



## International school in Qatar pilot project for a RFID-based STUDENT TRACKING SYSTEM

Automated school bus and student tracking for multiple  
buses and bus routes

Live route tracking and data transmission through GPRS

Safe and secure transportation of children

Authentication and SMS alerts to parents



INSIDE:

Key Requirements  
Solution  
Implementation  
Working  
Benefits  
Links

### 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](http://www.essenrfid.com)





## CASE STUDY

### KEY REQUIREMENTS:

Birla Public School in Doha, Qatar is an prestigious school fulfilling the educational needs of the children of expatriates and of other international students in Qatar. It conducts schooling for around 6,000 students from kindergarten to school-leaving age. Its facilities include a fleet of 120 school buses that transport these children from their homes to the school and back. The school's endeavor has always been to provide the best facilities including the adoption of the latest technologies for the benefit and safety of its students.

Since most parents are unable to pickup and drop-off their children to and from school, the school found it necessary to have a system in place 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 especially important since the school had a fleet of 120 buses and a technological solution was needed that would prevent students from boarding the wrong bus and could automate and manage the entire process without difficulty.

Main challenges:

- 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 information alerts 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.
- Monitoring the live location and path of each school bus on its daily trips.

### SOLUTION:

Essen RFID suggested 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.

### IMPLEMENTATION:

Xtenna Hybrid™ antenna-readers configured to be remotely programmable through Wi-Fi are mounted at the door of each school bus. Each student is issued a PERSONNA™ RFID tag as an identity card. Tags are registered using a Xtenna Proximity™ reader. Controller devices are installed in each bus, which interface with the mounted RFID reader. A Strada™ vehicle tracking device is fitted inside each school bus, which communicates with the central server



## CASE STUDY

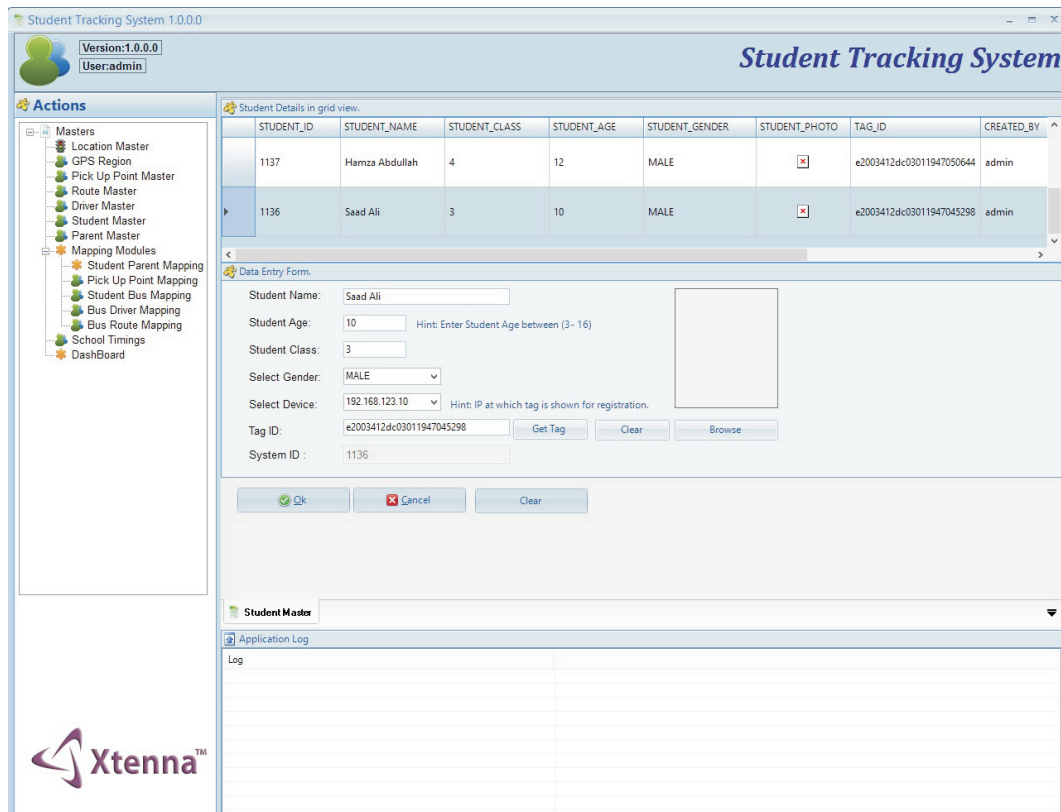
located in the school. The system uses SQL Server as a back-end database with .NET software as a front-end interface.

### WORKING:

Essen RFID's Student Tracking system was developed for tracking students as they entered and exited the school bus, along with an integrated school bus remote monitoring system. The main modules are as follows:

#### Student Master:

Information required of each student is entered into the database and in the master record of the school. This consists of data such as student's address, age, class year, parents' details, etc, along with photograph. Similarly, data of new students is 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.



STUDENT_ID	STUDENT_NAME	STUDENT_CLASS	STUDENT_AGE	STUDENT_GENDER	STUDENT_PHOTO	TAG_ID	CREATED_BY
1137	Hamza Abdullah	4	12	MALE		e2003412dc03011947050644	admin
1136	Saad Ali	3	10	MALE		e2003412dc03011947045298	admin

**Data Entry Form:**

Student Name:

Student Age:  Hint: Enter Student Age between (3- 16)

Student Class:

Select Gender:

Select Device:  Hint: IP at which tag is shown for registration.

Tag ID:

System ID:

**Student Master**

**Application Log**

Log

#### Parent Master:

This includes information regarding parents, including their own contact details and mobile phone numbers. This is necessary for the parent to receive a confirmation SMS from the system regarding their children's safe arrival in school.



## CASE STUDY

Student Tracking System 1.0.0.0  
Version:1.0.0.0  
User:admin

### Student Tracking System

**Actions**

- Masters
  - Location Master
  - GPS Region
  - Pick Up Point Master
  - Route Master
  - Driver Master
  - Student Master
  - Parent Master
- Mapping Modules
  - Student Parent Mapping
  - Pick Up Point Mapping
  - Student Bus Mapping
  - Bus Driver Mapping
  - Bus Route Mapping
  - School Timings
  - DashBoard

**Parent Details in grid view.**

PARENT_ID	PARENT_NAME	PARENT_CONTACT_NO	PARENT_ADDRESS	PARENT_PHOTO	SMS	RECEIVER	CREATED_BY	CREATED_DA
1095	Sabrina Ali	9228411312	Al Mamoura, Doha, Qatar		<input checked="" type="checkbox"/>	Y	admin	19-04-2013 6
1096	Intiaz Hussain	9774330621	Rumelah, Doha, Qatar		<input checked="" type="checkbox"/>	Y	admin	19-04-2013 6

**Data Entry Form.**

Parent Name:   
Parent Address:   
SMS SENT: ☒  
RECEIVER: ☒  
Contact Number:   
System ID:

**Parent Master**

**Application Log**

Log

### Student - Parent Mapping:

Each student is mapped with the parents or guardians that will receive confirmation SMS regarding pickup, drop-off and other necessary information that may be sent from time to time.

Student Tracking System 1.0.0.0  
Version:1.0.0.0  
User:admin

### Student Tracking System

**Actions**

- Masters
  - Location Master
  - GPS Region
  - Pick Up Point Master
  - Route Master
  - Driver Master
  - Student Master
  - Parent Master
- Mapping Modules
  - Student Parent Mapping
  - Pick Up Point Mapping
  - Student Bus Mapping
  - Bus Driver Mapping
  - Bus Route Mapping
  - School Timings
  - DashBoard

**Data Entry Form.**

Student Name:  Type Name of student  
Parent Name:  Type Name of Parent

STUDENT_ID	STUDENT_PHOTO	STUDENT_NAME
1136		Saad Ali

List of Parents which will be mapped to selected student:

STUDENT_PARENT_MAP_ID	PARENT_ID	PARENT_NAME	STUDENT_ID	TRN_STUDENT_FLAG
1	1095	Sabrina Ali	1136	N

**Student and Parent Mapping**

**Application Log**

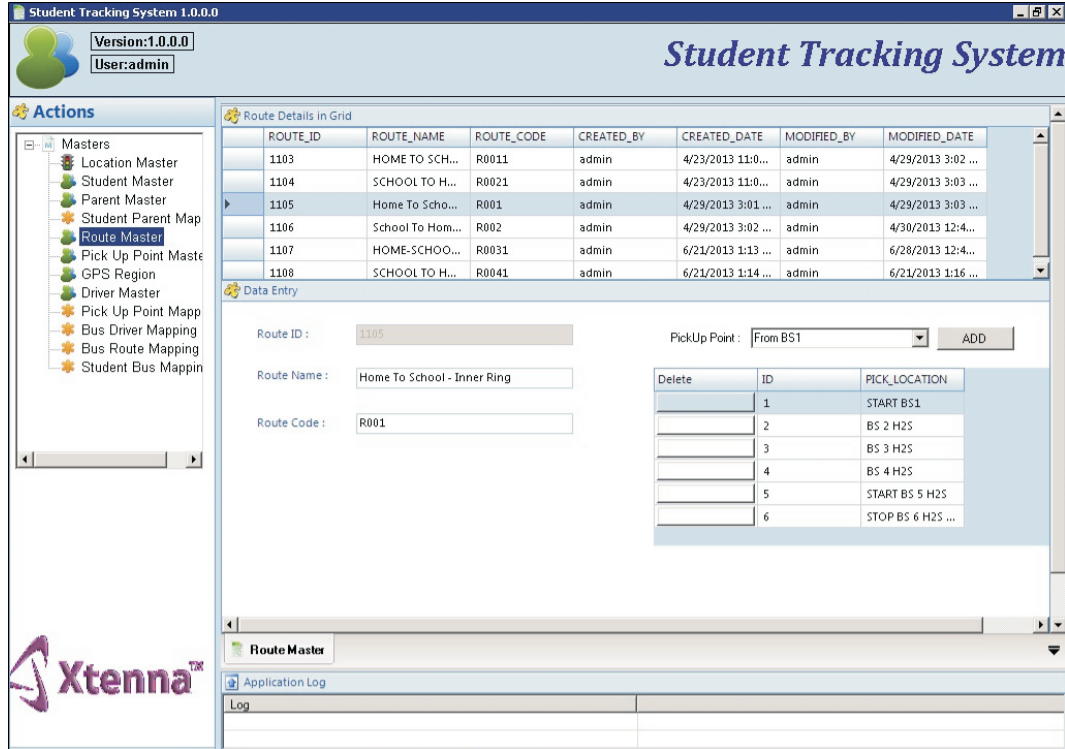
Log



## CASE STUDY

### Route Master:

All bus routes are created and maintained in the Route Master. Pick-up and drop-off points along the route are first created here.



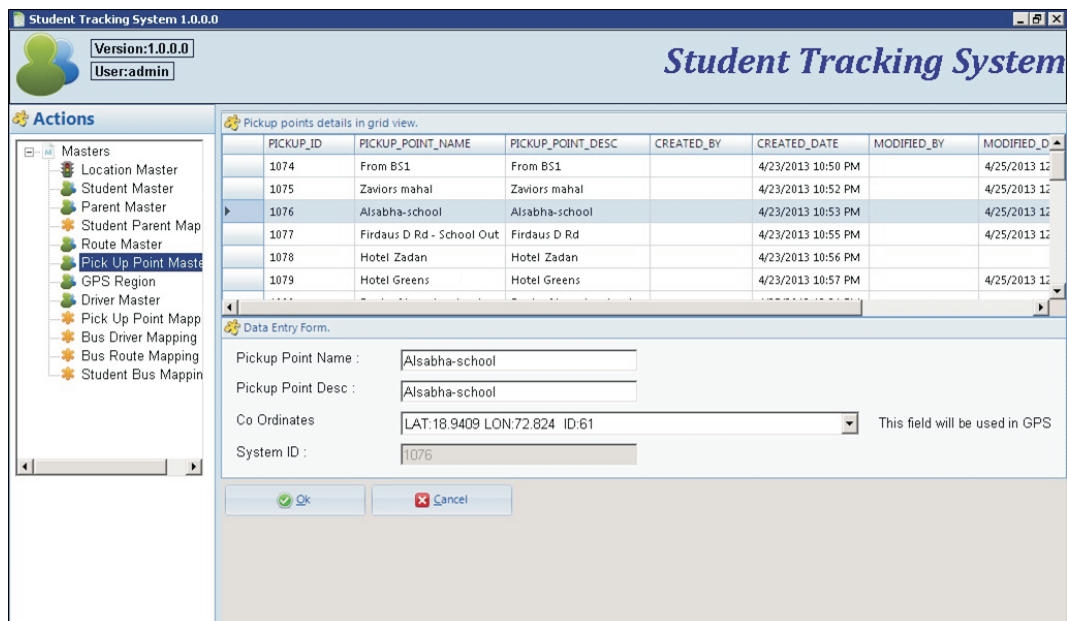
ROUTE_ID	ROUTE_NAME	ROUTE_CODE	CREATED_BY	CREATED_DATE	MODIFIED_BY	MODIFIED_DATE
1103	HOME TO SCH...	R0011	admin	4/23/2013 11:0...	admin	4/29/2013 3:02 ...
1104	SCHOOL TO H...	R0021	admin	4/23/2013 11:0...	admin	4/29/2013 3:03 ...
1105	Home To Scho...	R001	admin	4/29/2013 3:01 ...	admin	4/29/2013 3:03 ...
1106	School To Hom...	R002	admin	4/29/2013 3:02 ...	admin	4/30/2013 12:4...
1107	HOME-SCHOO...	R0031	admin	6/21/2013 1:13 ...	admin	6/28/2013 12:4...
1108	SCHOOL TO H...	R0041	admin	6/21/2013 1:14 ...	admin	6/21/2013 1:16 ...

Delete	ID	PICK_LOCATION
<input type="checkbox"/>	1	START BS1
<input type="checkbox"/>	2	BS 2 H2S
<input type="checkbox"/>	3	BS 3 H2S
<input type="checkbox"/>	4	BS 4 H2S
<input type="checkbox"/>	5	START BS 5 H2S
<input type="checkbox"/>	6	STOP BS 6 H2S ...

### Pickup and Drop-off Points:

Here the precise GPS co-ordinates of pickup and drop-off points are entered in the screen. This enables the system to monitor the movement of the bus and its halts along its designated route using the on-board Strada™ tracker.



PICKUP_ID	PICKUP_POINT_NAME	PICKUP_POINT_DESC	CREATED_BY	CREATED_DATE	MODIFIED_BY	MODIFIED_D
1074	From BS1	From BS1		4/23/2013 10:50 PM		4/25/2013 12...
1075	Zaviors mahal	Zaviors mahal		4/23/2013 10:52 PM		4/25/2013 12...
1076	Alsabha-school	Alsabha-school		4/23/2013 10:53 PM		4/25/2013 12...
1077	Firdaus D Rd - School Out	Firdaus D Rd		4/23/2013 10:55 PM		4/25/2013 12...
1078	Hotel Zadan	Hotel Zadan		4/23/2013 10:56 PM		4/25/2013 12...
1079	Hotel Greens	Hotel Greens		4/23/2013 10:57 PM		4/25/2013 12...

Pickup Point Name :	Alsabha-school	
Pickup Point Desc :	Alsabha-school	
Co Ordinates	LAT:18.9409 LON:72.824 ID:61	This field will be used in GPS
System ID :	1076	

Ok Cancel

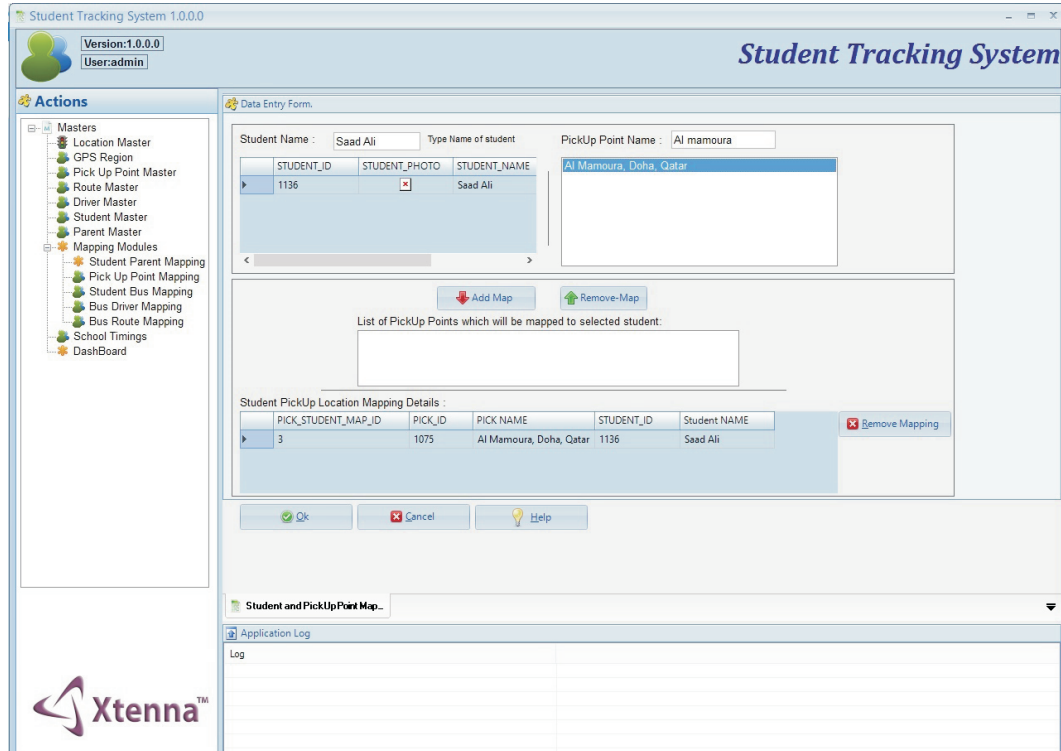




## CASE STUDY

### Student - Pickup/Drop-off Point Mapping:

In this module, each student is mapped with the pickup and drop-off point from where he/she will board and disembark from the school bus.



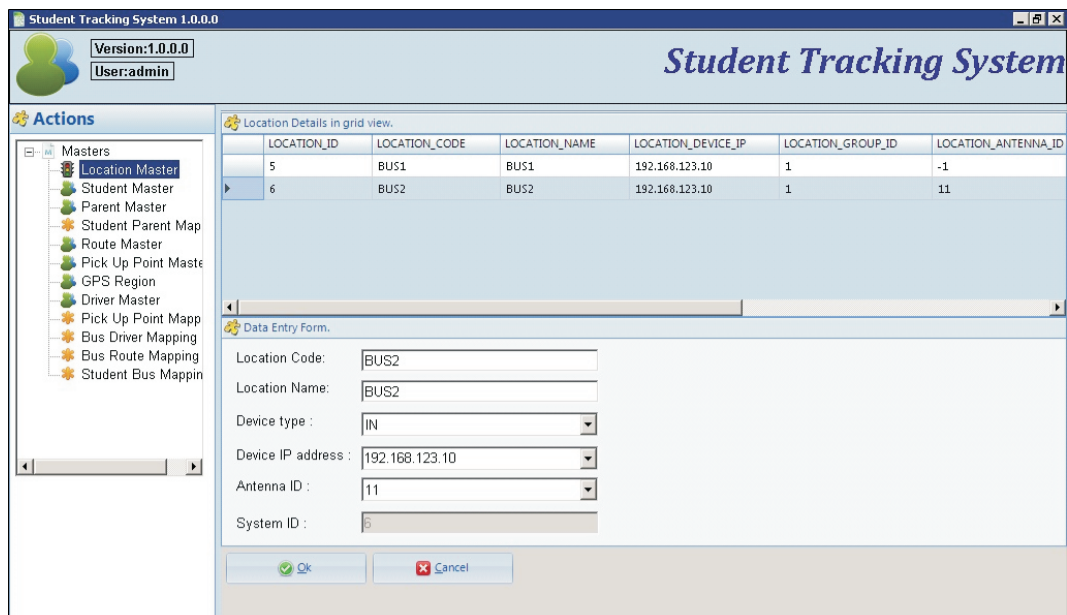
The screenshot shows the 'Student Tracking System 1.0.0.0' interface. The left sidebar lists 'Actions' including 'Masters' (Location Master, GPS Region, Pick Up Point Master, Route Master, Driver Master, Student Master, Parent Master) and 'Mapping Modules' (Student Parent Mapping, Pick Up Point Mapping, Student Bus Mapping, Bus Driver Mapping, Bus Route Mapping, School Timings, DashBoard). The main area is titled 'Data Entry Form' and shows a 'Student Name' field with 'Saad Ali' and a 'PickUp Point Name' field with 'Al mamoura'. Below these are two tables. The first table lists students with columns 'STUDENT\_ID', 'STUDENT\_PHOTO', and 'STUDENT\_NAME'. The second table, 'Student PickUp Location Mapping Details', has columns 'PICK\_STUDENT\_MAP\_ID', 'PICK\_ID', 'PICK NAME', 'STUDENT\_ID', and 'Student NAME'. It shows a mapping for 'Saad Ali' to 'Al Mamoura, Doha, Qatar'. At the bottom, there is an 'Application Log' section with a 'Log' table.

STUDENT_ID	STUDENT_PHOTO	STUDENT_NAME
1136		Saad Ali

PICK_STUDENT_MAP_ID	PICK_ID	PICK NAME	STUDENT_ID	Student NAME
3	1075	Al Mamoura, Doha, Qatar	1136	Saad Ali

### Bus Master:

Here the details regarding each school bus are entered, such as its licence plate registration number, etc. Also entered here is the device IP of the Xtenna Hybrid™ reader-antenna device mounted on that particular bus. Each bus is thus uniquely identified with the antenna device fitted on to it.



The screenshot shows the 'Student Tracking System 1.0.0.0' interface. The left sidebar lists 'Actions' including 'Masters' (Location Master, Student Master, Parent Master, Student Parent Map, Route Master, Pick Up Point Master, GPS Region, Driver Master, Pick Up Point Mapping, Bus Driver Mapping, Bus Route Mapping, Student Bus Mapping). The main area is titled 'Location Details in grid view' and shows a table with columns 'LOCATION\_ID', 'LOCATION\_CODE', 'LOCATION\_NAME', 'LOCATION\_DEVICE\_IP', 'LOCATION\_GROUP\_ID', and 'LOCATION\_ANTENNA\_ID'. Below the table is a 'Data Entry Form' with fields for 'Location Code', 'Location Name', 'Device type', 'Device IP address', 'Antenna ID', and 'System ID'. The 'Device type' is set to 'IN' and the 'Device IP address' is '192.168.123.10'.

LOCATION_ID	LOCATION_CODE	LOCATION_NAME	LOCATION_DEVICE_IP	LOCATION_GROUP_ID	LOCATION_ANTENNA_ID
5	BUS1	BUS1	192.168.123.10	1	-1
6	BUS2	BUS2	192.168.123.10	1	11

Location Code	Location Name	Device type	Device IP address	Antenna ID	System ID
BUS2	BUS2	IN	192.168.123.10	11	5



## CASE STUDY

### Driver Master:

Information regarding bus drivers with their contact details and driving licence number are entered here along with their photograph.

**Student Tracking System 1.0.0.0**  
Version: 1.0.0.0  
User: admin

**Student Tracking System**

**Actions**

- Masters
  - Location Master
  - Student Master
  - Parent Master
  - Student Parent Map
  - Route Master
  - Pick Up Point Master
  - GPS Region
  - Driver Master**
  - Pick Up Point Mapping
  - Bus Driver Mapping
  - Bus Route Mapping
  - Student Bus Mapping

**Driver Details in grid view.**

driverID	driverName	type	photo	driverLicence	Mobilenummer	CREATED_BY	CREATED_DATE	MODIFIED_BY
1	Sadu	Driver		Mh-01-21	97433937992	admin	4/19/2013 6:22 PM	admin
3	Irfan	Driver		mh-02-12	9224411312	admin	4/28/2013 5:35 PM	admin

**Data Entry Form.**

Driver Name:

Type:

Mobile No:

Driver License No:

System ID:

**Driver Master**

**Application Log**

Log

### Driver - Bus Mapping:

In this module, the drivers that were registered in the previous module are assigned to each school bus. This enables each individual school bus to have a designated driver for its trips. The driver can be changed only through the system.

**Student Tracking System 1.0.0.0**  
Version: 1.0.0.0  
User: admin

**Student Tracking System**

**Actions**

- Masters
  - Location Master
  - Student Master
  - Parent Master
  - Student Parent Map
  - Route Master
  - Pick Up Point Master
  - GPS Region
  - Driver Master
  - Pick Up Point Mapping
  - Bus Driver Mapping**
  - Bus Route Mapping
  - Student Bus Mapping

**Bus Driver Mapping Details in grid view.**

busDriverID	BUS LICENCE	Column1	DESCRIPTION	DriverID	BusID	FLAG	CREATED_BY	CREATED_DATE
1	BUS1	Sadu		1	5	C	admin	6/28/2013 2:01 P
2	BUS2	Irfan		3	6	C	admin	6/28/2013 2:02 P

**Data Entry Form.**

Bus Plant Number :

Driver Name :

Description :

System ID :



## CASE STUDY

### Bus - Route Mapping:

Here routes that were created earlier in the Route Master are assigned to the school buses. Each bus is assigned a particular route leading to the school. If the route assigned to a bus has to be changed, it is also done here.

**Student Tracking System 1.0.0.0**  
Version:1.0.0.0  
User:admin

**Student Tracking System**

**Actions**

- Location Master
- Student Master
- Parent Master
- Student Parent Map
- Route Master
- Pick Up Point Master
- GPS Region
- Driver Master
- Pick Up Point Mapping
- Bus Driver Mapping
- Bus Route Mapping**
- Student Bus Mapping

**Bus Route Mapping Details in grid view.**

BUS_ROUTE_ID	BUS_ID	Column1	ROUTE_ID	Column2	CREATED_BY	CREATED_DATE	MODIFIED
2	6	BUS2	1108	SCHOOL TO HOME	admin	4/28/2013 4:56 PM	
3	5	BUS1	1107	HOME-SCHOOL-HOME	admin	6/21/2013 2:06 PM	

**Data Entry Form.**

Bus Plant Number :

Route Name :

Description :

System ID :

**Xtenna™**

**Bus Route Mapping**

**Application Log**

### Tracker Master:

The Strada™ tracker fitted on each school bus enables real time GPS tracking of that bus along its route along with halt (pickup/drop-off) monitoring. In this module, the Strada™ location settings for each device are entered.

**Student Tracking System 1.0.0.0**  
Version:1.0.0.0  
User:admin

**Student Tracking System**

**Actions**

- Location Master
- Student Master
- Parent Master
- Student Parent Map
- Route Master
- Pick Up Point Master
- GPS Region**
- Driver Master
- Pick Up Point Mapping
- Bus Driver Mapping
- Bus Route Mapping
- Student Bus Mapping

**GPS Location Tagging in grid view.**

GPSLOCV_ID	GPSLOCV_LAT	GPSLOCV_LON	GPSLOCV_RADIUS
48	18.9248136	72.8268964	10
49	19.1873897	73.0413027	10
50	19.2183031	73.0861328	10
51	19.2353488	73.1267971	10
52	19.1133037	72.930376	10
53	18.9989837	72.841583	15
54	18.9259	72.8226	15

**Data Entry Form.**

Latitude :

Longitude :

Radius :

System ID :





## CASE STUDY

### Assigning School Bus to Student:

Finally each student is assigned to a particular school bus based on his/her pickup and drop-off point and the route taken by a particular school bus.

**Student Tracking System 1.0.0.0**  
Version:1.0.0.0  
User:admin

**Actions**

- Masters
  - Location Master
  - GPS Region
  - Pick Up Point Master
  - Route Master
  - Driver Master
  - Student Master
  - Parent Master
- Mapping Modules
  - Student Parent Mapping
  - Pick Up Point Mapping
  - Student Bus Mapping
  - Bus Driver Mapping
  - Bus Route Mapping
  - School Timings
- Dashboard

**Data Entry Form**

Student Name : Saad Ali Type Name of student Bus Code : Bus2 Type Code of Bus

STUDENT_ID	STUDENT_PHOTO	STUDENT_NAME
1136		Saad Ali

List of Parents which will be mapped to selected student:

STUDENT_BUS_MAP_ID	BUS_ID	BUS PLATENO	STUDENT_ID	FLAG
12	4	BUS2	1136	N

**Student and Bus Mapping**

**Application Log**

Log

### Admin View:

The system administrator/supervisor can view the total number of students and individual student details of those picked up or dropped off by each school bus on its route, along with alerts.

**Student Tracking System 1.0.0.0**  
Version:1.0.0.0  
User:admin

**Actions**

- Masters
  - Location Master
  - Student Master
  - Parent Master
  - Route Master
  - GPS Region
  - Driver Master
  - User Management
  - User Master
  - Role Master
- Utilities
  - Monitor SMS Sender
  - Monitor Email Sender
- Reports
- Mapping Modules
  - Student Parent Mapping
  - Pick Up Point Mapping
  - Bus Driver Mapping
  - Bus Route Mapping
  - Student Bus Mapping
- Dashboard

**Data Entry Form**

Bus Name : BUS2 Current Location : GPS OFF Transaction ID : 1

Route Code : SCHOOL TO HOME - QATAR Driver Name : Irfan

☒ Auto Refresh

**Students Inside Bus - [IN STATUS]**

TRIN_STUDENT_ID	Student Name	Student Photo	TRIN_ALERT_FLAG
1132	Omar		W
1133	Saad		W

**Students Dropped From Bus - [OUT STATUS]**

STUDENT_ID	STUDENT_NAME	STUDENT_PHOTO
1135	Ahmed	
1138	Gafar	
1137	Abdullah	
1136	Khalifa	
1133	Shoab	
1139	Hamza	
1134	Kamran	
1135	Shahid	

**Dashboard**



## CASE STUDY

### 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 the student is exiting from the bus.
- 2. Child 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 a message that the child has missed the stop.
- 3. Child reaching school:**

When the bus reaches school, its GPS is mapped to the school location and the entrance time is registered. The Xtenna Hybrid™ on the bus registers the child leaving the bus by detecting his tag first by antenna B and then by antenna A, and a corresponding entry is made into the system. A confirmation SMS is sent to the parent indicating that the child has reached school.
- 4. Child 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 tag ID and pops up an alert on the screen. This alerts the driver who prevents the child from getting into the wrong bus.
- 5. Child dropped off from school at destination:**

The student is dropped off at his destination mapped with the exact GPS co-ordinates obtained by the on-board Strada™ and registered in the database. A confirmation SMS is sent to parent with location name, date and time.
- 6. Child dropped off at different location:**

In case a student is to be dropped off at a different location for some reason, then the Strada™ device on the bus sends these co-ordinates to the server and this location name, date and time is alerted by SMS to the parents.
- 7. Child remains in bus:**

If a child is not dropped off and is still in the school bus, then the driver gets an alert that the student is still remaining in the bus.



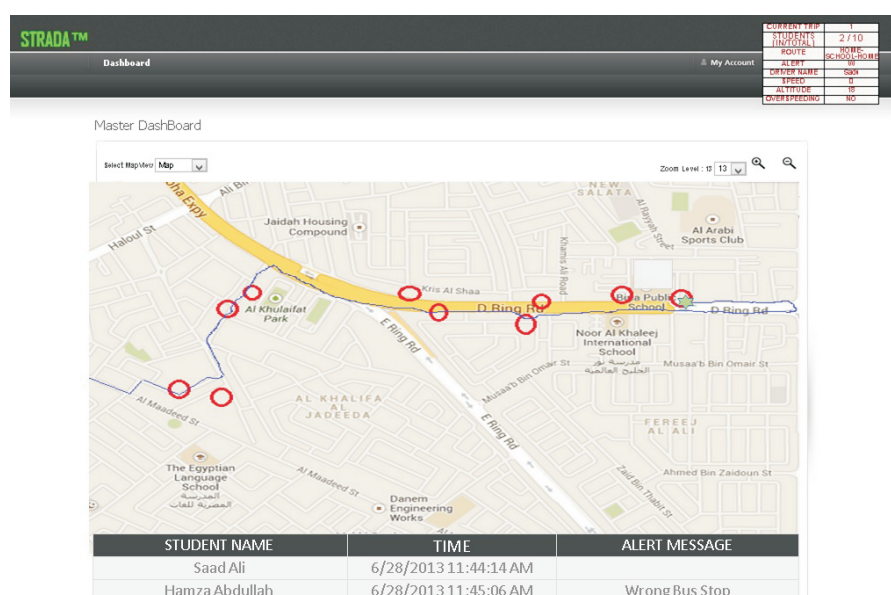
## CASE STUDY

### 8. Bus has not reached in time (Bus Tracking):

The Strada™ vehicle tracking device continuously sends GPS co-ordinates to the central server database. The system administrator can select each bus for tracking and viewing its current position on the route in real time. This enables strict monitoring of the school bus as to its schedule and whether it is having any stoppage or breakdown or is running late. The driver can then be contacted over his mobile phone for the reason. SMS updates or alerts can also be sent to parents if there is any change in timings.

### Web-based School Bus Tracking:

Real time route location of any particular bus can be viewed by the system administrator / supervisor on the software dashboard screen. Each bus screen will also display information such as Bus Route, Driver Name, Number of Students in the bus, Speed of bus, etc., along with alerts.



### BENEFITS:

- Effective live monitoring of multiple school buses.
- Monitoring of each individual student from home to school and back.
- Data transmission in real-time through GPS technology.
- Administrator control and overview of school bus operations, with alerts.
- Safe and secure transportation of the child.
- Parent authentication when child is dropped off at destination.
- No child is left unattended on the school bus.
- Eliminates chances of student getting on the wrong bus, getting off at the wrong stop or being left behind after the route has been completed.
- Ensures that the child is not left behind sleeping in the bus.
- SMS alerts to parents when children arrive at school or are dropped off.
- Live tracking of school bus location along its route.



## CASE STUDY

### LINKS:

#### Hardware:



#### Tags:



#### Software:



#### Reference Example:

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