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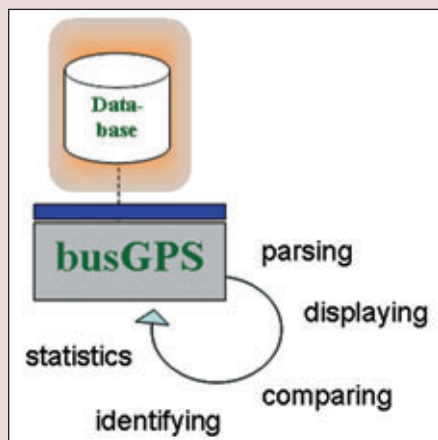
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# Part 7: Checking Bus Movemen

## GPS Applications in Portugal

More and more Location Based Applications and Services using GPS are appearing on the market. Information about the position of moving objects is getting more important and relevant to everyone. The Bus example: operators want to know the exact location of their bus-fleet, customers want to know when the next bus is coming or where it actually is, and the transport authorities want to know everything about all buses in town. A new GIS created by ISEGI/New University of Lisbon offers the base for all these purposes.

By Thomas Bartoschek, Marco Painho and Roberto Henriques



busGPS: Basic functionalities.

### Introduction

The Lisbon Transport Delegation, DTL, is one of the components of the DGTT (General Directorate for Land Transportation) structure, operating in the Region of Lisbon. DTL is using a GIS to facilitate the mapping, storage and integration of data for transport analysis. For checking issues a location based application is the solution needed. The use of this

technology could supply new instruments (location based statistics), increasing the efficiency of the operators service and control of the authorities.

An Integrated Geographic Information System (SIIG) with five distinct but complementary applications, that are related to each other through a general database, has been set up by ISEGI. It is in use both on DTL as on operator side. The system is meant to automate work processes and routines, to be more efficient in the inspection and licensing process and to establish a database on the public road-transport passenger service.

The existing GIS needs a module that treats live tracking position data for different issues. This module has to be compatible with the other applications to supply them with this new additional information. The use of GPS for this kind of location based application is inescapable. Finding the position of a moving object needs a certain accuracy, which has increased in the GPS since new systems like WAAS/EGNOS are included.

### busGPS

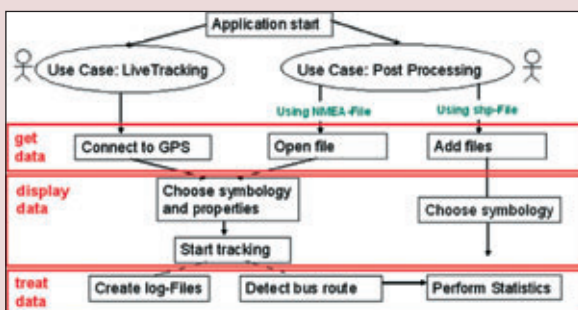
ISEGI created a stand-alone application, busGPS, with basic GIS Viewer functionality as zooming, mapping and measuring. It allows tracking of a moving object, in this case a public bus, with a GPS receiver. The application saves the geographical data with the needed attributes such as speed, time error, and heading in formats like shape and ASCII. It is connected to the SIIG database containing data on bus routes, bus stops and timetables.

Out of the collected GPS data (NMEA format) the application recognizes the driven route on or the most approximate one on runtime. It displays information provided by GPS on the map, like position, speed, and error, and recognizes the bus stops, where passengers entered or got out of the bus. For checking matters the user can optionally see the passing NMEA sentences, satellite positions and signal strength. The collected data can be saved for efficiency checking and statistics can be done to support operational performance. For this issue busGPS offers data analysis tools providing several statistical indicators on geographical deviations of bus routes/bus stops.

### Kinds of Uses

Operators can use busGPS during the route planning phase to create new routes, collect GPS data on existing bus stops or time analysis. Other uses could be calculating statistics on the efficiency on time delays, or to improve timetable management. Further possibilities are the extension of the application to a Passenger Information System or Fleet Management System. The basic data for these kinds of applications is given with the parsed GPS data and the connection to the database on routes, bus stops and timetables.

# ts in Greater Lisbon



Application workflow.

## User Case DTL

The application can be used by DTL for checking if a bus is on its licensed route: Based on the given bus position, received through GPS, the route database, which contains data of all operators, is searched for passing routes in this point. After a short time the certain route is found. If it is not found, that is if the bus is on a not licensed route, this would lead to a fine for the operator.

The statistics tool performs spatial analysis operations on the measured GPS points and provides statistical indicators to see in which terms the bus has left its original route. The results can be shown in a report and/or spatially on the map. An analysis of the bus stops can be done by comparing the points where speed is equal zero to the bus stop data base with an eligible tolerance.

## Design

The User Interface Design of busGPS is adapted to the design of SIIG, to maintain the link between these applications. It is kept easy with the map in its centre and a toolbar with common buttons for GIS applications. Interesting numerical GPS attributes, like coordinates, altitude, date, time, speed, heading, and error, are shown on the right side of the map. Additional components like legend and satellite dis-

play are available in extra windows on click demand, not to confuse the user with too many objects in the main window.

## Implementation and Tests

Like all other SIIG Applications busGPS is implemented in Visual Basic 6 using the component software technology Map Objects 2.2. from ESRI. The

application was tested with different GPS receivers to ensure its equipment-independent functionality. Tests have been run on GPS receivers of the following brands: Magellan, ANYCOM and Garmin. The geo-statistical functionality was tested with data from Vimeca, an operator serving the western Lisbon area, who also facilitated live tests on its buses.

## Results and Future Work

The result is an application with some general and some very specific functionality. It is adapted to the particular needs of DTL. Some features:

- GIS/GPS-viewer abilities;
- live tracking;
- location-based analysis;
- statistical operations;

The application is still in its development process and not yet in use for DTL or operators. Additional features and enhancements, such as a conceptual user interface, will be implemented and tested to reach a more user-friendly but still powerful level. Main objective on future work is the implementation of busGPS for a mobile device, like a PDA to provide better mobility. Other relevant possibilities are the implementation of a Passenger Information System, offering time delay or vehicle position data

collected with busGPS to the customers. The time delay could be displayed in a numeric form on a panel at the bus stop or graphically on a web-interface offering platform-dependent information.

## Conclusion

In the transportation area, geographic analysis is the key to making better decisions. Geographic Information Systems and Location Based Applications using GPS are, in this way, very efficient tools for managing and analysing information with spatial qualities.

The use of GPS as a source of location data is increasing and new technologies (WAAS/EGNOS) improve its accuracy on runtime. This makes the system even more mobile, because no post processing is needed since the accuracy achieved is sufficient for the proposed system.

Future developments and the launch of the Galileo system will still improve accuracy and offer a lot of new opportunities creating Location Based Applications. The Laboratory of New Technologies at ISEGI/UNL is looking forward to work on these challenges.

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