Proposed Solution for Implementation, Monitoring and Maintaining Vehicle Tracking System for vehicles of Solid Waste Management
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Automated Vehicle Tracking System (AVTS)

The Global Position System (GPS) mounted as part of the Vehicle Mounted Unit in the Solid Waste Management vehicles will receive the Positional Information (longitude and latitude coordinates) from the Satellite through a process of triangulation. This information is then sent across to the Data Centre (DC) through the wireless communication link – GSM / GPRS. The GPS data to be integrated with a GIS map for identifying location of Solid Waste Management vehicles on real time basis. The system will also have facility to identify functional status of the Solid Waste Management vehicles (en-route, garaged etc.) in the form of interactive user friendly querying tool and also through reporting tool.

This is typically achieved by incorporating GPS-GSM-GPRS, data collection and communication devices installed in the vehicle and a back office management tool. This solution is the perfect add-on to the vehicle management system, enabling real time tracking and alerts on any irregularities.

This device is integrated with GPS, to track the position of the vehicles and to send the GPS data to the server using GPRS technology. This product provides great feasibility for vehicles location to stay connected, which otherwise would not have been possible for Tracking, Monitoring and Controlling. The vehicle tracking management system will be developed using web based technology which will provide easy interface to manage the vehicle tracking process.

The GPS-GSM based Automated Vehicle Tracking System will have the following functionalities:

- Exact location of the vehicle can be viewed anytime on real time basis.
- Speed of the vehicle can be viewed as per GPS.
- Engine operating and stoppage time can be generated for defined period of time.
- Alerts can be set to predefined E-mail Id’s.
- Vehicle History
- Work-Hours Summary
- Stop Hour calculation
• Geo Fencing
• Speed Violation
• Summary of the Entire Trip
• Alert on route deviation
• Harsh braking
• Harsh Acceleration
• All location to be covered by the vehicle will be marked on the local map with indication. Whenever the vehicle cross the scheduled location the indication colour will change automatically and report the system as desired.
• The actual movement of the vehicle to be displayed with a marker / indicator from source to destination along with location names in the local map.
• The administrator will be provided with an interface to update telephone numbers and other data as per the requirement.
• Vehicle Fleet Summary Dashboard report.

The Central Control Centre would be key / central point for the proposed system. It would manage the integration of all the subcomponent of the system. Key functionality of the system is as follows:

• The Central Control Centre will process the data received from Solid Waste Management vehicles and compares the actual location of the Solid Waste Management vehicles at a given time with its scheduled location from the data received from the Solid Waste Management vehicles. Also calculates the time for the Solid Waste Management vehicles to reach all subsequent stops along the route taking into consideration Solid Waste Management vehicles speed & any deviations from the schedule. On processing, the Central Control Centre transmits the data to the relevant Solid Waste Management vehicles stops for displaying predicted arrival time of the Solid Waste Management vehicles.
• The Central Security System (CSS) holds the user credentials for all users. The authentication and authorization is done for all services, like Website access, content publishing, content management access, database access etc.
• The geographical information system (GIS) applications shall enable display of the position of vehicles on a detailed digitized road map and linked with the communication control and reporting applications.
The Command and Control Centre applications that will be web-enabled, shall provide for appropriate user access and security controls.

The GIS system shall provide for colour coded display based on arrival times of Solid Waste Management vehicles at various Solid Waste Management vehicles stations.

The application software shall support facilities to zoom-in to enable close-up view of the vehicle of interest or to zoom-out to view all the vehicles on the screen.

The application shall support dynamic monitoring of vehicles moving out of their defined routes and be able to raise alerts to be sent across to the driver of such vehicles.

The interface of the application shall support multiple window views for an overview with capabilities to close up and enlarge a screen of interest.

The application shall be able to receive emergency messages from the vehicles by generating alarms at the control centre to attract the operator’s attention and with provision for sending an acknowledgement to ensure that the message has been received and read.

Sample view of control center.
Solution Architecture

Key Challenges and Approach for addressing Scalability, Availability, Performance and Manageability

The architectural considerations that characterize and differentiate the system included the following:

**Reliability** – system behavior on malfunctioning such as an application crashed. Solution would be implemented with clustering technology to ensure the system reliability. Portal server and Integration server are clustered at application level and database server is clustered at Operating System level.

**Availability** – system behavior in the failure of CPU, memory, applications. Availability is ensured by system level redundancy including the communication network.

**Scalability** – system behavior in the case of functional or user base expansion. Servers that run enterprise applications scale up or scale out depending on future requirements by CPU or Memory or add-on servers using clusters technology. The recommended products are proven in the field to scale well in order to meet large enterprise requirements. Key components such as personal computers, servers, application servers and network are of modular design to ensure scalability of the system. System integration infrastructure in the data center is not message-centric so integration scalability is non-issue in this case. Major scalability is required only for application and database servers.

**Maintainability** - system support to self-heal, etc. The products are considered for system & network management, which are well known for providing maintainability of the systems by configuring automatic scripts.

**Manageability** – system support to reduce manpower & operation cost. Again, The management products serve the system and network administration requirements through central monitoring and management of entire IT system. This will ensure to keep the operation cost low.
Security – system support to protect the system from vulnerable security holes and hackers. Demilitarized zone prohibits any security attack on the system. VPN services ensure secured tunnel for external communications with partners. RFID card security with encryption of keys will be introduced.

User-friendliness: Intuitive system design features of the application will enhance the customer stickiness service. The design will include advance graphic and plug & play modular display objects.

The detailed implementation of these architectural considered are defined in respective sections of Technical Architecture for Server, Storage, Network and IT Security Components.

Detailed Description of the Proposed Architecture

The solution architecture for the Automatic Vehicle Location System (AVLS) has been proposed in alignment to the envisioned concept by Kolkata Municipal Corporation in tender document. The solution is designed to address electronic delivery of services by adopting forward-looking business & architectural principles built on advanced technologies and products from world-class leading vendors. A right blend of practical Solid Waste Management business scenarios, advanced technologies, skilled people, and matured processes has enabled superior feature set of the proposed solution.

The solution considers certain business principles and the proposal design. They are,

- Forward-looking Solid Waste Management business scenarios
- Scalable architecture with long life expectancy
- Provide meaningful and effective service offerings to the citizens & other stakeholders
- Leverage existing infrastructure and services capability
- Web Services & Services Oriented Architecture
- Server centric n tier application architecture
- Secured and guaranteed Solid Waste Management business transactions
An illustration below outlines the system architecture overview by identifying the core systems namely Automated Vehicle Monitoring System (AVMS) Infrastructure and Control Centre (CCC).

The Data Center Infrastructure includes the application servers and operational data stores. It provides portal based electronic service delivery to the Commuters.

Besides Portal, the application delivers electronic services such as travel information, Data Center, MIS reporting application as required by management & Data Center operations perspective.

The key components in the solution are listed below with a brief description. Besides the infrastructure (hardware & software) readiness, a set of processes and templates will be defined for each component/stakeholder to support their operations.

The Automatic Vehicle Location System (AVLS) proposed have its primary focuses to provide timely information to the commuters and passengers of the availability and accessibility of the transport services in real-time.

The Interface for Real Time Information specifies an interface standard for exchanging information about the planned, current or projected performance of real-time public transport operations between different computer systems.

This architecture is extensible and it is expected that additional services will be added over time using the same communications layer. The modularization allows an incremental approach: only the subset of services actually required needs to be implemented for a particular application. The expectation is that users may start with just one or two services and over time increase the number of services and the range for supported options.

This overview of the proposed solution covers the details of the following solution components proposed along with how each of the solution components would meet the requirements. The key components are:
Technical Architecture – AVLS

AVLS Module

The scope of the AVLS module is to help the user to locate and track the desired vehicles in real-time over the geographic map. AVLS module is the heart of the system on which all the other modules are dependent, AVLS module interacts with the database and presents the tracking records stored in the database. The AVLS module provides following functionalities

- Live tracking: enables tracking a Solid Waste Management vehicles in real-time over the map
- Route reply: enables history tracking on map with a dynamic reply of the route travelled by the Solid Waste Management vehicles.
- Trip status: Shows the progress of the trip done by any of the Solid Waste Management vehicles assigned with trip schedule
- Generates various reports based on the tracking information available in the database

VMTS Context Diagram
Dashboard:

Following are the salient features of the dashboard.

- Total Registered vehicles
- Total Tracking Vehicles
- Total Non tracking vehicles
- Pie Chart detailing tracking and non tracking vehicles

Tracking Vehicles

The Total tracking vehicles is divided into sub categories

- Total vehicles on Halt
- Total vehicles running
- Total vehicles running which are in NO GPS area
- Total vehicles running on secondary battery

The user can choose the desired option; based up his choice the list of vehicles will get automatically gets loaded

Non Tracking Vehicles

Non tracking vehicles is also divided into sub categories

- No data received from vehicles
- Idle vehicles
- No GPS vehicles
Municipal Waste Pickup Management System

- Offline Vehicles (data not received from more than half hour during the day)
- Device Dead combination of Secondary idle and No GPS secondary vehicles

View on Map

Corporation can view all the vehicles on map at once on a single click by selecting the desired category.
Municipal Waste Pickup Management System

Current Fleet Summary
Route Replay on a single click

KMC replay the history data on single click. Replay option is provided under the Last Tracked time.

Daily Report on a Single click

To view the daily report, report option provided in the distance. The daily report of the selected vehicle will be displayed. First data packed received time and last data packed received time are the default values.
Track Vehicle(s)

Allows the KMC to track the vehicle. This has the following sections
1. Locate Vehicles New
2. Travel Replay

Locate Vehicles

With this feature KMC can locate all the running and idle vehicles in a specified area and specified kilometer range.

Travel Replay

KMC can replay the history data on single click. Replay option is provided under the Last Tracked time.
KMC can generate the various reports depending upon requirement. The reports are categorized into two sections.

1. Basic Reports
2. Advanced Reports

Basic Reports

Following are the list of basic reports.
1. Daily
2. Monthly
3. Speed
4. Halt/stop
5. Engine Report
6. Current track info
7. Geotag location report
8. Track info Excel
9. Geofence violation report
10. Panic Alert Report
Daily Report

The tracking details of a vehicle for a particular day and for a specified time period are displayed. This feature also provides information such as the location, distance covered, driver’s name, a/c status and also the fuel level in the vehicle.

Monthly Report

Displays the tracking details of the vehicle for a specified month. The tracking details include start time, end time, start location, end location, driver’s name, fuel graph and distance travelled.
Municipal Waste Pickup Management System

**Speed**

This specifies the details such as start location, start time, end location and end time during the specified time period.
If the vehicle has exceeded the speed limit, then it displays the duration of over speed.

<table>
<thead>
<tr>
<th>Date</th>
<th>From Time</th>
<th>From Location</th>
<th>To Time</th>
<th>To Location</th>
<th>Maximum Speed</th>
<th>Duration of overspeed</th>
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<tbody>
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<td>6</td>
<td>00:00:00</td>
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</table>

Halt/Stop

KMC can view the number of times the vehicle has came to halt/ stop. It also specifies the duration for which the vehicle was on halt/stop.
Municipal Waste Pickup Management System

Engine Report

It displays the Engine On time, Engine On Location, Engine Off Time, Engine Off Location and also the duration of its travel.

Geofence violation report.

Geofence is a virtual boundary created by the user. Geofence violation feature in the Aquila track website provides details if the vehicle has crossed the Geofence boundary. The details like the Fence in time/date, Fence out time/date, fence in location, fence out location are mentioned.
### Panic Alert Report

Displays the alerts which were reported during the specified duration. This is optional feature for which user has to install the panic button in his vehicle.

### Route Trip Management

### Advanced Monthly Report

This report will give a clear picture on day wise vehicle travelled area distance and speed.

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>End Time</th>
<th>Start Location</th>
<th>End Location</th>
<th>Distance(KM)</th>
<th>Speed</th>
<th>Travelled Area</th>
<th>Fuel Added (Y/N)</th>
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<td>23:59:09</td>
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</table>
Vehicle Management

Allows KMS to manage vehicles and drivers.

Group Vehicles

This option enables users to group the vehicles as per requirement.
### Vehicle Settings

<table>
<thead>
<tr>
<th>No</th>
<th>V/NO</th>
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</tbody>
</table>
Alert Settings:

This feature enables KMS to set the alert settings like:

- Panic Alert
- Halt alert
- Geo tag In/Out alerts
- Geo Fence violation alerts
- Over speed alert
- Power failure alert
Route Trip Management

The objective of the GIS module is to enable some of the GIS features in to the application such as

- Creating Route
- Route creation history
- Creating trips
- Trip creation history
- Trip Dashboard
Creating Route

Route Creation History
**Creating Trips**

This feature enables the user to create the trip, assign trip to the vehicle, route fencing and also determines the Expected Time of Arrival (ETA).

**Trip Creation History**
**Trip Dashboard**

This is an innovative dashboard which will help the user in identifying the vehicles which are on:
- On Trip
- Off Trip
- Trip Scheduled
- Start delayed
- Destination delayed