AUTOMATED VEHICLE TRACKING: GEOVISION'S APPLIED EXPERIENCE IN THE REGION THROUGH CASE STUDIES

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Abstract
This paper will present case studies and demonstrations of GeoVision's experience in the region within one particular domain: Automated Vehicle Tracking. The paper will discuss briefly the definition and different types of vehicle tracking, and then go on to discuss the different aspects of vehicle tracking functionality and architecture through true case studies and demonstrations.

Keywords
Vehicle Tracking
Automated Vehicle Location (AVL)
Geographic Information Systems (GIS)
Global Positioning Systems (GPS)
Location Based Services (LBS)

Introduction

GeoVision s.a.l. is a regional leader in GIS solutions, with a pool of experienced GIS professionals that have designed and developed many systems. Since the year 1999 GeoVision has devoted serious effort to the development of comprehensive GIS vehicle tracking solutions covering mapping, database integration, software design and development, hardware specification design, training and project management.

GeoVision is a pioneer in this field in the Arab World, having accumulated much expertise through the numerous implemented vehicle tracking projects in different domains, the major ones of which will be discussed as case studies to better understand the nature of the vehicle tracking market and systems.

What is GPS?

GPS (Global Positioning Systems) are systems which use satellite constellations to identify positions on the ground. GPS units read incoming signals from these satellites to determine parameters such as location, heading and speed.

What is Automated Vehicle Tracking?

Automated Vehicle Tracking is the integration of GPS-based technology with maps, data and software to identify the tracks (movement and location) of vehicles, showing the stops, speed, and headings. There are two main types of vehicle tracking:

1. Offline Vehicle Tracking. Offline, or after-the-fact vehicle tracking describes the type of tracking that is reported after the vehicle has completed its journey. In this type of tracking the GPS data is retrieved upon vehicle return, and imported to the appropriate software for reporting on the track. Offline vehicle tracking is usually employed as an audit tool, used to analyze track patterns, identify stops, durations, times and speed values, in effect controlling and monitoring the given operation. This is usually ideal for industries such as distribution where real-time positions are not required, and it is less costly than the alternative.

2. Online Vehicle Tracking. Online tracking means real-time or live tracking whereby the user can view vehicle activity live on a GIS mapping tool. In this scenario the data is being sent live to the control center through means of long-distance communication such as SMS, GPRS, TETRA network or Satellite-based communication. This is required for operations such as dispatching, Security Forces and Couriers being two prime industries that can make use of it.

The benefits of vehicle tracking are various, ranging from route optimization, operational audits, fleet management and customer service improvement to anti-theft, security measures, live dispatch and decision-making tools.

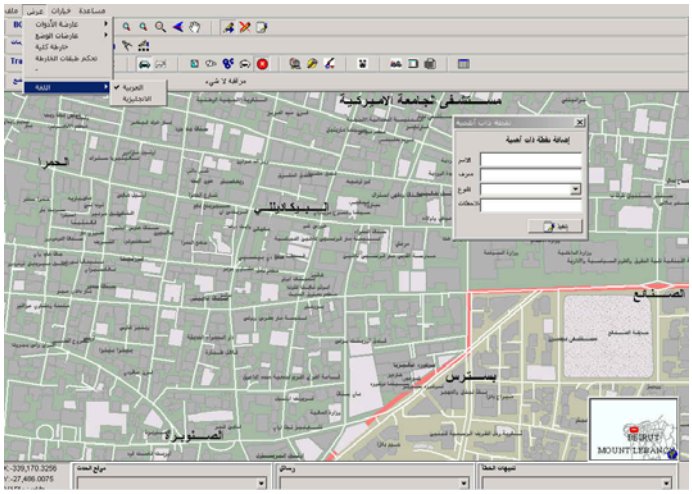
Objectives of Paper

To educate on Automated Vehicle Tracking technology thus improving awareness of it in the Arab community, resulting in a higher standard of technological achievement, and setting a benchmark for others to follow.

Case Study 1: Vehicle Tracking For Police Operations

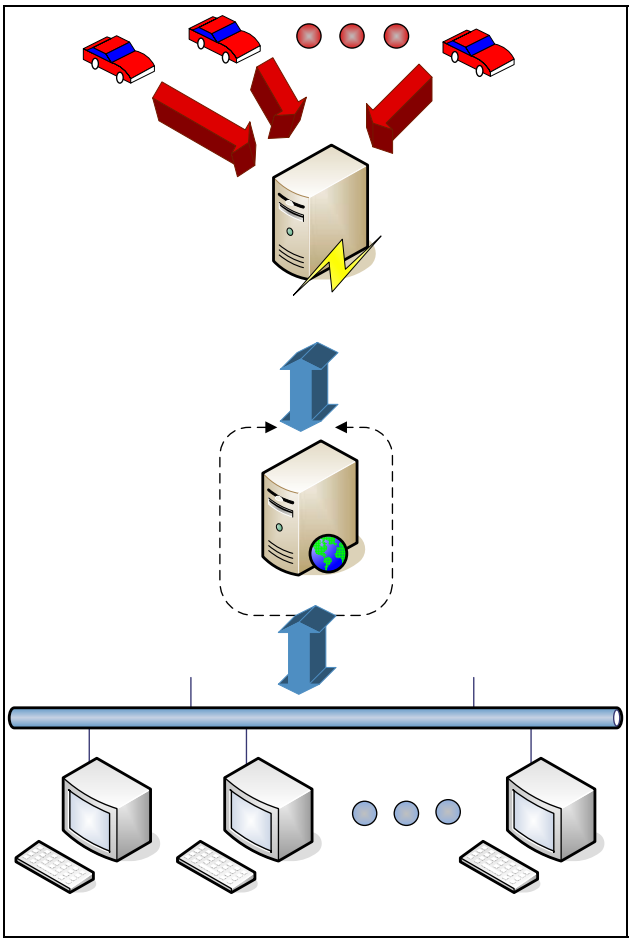
Aim/Requirement: The Lebanese Internal Security Forces wanted an online vehicle tracking system for police operations. This system was intended to view all police vehicles in real-time, and be able to help the operations & control room officers in critical decision making by providing such decision-making tools.

Description of solution:
The Automatic Vehicle Locator (AVL) on-line tracking solution for the Lebanese Internal Security Forces (LISF) was the first online tracking application for a security body in the region over tetra network communication and based on professional requirements. The LISF currently use this solution to track and dispatch up to several hundred vehicles anywhere in the Lebanese territory, being able to communicate through the system with the vehicles.



The project was executed in cooperation with OTE/Marconi, who supplied the tetra-network, and used their experience with international Police Agencies to set the requirements and standards for the system. Tested at OTE/Marconi laboratories in Florence, the application was bombarded with data to ensure a smooth refresh rate and system stability. This project has now been implemented, and is in service at three of the main control rooms of the Lebanese Internal Security Forces.

The unique architecture of this Police system is driven by a **communication server**, which was built to interface with the tetra network from one side and communicate in both directions all feedback from vehicles to users, and commands and messages from users to vehicles. This communication server application can sustain **more than 80 messages per second** coming and going all directions.



AVL Unit

Another notable feature is that this automatic synchronization of all users and communication server was based on very **minimal bandwidth specifications** (128 kbit per sec) – especially for remote control rooms – and the reliability of the overall system architecture is built in such a manner that if one client goes down, the rest of the system will still operate. Very powerful system speed

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allows users to get an on-screen refresh rate of **over 500 vehicle locations per second**.

The system also has **intelligent dispatch functionality**, allowing the operation's room officers to make informed decisions. This is done through **mapping events** (incidents, or accidents), **detecting the closest vehicles** to these events, assigning and **routing the vehicle** to the event, automatically detecting when the vehicle reaches the event. There is also an automatic reminder for incomplete events, and all this information is saved in a history database for later querying, analysis and reporting.

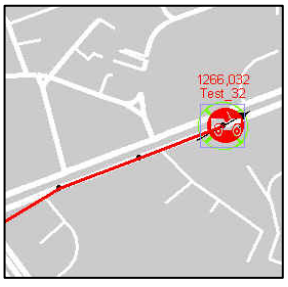
An elaborate **access rights** system was built to allow the definition of what users can view and manipulate which vehicles and vehicle groups. Automatic detection of all abnormal behavior such as **out-of-communication vehicles** and **out-of-jurisdiction (geo-fencing)** vehicles is also available.

In addition to the standard GIS map navigability and manipulation (zoom in, zoom out, panning, layer management, editing points of interest…) and search features (explore data on the map, information tool retrieval, search using criteria to find map locations or vehicles…), a customized and focused set of functionality was designed to meet the needs of the policing operation as follows.

1. Vehicle Tracking and Monitoring

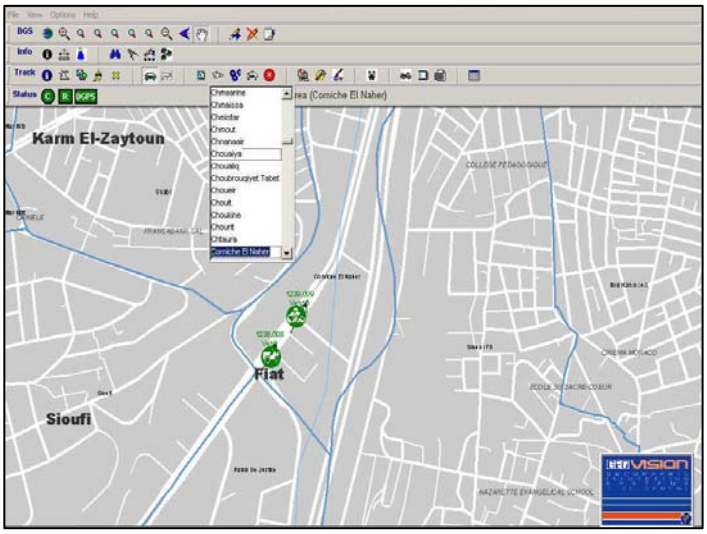
Vehicles can be **grouped** and given a group symbol to distinguish them on the map. Groups also have a **jurisdiction**, an authorized area that a vehicle can pass through (a concept also known as **geo-fencing**). The assigned **mission** is also an attribute of the vehicle, as well as the color-coded **priority** for the assignment. The vehicle's identification parameters with position and properties can be retrieved easily by clicking on any vehicle with the identify tool.

The user can **monitor a vehicle or set of vehicles**. As shown in the adjacent image, the vehicle mission prioirity is shown in the color code, and vehicle group symbol with ID code is shown as well. Arrows

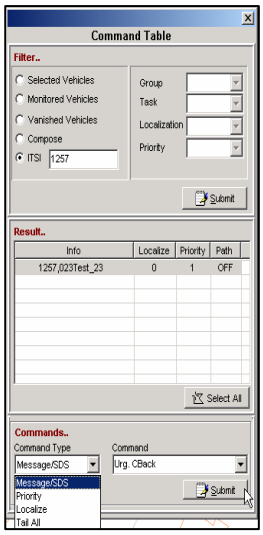


showing the heading (direction) are drawn as well as a tail representing the trail that the vehicle has traced.

A set of vehicles can be monitored using several different criteria: the user can select a set of vehicles dynamically on-screen, or he may opt to select a specific area or group of vehicles. Other vehicle properties can be used to monitor a set of vehicles, such as all vehicles assigned to a specifi task/event.



Users may need to **follow/center a certain vehicle** irrespective of its monitoring mode. As a result, the map will be panned to keep the followed/ceneterd vehicle in its extent/center.



Automated system alerts are issued to the user if a vehicle goes out of communication coverage, crosses its authorized jurisdiction (geo-fencing), or issues an on-board alarm.

The system users can monitor a vehicle track of the current day within a certain time interval, or **load an old track from history**.

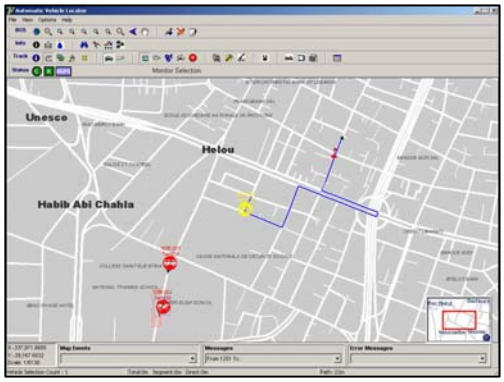
In addition to controlling vehicles, AVL users can communicate with vehicle drivers. Users with administrative rights can send messages to certain vehicles whereas drivers can send messages to all AVL users.

2. Taking Action on the Map

Adding events to the map (which could be accidents, crimes or other incidents) is possible, with ability to **manipulate and view event history,** through an event manager. Vehicles are **allocated to events**, that is to say, given an assignment, and once this is done the event changes color to indicate that it has been assigned.

3. Dispatch and Decision-making

Two prime functionalities greatly assist in decision-making using the system. **Finding the nearest vehicle** allows the system to identify the nearest vehicle to any point for the user, and the resulting path distance is displayed in the status bar. **Finding the shortest path** determines the shortest route between two or more vehicles taking into consideration the road direction. The path's connecting points will be displayed on the map with the total distance.



Case Study 2: Vehicle Tracking For Waste Collection & Management

Aim/Requirement:
In the waste collection business, fleet management and vehicle monitoring are critical issues. A fleet of hundreds of vehicles requires automated tracking – auditing stop locations and travelling speed – and ensuring that the bin locations have been visited, daily targets have been achieved and safety standards have been complied with.

Such was the requirement of Averda-Sukleen for waste collection in Lebanon and Dallah in Mekka and Medina, KSA.

Description of Solution:
GeoVision has implemented GIS Automated Vehicle Tracking and routing solutions for waste collections operations, supplying management with tangible, on-ground information about the vehicle's performance allowing them to keep track of their team and audit the work being done. It is imperative to know:

- Vehicle trajectory routes
- Bin visits and visit sequence
- Stop locations, durations and times
- Driving speeds and headings

Using such systems operators are able to:

- Input routine routes
- Find out where the vehicles have been, and when they were there
- Make sure that all stops are work-related
- Generate exception reports showing any unvisited bins, unscheduled stops, unsafe levels of speed reached and exactly where they took place.

Using build-up of statistical data operators are able to:

- Analyze the track history at any time in the future, with playback features to simulate live tracking
- Optimize planning operations and vehicle routes

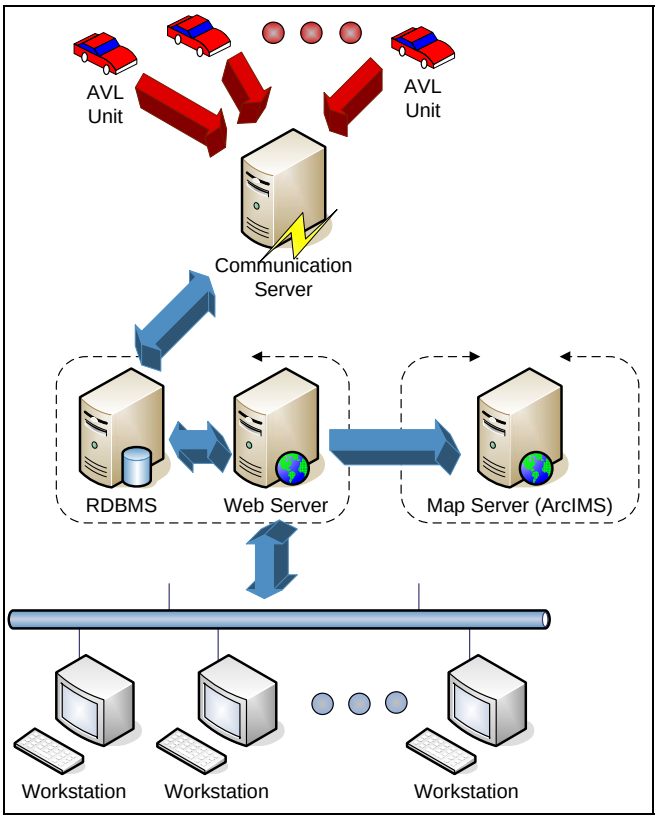
The major part of the solution that is applied to the Waste Collection industry is offline vehicle tracking, since the routes are preset and no live dispatch or intervention is required. However, an online component can be added (and this marriage between offline and online tracking systems has been implemented previously by GeoVision in its solutions) allowing added benefits such as:

- anti-theft measures
- dispatch capability
- live alerts and notifications
- geo-fencing: alerts if vehicles leave their jurisdiction

Architecture:
For such solutions which are commonly required to be shareable with many users in a large institution, GeoVision adopts a web-based architecture. This allows multi-user capability, with no client-side installation, licensing or maintenance required.

The maps and application are centralized in a server(s), and any user that can access the LAN or WAN or the institution will have access to the application through a regular web browser (given that they are supplied with a username and password of course).

An access rights system is in place to ensure that each user has access only to the data and functionality that matches their functional role in the institution.



Major benefits and Functionality:

1. Visualizing the Terrain

i. Navigation through the city. Numerous GIS tools are available to allow browsing through the map.
ii. Import bin locations through GPS readings on the map.

2. Creating Visual Routes and Plans

iii. Creating waste collection routes.
iv. Planning waste bin cleaning and street sweeping.

3. Exporting Route and Plan Information

v. Print the planned routes on maps for drivers and sharing with the Public Authorities (Municipalities).
vi. Print map screens depicting waste bin locations to

evaluate the location and geographic density of your waste bins and report this through hardcopies.

4. Easily Update Your Information

vii. Update the location of your waste bins individually and edit the planned routes using edit tools.

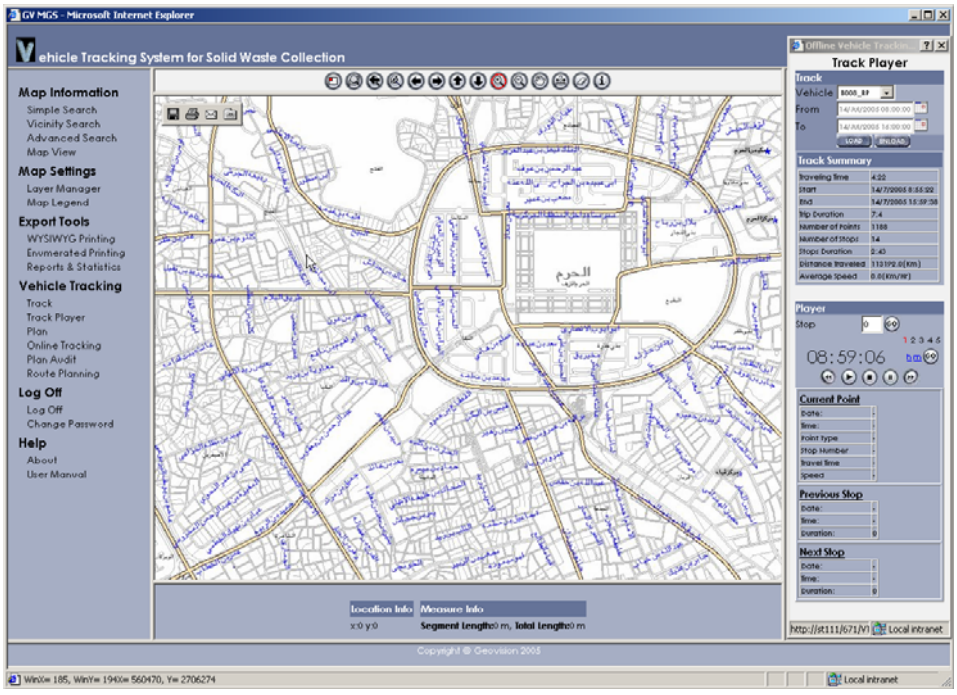
viii. Input GPS readings to either update bin locations in one bulk operation, or plot your vehicle tracks (if this information is available in GPS format).

5. Fleet Control

ix. Evaluation and auditing of the drivers' journeys. Knowing which bins were visited and which weren't, with the time of visit, duration of each stay and adherence to planned routes.

x. Ability to calculate drivers' business mileage.

xi. Mobile clock-on system. All fleet work hours are logged and reported, providing the ability to calculate hourly payment using the system.



6. Fleet Intelligence

xii. Notification of deviations from set routes.

xiii. Detailed vehicle statistics. For each track, data such as vehicle speed, start and stop times, direction (heading), and idle times can be reported and analyzed.

xiv. Track History Database and Weekly reports.

7. Safety and Security

xv. More realistic scheduling. Weekly reports ensure that management is not expecting too much from its drivers.

xvi. Third party accident claims can be disputed if false.

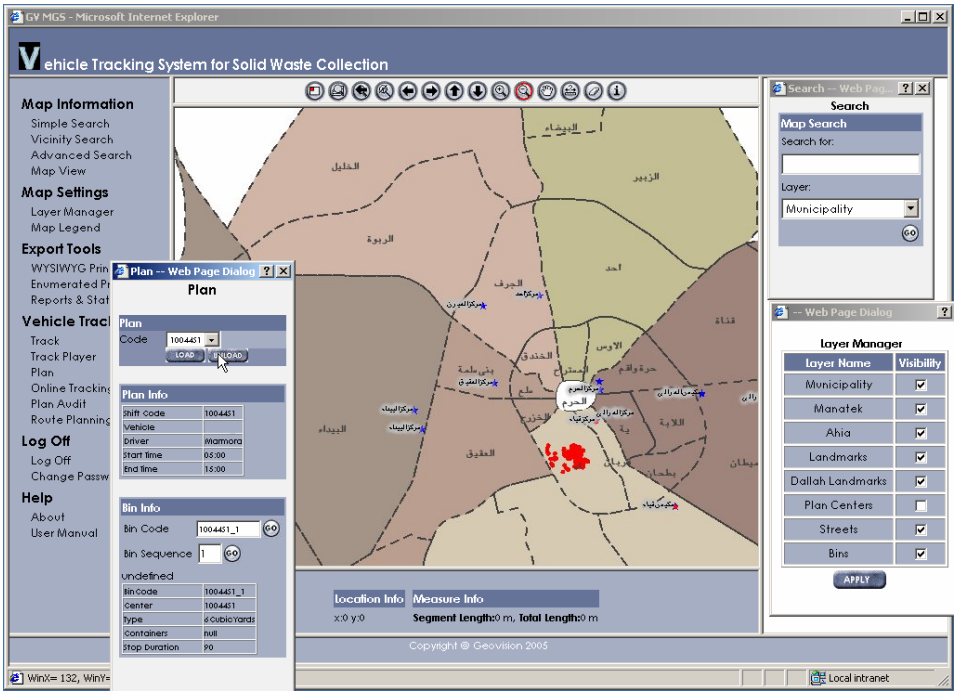
xvii. Monitor Driver Speed.

8. Increased Efficiency and Cost Savings

xviii. Lower (running) fuel costs.

xix. Journey times are reduced.

xx. Overall improved performance of field staff.



9. Operator-Initiated Actions (when online tracking is enabled)

xxi. Remotely disable stolen vehicles.

xxii. Locate idle (stationary) vehicles.

10. Automated Alerts (when online tracking is enabled)

xxiii. Geo-Fencing (Enforcing Geographic Boundaries). Whenever a vehicle crosses or reaches geographical boundaries (that can be defined by the user) an alert is sent.

xxiv. Monitoring driver behavior and report on parameters such as excessive speeding.

Case Study 3: Vehicle Tracking For the Oil&Gas Industry

Pilots for the Oil&Gas industry have been run for the Ministry of Oil in Iraq and for TOTAL in Lebanon.

In such solutions, online vehicle tracking is augmented with security sensors to detect product levels and potential tampering. Long journeys in desert areas also make the vehicles susceptible to loss of communication (in case of GPRS), and so they are equipped with satellite communication modems. The switching between GPRS and satellite communication occurs automatically upon loss of the GSM network.

In such applications, monitoring driver speed is very important, as the volatile nature of the products is a potential hazard to public safety.

Case Study 4: Vehicle Tracking For the Distribution Industry

GeoVision's experience with the distribution industry is vast, ranging from P&G, Unilever, Pepsi, Coca Cola to various pharmaceuticals distributors and others.

Offline vehicle tracking is usually used in the distribution industry as the most crucial aspect is vehicle audit and monitoring: knowing where the sales and distribution people are going and how their time is being allocated. In addition, this tracking enables companies (especially those that are ISO compliant) to conduct statistics on their client visits: average time to reach client, number of visits per week, and so on.

Exception reporting allows managers to quickly identify operational bottlenecks at the end of the day with exception reports stating all problems without requiring management to check detailed tracks (vehicles not moving according to plan, clients not visited, stops that are too long, excessive speeding…).

Integration of such vehicle tracking systems with sales tools (often PDA-based) and fleet management software (spare parts

inventory, preventive maintenance reminders…) is another feature GeoVision has implemented.

Case Study 5: Vehicle Tracking For Courier Operations

GeoVision has implemented solutions for clients such as Aramex and DHL.

Couriers require a dispatch application, where online vehicle tracking is integrated into a call center with customer referencing (automatic identification of location upon acceptance of call) and communication with couriers for dispatch.