Geographic Information Systems in the Vehicle Tracking and Dispatch Industry: An Applied Experience

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Abstract

Automated Vehicle Location (AVL) and Dispatch Systems are increasingly becoming the technology of choice for many institutions involved in transportation and logistics in the Arab world who are looking for efficiency and higher return-on-investment (ROI). As the great benefits of such systems are known to a wider audience, more companies are realizing the need to procure and implement AVL and dispatch solutions, where technology companies are racing to provide these solutions.

This paper approaches the topic of vehicle tracking and dispatch by describing the various constituting components of such systems and the resulting benefits while highlighting the contribution of the GIS infrastructure on the overall system.

Applied experience to major institutions in the region, such as courier companies (ARAMEX and DHL), security bodies (Lebanese Internal Security Forces), utilities (Saudi Electric Company-SEC), governmental bodies (Saudi Ministry of Transport-MOT), and municipalities (municipalities of Mekka, Medina, and Jeddah) will be presented. Furthermore, utilization of various ESRI technologies to provide the different functional elements will be demonstrated through these diverse case studies.

Keywords: GIS, AVL, IT, Dispatching, Vehicle Tracking

1 Introduction

As more and more public and private institutions are becoming aware of the huge benefits an enterprise AVL system can offer, an expanding installation base of such systems is gaining more grounds and popularity in the region.

Based on our varied experience in vehicle tracking projects and dispatching solutions, we have built a number of integrated applications and systems offering numerous valuable features targeted at achieving the different objectives and goals for the different clients.

We would like in this paper to share with the audience this experience of project implementations covering a broad variety of clients working in the various fields of operation ranging from specialized solutions for municipal services (waste-collection, sanitation, inspections, maintenance…), to couriers and electric utility companies, to police and emergency services.

This paper will define AVL systems, justify their implementation, introduce main adopters, and discuss a number of case studies where we used ESRI GIS platforms in our proposed solutions.

2 Defining Automatic Vehicle Location (AVL)

Broadly defined, automatic vehicle tracking is concerned with the remote determination of vehicle location and travel information (heading, speed…etc), thus giving the ability to monitor a fleet of vehicles from a distance.

To achieve the purpose and benefits of automatic vehicle tracking, a group of components has to be selected and combined skillfully in a way that caters for the different system variables and client requirements as well. These components are: the location determination device, the communication method, the maps and data processing applications, and the end users. Figure 1 below illustrates these components.

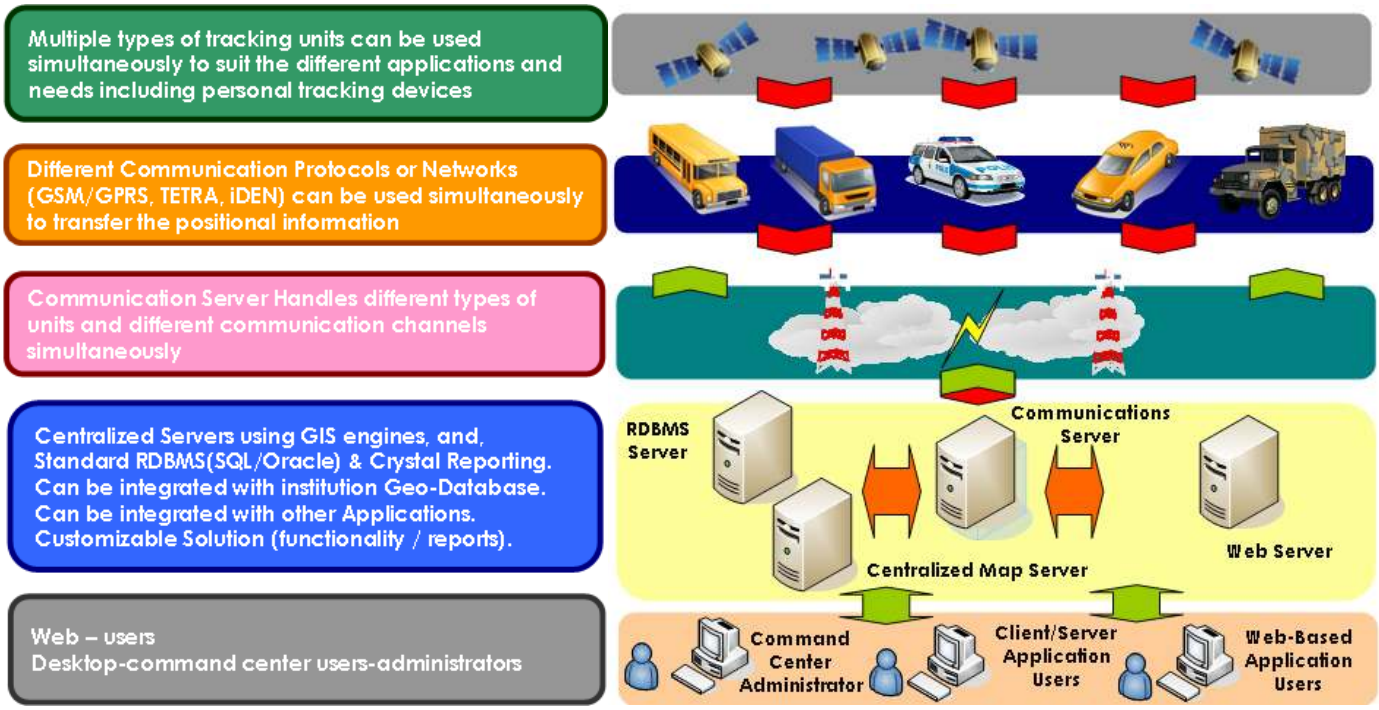


Figure 1: components of modern AVL system

To elaborate more on these components:

- The location determination technology: historically, a number of methods with varying precision have been devised to calculate the location of a vehicle. Dead-reckoning, ground-based radio, signpost and GPS (Global Positioning System) are examples of these technologies with the last one being the most viable and popular option in the recent decade. Sometimes, a combination of two technologies - GPS being the default option – may be used as a way for providing a backup mechanism when the signals of GPS satellites are obstructed.

- The communication system: this is the method of transmitting the positional information from the vehicle to the monitoring station or command center. Third-party providers come here to offer the medium of communication which would be the GSM cellular network, a TETRA network, an iDEN network, or a satellite network. Choosing the preferred medium depends on many factors such as the client's operation area, the available network coverage, and the basic system requirements. It's important to note here that if live tracking is not necessary, a cheaper option can be provided by installing a wireless-download base-station where vehicles can send their information once they arrive to their base at the end of the day (using WiFi, for example).

- Servers and the data processing applications: This component of the AVL system is actually composed of three different sub-systems as follows:

    - *The Communications Server:* This is responsible for facilitating the exchange of data between the installed AVL units and the back office system through the selected communication channels.

    - *The Database and Map Server:* Here is where the actual storage of AVL critical data elements takes place. This data includes general system data, map layers and points of interest, planned routes and operation plans, users and vehicles lists,…etc, and very importantly, the historical tracking data received from the field through the communications server.

    - *The AVL Application Server:* In this component the data processing and analysis engines reside in addition to the web applications and tools. The data processing and analysis engines work in the background to provide the database server with a stream of processed data ready for human use and understanding. The web applications and tools include all the GIS and AVL statistics, reporting, and administration functionality served to the web-users connected to the system (whether over Internet or intranet).

- End users: These are system users who access the AVL application through their PCs. Web browsers or client/server applications are used to display required information and enable interaction with the various system functionalities, either over Internet or intranet.

It's worthy noting here that the terms fleet management and AVL are sometimes used interchangeably while it's not necessary for each fleet management solution to contain the vehicle tracking component. Much often fleet management systems are asset management applications that deal with vehicle financing and maintenance, fuel management and so on which helps companies relying on transportation in their business to remove or minimize the risks associated with vehicle investment.

Furthermore, computer-aided dispatch (CAD) systems, which are concerned with call-taking, incident locating and vehicle dispatching to incident locations, contain AVL as a subsystem. Examples of CAD systems are those used in police and taxi operations.

3 Why do institutions need an AVL and/or Dispatch system?

Nowadays, for many fleet operators and enterprise owners, having a vehicle tracking system is no more a "nice-to-have" but rather a "must-have" issue. The increasing number of fleet vehicles, the need to save time and to control consumption of all vehicle components, the spawning options of telecommunications services at affordable cost, the availability of cheap and small GPS receivers, the increased competition and desire to offer better customer service, the incrementing security and terrorism fears, the introduction of full-fledged web-enabled AVL services, and the increased awareness of AVL benefits are all reasons for adoption of an automatic vehicle location system for fleet owners.

To better classify the factors that fuel the movement towards an expanding AVL customer base, we may cast them into the following categories:

- *Live dispatching and live monitoring:* security and public safety bodies, taxi fleets, maintenance teams of public utilities (gas, water, electricity…etc), and delivery trucks and delivery services all share the need to locate and monitor their vehicles in real-time, and to dispatch the nearest unit to the incident or customer location. This results in reduced response time, safer working conditions, better customer service, and enhanced decision making based on live spatial data feedback.

- *Auditing and optimizing performance:* through analysis of historical tracking data (stops, durations, sequence…etc) provided by the AVL system, fleet owners can check the level of compliance to plans and calculate route efficiency, which ultimately suggest modifications leading to optimized performance.

- *Driving behavior:* the driver, the passenger, and the people and properties around enjoy a safer environment when AVL systems are used to monitor driver behavior to see how aggressively a vehicle is driven. A fleet owner can therefore set a benchmark for driving habits to guarantee minimum amount of violations such as harsh speeding or breaking or not wearing the seatbelt, for example. Furthermore, the playback functionality can help in validating or disputing claims of violating traffic rules and accident claims since the location of vehicles is known on any given day.

- *Vehicle running cost optimization and vehicle maintenance:* by combining the raw data obtained from a basic AVL system on distance covered, number of stops, and total trip durations a fleet owner can quickly benchmark the total consumption of his vehicles in terms of the various consumables (fuel, oil, tires…etc), thus enabling him to devise better maintenance procedures and schedules. In addition, automatic system reminders and alerts enable periodic vehicle servicing which leads to less breakdowns.

- *Security and remote vehicle control:* supporting fleets with AVL units greatly facilitates the job of public safety personnel who can promptly pinpoint the whereabouts of stolen vehicles. Moreover, the ability to remotely immobilize the units can lower the risk of related crimes. In some other cases this has even resulted in lower insurance costs by insurance companies for AVL-enabled vehicles.

4 Who needs AVL and Dispatching?

A brief scan of the above reasons that justify implementing an AVL system leads us directly to the industry segments that represent the main adopters of this technology, they include:

- Transit agencies: buses and taxis
- Public transport planning administrations: local transport authorities/ministries
- Law enforcement and public safety authorities: police, emergency, fire
- Distributors: couriers, fuel distribution companies, publishers, fast food, long haulers …etc
- Municipalities and utilities: inspection teams, maintenance teams…etc
- Private car owners: small businesses and car rental

Historically, the first demonstration of AVL was in Europe in Hamburg, Germany, in 1964, followed by the US Department of Housing and Urban Development (HUD) proposing AVL use in its 1968 report to Congress, *Tomorrow's Transportation.* During the same period HUD initiated a program with Chicago Transit Authority (CTA) to improve public transportation resulting in Chicago becoming the site of the

first AVL deployment in the United States using a signpost location technology developed by Motorola and used by 500 buses for the next 5 years.

Although AVL technology in the Gulf and Middle Eastern markets is recent as compared with the US and European markets, its implementations are growing in popularity and number as their benefits are becoming more visible to public and private potential customers. For example, the Saudi Public Transport Company (SAPTCO), which operates more than 2500 modern buses connecting the cities of the Kingdom and the gulf region, has installed tracking units in about 2000 of its fleet. In the UAE, Dubai Taxi Corporation (DTC) which owns over 3000 vehicles, has most of its cars with GPS-enabled AVL systems and the number is expected to grow to cover the entire taxi fleet. The same applies to Mowasalat, the leading provider of taxi, limousine and public and private bus services in Qatar, which adopted TETRA-based tracking solution for 1800 vehicles (around 50% of its fleet) to better control and monitor its fleet while on the road.

5 Case Studies on AVL Applications

There are numerous case studies that demonstrate the vital role of the GIS component in AVL implementations. In what follows, we will shed some light on a number of projects that we were involved into where the GIS dimension has its impact on the overall system value and functionality.

5.1 Waste Collection & Municipal Operations at Mekka, Madina, and Jeddah – KSA

Part of the role of the various municipalities is to ensure the cleanliness of their streets and neighborhoods. Each year, millions of riyals are spent on solid waste collection, street sweeping, and other municipality responsibilities. The activities of solid waste collection and other sanitation duties are subcontracted by the municipalities to contractors in a bid for the most qualified.

With the advancement of AVL, the various municipalities have realized the need for AVL to be integrated in the waste collection requirements, so that they can have transparency and audit the activities of the contractors, ensuring that the money is well-spent and that the cities remain clean.

Three such systems were implemented for municipalities in KSA, starting from 2005 and in very steady operation till today (around 1000 vehicles). The Vehicle Tracking System for Waste Collection & Municipal Operations is an intranet web-based GIS system deployed at the client site. This solution is based on the ESRI ArcIMS platform allowing efficient map serving to the multiple simultaneous users who use the system. The application functions in conjunction with an MS SQL Database as well as Crystal Reports. In addition to the core application, the Municipality GIS

departments are provided with ESRI ArcGIS for map maintenance and other GIS administrative operations.

The implementations for Medina, Mecca and Jeddah municipalities differed in some aspects, as each was a customized solution catering to the needs of the particular municipality.

Figure 2: Snapshots of Mecca tabular (left) and graphical reports (right)

However they shared many main factors:

- Digital maps were combined with bin location surveys to allow routing & planning to be prepared at company headquarters
- The system allows users to view the vehicle tracks and audit them in comparison with their preplanned routes. Location data is downloaded from the online and offline GPS units installed in the vehicles and viewed on the map along with a set of audit and statistical reports on bin visits and maintenance reports on vehicle usage
- The systems were web-based GIS-AVL applications, allowing multiple users and could be used by both the Municipality and Contractor Management to monitor and audit the operation
- The systems were bilingual (Arabic-English)
- The systems allowed the import of planned vehicle activity so that once the actual track is done, there is an automatic audit producing a management summary report showing the operator what is being done and what is not, and where there are potential problems
- A database of all track history is built and kept for statistics and reporting, track playback and analysis
- The most notable features of these systems is the automated, intelligent audit tool which utilizes GIS and AVL technologies to point out clearly which vehicles complied with their plans (e.g. planned bins to visit, planned routes to sweep, etc) and which did not. This provides the operations team and management alike with visibility of their entire fleet operation, through reports that pinpoint the issues and bottlenecks. As such, the value of the system lies in the after-the-fact audit and

hence the "live" tracking aspect (using online communication) in such operations is of secondary importance.

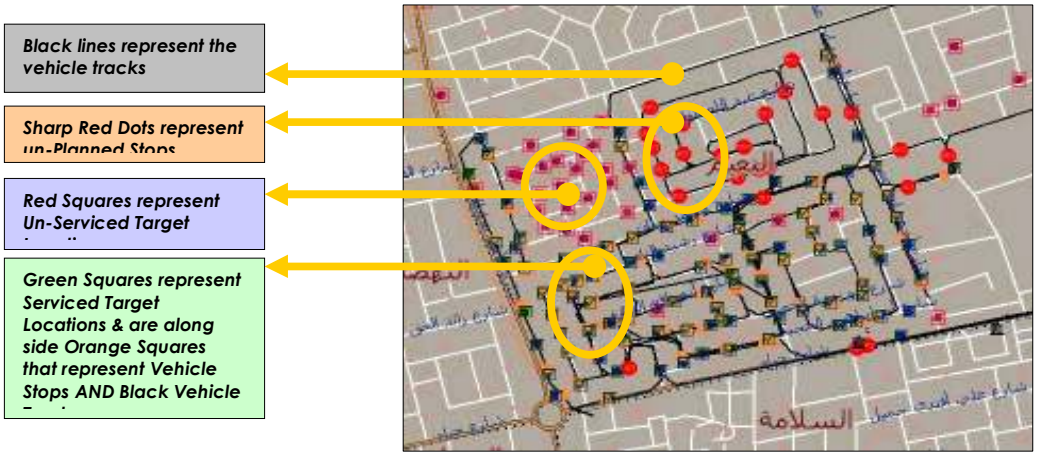


Figure 3: Snapshot of the reported GIS result of waste collection Medina Municipality

One of the earlier systems designed and deployed, the Medina Municipality solution focused on offline communication. Tracks are stored onboard the AVL units in the vehicles (units can store several days of GPS information), and once the vehicles return to the parking area, a wireless transmitter automatically signals to the wireless receiver in the office, and downloads its data. This happens consecutively until all data has been downloaded from the vehicles.

Medina Municipality has successfully used this system since 2005 on around 130 vehicles. Not only has the AVL system uncovered operational issues and helped to keep vehicle adherence to plans, it has also shown logistics' managers better ways of planning the vehicle routes and managing the waste collection operation:

1. The system uncovered that there had been no proper planning or compliance with plans;
2. The project uncovered areas which were not served properly & other areas (in which 30% of the time was spent) which had empty bins all the time, wasting travel time in those areas;
3. The distribution of bins themselves could use some revision (as part of the project involved mapping all the bins and placing them on the GIS maps);

Mecca Municipality

The Mecca project was a similar implementation to Medina, with similar objectives and achievements. One difference however is the communication medium used. Mecca Municipality decided to have a mixed fleet, in which half of the vehicles used the above-mentioned offline download, while the other half had live tracking through GSM-GPRS network (around 200 vehicles in total).

The AVL applications function in the same way no matter how the data is obtained from the vehicles (live or end-of-day). Obviously, vehicle not equipped with the GPRS communication cannot be viewed live.

Jeddah Municipality

Jeddah Municipality, the most recent (2006) addition to the Municipality trio, decided to implement only online vehicles (operating in the abovementioned hybrid mode of GPRS and storing points where areas of no coverage are encountered).

Municipal Operations often cover more than sanitation operations, as is the case in Jeddah. Other operations which are covered by the AVL of this case study include operations such as Insect-Spraying, whereby vehicles roam pre-planned streets while dispensing a chemical spray. It is important to have a versatile audit engine that can be adapted to the different operations and parameters; in this Insect-Spraying operation the compliance check not only involves whether or not the vehicle traversed these pre-planned routes, but also the speed at which the traveling was done, since spraying the chemicals at high speeds would render the whole process ineffective.

5.2 AVL for Courier Operations at Aramex (Beirut and Amman), and DHL (Beirut)

Courier operations are characterized by the fact that parts of the operation are pre-planned (e.g. orders that are known to arrive and be delivered at a certain time), while other parts are ad-hoc and on-the-fly (e.g. calls come in asking for packages to be picked-up). The AVL system in this case has both elements of an after-the-fact audit (checking planned routes against actual tracks), as well as live tracking and dispatch (when a call comes in, checking the closest courier to that location and sending him in for pickup).

In addition to the above considerations, couriers often have PDA solutions for sales operations, and these can be integrated with the AVL systems for a total-solution linking sales data to geography.

This case study involves three systems deployed at each of ARAMEX-Beirut, ARAMEX-Amman, and DHL-Beirut. Though DHL and ARAMEX are both courier operators the solutions differ as each company has different goals and operational considerations.

At DHL, the system is focused on live tracking and dispatch. The single-user application is based on ESRI ArcGIS with a client-server desktop operation (which can be expanded to more users). It reads the vehicle tracks from the communication server and depicts all operations – live – on the screen. DHL's vehicle tracking system includes live dispatching, live geo-fencing alerts, and live vehicle control from the command center.

The systems at DHL are currently been integrated with the existing handheld solutions to create an automated synchronization of the mobile scanning data (transaction ID, client ID, Airway Bill Number) and the vehicle tracking data (stop time, stop location, stop duration…). The applications in this way have the appropriate data to generate useful reports and statistics.

The vehicles at DHL are equipped with sensors and control relays allowing the remote locking of doors, windows, as well as immobilizing vehicles, all from the command center at the touch of a button. This is mainly to prevent the theft. The units are installed on both cars and motorcycles.

In early 2007, a DHL motorcycle was stolen in Beirut. Vehicle immobilizers were only installed on the cars; however the motorcycle was tracked (live) by the DHL command center on the GIS maps of Lebanon. The police were contacted and dispatched to the location of the motorcycle. After heavy pursuit (involving gunfire), the assailant was arrested at the final location, where a number of other stolen vehicles were also found. The DHL motorcycle was successfully recovered.

At ARAMEX, on the other hand, the AVL system is aimed at enabling fleet usage analysis for optimization, achieving better customer service, and integrating customer and jurisdiction layers into their maps according to their own addressing standard. The ARAMEX AVL application is implemented for 60 cars in Lebanon and 25 cars in Jordan but is expected to reach 500 vehicles in the region covering Lebanon, Jordan, Kuwait, KSA, Egypt, and UAE.

The architecture of the application is also very different: ARAMEX have a multi-user web-based AVL implementation (similar to that of the Mecca, Medina and Jeddah Municipalities), powered by ESRI ArcIMS, and again integrated with MS SQL Server and Crystal Reports for extensive reporting capabilities. Allowing the maps and applications to be centralized in this way simplifies the maintenance and update process, and such web-based systems are characterized by their advantages of not needing any client-side software, installation, licensing or maintenance.

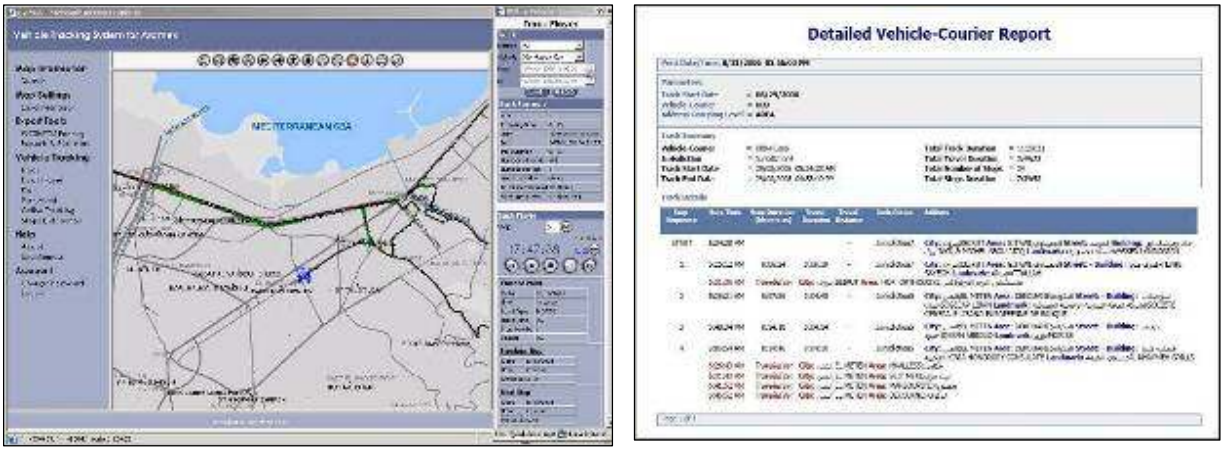


Figure 4: Geographic as well as tabular driver information can be retrieved by the system for further analysis

Though the AVL system at ARAMEX is tracked live (a necessity for a courier), it is the after-the-fact audit and analysis that is a valuable feature. We have applied GIS to allow the logistics operator to analyze and optimize his operation in several ways, through a versatile tool known as Stops Distribution Analyst. This allows for the geographic representation and analysis of the stops of the vehicles. It is of great use to dispatchers in courier services, planners of distribution paths, sales operations, etc. since it provides a comprehensive view of the overall operation and can provide visual clues to problems in planning and service so that the proper adjustments can be made.

The user can view the overall distribution of stops from different vehicles over multiple days and varying time ranges, displayed on the map with overlaid color legends that show the user different stop characteristics in the same view. The user selects input parameters that filter for the stops of interest, identifies the legend to be used to represent the different stops, and specifies the adequate labeling for these stops. The output is presented on the map as shown in the following example:

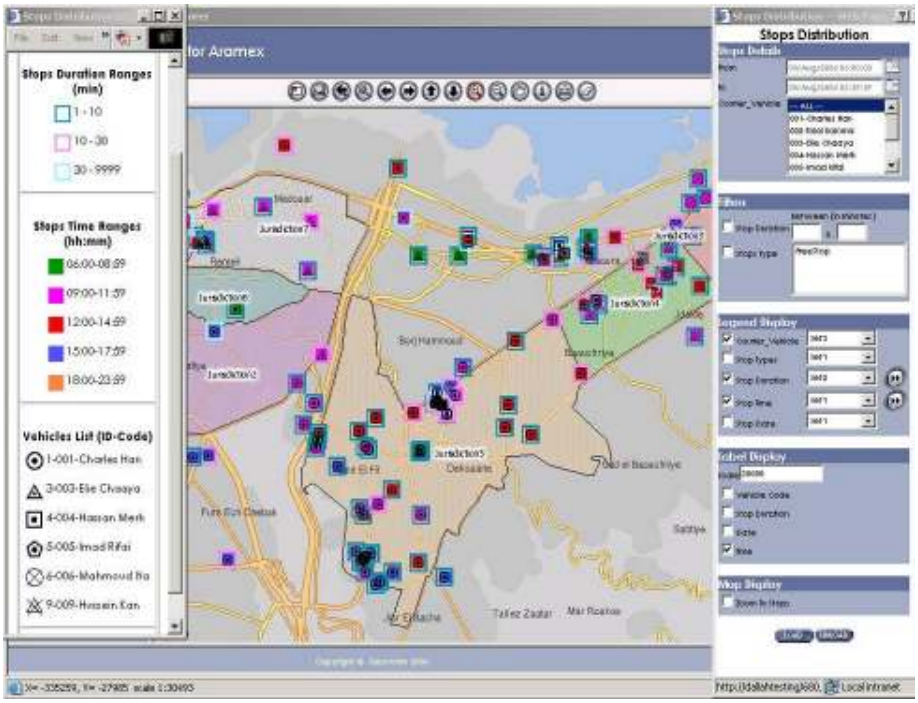


Figure 5: Up to three dimensions of information can be incorporated in the way the stops are displayed: *Colored Empty Squares to represent Stop Duration Range, Colored Squares to represent stop-time range, and Different black symbols to represent different couriers*

5.3 Fuel Distribution Auditing and Vehicle Tracking: TOTAL– Lebanon

For a French Conglomerate fuel distribution company such as TOTAL, vehicle safety and driving behavior is key. With a fleet of over 60 distribution trucks, in addition to a considerable number of sales vehicles, fleet control, monitoring and planning are also important issues. Tracking these vehicles - auditing stop locations and speed - ensures that security and safety, in addition to TOTAL-Lebanon's public reputation, are preserved.

In addition to TOTAL's safety considerations, TOTAL wanted a subscription-based system which they could access through the Internet, thus alleviating the hassle of client-side servers, installation, and the necessary IT staff to maintain this. Thus this Internet-based portal was provided as an AVL web application to provide TOTAL with everything they need. In addition to live tracking, live audit, stops analysis, and activity reports, the system provides means for monitoring the performance of drivers, mainly through exception reports that indicate the instances of violating certain criteria.

Exception reports ease the monitoring effort by being targeted at specific needs (like focusing on speed violations, or stopping violations, etc.) and by displaying only the problematic cases that require the supervisor to take action (penalizing drivers for

removing the seatbelt, sorting out long delays with customers, etc.). The reports may also be sent automatically to the relevant users on a periodical basis.

GIS was applied in quite a unique way to the TOTAL AVL system. Many AVL systems in the market report on over-speeding by merely reporting speeds above a certain pre-configured threshold. With TOTAL however, it was required that the speeding rules be based on the type of vehicle and level of road the vehicle was on. So, a fuel distribution vehicle moving at 80km/h on the highway might be acceptable, however moving at that same speed in a secondary road would be hazardous. Thus the speed audit engine compares the speed and takes into account the GIS road layer properties as well as the vehicle type, to determine whether or not there is an exception.

Example 1 Overspeeding Report: This report displays the time at which the speed of the vehicle exceeded a certain limit, with the overspeeding duration and location (area and street), for each vehicle in a given day.

Example 2 Seatbelt Violation Report: This report reflects when, where, and for how long the driver has been driving without putting on his seatbelt.

Figure 6: Overspeeding report (left) displaying all relevant details (time, duration, and location), and Seatbelt violation report (right) displaying all relevant details (time, duration, and location)

5.4 Vehicle Tracking and GIS Command Center at Lebanese Internal Security Forces (LISF)

Originally in 2003-2004, an AVL command center was built for the LISF to allow for live tracking and vehicle messaging/communication through TETRA. The solution was a client/server intranet GIS system that provides police with the means to geographically locate and monitor live all of their vehicles, to allocate accidents or events to one or more of these vehicles, and to follow up on the progress of their activities.

This was the first tracking application for a security body in the region based on this architecture and technology, with vehicle tracking and dispatching achieved with a refresh rate of 300 vehicles per second over a small bandwidth. Detailed maps coverage and navigable road network were integrated to work with this application. The application was launched in 3 different command centers of the Lebanese Police, and was based on ESRI's ArcGIS desktop platform.

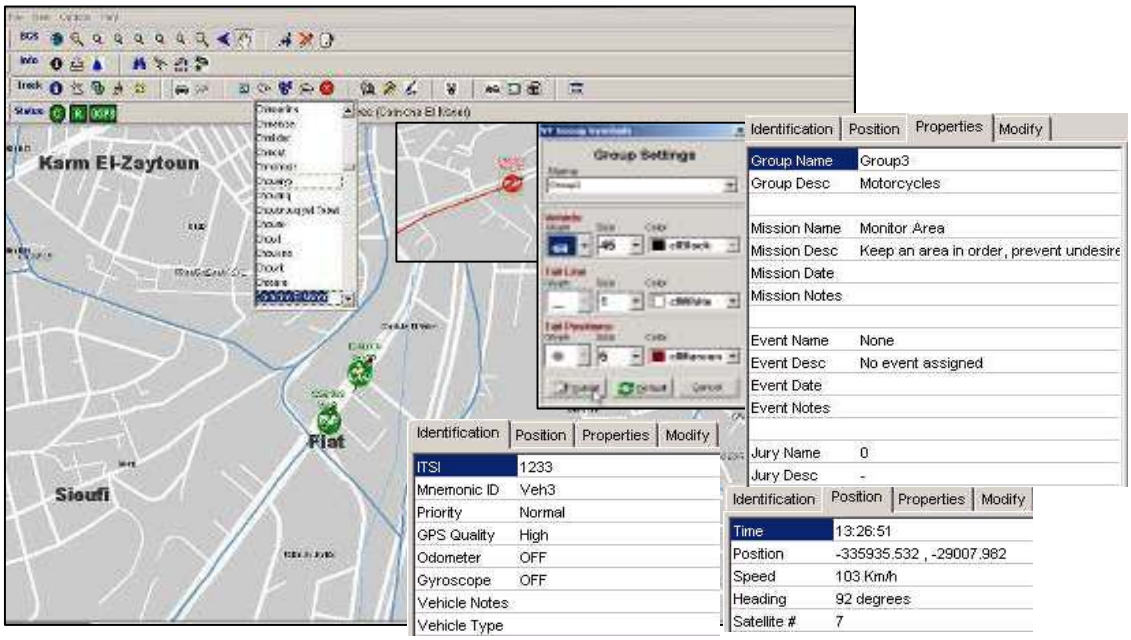


Figure 7: LISF GIS tracking application provides police with the means to geographically locate, monitor, and allocate vehicles and events, in addition to following up on the progress of activities.

In 2007 this project was upgraded to include a web-based component allowing non-operations room personnel to access GIS maps and track vehicles (without the complexity of CAD and incident management which is not needed outside the operations room). In addition, the communication server was upgraded to accept all kinds of communication media; the system currently receives simultaneous data through TETRA, GPRS and SMS, and tracks all kinds of vehicle (cars, motorcycles, others), as well as specialized GPS units to track personnel and allows them to

communication with HQ covertly. This web-based component of the system is based on ESRI ArcIMS map server technology.

Figure 8: LISF GIS web–based tracking application allowing non-operations room personnel on the road to access GIS maps and track vehicles

The LISF application is bilingual, supporting Arabic and English languages in both its interface and maps. Assets (vehicles, personnel or other) can be tracked live on-screen, and grouped and represented by the operator in any way desired. Live alerts will inform the operator when a vehicle goes out of its allowed boundary, goes beyond an allowed speed, goes out of communication, and other such notifications.

Very importantly, the command center application is a decision-making tool, allowing the operators to place incidents (events) on the screen – reflecting real world incidents such as an accident, crime or other. The application will inform the user of the nearest available asset, and can calculate the shortest path to get there, making the dispatch decision much faster. The command center supports multiple users working in a synchronized environment. This client-side is scalable and more users can be added.

The Multi-user Web-based GIS portion of the system is an information retrieval system, where the users can retrieve information on any business, street address or any other geographical aspect. The power of this system lies in its geographical interface with navigation and search capabilities, not to mention the powerful maps and data that will be supplied with this solution.

This application allows for:

- Geographical Information and Data Retrieval;
- Advanced search and filtering capability;
- Sharing the data with multiple users allowing different access rights, and hence definition of roles between different users (different users have different input/output abilities controlled by the system Administrator);
- User-friendly web interface allowing use of the system for all levels of management, with no need for IT or GIS expertise;

- Reporting capabilities including pre-defined reports that can be generated with updated data just by selecting the report name;
- All web browsing, navigation and manipulation abilities (zoom, pan, locate, identify, print…);

The combination of the above functionalities allows the operators to add layers of information, and perform analysis. One example is placing all points of crimes of a certain type on the map, and checking the density (which areas have high criminal activity). Or, for example, placing a layer of all points of crimes over the past year and color coding them by month, thereby performing a geographical-temporal analysis of the criminal activity.

Operators can also add plans (for example, the security plans for New Year's eve, or the operational layout for a certain tactical operation) onto the maps for viewing and comparison.

5.5 The GIS Vehicle Tracking at Saudi Electric Company (SEC)

Building an efficient outage management system is a multi–faceted challenge that requires careful analysis of and attention to user needs and utility complexities. The SEC is currently implementing a dispatch center to receive emergency calls and dispatch field crews for electrical network maintenance and other works. The project integrates GIS, AVL dispatch, and in-vehicle tablet computers which have onboard software for GIS dispatch and map navigation (with voice directions). The command center will monitor the field teams and track their progress/location in real-time.

The objective is to:

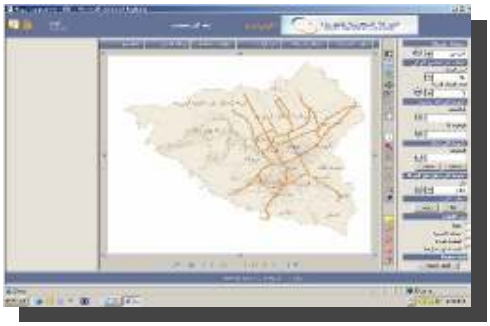
- Effectively manage incidents
- Increase electrical network maintenance reliability
- Improve Customer Service

The Offered Solution: Approach and System Components

To address the above objectives, a series of meetings with key staff members and corporate managers were held to extract the current operation workflow, the new procedures/functions to be added, and the main goals to be achieved once the envisioned system is operational. A set of flowcharts were prepared for each department describing the operation of each key player and the various possible conditions he may reach when handling his tasks. After double-checking these flowcharts with SEC for consistency and correctness, these flowcharts were mirrored into the corresponding software and hardware modules to be used in the new system.

Finally, we managed to build a system which consists of five interacting components, namely:

- The GIS component: providing both general GIS functionalities and specialized GIS features related to the nature of work and needs at SEC
- The AVL component: to be able to track SEC vehicles lively and run all previous tracks for later analysis and study
- The Call-Taking component: which provides user-friendly interface for the call-takers and help them perform their jobs efficiently
- The dispatching component: to help dispatchers order tickets by preset priority criteria, send teams, view alerts, and track field operations and status of tasks
- The in-vehicle component: to empower field teams with mobile GIS capabilities through map-assisted guidance and dispatching with real-time interaction with the operations room



GIS Component

AVL Component

Call-Taking Component

Dispatching Component

In-Vehicle Component

Figure 9: Various components under implementation for Saudi Electric Company

GPS-enabled PDAs will be available in the vehicles and field teams, communicating with the command center through GSM/GPRS. The command center will be able to locate, dispatch and communicate (via the in-vehicle screens) with the on-ground crew. The first phase of this project includes 100 vehicles.

The provided AVL applications include the following functionality:

- Tasks addition to the pipeline
- Tasks field allocation / planning
- Distribution of teaks to teams on the ground
- Live dispatch and follow-up
- Field applications
- Management overview applications
- History recording and analysis

Results and Conclusion

A typical scenario would involve all of the above components starting from call taking, to dispatching the field team, to live vehicle tracking and monitoring of activities, to interaction with field teams until the task is closed. As a project on-progress, we are using ESRI technology (ArcGIS and ArcIMS) and expect the SEC to reap the following benefits once full deployment is achieved:

- Faster, more efficient, and map- and system-guided call taking process
- More satisfied customers
- Safer and more transparent working environment
- The field teams will receive and close tasks using reproduced paper forms onto their PDAs, thus reducing paperwork and probability of erroneous entries
- Faster response to SEC tasks

5.6 The KSA Ministry of Transport (MOT)

One of the Ministry of Transport's many responsibilities is the maintenance of the roads and traffic infrastructure. To this end, the MOT has selected several Contractors (to cover various geographical regions of KSA) whose job is to drive the roads of KSA to check for any problems and report on them. For example, a broken highway rail due to an accident, a pot hole, an obstacle causing traffic congestion, or anything that requires intervention and maintenance.

A recent AVL project at MOT has been awarded and is in the process of implementation, the purpose of which is to install GPS devices inside the contractor’s vehicles and have the AVL applications at the MOT to audit and monitor all contractor operations. This will ensure that the work is being done and that the

set plans are being implemented. This phase of the project involves around 300 vehicles.

The contractor vehicles will not only have GPS-AVL devices for tracking, they will also have a push-button connected to a digital input of the device, allowing the driver to push this button whenever there is any problem or issue on the road to be reported. The signal is received by the MOT AVL applications (through GSM/GPRS) and registered on the map as an intervention point. The Contractors will later provide their input to MOT on what kind of issue was at each point (data entry to associate description with intervention points – for MOT planning and action).

Figure 10: The in-vehicle Emergency and Maintenance buttons and LEDs and the corresponding application windows for retrieving the list of alerts for each vehicle and filling incident details

The AVL applications main purpose is to audit the operations: reports are presented on the roads visited, as well as the intervention points reported with descriptions of each point.

Figure 11: The web–based multi-user GIS-AVL application interface at MOT (on the left) allows users to access the system utilizing GIS capability, AVL tracking, reporting, analysis, statistics, and more, from the centralized applications and contract plans (on the right) on the MOT servers.

The applications installed are advanced web-based, multi-user GIS-AVL applications. These allow virtually unlimited MOT users to access the system utilizing GIS capability, AVL tracking, reporting, analysis, statistics, and more, from the centralized applications and maps on the MOT servers.

The main features of the MOT AVL applications include:

- Advanced web-GIS, allowing map manipulation and navigation, layer management, search and queries, printing, reporting
- The system is multi-user (as it is web-based as many users as desired can be added without any additional installations or licensing) and fully bilingual (Arabic and English maps, interface and data)
- Allows live tracking of all contractor vehicles
- Allows offline playback and historical data analysis
- Shows intervention points and compiles reports for MOT action planning
- Performs vehicle-stops distribution analysis

6 Conclusions

There are numerous examples in the region that demonstrate the vital role of the GIS component in AVL implementations. AVL can virtually have its place in any industry segment that involves a fleet of vehicles to be managed effectively and safely. ESRI GIS software solutions are enabling technologies that have their proven track of success and became a standard choice of AVL system integrators and vendors. The growing awareness of AVL benefits is a key factor in this area that is urging regional institutions in transportation and logistics to procure or implement AVL solutions to achieve their various business and operational goals.