 1/25

Rehan
Iqbal
Irfan
Amar
Muhammad
Farhan

All Users

Send
Newline

SAMSUNG
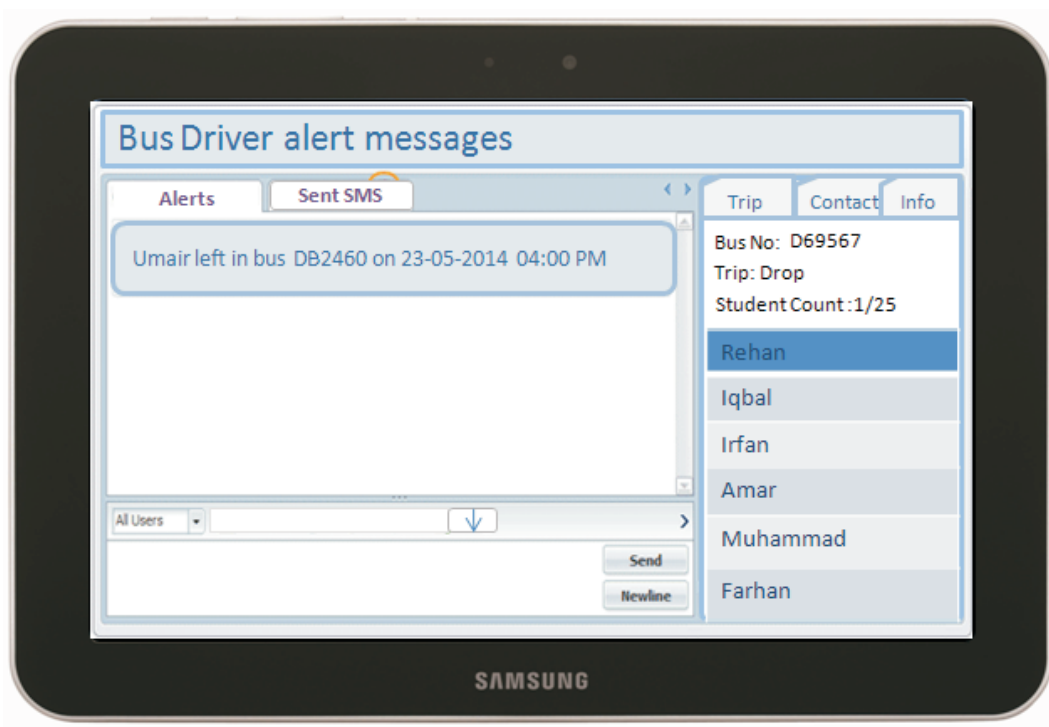
11. After all students have alighted from the bus, the driver ends the trip using the Trip Selector on the Indicator panel on the bus before starting a new trip.

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Special Features:

1. Parents have access to view the location of their child's school bus.

2. Bus delays at the bus stops are informed to parents. Intimation of early arrival is also sent in case the school has to be closed earlier for any reason.

3. Parents get SMS notifications when their children reach school, as well as leave school for home.

4. If a student has left school earlier having been picked up by the parent, then the bus driver and administrator are notified.

5. If a student is dropped off to school in the morning by the parent instead of the school bus, then the bus driver and administrator are notified.

6. If a student is unable to proceed to school while in the bus due to health reasons, the parents are intimated by the bus assistant using his tablet device and the child is dropped off at the next bus stop.

7. If a student gets back into the bus after alighting, either before the door closes or after the door closes and re-opens, and then alights at a different stop, the system updates the notifications sent.

8. If a student boards the wrong bus when returning from school, there is an immediate alert to the administrator.

9. Information about the bus driver and bus assistant gets sent to parents and the administrator with each alert.

10. Information about new bus drivers and assistants is intimated to the parents for safety purposes.

11. When a bus trip starts, the trip and driver information is sent to the server.

12. In case a black-listed driver tries to enter the bus, the system sends an alert to the administrator.

13. In case of route change due to unforeseen reasons such as road repairs, heavy rains or accidents, an update message is sent to the parents.

14. In case students are shifted to another bus midway through the trip due to bus breakdown, updated information is sent to the server as well as to the parents of these children.

15. If students leave their ID tags behind in the school bus, the bus assistant informs the parents using his tablet device.

16. Each trip is logged and its records are stored in the server database.

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BENEFITS:

- Safe and secure transportation of students, to and from school.
- Up-to-date information to parents regarding their children's school trips.
- Instant alerts and notifications help prevent students from getting on the wrong bus, getting off at the wrong stop or being left behind after a route has been completed. Ensures that a student is not left behind sleeping in the bus.
- Rear view alerts when students are inadvertently standing behind the bus.
- SMS alerts to parents when children arrive at school or are dropped off.
- Easy assigning of driver to school bus if any driver is absent or if any bus has been replaced.
- Data transmission in real-time through GPS technology.
- Live monitoring of school bus location along its entire route.
- Accurate overview of students whereabouts on various school buses for the system administrator.
- Trip logs and reports can be analyzed by the management in real time.

LINKS:

Hardware:

Xtenna Proximity™

Xtenna Hybrid™

STRADA ™

Tags:

PERSONNA ™

Software:

Xtenna WebToolkit ™

Xtenna Studio™

Reference Example:

http://www.essenrfid.com/Mailer/persontracking-flash-demo.pdf