INTELLIGENT MONITORING OF CONTAINERS - IMC

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Abstract: Intelligent monitoring of containers is an innovative and modern system dedicated to container management in multimodal transport being developed in Romania into an national research project.
The system offers services for planning and real time survey of the container transport and transported freight.
The system is an information system that support activities regarding freight mobility being dedicated to goods providers, goods buyers, brokers, road transport operators, railway transport operators, naval transport operators, air transport operators, assurance agencies, container owners,
The technologies that have been used and integrated during system development are .Net, GPS (Global Positioning System), GIS (Geographical Information System), GSM (Global System for Mobile Communications).

Key words: Goods multimodal transport, container monitoring, transport planning and surveying, Net, GPS, GIS, GSM.

1 Introduction

Intelligent Transport Systems are transport systems that use information and communication technologies, and control technologies to improve transport network operation having as finality the increase of the transport efficiency and security.

The strategy for the Intelligent Transport Systems has been developed in principal in U.S.A., Europe and Japan.

The intelligent transport systems represent a new challenge for research, development and technological innovation.

The transport is a key factor in a modern economy.

Goods movements are a business that has a major impact on all activity areas.

The multimodal transport development integrates the conventional transport modes and is the way to reduce the time travel and increase transport efficiency.

The usage of information and communication technologies is the key for increasing the efficiency of the transport services oriented on clients.

The success of the intelligent transport systems comes from modern technologies usage.

The new transport strategies are oriented on:

- Multimodal transport;
- New services for mobility assurance;
- Positioning systems;
- Services based on communication using satellites;
- Integration of services and systems developed for different transport modes;
- Development of interfaces between different transport modes.

The multimodal transport is a complex transport mode that integrates at least two of the following transport modes:

- Road transport,
- Railway transport,
- Naval transport and
- Air transport.

In order to optimise transport activities, at transport mode level, have been developed a diversity of computerised systems for data acquisition, data processing, route optimisations, data storing, data distribution, data retrieval, data representation on map.

The multimodal transport is a relative new mode of transport through which the goods are transported between two locations or on a chain of locations

(departure, destination, transit) using different means of transport that are specific to different transport modes (fig. 1)

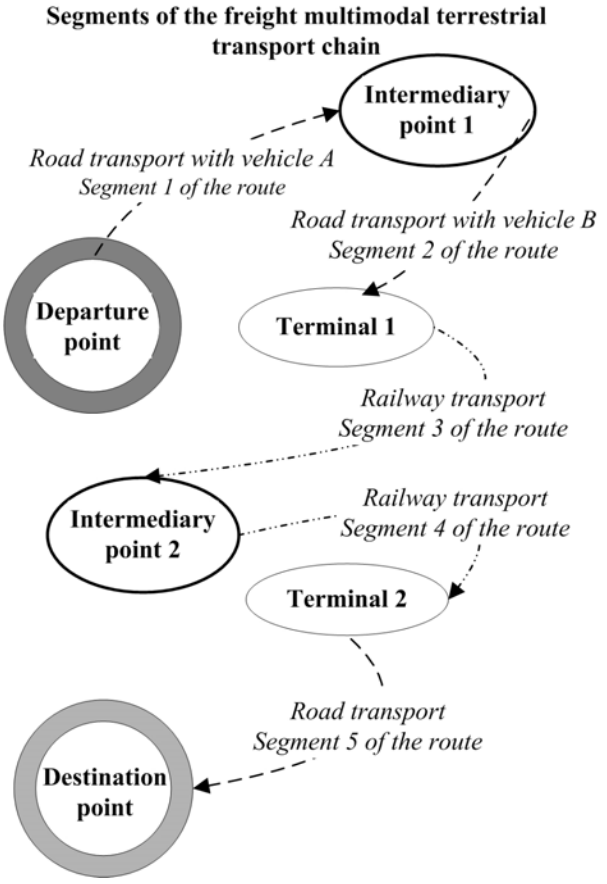

Fig. 1 Multimodal Transport Chain (example)

An intense research activity is dedicated, in the last years, in high developed countries and in FP6 Program to the development of new information systems for multimodal transport management Taken into account this new research strategy for transport area a new approach for computerised system development dedicated to multimodal transport has been considered.

The principal aspects considered in IMC (Multimodal Network System) development refer to the planning of the multimodal transport of the goods (fig. 2), multimodal transport surveying, and container management in multimodal transport using autonomous GPS & GSM devices

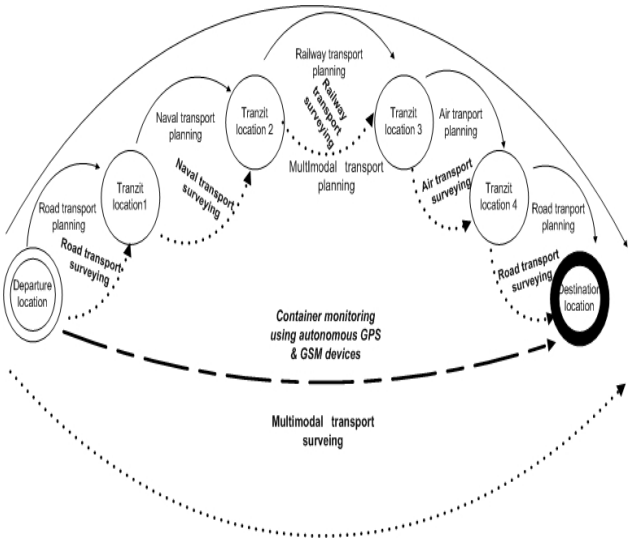

Fig. 2 Multimodal transport management using IMC system

2 Problem Formulation

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The target of the IMC system is to provide hardware and software integrated components to assist in real time all processes specific to planning and surveying of the container transport and contained goods in multimodal transport anytime and anywhere using innovative information and communication technologies.

3 Problem Solution

3.1 Development Framework

The first Romanian system for the management of containerized goods in multimodal transport, based on Web, GIS, GSM and GPS technologies was developed under the coordination of the National Institute for Research and Development in Informatics – ICI Bucharest into a research and technological development Romanian project, by a consortium that contained a research institute, a research centre from the "Politehnica" Bucharest university, a private company and agents involved in multimodal transport.

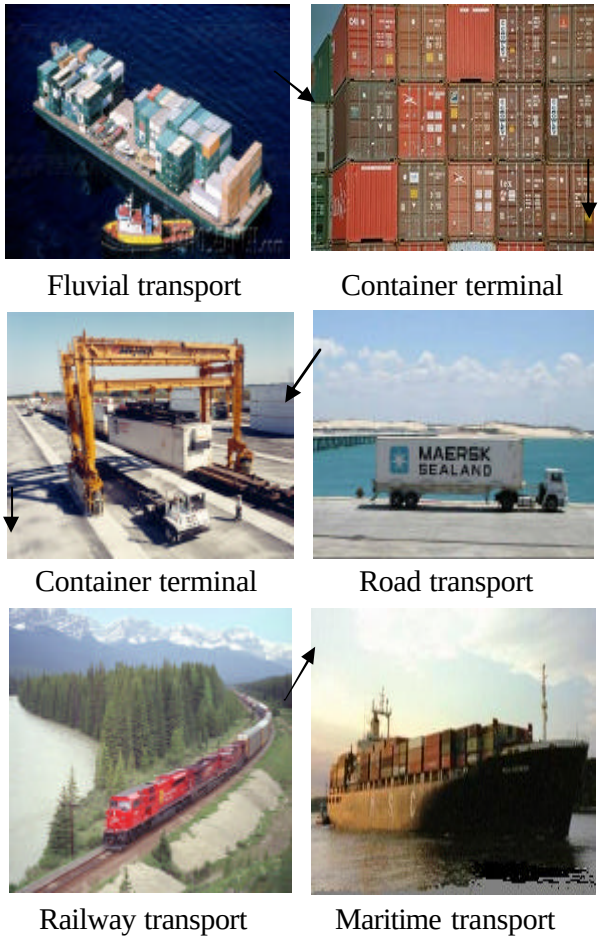
3.2 Characteristics

The system monitors the physical and information flows on the segments of the multimodal transport chain, contributes to the increasing of the

information level, of the responsibility in task accomplishing, and of the transport security by a real time supervising of the goods mobility.

The system complexity consists of modern information technologies, mobile and satellite communication used into an integrated and distributed system for an advanced container monitoring and contained goods in the multimodal transport.

IMC is a modern, integrated, interactive and intelligent system, being dedicated to the provision of electronic services for the multimodal transport management (fig.3) of containerized goods at worldwide level.



Fluvial transport | Container terminal

Container terminal | Road transport

Railway transport | Maritime transport

Fig. 3 Example of assisted multimodal transport

IMC:

- Manages the information concerning the planning and the surveying of the multimodal transport anytime and anywhere;
- Monitors, in real time, the container position and integrity;
- Supports the activities regarding the mobility of the goods transported in containers;
- Provides a direct management of the containers and an indirect management of the vehicles along the different segments of the multimodal transport chain;
- Offers Web services for all the agents involved, with different roles, in the containerized goods multimodal transport;
- Performs data acquisition, data storing, data processing and data retrieval;
- Optimizes business processes and increase the transparency and the responsibility inside the business groups involved in the goods multimodal transport.

The container monitoring in multimodal transport, considers as transport segments road transport, railway transport and fluvial / maritime transport.

The goods multimodal transport chain contains:

- Departure Point (DP);
- Destination Point (DP);
- Transit Points (TPi) in which the transit of the goods / containers from one mode of transport to another is performed.

3.3 IMC working environment

The working environment promoted by IMC is presented in the figure 4..

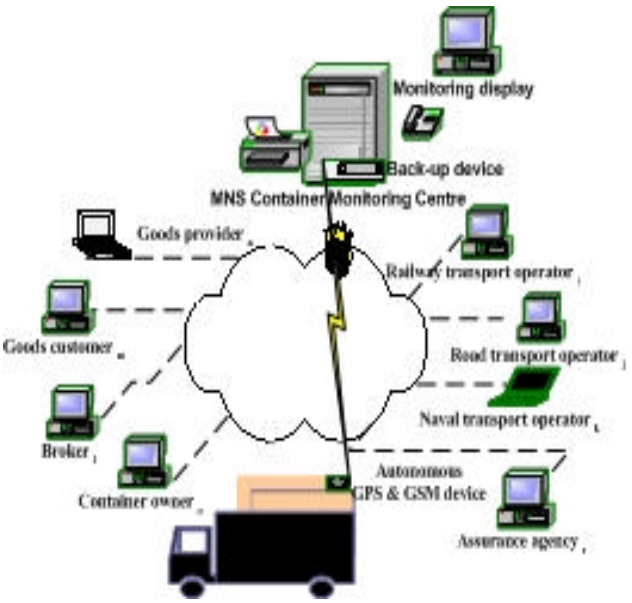


Fig. 4 IMC working environment

The working environment promoted by IMC is presented in fig. xxx and contains:

- Container Monitoring Center;
- Goods providers;
- Goods consumers;
- Brokers;
- Container owners;
- Railway transport operators;
- Road transport operators;
- Naval transport operators;
- Assurance agencies.

In figure 5 is presented the hardware component created to container monitoring anytime and anywhere on multimodal transport segments using GPS and GSM technologies.

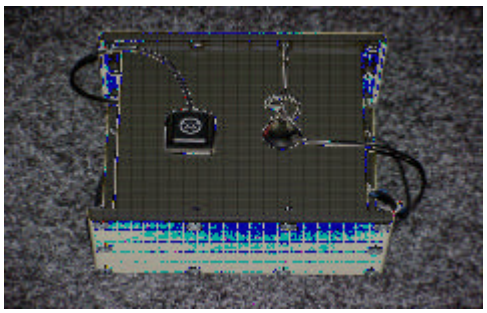


Fig. 5 Asynchronous GPS&GSM device

The mobile electronic equipments used to survey the containers are located on a protected place situated on the external part of the containers. It communicates to Monitoring Center, in real time or periodically, in conformance with the user requirements, the container geographical co-ordinates, the container status parameters and mobile equipment status parameters.

3.4 System structure and functionalities

IMC is structured in two types of components:

- User oriented components offer computer aided services for multimodal transport management;
- Administration oriented components to reliable system operation perform the system administration and the container dispatching using autonomous GPS & GSM devices.

The system enables the registration of an organization involved in the multimodal transport, as an agent, and also enables the registration of the agent's business partners and the organization's employees which administrate or use the information.

The system allows the administration of the goods, containers, vehicles, multimodal transport routes by highlighting the transport chain segments.

The system provides confidentiality, ensuring the access to the information only for the agents that have received the access rights at the multimodal transport chain in which they are involved.

IMC offers to clients the following services:

- Registration as Agent or User;
- Multimodal Transport Planning;
- Multimodal Transport Surveying;
- System Operation.

The "Registration as Agent or User" service allows the registration of the organizations (goods supplier, goods buyer, forwarding agency, container owner, road transport operator, railway transport operator, naval transport operator, air transport operator and insurance company) involved in the multimodal transport.

The "Multimodal Transport Planning" service allows the registration of the information regarding the multimodal transport planning, the visualization of the information regarding the multimodal transport planning and the visualization on the map of the planned transport route.

The "Multimodal Transport Surveying" service allows the registration and the visualization of real multimodal transport routes and container monitoring using GPS and GSM technology.

The "System Operation" service allows the registration into the system database of the system operators, the specification of the access rights, and the validation of the access to the system and the dispatching of the autonomous GPS & GSM devices.

The search criteria that can be considered to define the selection formula are the following:

- „Planned Container";
- „Real Container";
- „Only unfinished routes";
- „Only finished routes";
- „Both finished and unfinished routes";
- „All registered routes".

A global structure of the IMC system is presented in the figure 6

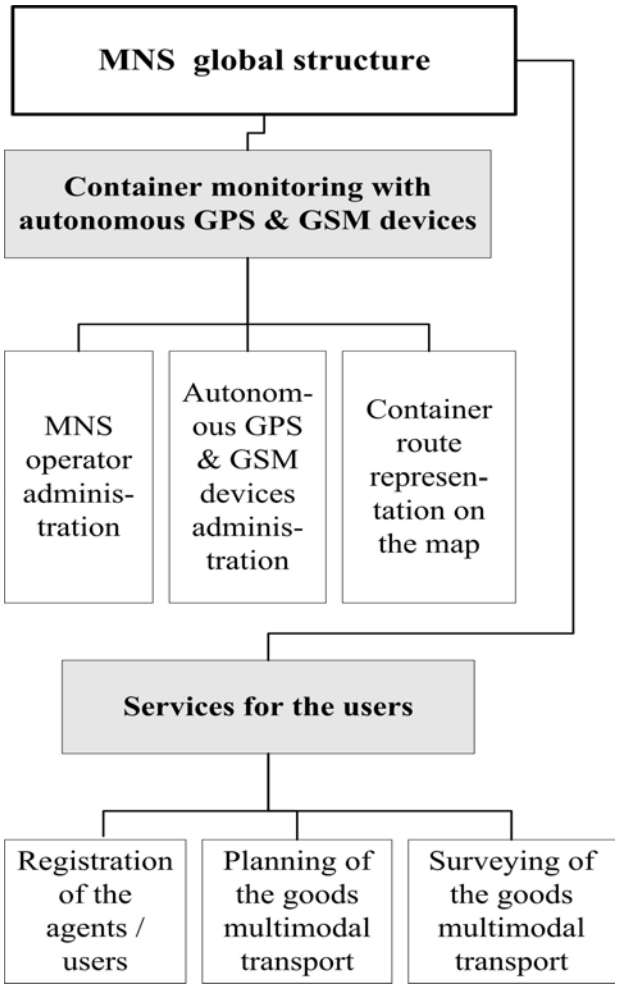


Fig. 6 Global structure of IMC

Administration components are:

- „Client management" defines the access rights and verify the access to the system in conformance with access rights.
- „Mobile equipments management":
  - Mobile equipment monitoring manages the functional parameters of the mobile equipment. Has been identified a location on the external part of the container where the mobile equipment will be installed in order to do not disturb the container manipulation or to do not produce perturbations in the mobile equipment functionality.
  - Data acquisition: the mobile equipment collects container GPS position, container status parameters, and mobile equipment parameter status. The system verifies the collected data before to be stored in the system database.
  - Displaying of the information received from the mobile equipment: The system display the collected data and the alarm messages. Has been implemented a zoom function for the information represented on the map.

3.5 Managed information

The managed information (fig. 7) is structured, taking into account the agent roles in the system, in data categories:

- Agent types, agents, business partner groups;
- Administrators of multimodal transport agents, GIS administrators, system administrators;
- System operators, goods, containers, vehicles;
- Transport routes, segments of the route, transport modes, locations (departure, destination, transit);
- Autonomous GPS&GSM device for container monitoring, maps.

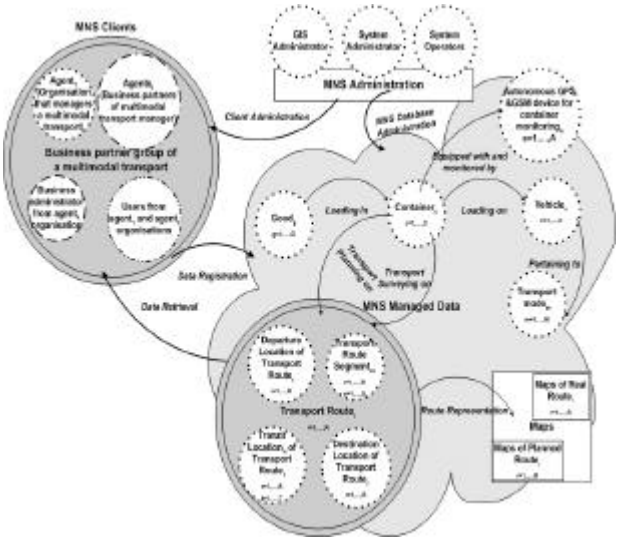


Fig. 7 Structure of managed information

3.6 Technical Architecture

From hardware point of view, the system contains:

- Mobile equipment installed on the container that is composed of:
  - GPS receptor;
  - GSM modem;
  - Control unit (surveys the receptor and modem functionalities, performs data acquisition, data storage and data transmission);
  - Accumulator;
  - GSM antenna.

- Equipments from Monitoring Center:
  - Application server with contains the software for the transport management and the container management;
  - GIS server;
  - communication server;
  - modem;
  - GSM antenna.

From software point of view, the system contains modules to:

- Mobile equipment configuration;
- Data communication;
- Means of transport and freight management (planning and survey);
- Positioning on the map of the planned routes and real routes of the freight multimodal transport;
- System administration.

Principal technical components of IMC system are presented in the figure 8.

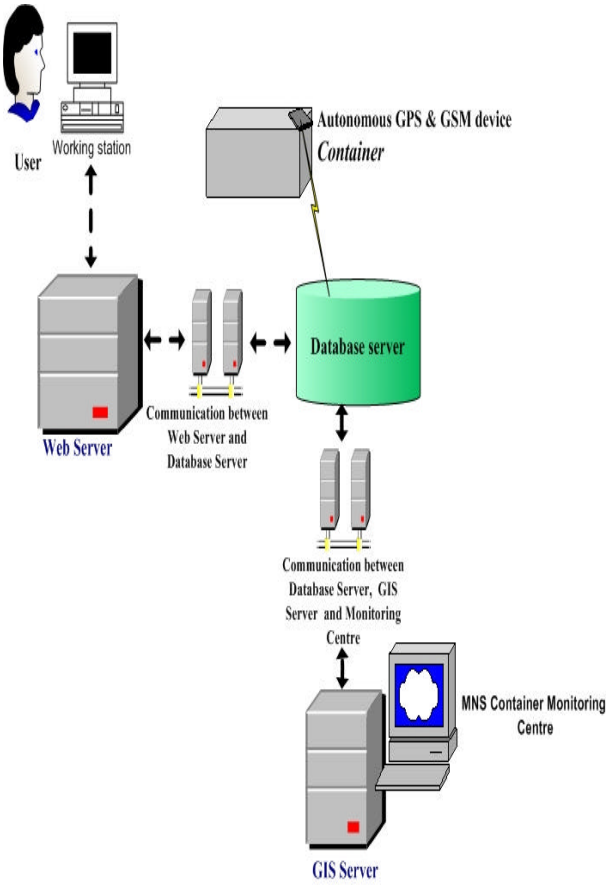


Fig. 8 IMC technical components

The technical components of IMC presented in the figure 5 are the following:

- IMC Container Monitoring Center;
- GIS server;
- Database server;
- Asynchronous GPS&GSM device;
- Web server;
- Communication between Web server and Database server;
- Communication between Database server and GIS server and IMC Container Monitoring Center;
- Workstations for users.

3.7 The platform interfaces examples

Some examples of user interfaces offered by IMC systems are presented in the below figures.

The multimodal transport route segments are represented on the map. Detailed information about the goods, route segments, containers, vehicles is also provided. The system offers an interface for real time management from the Monitoring Center of the autonomous GPS&GSM devices.

Fig. 9 Route segment registration

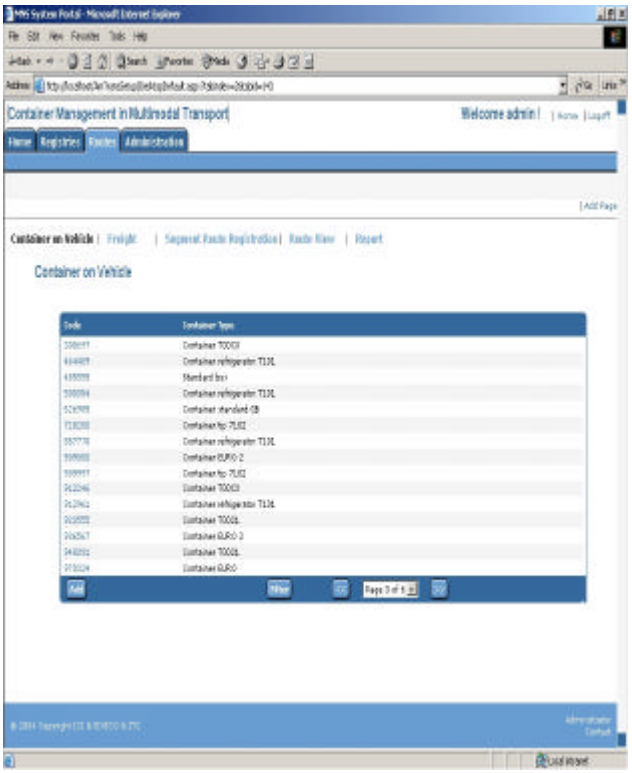


Fig. 10 Container – vehicle relation management

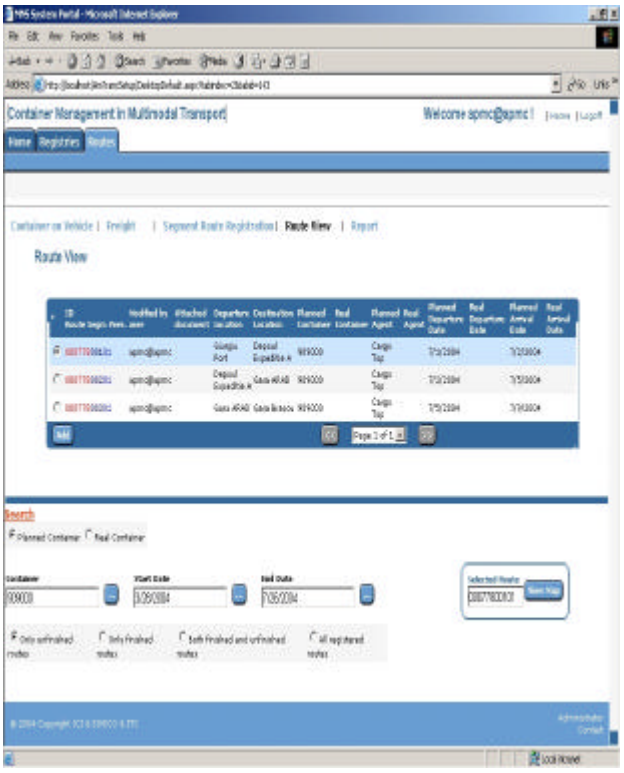


Fig. 12 Route segment search

Fig. 11 Management of freight transported in Containers

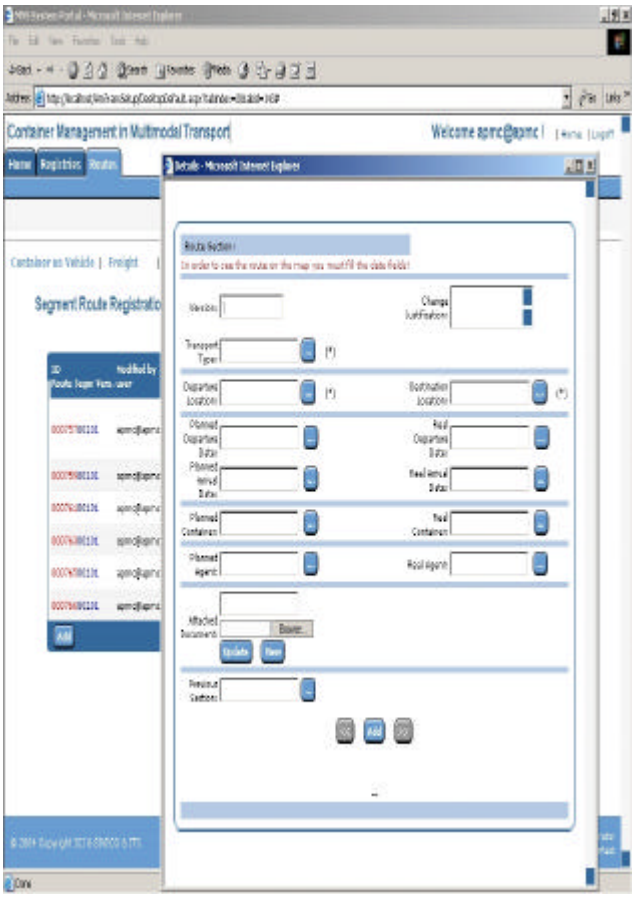


Fig. 13 Multimodal transport route segment registration

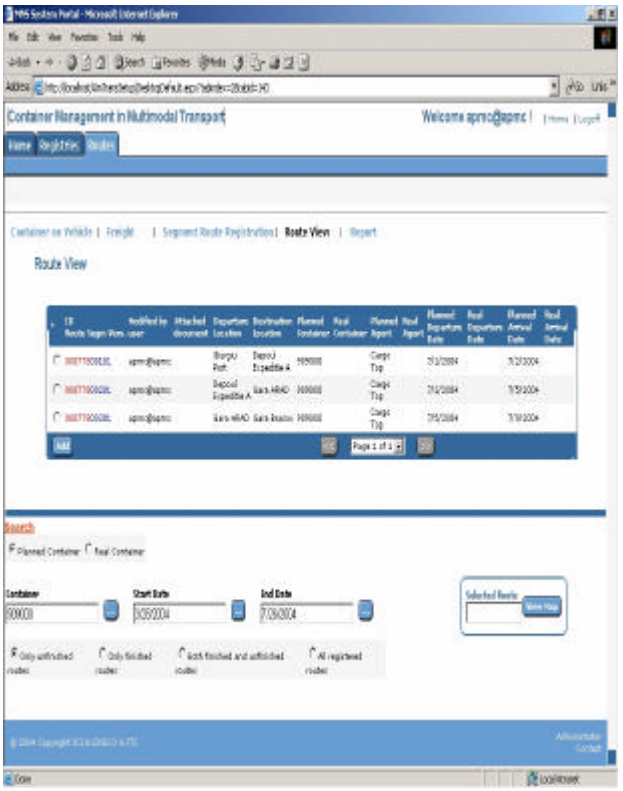


Fig. 14 Route view

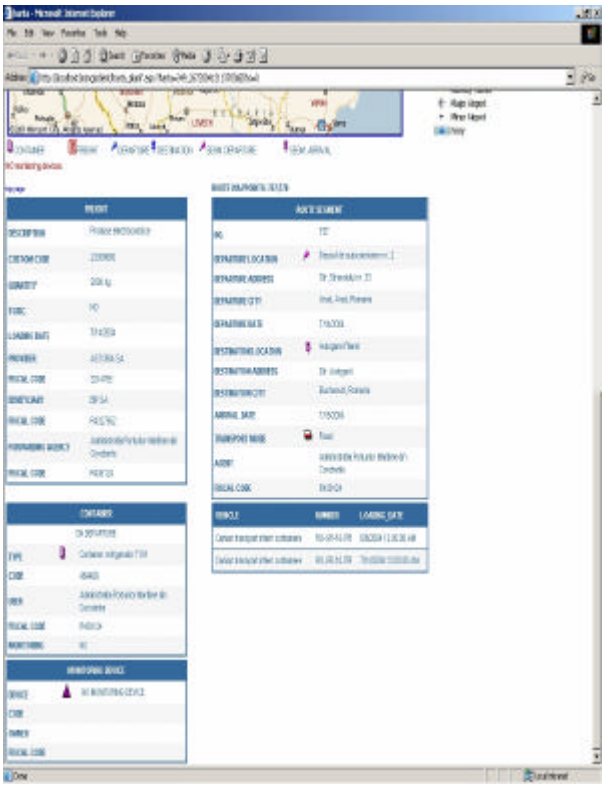


Fig. 16 Representation of the planned route (2)

Fig. 15 Representation of the planned route (1)

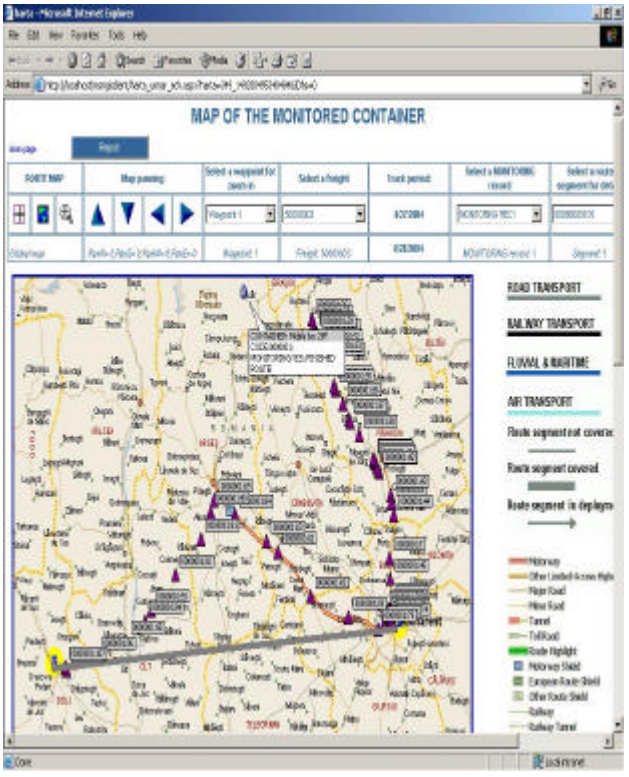


Fig. 17 Container monitoring by users through Internet

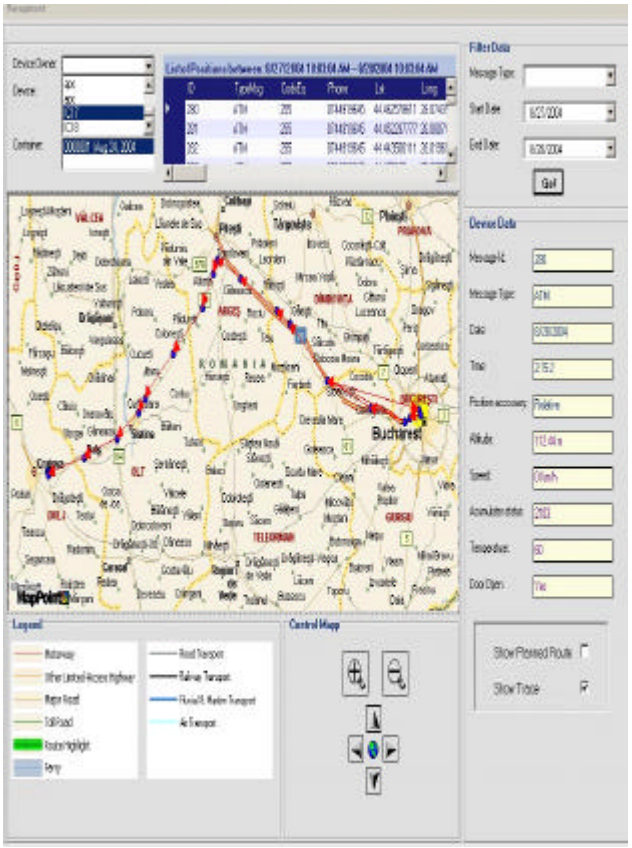


Fig. 18 Container monitoring from Monitoring Center

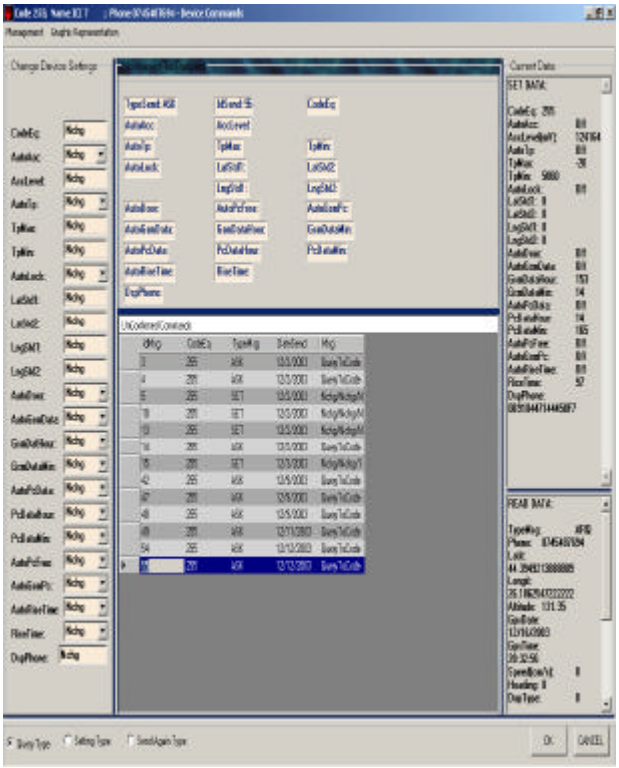


Fig. 19 Autonomous GPS&GSM device management from Monitoring Center

3.8 Considered tools

IMC uses and integrates a diversity of technologies like:

- Microsoft technology for Internet application development (.Net, SQL Server, MapPoint 2002, XML);
- Positioning technology (GPS – Global Positioning System);
- Communication technology (GSM – Global System for Mobile Communication);
- Vectorial map management technologies (GIS – Geographical Information Systems);
- Relational databases management;
- Monitoring analyses support for decisions and evaluation.

3.9 Qualities and benefits

The IMC system:

- Has a high contribution in the increasing of the multimodal transport efficiency;
- Monitors, in real time, the position and integrity of the containers;
- Provides Web services for agents involved in the multimodal transport;
- Influences the development of an open electronic market for multimodal transport;
- Contributes to the increase of human resource efficiency;
- Allows the planning and the tracking of the goods multimodal transport;
- Ensures the increase of the goods multimodal transport quality;
- Minimizes the number of lost containers and the risks in the management of containers;
- Allows a friendly dialogue with the users, a special training for its use being unnecessary;
- Influences the environment protection by diminishing the pollution risk;
- Ensures the development of an efficient mode for communication between the agents involved in the good multimodal transport contributing to the increase of responsibility and transparency;
- Increases the responsibility and information transparency at the level of business partners involved in the goods multimodal transport;

- Increases the information flow efficiency specific to goods multimodal transport;
- Increasing of the responsibility of the partners involved in the containerized goods multimodal transport;
- Decreasing of the time used to search and manage the information specific to containerized goods multimodal transport;
- Increasing of the human resource efficiency and performance;
- Decreases the administration costs in the goods multimodal transport;
- Decreases the search costs of the containers that "deviated" from the planned route.

4 Conclusion

The intelligent transport systems for goods multimodal transport management are in the research and development stage at European level and at national level, in particular in the countries that uses on a large scale this kind of transport.

The communication and the integration of the business data specific to information flow of goods multimodal transport can be more efficient and well used only by using Information and Communication technologies.

A real time survey of the container cannot be realized without new positioning technology.

A real time access to the information from anywhere and anytime is a principal condition for acting to support an active business.

A quick analysis of the goods transport real status in rapport with the planned one is impossible with traditional working methods.

The system users, in conformance with access rights, can create selection criteria based on a diversity of filter facilities provided by the system and obtain information concerning planned goods multimodal transport.

The system offers two-display modes one provides information regarding containers, goods, route segments, means of transport, agents, date, time, etc. without geographical data and another one uses a digital map representation of the planned route.

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