Automatic Vehicle Location Systems

Sotirios MILIONIS

Mr. Sotirios Milionis, National Technical University of Athens,
Department of Architecture and Urban Planning, 17, Pavlou Mela, Marousi 15125, GREECE. e-mail: milionis@central.ntua.gr

1 INTRODUCTION

Automatic Vehicle Location Systems are practically based on a combination of GPS, GIS and Telecommunications technologies. They provide vehicle location equipment as well as monitoring of the data transferred by AVL equipment through the telecommunications network (whether private or public).

AVL offers the automatic tracking of moving assets in real time, the display of their position on a digital map and the creation of statistical reports, based on the stored data concerning the location and status of a vehicle. At the same time they offer the display of digital maps (street level) combined with the real position of the 'vehicle' on a monitor within the 'vehicle', in order to assist the driver.

2 HOW DOES THE VEHICLE CALCULATE ITS POSITION?

G.P.S. consists of 30 satellites and 3 supplementary ones that constantly send radio signals containing the exact time and location in relation to the Earth. Knowing the position of three or four of them and by calculating the time gap between the transmitted radio signals, the GPS receiver is able to calculate its geographical position at any part of the Earth.

3 MODE OF OPERATION

The central unit of each vehicle receives signals from the satellites of the GPS system and calculates its position. Then, according to its programming, it sends the data through the telecommunications network to the AVL server, where it is processed and stored. This data is used by the workstations for the display of vehicles on a digital map, which originates from GIS applications. Also, from each workstation it is possible to send data – orders to one or more vehicles, again using the infrastructure of the telecommunications network.

The vehicles and the route of each one are graphically presented on a GIS map. Vehicles can be monitored for any deviation from the assigned route or any suspicious stops or delays. In such cases, the AVL operator can send messages or activate an on-call information signal from any vehicle or pre-selected groups of vehicles or any combination of vehicles that may be of particular importance. "Street level" data are available to the driver, through the coloured touch screen display installed in the vehicle, in a way that does not obscure the driver's view. Reports are also available on a per vehicle basis or for the selected group. Historical data retrieval and graphical display, is also possible, at every AVL Operator Console.

Vehicle information is automatically updated for each vehicle being monitored. The information provided from the vehicle can be real time constantly transmitted upon predefined time intervals. The frequency of transmission can be selected in a way that non-critical information is not flowing over the network.

The architecture of AVL systems comprises of three core elements: the in-vehicle equipment, the AVL Operator Console and AVL Server.

4 IN VEHICLE EQUIPMENT

The in-vehicle equipment consists of:

- Communicator GPS unit
- GPS antenna (covert where applicable)
- Key-fob receiver
- Battery Back up System (included in the central unit)
- Colour Monitor Display
- Panic/Distress button
- Impact Sensor
- Installation Material
- User guide which covers installation instructions

The Communicator GPS unit is covertly installed so that it cannot be distinguished and damaged by any unauthorized personnel. The details of each respective driver are identified automatically and after any unauthorized movement, a movement alarm is transmitted to the operations centre. Other alert data is also transmitted when an alarm situation comes up (i.e. collision, activation of vehicle alarm system etc). An alarm button is also available in the vehicle and may be activated by the driver. The operator can also arm or disarm the vehicle's security system remotely, provided that the security system of the vehicle provides digital input/output for interfacing with the communicator unit. These services can be implemented, by connecting external triggers/sensors to the inputs of the in-vehicle unit. The inputs of the in vehicle unit can be connected to: the car alarm (if available in the car), the ignition of the vehicle, the Panic/Distress Button, the Impact Sensor, enabling the vehicle's status data to be transmitted to the operator. Two of the outputs of the unit, may be connected to the vehicle security system (if available in the car and provided that the necessary digital inputs are available), enabling the operator to arm or disarm it remotely.

5 AVL OPERATOR CONSOLE CAPABILITIES

The AVL Operator console presents information of vehicles that it is currently tracking, displayed in graphical form on a GIS map. The system is flexible, allowing the user to decide on the data to be displayed and the control of the data sent from every car (poll, get log, activate outputs).

The management of vehicles is done from any P/C, which has been installed with the usage software (AVL Operator Console). A username, an access password and an operational personal profile correspond to each user of the system. The profile includes details such as how many vehicles will be visible on the screen and which capabilities will be available (e.g. dispatching of a message to a vehicle, matching of driver to key fob, etc.). Upon logging into the workstation, the real picture of a vehicle's operations becomes available to the user. The capabilities provided by the system to the operators of the workstations are described directly below:

- Vehicle Status is used in order to present the current status and location of all vehicles controlled by the system. Each vehicle will be depicted with a particular graphic symbol and in a colour that represents its status at the time. This status can be one of the following (in motion, stopped, ignition on-stopped, alarm, over the speed limit, battery status). These statuses can be differentiated for each vehicle of a vehicle group (e.g. connection with siren). A window presents the data of those vehicles allocated to each user name and password. The screen appears like a table, presenting one row for each vehicle and in order for this data to change, new data will have to arrive. The vehicles may appear with different colours and this will depend on the reason for which each incident is reported.
- Discovery of a vehicle's location in real time: The vehicle automatically sends information at a predetermined time, which can vary. A suggested rate, which derives from equivalent systems and according to experience, for the predetermined time for data transmission is 2 min. The operator, in the case of an incident, can change this rate. Apart from the automatic transmission of the location and status of each vehicle, depending on the programming of the main unit it is fitted with, it is possible that the location and status are transmitted following an operator's request. In combination with the incidents reported by the vehicle, you can request the location of a vehicle at any time. It must be noted that the vehicle will respond only if its engine is on. If the ignition column indicates that the engine is 'OFF', then it is likely that you will not receive an answer from the vehicle. If you have requested the location of a vehicle and the vehicle's engine is off, then the message you have sent will be forwarded to the vehicle and will be stored. This way you will not have to request its position again. The vehicle will answer as soon as its engine is ignited. You can selectively request the location either of an individual vehicle or of a group of vehicles.
- Search on the digital map: Given that the GIS map provides the relevant information, the program provides the capability to search for streets, pharmacies, theatres, etc.
- Background report on a vehicle's itinerary in relation to the points of interest, which may be either predetermined on the GIS map, or defined by the user. In other words, it is possible to discover if a vehicle passed by a certain point on the map. The background feature is used in order to present the background of each vehicle. The window will only present the vehicles corresponding to certain usernames. We select the vehicle, and right-click on the vehicle we want. By choosing current background we are able to view the background from one day to one week. By selecting background period we are able to view the background of the particular vehicle for the time period we desire. By selecting route representation on the map the following window appears:

By pressing PLAY the positions of the vehicle whose background was requested, along with the information concerning the time and date, start to appear on the GIS map.

- Time in motion, kilometres covered and duration of stops during the selected itinerary for the particular vehicle.
- Location of the vehicle closest to a selected point of interest.
- Location of the point of interest closest to a selected vehicle.
- Checking of a vehicle's status: in motion, stopped, ignition on – stopped, alarm, over the speed limit, battery status.
- Transmission of a text message to the vehicle appearing on the vehicle's terminal screen (e.g. VHF radio).
- Automatic briefing on important events (panic button, alarm, collision, non-authorised driver). In the case where such an incident is received, a pop-up window containing details about the incident informs the operator.
- Monitoring of a vehicle's itinerary with the use of a continuous line or of dots.
- Selection of vehicles that are to be displayed on the map (filtering per vehicle group – according to the groups that can be created during the system configuration phase).

Plate 1: Route Representation Window

6 GENERATION OF REPORTS

AVL produces detailed reports, which analyse vehicle activities. These reports are available to the workstation operators that have the necessary access rights.

The reports are produced for a specific vehicle or vehicle group. Following is a detailed list of the reports:

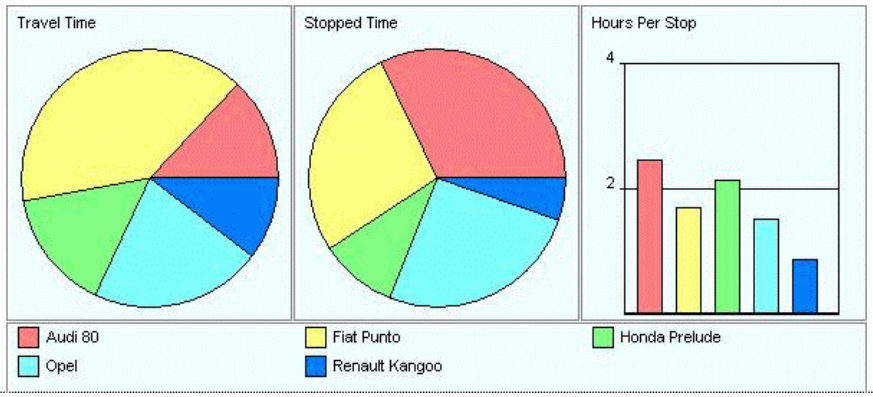
6.1 For vehicle groups

- Time Summary Reports
- In this particular report we can see:

Total travel hours
Total stopped hours
Total Hours
Total stops
First start time (Daily average)
Last stop time (Daily average)
Travel hours (Daily average)
Stopped hours (Daily average)
Total hours (Daily average)
Stops (Daily average)
Hours per stop (Daily average)

Plate 2: Time Summary Report Example

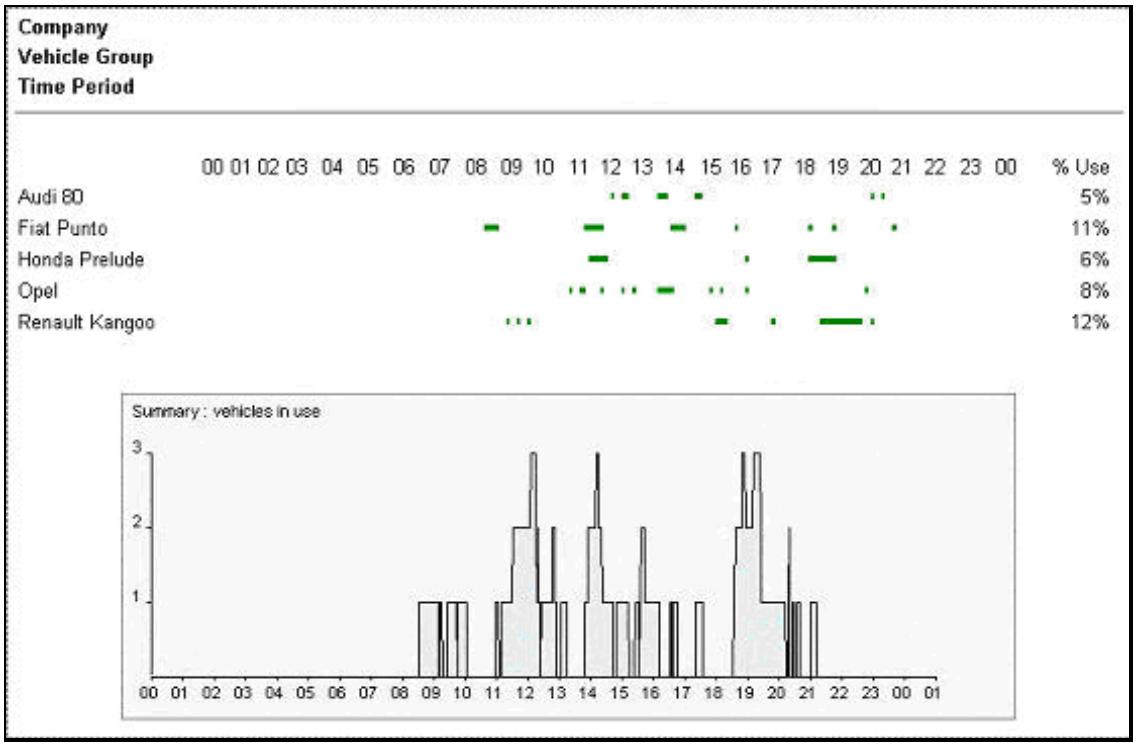
					Daily Average						
Mobile	**Total Travel Hours**	**Total Stopped Hours**	**Total Hours**	**Total Stops**	**First Start Time**	**Last Stop Time**	**Travel Hours**	**Stopped Hours**	**Total Hours**	**Stops**	**Hours per Stop**
Audi 80	7:39	86:48	94:28	41	08:27	21:56	01:05	12:23	13:28	5	02:28
Fiat Punto	23:31	72:39	96:10	46	07:24	21:57	03:21	10:22	13:43	6	01:43
Honda Prelude	8:55	25:58	34:54	14	10:18	19:02	02:13	06:29	08:42	3	02:09
Opel	12:44	69:17	82:01	46	08:34	21:54	02:32	13:51	16:23	9	01:32
Renault Kangoo	6:08	14:21	20:30	16	09:07	19:14	03:04	07:10	10:14	8	00:53
Total	**58:59**	**269:05**	**328:04**	**163**							
Average	**11:47**	**53:49**	**65:36**	**32**	**08:46**	**20:48**	**02:27**	**10:03**	**12:30**	**6**	**01:45**



- Fleet's Daily Usage Report

With the fleet report, by selecting a date, we can see the movement of all vehicles during those particular 24 hours.

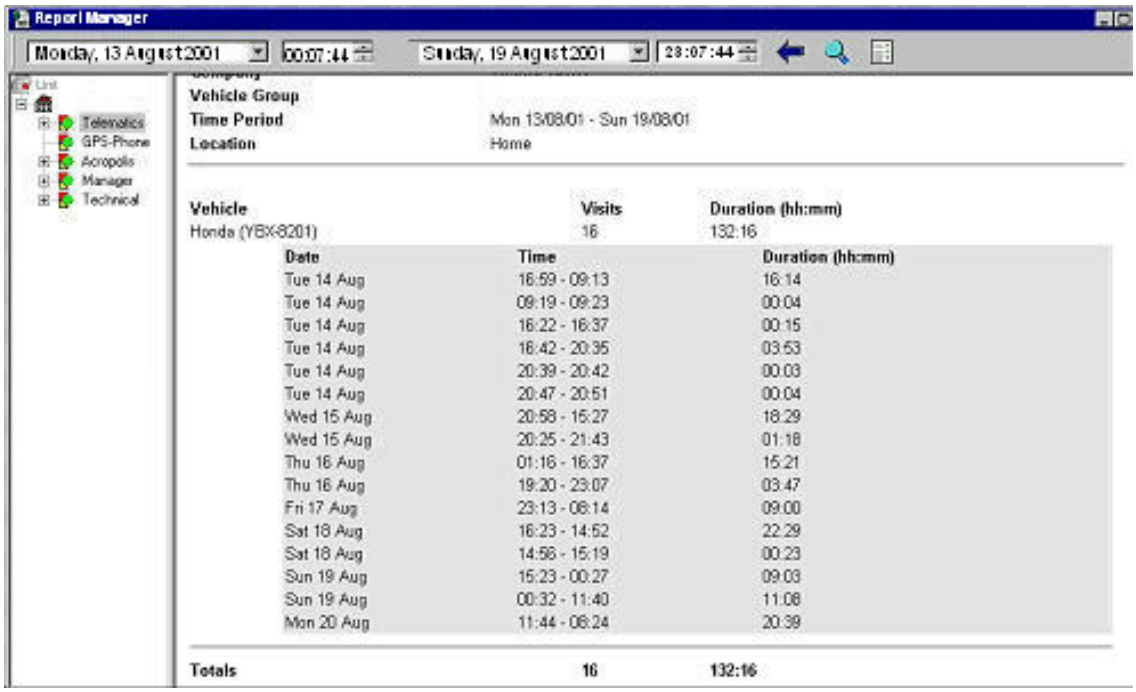
Plate 3: Fleet's Daily Usage Fleet Report Example



- Collective Weekly Work Report
- Visitability Report

By selecting FLEET VISIT we can see the visits made by the fleet to a point of interest.

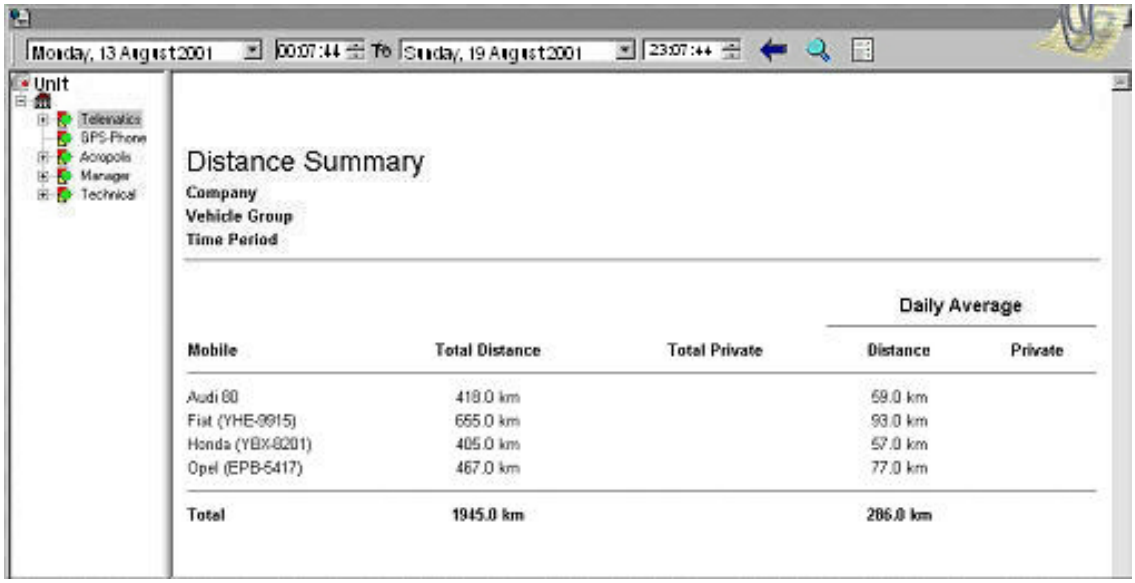
Plate 4: Visitability Report Example



- Weekly Report on Distance Travelled

By selecting DISTANCE SUMMARY REPORT we can see the total number of kilometres travelled by all vehicles in a week.

Plate 5: Distance Summary Report Example



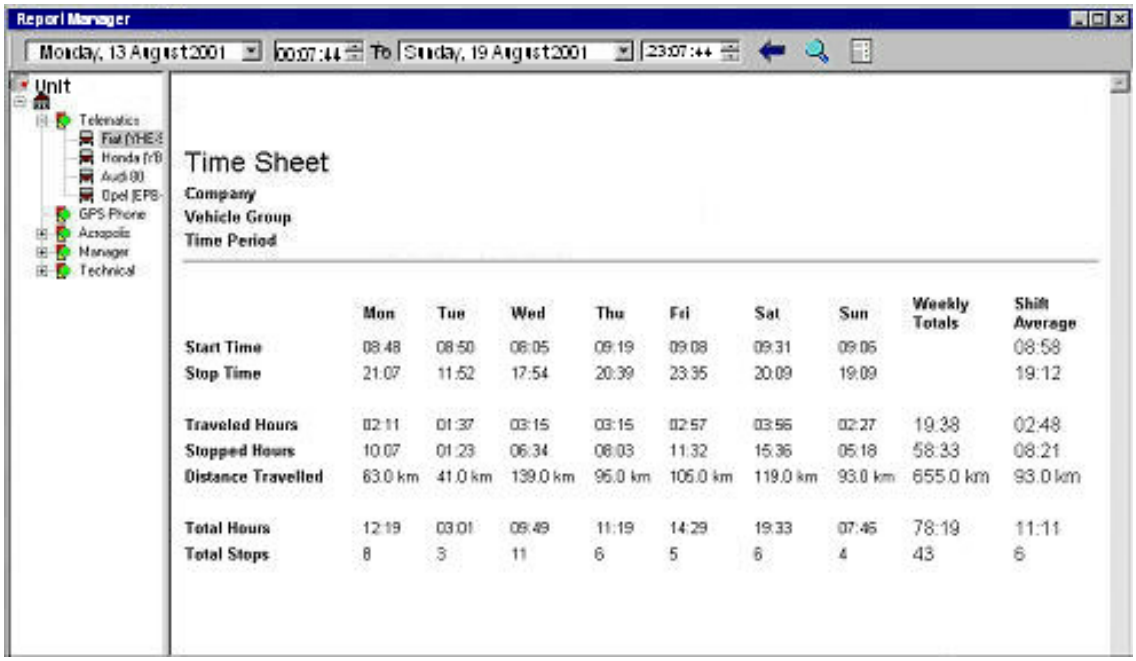
- Log on to the system Report

6.2 For a particular vehicle

- Time Sheet Report

By selecting a TIME SHEET REPORT we can see the schedule and kilometres travelled by a vehicle during a week.

Plate 6: Time Sheet Report Example

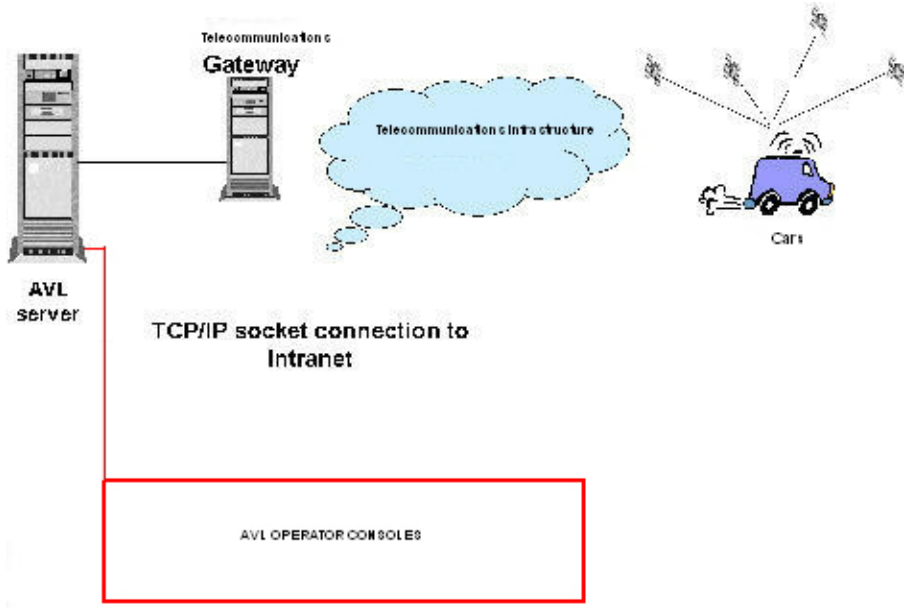


- Stops Report
- Activity Report
- Geographical Points of Interest Report

7 AVL SERVER

The AVL server can be connected to the telecommunications network through a TCP/IP protocol connection. The server and data storage system are responsible for parsing information from the vehicles and distributing it to the AVL Operator console.

Plate 7: AVL System Structure



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