

INTEGRATED SOLUTIONS FOR FREIGHT MULTIMODAL TERRESTRIAL TRANSPORT MANAGEMENT

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Abstract: SINMAR-TMM is an intelligent system that integrates innovative solutions developed through a Romanian research, development and innovation project for freight multimodal terrestrial transport. National Institute for Research and Development in Informatics has coordinated the project. The solutions have been created in cooperation with CEPETET research centre of Politehnica University from Bucharest. The system has as principal user and co-financier CFR-MARFA – Romanian freight railway Transport Company. The SINMAR-TMM system solutions support the planning and monitoring processes specific to freight multimodal terrestrial transport being dedicated to economic agents involved in this transport mode as freight providers, freight buyers, forwarding agencies, freight railway transport operators, freight road transport operators, container / standard transport unit owners, warehouses / terminals operators. The SINMAR-TMM system contains and integrates a diversity of hardware and software components created using different ICT¹ technologies.

Key words: multimodal terrestrial transport, container, transport planning, transport monitoring, GPS, GIS, RFID, GPRS

1 Introduction

Transport development has been a consequence of the worldwide economy development that increases continue the freight transport volume.

European Union established a clear vision to intelligent transport systems based on specific policies and key objectives in order to be launched important initiatives for development in Information and communication technologies area.

The economic modifications have a strong impact on intelligent transport systems. The agents that work in transport area begin to be familiarised with concepts and tools specific of intelligent transport systems.

The majority of intelligent transport systems are the results of the complex research and technological development projects where are involved as partners research institutes, universities, economic agents from transport area, private companies

Multimodal transport is the transport mode that supports the movement of goods or persons between different locations using at least two means of transport.

Terrestrial multimodal transport uses road transport or railway transport on the transport segments in order to make more efficient the transport between specified locations.

SINMAR-TMM system is a modern, innovative, multifunctional and integrated system for informational management of the freight multimodal terrestrial transport. The system integrates new technologies that support the data acquisition and information management. The system integrates into a multifunctional platform hardware and software components developed for freight multimodal terrestrial transport flow planning and monitoring. An example of freight multimodal terrestrial transport flow assisted by SINMAR-TMM system is presented in the Fig.1.

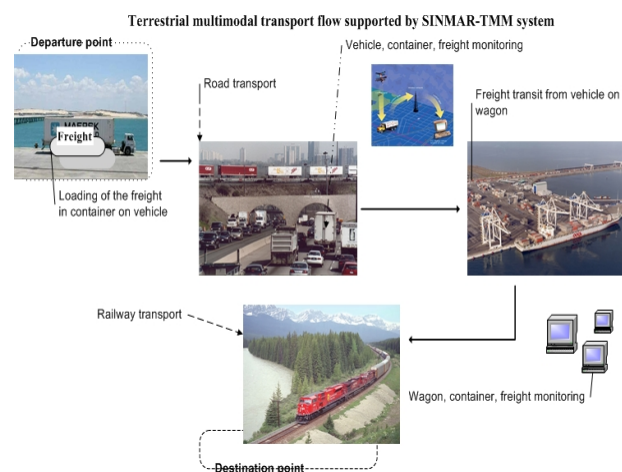


Fig. 1 Terrestrial multimodal transport flow

¹ ICT - Information and Communication Technologies

2 Problem Formulation

The development of integrated solutions to support the planning of the freight multimodal terrestrial transport and the real time transport monitoring of the freight and standard transport units on the multimodal transport segments using ICT is the problem that had to be solved. The route of freight multimodal terrestrial transport contains transport segments that link the successive points of the transport route. Two successive transport segments may be of the same transport mode.

3 Problem Solution

SINMAR-TMM is the system that through his functions structured in six categories integrates the developed solutions for supporting the planning and monitoring of the freight multimodal terrestrial transport.

3.1 Functionalities

The system assures the following functionalities:

- Freight transport modalities management:
 - Management of the agents involved in multimodal terrestrial freight transport: agent registration, information update, agent access management;
 - Multimodal transport route management (departure and destination points of multimodal route, route segments, and means of transports used on different segments);
 - Freight management on the segments of the terrestrial multimodal freight transport route;
 - Container management on the terrestrial multimodal transport route;
 - Vehicle management on the road freight transport segments of terrestrial multimodal transport route;
 - Wagon management on the railway freight transport segments of the terrestrial multimodal transport route;
 - Wagon set management on the railway transport segments of terrestrial multimodal transport route;
 - Representation of the transport flow on the Europe digital map.
- Transport monitoring devices management:
 - Management of the DPPC devices used for vehicle monitoring on road transport route;
 - Management of the DAPC devices used for container monitoring on terrestrial multimodal transport route;
 - Management of the DFLR devices used for wagon and wagon set monitoring on railway transport route.

-Access and communication management:

- Assurance of the access security to the information in conformance with access rights;
- Assurance of the communication security between system components.

-Information visualisation:

- Visualisation of the information managed by the system based on user requirements at agent level involved into a terrestrial multimodal freight transport route using selection criteria created dynamically by the user;
- Providing of status reports, information reports and statistic reports.

-Information archive management:

- Automatic creation of archive with data managed by the system;
- Information extraction from archived data.

-Database saving and restoring:

- Saving system database;
- Restoring system database.

3.2 Services

System offer services as:

- System administration: functional and database integrity assurance, information confidentiality keeping at business partner level, real time answer to user requirements, authentication control, monitoring devices management.
- Client registration and password and access rights providing.
- Multimodal terrestrial transport planning:
 - Connection to the system using the identification number and password;
 - Business partner and multimodal transport contract registration;
 - Multimodal terrestrial transport route segment registration;
 - Route search and route segment search.
- Multimodal terrestrial transport monitoring:
 - Management of the devices used for transport standard unit (wagon, vehicle, container) monitoring in real time on multimodal terrestrial transport route;
 - Device parameter setup;
 - Data acquisition regarding transport standard unit location;
 - Freight and transport standard unit monitoring on transport segments included in the transport route specified in multimodal terrestrial transport contract;
 - Representation on the map of information concerning freight and transport standard unit monitoring.

3.3 Transport monitoring devices

Hardware components of the created system are:

-Programmable Device for Positioning and Communication (DPPC) for data acquisition to real time vehicle monitoring using GPS, GSM and GIS technologies.

-Autonomous Device for Positioning and Communication (DAPC) for data acquisition to real time container monitoring using GPS, GSM and GIS technologies.

-Radio Localization Fix Device (DFLR) that uses electronic labels and electronic label readers based on RFID technology, for data acquisition to real time wagon monitoring in railway transport.

Different transport strategies have been considered. For each strategy, there are one or more solutions for real time transport monitoring as it is presented in the table 1.

Tabelul 1 Transport monitoring strategies

Monitored object	Transport mode	Devices for transport standard unit monitoring		
		Container	Vehicle	Wagon
Freight in vehicle	Road		DPPC	
Freight in vehicle on wagon	Railway		DPPC or DFLR	
Freight in container on vehicle	Road	DAPC or DPPC		
Freight in container on vehicle on wagon	Railway	DAPC or DPPC or DFLR		
Freight in wagon	Railway			DFLR
Freight in container on wagon	Railway	DAPC or DFLR		
Vehicle	Road		DPPC	
Vehicle on wagon	Railway		DPPC or DFLR	
Wagon	Railway			DFLR

3.4 Software components

Software components are structured in 5 categories:

- Client subsystems for freight multimodal terrestrial transport management by the user;
- Central management centre to device management.
- Data acquisition with monitoring devices;
- Web services for system component integration;
- Database and database management system.

3.5 Communication flow

The communication flow between monitoring devices, users and operating center is presented in the figure 2.

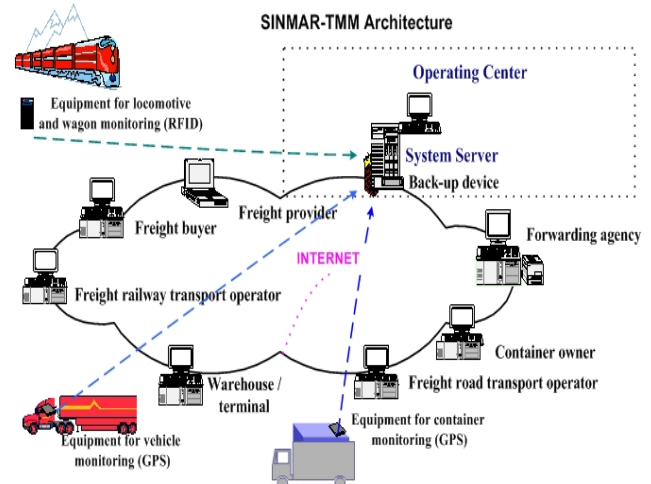


Fig. 2 Communication flow

3.6 Users

The system users have been structured in 7 categories: freight provider, freight buyer, forwarding agency, freight railway transport operator, freight road transport operator, container / standard transport unit owner, warehouse / terminal.

3.7 Qualities

The quality characteristics regarding system architecture are: flexibility, openness, modularity. The principal quality characteristics of the system services are: accessibility, confidentiality, real time dialog. The qualities characteristics concerning system functionalities are: reliability, security, interoperability, robustness, security, user-friendly interface. The system interfaces can be translated in any language.

3.8 Technologies

The system uses and integrates languages, technologies and tools like:

- GIS - Geographical Information System;
- GPS - Global Positioning System;
- GSM - Global System for Mobile Communications;
- GPRS - Global Packet Radio Service;
- RFID - Radio Frequency Identification;
- SQL - Structured Query Language;
- T-SQL - Transact-SQL;
- MS-SQL 2000 Server;
- programming framework .NET;
- C#.Net, VB.Net;

- IIS5.0 - Internet Information Services;
- Web services;
- WSE2.0 - Web Services Enhancements;
- XML2.0 - eXtensible Markup Language;
- ADO.Net - ActiveX Data Objects;
- WSDL - Web Services Description Language;
- UDDI Universal Description Discovery and Integration.

3.9 Interfaces

The system is in the testing phase. Some of system interfaces are presented in the below figures.

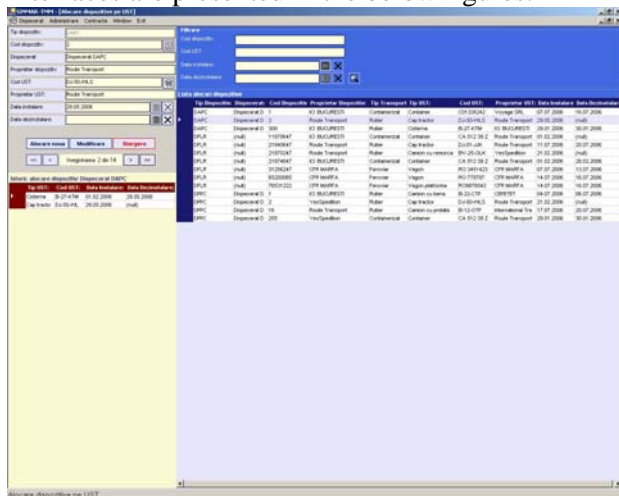


Fig. 3 Allocation of the monitoring devices to standard transport units

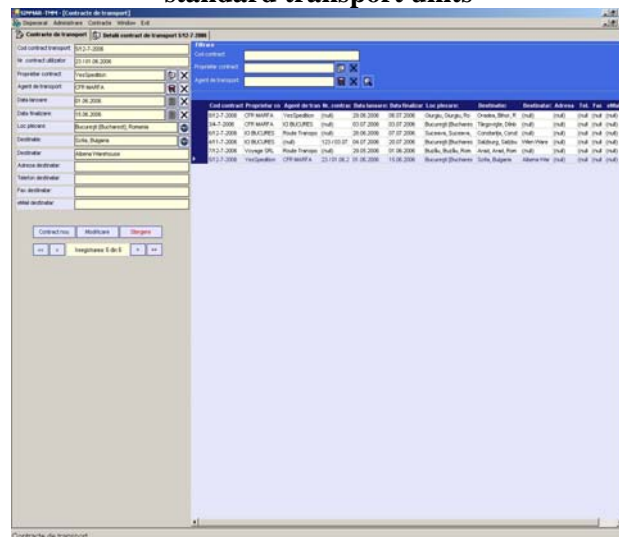


Fig. 4 Management of the transport contract

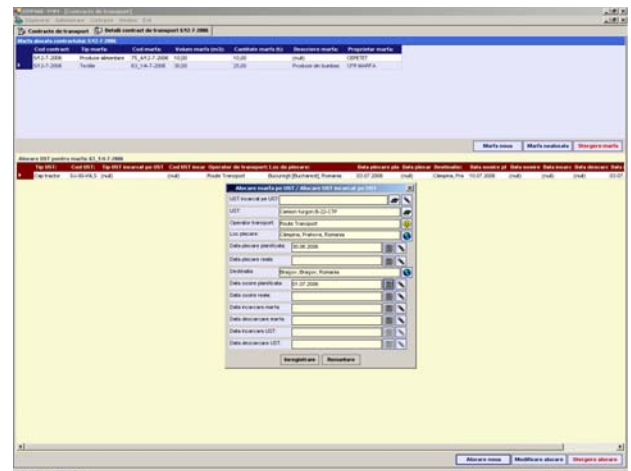


Fig. 5 Management of the freight, transport segments and means of transport to a contract



Fig. 6 DPPC device monitoring

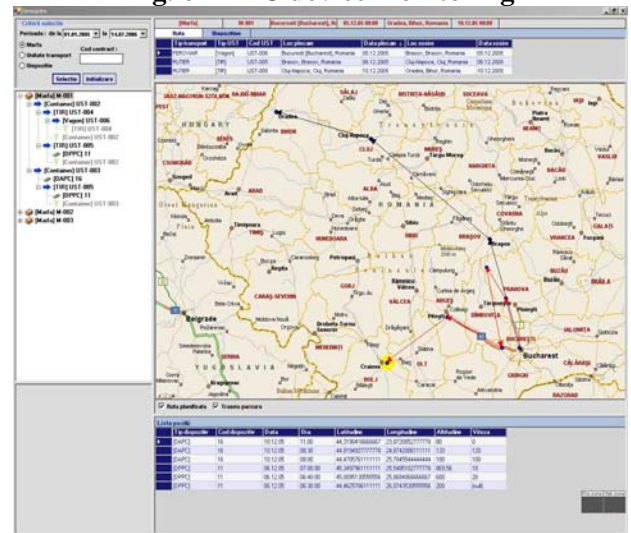


Fig. 7 Freight monitoring on the multimodal transport route

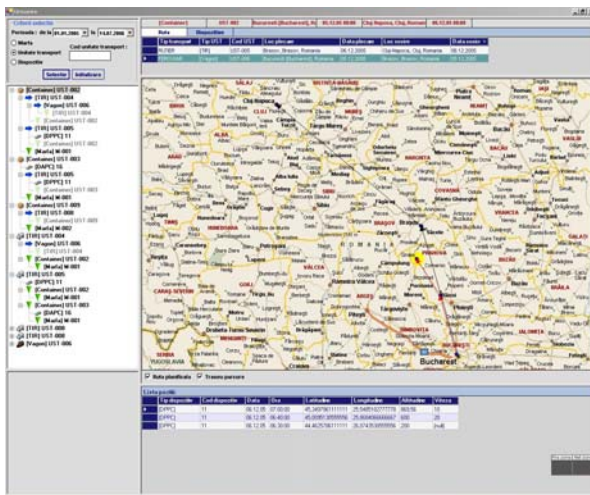


Fig. 8 Transport standard unit monitoring on transport segments

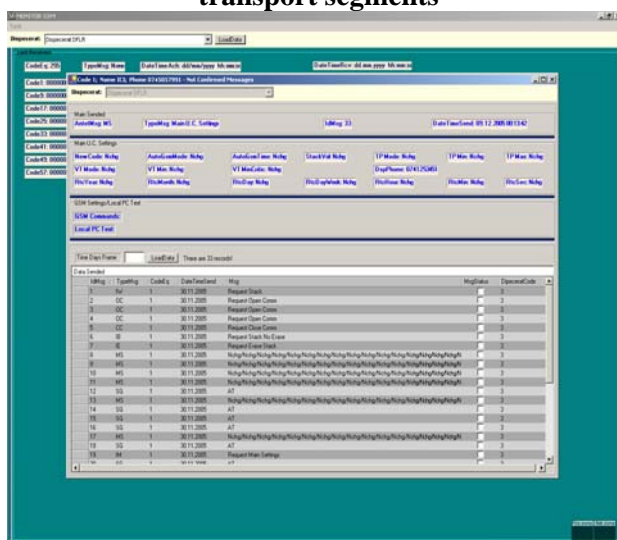


Fig. 9 Management of setting and query messages with Radio Localization Fix Devices

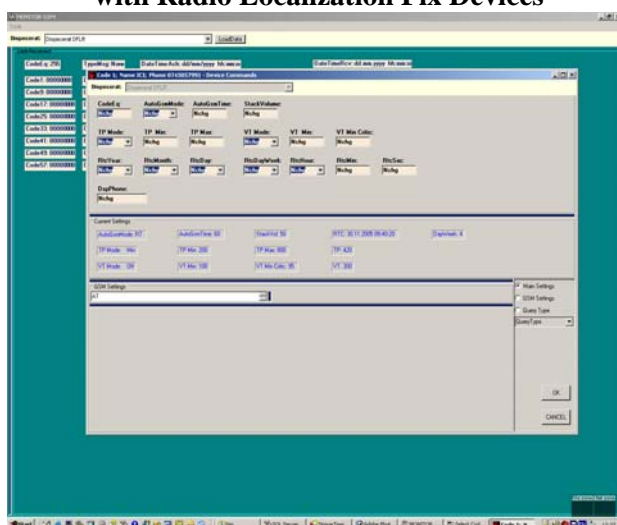


Fig. 10 Radio Localization Fix Device management

4 Conclusion

SINMAR-TMM:

- Has a high reliability, openness, flexibility, functional consistency;
- Is dedicated to different specific groups of users involved in freight multimodal terrestrial transport;
- Provides the Internet access to manage business information anytime, anywhere and from any hardware platform connected to Internet;
- Assures a high level of information and communication security and integrity;
- Provides a user interface accessible without a special training concerning information and communication technologies;
- Increases the productivity and the efficiency of the activities specific of terrestrial multimodal transport;
- Supports electronics open market development in transport area;
- Has a real contribution in decreasing of the fuel consumption, traffic and pollution;
- Minimizes the vehicle management risk;
- Improves service quality in terrestrial multimodal transport;
- Improves vehicles, containers and wagons security;
- Minimizes the communication time between agents involved in terrestrial multimodal transport.