Geographical Awareness for Modern Travellers: A GIS Application for Maritime Transportation in the Mediterranean Sea

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Abstract

Modern travellers are becoming increasingly demanding and specialized, willing to play an active role in shaping their journeys. Spatially enabled applications can efficiently cater for the needs of today's tourists, enabling them to dynamically adapt their trip according to contingent events.

Ship Information And Management System (SIAMS) is an international project within the Telematics Application Programme of the European Commission aiming to provide novel services to shipping companies, travel agencies, passengers, citizens and local authorities through the use of the most advanced technologies in telecommunications, GIS and networking applications.

A MapObjects application has been implemented to provide, at any given moment, information regarding position and conditions of the ships and spatial links to other services. Multimedia information kiosks at port location and on board, as well as any internet client using a MapObjects Internet Map Server, will be able to assist users in getting real-time ship schedules, retrieving general tourist information on trip destinations, finding connections to other means of transportation and accessing on-line booking services (hotels, car rentals, etc.).

Introduction

Background

Maritime transportation plays a fundamental role in the Mediterranean basin especially in the field of tourism. Within this context, a number of crucial issues, such as overly long waits for boarding and on board, frequent and often unannounced delays, lack of organization of port operators due to limited communications between authorities and operators and insufficient integration between maritime data and Tourist Information Systems, are becoming increasingly evident and in need of new solutions.

Objectives

Adequate infrastructures and new telematic services can provide the solution to the above mentioned issues. Spatially enabled applications can assist in providing timely and accurate data on ongoing and scheduled trips and port destinations. Such information can be made available through internet or by public information kiosks located on board or at destination/arrival ports, offering the traveler the chance to review, schedule and plan his/her trip in real time.

GIS powered services will integrate dynamic data and digital maps into SIAMS data services in order to produce real time trip information and interactive maps of tourist facilities and transportation networks at destination harbors.

Outcomes

The project started in February 1998 and is expected to continue until mid summer 2000 with the demonstration of the newly available services at demo multimedia kiosks in the ports of Venice and Bari (Italy) and Patras, Corfu, Piraeus, Heraklion and Chania (Greece) and onboard a pilot ship (Aretousa, Minoan lines). Through internet and the virtual private network, the services will be also selectively available to shipping lines, port authorities, travel agencies and internetguests.

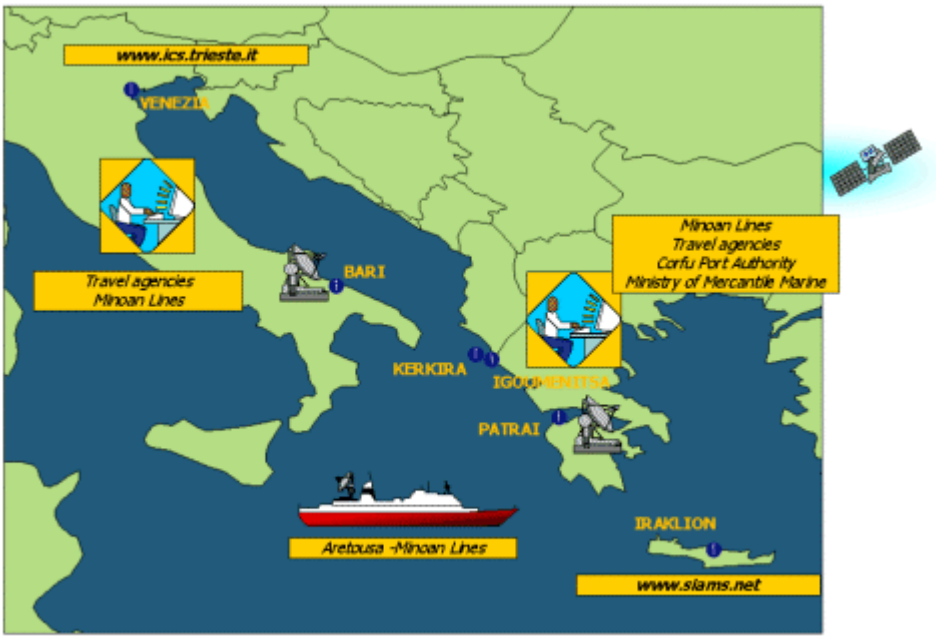

Fig.1. The demonstrator

System architecture

SIAMS is built upon the integration of four sub-systems that constitute the architecture of the information system. The subsystems cover both the hardware and software domain.

Networks

In terms of hardware components, the project aims to build a fully networked infrastructure to connect all the nodes, i.e. the SIAMS server sites and local network, the kiosks, the corporate sites (authorities, etc.) and internet access points.

Up-to-date networking techniques will also be employed to provide a secure means to circulate confidential information; virtual private networks will be used in order to provide the necessary security level for restricted access services.

Satellite communications

The structure of the network includes the use of satellite communications which will contribute to the physical architecture of the components in terms of connections with the mobile sites (i.e. the pilot ship). Two earth stations will be installed and a gyroscopic satellite antenna with auto-tracking and stabilization platform will be mounted on board. Communications will make use of the Eutelsat commercial satellite. A remote control and management system is also being planned for the system.

Software development

The software component development of the system covers three main areas: application programming, database services and man-machine interaction. The outcome will be the setup of a series of services which require user input and, in the majority of cases, produce a character-based or graphical output. There is therefore the need to implement a user interface.

The implementation of a classical three-tier client/server database application architecture using Java and Corba technology has been selected in order to guarantee multi-platform support.

Java programming language, with all the necessary extensions for communication with the middleware, will be used for the development of the client side. The middleware based on CORBA technology will be created using Inprise Visibroker 3.2 for Java while the central database system acting as the data repository, will be designed with Sybase's database management product.

GIS

The forth component of SIAMS Information System is represented by the GIS environment. A fully independent customized GIS application will power some of the services with typical GIS spatial analysis functionality. A geo-graphical user interface will also be available to the users.

The GIS application will operate in two different modes: as a common GIS customized application, displaying maps with tools and buttons, or in the background receiving requests from the character based interface and providing either answers to spatial queries (e.g. estimate arrival time) or simple picture maps (GIF format).

In order to carry out these procedures, a bi-directional communication GIS-database will be implemented.

GIS architecture

In the light of a user requirements analysis carried out at the beginning of the project, it was decided not to choose a fully functional GIS product to fulfill the project tasks but to opt for a tailored solution in order to:

- integrate the appropriate level of GIS capabilities focusing on the services;
- provide the necessary level of customization for non GIS-trained users focusing on the ease of use;
- speed up the development, the deployment and the application performance, focusing mainly on large and detailed data sets collections.

Higher efficiency, speed and reliability can be achieved by creating a brand new application featuring only the main GIS tools instead of customizing a fully featured software package.

The GIS software platform

ESRI Map Objects programmable objects technology was chosen according to the following criteria:

- state of the art in programmable GIS object components
- number of worldwide proven implementations;
- compatible geographical data sets available;
- number and quality of compliant GIS software packages for geographical data sets processing and management (ArcInfo, ArcView).

The environment used for application development is Microsoft Visual Basic Professional version 6.0.

An additional criterion for choosing Map Objects was also the availability of an extension to serve maps via Internet (Map Objects Internet Map Server). Since the general user interface is based on a customized browser application, the map server may be easily integrated in a single environment. If on the one hand this solution would provide platform independence and one-step software management and updating or dataset modification, it cannot, however, be implemented on-board the pilot ship owing to an excessive network load compared to the bandwidth available with the satellite system utilized at this stage.

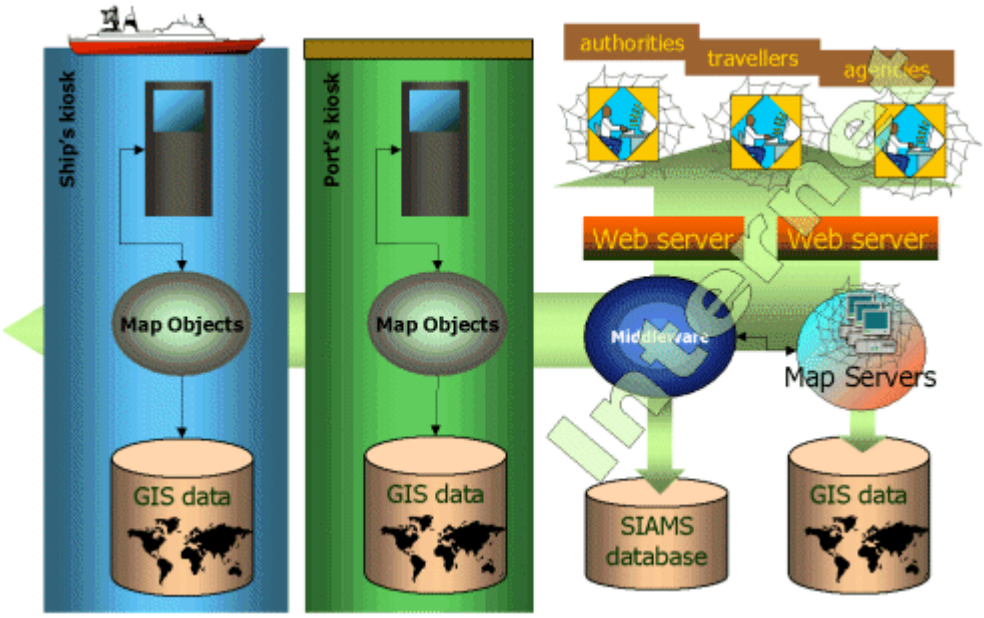

Fig.2. The GIS architecture

Therefore, two different GIS user interfaces are being set-up: a Map Objects stand-alone application to be installed on board and at port kiosks and a MOIMS solution available to internet users and to certain authorized users.
Concerning the Internet Map Server architecture the web server and map server will be hosted on two separate machines, in order to maximize the performances of the system. The web server will be a Microsoft IIS 4.0 hosted at the ICS premises (http://www.ics.trieste.it) while the MapObjects Internet Map Server will be hosted on a Windows NT 4 workstation, Pentium III, 500 Mhz, 256 Mb RAM.
Further tests may eventually lead to installing a mirror IMS site in Greece at the FORTHnet premises.

Bridging different environments: guaranteeing inter-operability

Any software component must be based on a *Component Model*. The two dominant models are CORBA (Common Object Request Broker Architecture) and Microsoft's OLE/COM (Object linking and embedding/Component Object Model).
Map Objects is based on the OLE/COM model, while the User Interface is developed in a Java/CORBA environment.
In order to build up a fully integrated environment a bridging software (Visual Edge Software Ltd. ObjectBridge for COM-CORBA) has been included in the system architecture.
Considering the interaction between the GIS interface and the browser-based user interface, three levels of inter-operability are required: low-level compatibility (guaranteed by the bridge application), switching between interfaces and exchange of parameters and/or commands (sockets will be the solution for inter-application communication. This kind of communication also requires the development of a common protocol, currently under construction, for information, parameters and commands exchange).

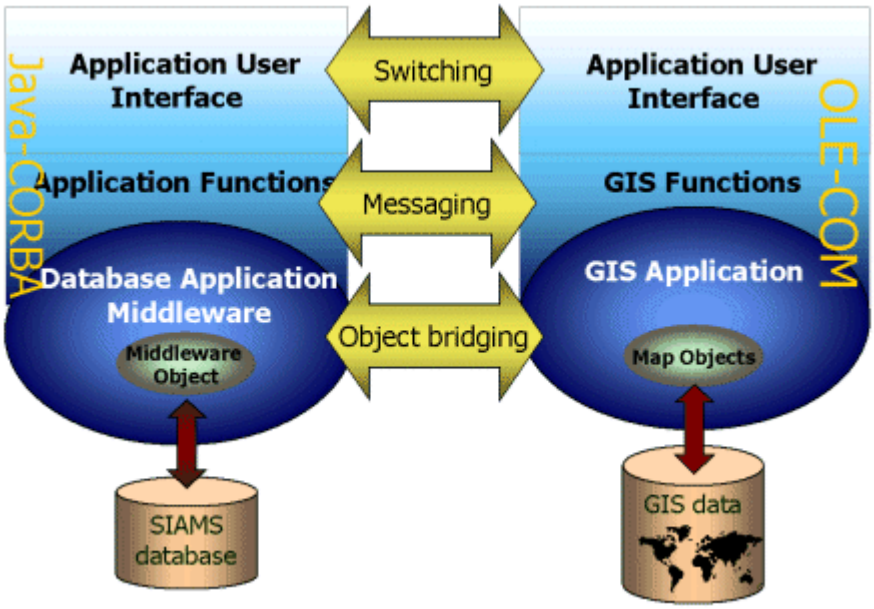

Fig. 3. The architectural solution

SIAMS services

The design of the services is expected to cover all the phases of a ship based journey: from it's planning at home/office, through reaching departure location, boarding procedures and on board assistance to supplying useful information at destination sites.

Two main types of services will be developed: a set of publicly accessible services, mainly addressed to travelers for tourism or commercial purposes, which will be available at multimedia kiosks or via internet, and a set of restricted services for transportation management designed for transportation providers (shipping lines, travel agencies) and controllers (port authorities, custom, etc.). Public services will provide information relating to the trip (ship position, schedules, estimated timetables), booking facilities, tourist information, Internet access on board, announcements, weather conditions and more. Authorized services will include ship management issues (personnel, finance, monitoring), boarding plan administration, real-time trip information (ship precise positioning, speed), office procedure automation.

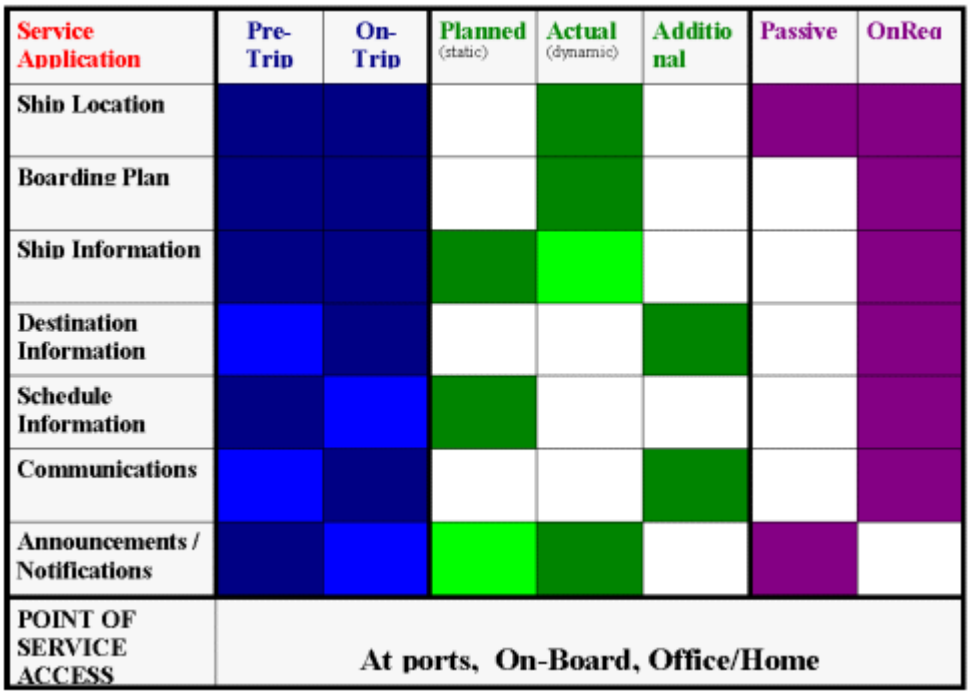

Fig.4. Services classification

GIS powered services

Among the services developed, four are supported by the GIS functionality provided by the Map Objects application. These are: Ship Location (public and authorized), Schedule Information and Port Information.

As mentioned above, the GIS services have been designed to support two interfaces, a stand-alone one for the user at a kiosk and an Internet one retrievable through a browser such as Netscape™ or Microsoft™ Internet Explorer. The two interfaces will, as far as possible, feature the same level of functionality.

There follows some information and a series of snapshots describing the services, their purpose and the interface outlook.

Public_Ship_Location

Purpose of the service

To give a rough representation of a ship's position to both passengers on board and users at port kiosks or connected via internet.

Ship position
The position information retrieved from the GPS system installed on the vessels is transmitted via satellite and stored in the database in order to make it accessible to every

GIS application; the service will be developed to manage more vessels at the same time; at this pilot stage only one ship position will be tested.

Fig.5. The ship location service

Arrival time estimation

The real-time ship location information will be used to estimate the approximate arrival time. This will be either displayed on the GIS interface or calculated on request and passed on to the User Interface.

The calculation of the estimated time will also make use of the vessel's passage plans provided by the shipping companies. The passage plan reports the expected route followed by the ship, broken down in segments of known length and expected time duration, and it is determined before departure. Conventional GIS spatial analysis procedures will be employed to determine the total amount of time needed to arrive at each destination.

The GIS interface will therefore give the actual time lapsed since departure, the estimated time left to reach the next port and any subsequent stop and a map showing an approximate location of the ship. Weather information along the route will also be displayed.

The passage plan will also be reported on the map, offering the passenger an overview of the trip route.

Position accuracy

In accordance with the project specifications, the service is allowed to provide only an approximate position, due to security restrictions; the ship's actual coordinates, retrieved from the database, will not be shown on the interface and the zoom level will be limited in order to avoid accurate positioning. For the same reason, the level of detail of the background will also be limited by the controlled accuracy of the vector and raster datasets used (see below for details).

Geographic representation

Regarding the geographical background on which the ships will be represented, the solution adopted is the combination of a raster Digital Terrain Model (DTM) overlaid with thematic vector data derived from the Digital Chart of the World dataset (scale 1: 1.000.000). The DTM data are supplied on the Internet by the National Geophysical Data Center and have a spatial resolution of 30 Arc Seconds.

Arc/Info data processing and elaboration has been necessary to mosaic the different tiles that cover the Mediterranean Sea region and this procedure has been repeated also for vector data representing country and province boundaries, major cities, airports, sites of interest, rivers, etc.

GIS platform implementation

The service will be implemented on both the kiosk stand-alone platform and on the Internet Map Server.

Authorized_Ship_Location

Purpose of the service

To give a precise representation of a ship's position to shipping companies and port authorities. This information is of extreme importance to monitor the functioning of ships and to speed-up intervention measures in case of critical situations.
Confidential information will be provided and security measures will be adopted to avoid exposure of sensitive data.

Service features

The design of this service follows the framework of the Public Ship Location service conveying, however, two extra elements: the actual vessel coordinates for each ship and their speed.

GIS platform implementation

Considering the heterogeneous environment in which a stand-alone application should be implemented, the service will be available only through the Internet Map Server application. The use of the Virtual Private Network will be required in order to guarantee the necessary safety level.

Schedule_Information

Purpose of the service

The SIAMS database will be structured to manage, analyze and retrieve information regarding all the ship based trip schedules in the Mediterranean basin. A Java based user interface will allow users to retrieve information on all available connections between a

departure and a destination port with a specified date and time lag. A multi-step window menu will eventually lead to a list of all ships covering the specified itinerary with a detailed time table showing departure/arrival times, trip duration, intermediate stops. An optional button will allow the user to switch to the GIS interface.

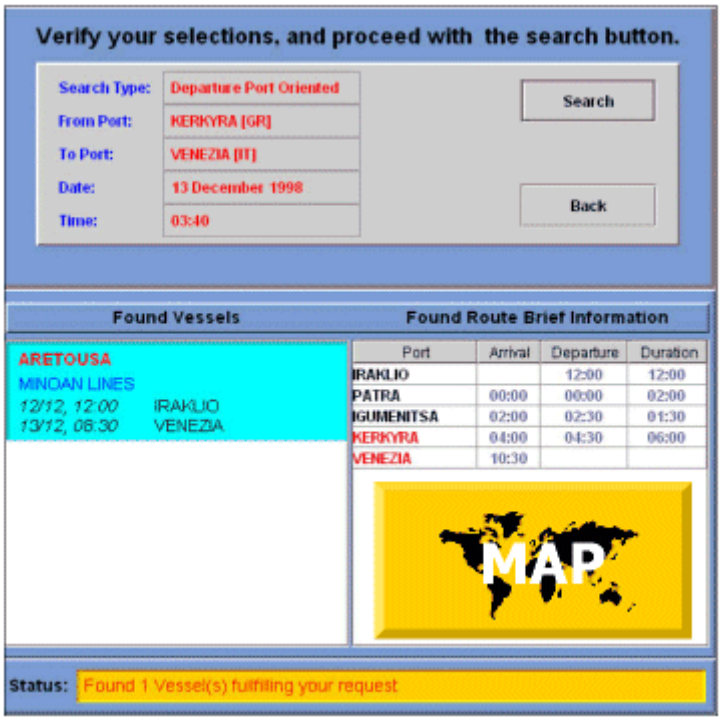

Fig.6. The trip schedule interface

The GIS interface of this service will provide the map of the ship's entire itinerary highlighting the user's specified section, navigation buttons, the official timetable and a link back to the character based interface.
A visually driven selection of itineraries to obtain scheduling information is currently under study.

Fig.7. The GIS schedule interface

GIS platform implementation

The service will be implemented on both the kiosk stand-alone platform and on the Internet Map Server.

Port_Information

Purpose of the service

The aim of the service is to offer travelers a set of useful information on the departure or destination of their trip.

Service features

The GIS interface of this service will provide a detailed map of the port area, indications to reach a port or other selected destinations, road networks and connections to other means of transportation, sites of interest, weather information. Navigation tools for visualization at multiple levels of detail (district, town, street) and search capabilities (attribute based and spatial queries) will support the user. Hot-links to other services and to multimedia information (pictures, text, etc.), links to web sites (hotels, museums, etc.) and to Tourist Information Systems for online booking will also be supplied.

Ports data

A very critical issue for this service has been the retrieval of highly detailed digital data sets of the ports and surrounding areas of the sites involved in the pilot project (Venice and Bari for Italy and Corfu, Igoumenitsa, Patra and Chania for Greece). Such data are crucial to the creation of maps at an adequate scale and to the localization and displaying of facilities of tourist interest.

TeleAtlas provided the data for the Italian sites (scale 1:10.000) while ESRI Greek distributor retrieved those relative to Greek ports.

At this stage of the project, elaboration of these data-sets is in progress.

GIS platform implementation

The service will be implemented on both the kiosk stand-alone platform and on the Internet Map Server.

Where does GIS make the difference?

The use of GIS technology offers added value to the Information System since it plays a key role in a field which is eminently geographical.

A number of features, peculiar to this system, are worth highlighting:

- the system will feature a (geo)graphical user friendly interface to explore the information space;

- the integration of dynamic data and digital maps will be used, for example, to provide real time information on distances and delays;
- interactive mapping will be available on request, extended also to internet users;
- spatial queries and analyses based upon the relationships between entities (e.g. route estimations, finding features in a certain radius, etc.) will be easily performed;
- background spatial support to the common user interface will be also implemented as an alternative operative mode.

Future development

The setting up of an exploitation plan will be one of the outcomes of the project. The architecture of the system is structured to be open and scalable in order to eventually cater for multiple vessels, multiple shipping lines as well as new services.

Two main directions of development are foreseen with regards to the GIS component of the project: internet services and advanced scheduling capabilities.

- Fully Internet based services

As cheaper satellite connections and faster Internet connections become available, the services could be based entirely on Internet Map Server technology.

- Intermodal transportation scheduling

Functionality such as finding the best or the cheapest route, combining multiple means of transportation and/or multiple shipping companies, etc. could be integrated using network analysis algorithm components (e.g. NetEngine).

Project partners

Ship Information And Management System (SIAMS) is an international project within the Telematics Application Programme of the European Commission. The project is coordinated by FORTHNET SA from Greece; other participants include Alfa Ltd., Greece, Visual Software Italy srl, Italy, TOP-REL srl, Italy and the Instituto Balear de Innovacion Telematica, Spain. ICS – UNIDO, Italy, is responsible for GIS services implementation.

Associated Partners are Minoan Lines Shipping SA, Greece, the Greek Ministry of Mercantile Marine, HTA - High Technologies Associate Ltd, United Kingdom and Systron srl, Italy.

Sponsoring Partners for Tourist Information Systems are Regione Puglia (Italy), Egnatia Foundation & Region of Epirus (Greece), Region of Crete (Greece) and the Provinces of Drama, Kavala, Xanthi (Greece).

Sponsoring Partners for GIS software & geographic data are ESRI Inc., ESRI Italy, TeleAtlas (Italy) and Marathon Data Systems (Greece).