DRAŠKO MARIN, D. Sc.
Ministarstvo pomorstva, prometa i veza,
Prisavlje bb, Zagreb

COMMUNICATIONS AND POSITIONING BY SATELLITE IN THE INTERNATIONAL ROAD TRANSPORT SYSTEM

SUMMARY

This article describes the basic technology of satellite systems related to the geostationary satellites particularly with regard to the system of satellites in the European network of EUTELSAT (European Telecommunications Satellite Organization) covering Europe, North Africa and part of the Middle East.

This enables positioning of vehicles in the international road transport system in the territory which has been covered by the satellite signal.

The EUTELTRACS system within the EUTELSAT organization enables not only positioning with preciseness of about 300 m, but also two-way communications between vehicles and company headquarters, which is an advantage compared to the other positioning systems.

EUTELTRACS service belongs to the land mobile satellite services with secondary status (it must not impose any interference to other radio-communication services and cannot claim protection from other services).

The use of frequency bands is for the up-links 14.0-14.25 GHz, and for the down-links 10.25-11.20 GHz, 11.45-11.70 GHz and 12.50-12.75 GHz.

The EUTELTRACS system provides services by means of OmniTRACS terminals and CEPT (European Conference of Postal and Telecommunications Administrations) administrations issue type approvals, designating the terminal marking and make decisions regarding free circulation of terminals in conformity with their national regulations.

The OmniTRACS terminal system has been specially presented as well as the fixed part of EUTELTRACS system with the satellite segment.

Every transport company has been considered as a subscriber to an authorised EUTELTRACS service provider.

The service for tracing trucks in the international traffic throughout Europe and Middle East can be fully expressed by including the stronger transport companies (more than 10 trucks) which can establish the transport more rationally through EUTELTRACS service.

The implementation of the EUTELTRACS service has been imposed on the Croatian companies, whose international transport could be well developed.

Croatia has been a member of the EUTELSAT organisation since December 1992, and this has provided the basic conditions for organising this service. The service provider can be the acting telecommunications operator, in this case the Croatian Post and Telecommunications (HPT), or any other company in co-operation with HPT (leasing the telecommunications lines, tariffs, maintenance etc.).

The article presents the possibility of implementing the EUTELTRACS service in Croatia with the responsibility of the service provider to establish connections between any dispatch centre in Croatia by means of Croatian telecommunications network, and through international network to the HUB station and the corresponding geostationary satellites, including the accounting matters.

It also presents the usage of the computerised road maps for accurate vehicle position-plotting and free circulation for OmniTRACS terminals.

1. INTRODUCTION

The EUTELTRACS service is based on the geostationary orbit satellite system. Geostationary orbit (GSO) is a circular orbit above the equator at an altitude of 36,000 kilometers (to be more precise at 35,800 km) and each satellite in the GSO will orbit the Earth in approximately one day (23 hours, 56 minutes). Therefore, satellites in the GSO are synchronous with the Earth rotation and appear when observed from the Earth to be at a fixed point in the sky (i.e. geostationary).

The fact that a geostationary satellite is always visible from any point within its potential service area (about 40% of the Earth surface) has been especially significant because it means that fixed ground antennas do not have to be continuously re-oriented to track the satellite.

The 40% coverage of the Earth surface from one geostationary satellite may be well applied within the European territory.

EUTELSAT (European Telecommunications Satellite Organization) as the largest satellite operator in Europe provides support to the communications via satellite in the European area.

EUTELSAT was created in 1977 by an agreement between the postal services of 17 countries and now operates under an intergovernmental Convention of 1985 to which all the European states can accede. The organisation has its headquarters in Paris (France) and there are more than 30 member countries. Croatia joined EUTELSAT in December 1992.

EUTELSAT provides satellite services for all forms of communication, including telephone calls, telex, fax, data messages, and the distribution of television and radio programmes.

In 1990, EUTELSAT diversified into mobile communications with a large scale of two-way message exchange and position-reporting service for vehicles in Europe. This service, now commercially available under the name EUTELTRACS enables users to manage their mobile resources efficiently and economically anywhere in Europe as well as in North Africa and parts of the Middle East.

2. PRINCIPLES OF EUTELTRACS SYSTEM OPERATION

Questions that have to be answered by the fleet managers and dispatchers in road transport, such as:
- how quickly a transporter responds to a client's new order,
- how accurately the arrivals and deliveries are scheduled, and
- with what precision can the future availability of the fleet be predicted for the new clients;

have long been the key issues in planning procedures in order to establish better customer service, increase revenues, reduce operating costs, and improve job satisfaction for drivers and dispatchers.

With the introduction of radio-telephones and cellular telephones many companies have been able to speed up the exchange of information between drivers and their dispatchers. Other data technology advancements such as the fax and the pager have improved communications with drivers. However, these communications may be costly to use, demand development of a terrestrial infrastructure and limit the use to a specific region or country. The use of mobile telephones by drivers may be easier and more convenient, but the dispatcher must still have a free line in order to talk to him, and needs to find more free time to better plan the fleet operations.

Another means of mobile communications is available today via satellite. Satellite-based communications service under the name of EUTELTRACS via EUTELSAT satellite system allows the users to maintain a flexible two-way contact across borders and in isolated areas and to benefit from the security of private communications network.

EUTELTRACS, as satellite-based system, whose commercial service opened to customers in January 1991, is distinguished from other mobile communications by its capacity to offer fully integrated messaging and position-reporting service throughout the entire satellite coverage zone which includes all of Europe, North Africa and parts of the Middle East.

The EUTELTRACS network is provided by EUTELSAT and is backed by the mobile communications expertise of ALCATEL-QUALCOMM, a company specially formed to develop the new service in Europe. ALCATEL-QUALCOMM has supplied the equipment to run the network and also provides the terminals.

The dispatcher in the EUTELTRACS system will actually be able to manage a greater number of trucks, while decreasing the operating inefficiency, such as out-of-route or empty kilometres, and late deliveries. The EUTELTRACS service offers real-time communications without time-consuming phone calls. This gives flexibility to the driver, dispatcher and customers, and the driver or dispatcher can send the message and then get back to other work whilst waiting for the reply.

By means of fleet-wide or group messages, drivers can be included into the information loop and, consequently feel more involved in the company. Also, by inter-company news bulletins or equipment recalls, and customer complaints or queries, EUTELTRACS system can put the office into each truck and eliminate the problems which may arise due to untimely, late or missing communications between the driver and the company.

3. BASIC STRUCTURE OF EUTELTRACS SYSTEM AND MEANS OF OPERATION

EUTELTRACS is the Land Mobile Satellite Communications System whose activity is set up for regional, national (for large countries only) and international transport routes.

Two EUTELSAT satellites are used for EUTELTRACS. They are controlled and monitored from EUTELSAT headquarters in Paris.

The system nerve centre for on-ground operations is the EUTELTRACS HUB station, which is composed of two satellite Earth stations located at Rambouillet (France). The larger Earth station is used for the messaging system and the smaller one for positioning (Figure 1).

The complete basic structure of the system is presented in Figure 2.

Any message sent from the dispatch centre (Subscriber terminal) passes through the Service Provider
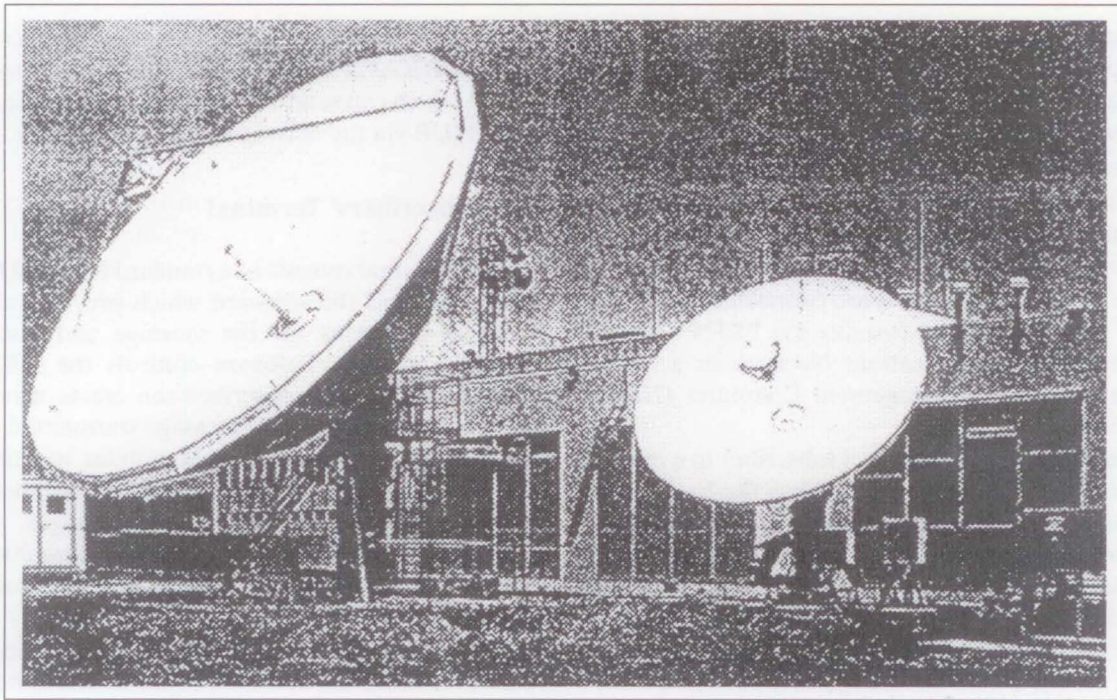
Figure 1 - Satellite Earth Stations in Rambouillet (France)

Network Management Centre (SNMC) to the HUB. The message is then transmitted via the messaging satellite to the target vehicle or vehicles. Messages transmitted from the vehicles travel the same route in the opposite direction.

The position-reporting signals pass simultaneously via the ranging satellite.

As indicated in Figure 2, the Mobile Communications Terminals (MCT) fitted in the vehicles consist of:
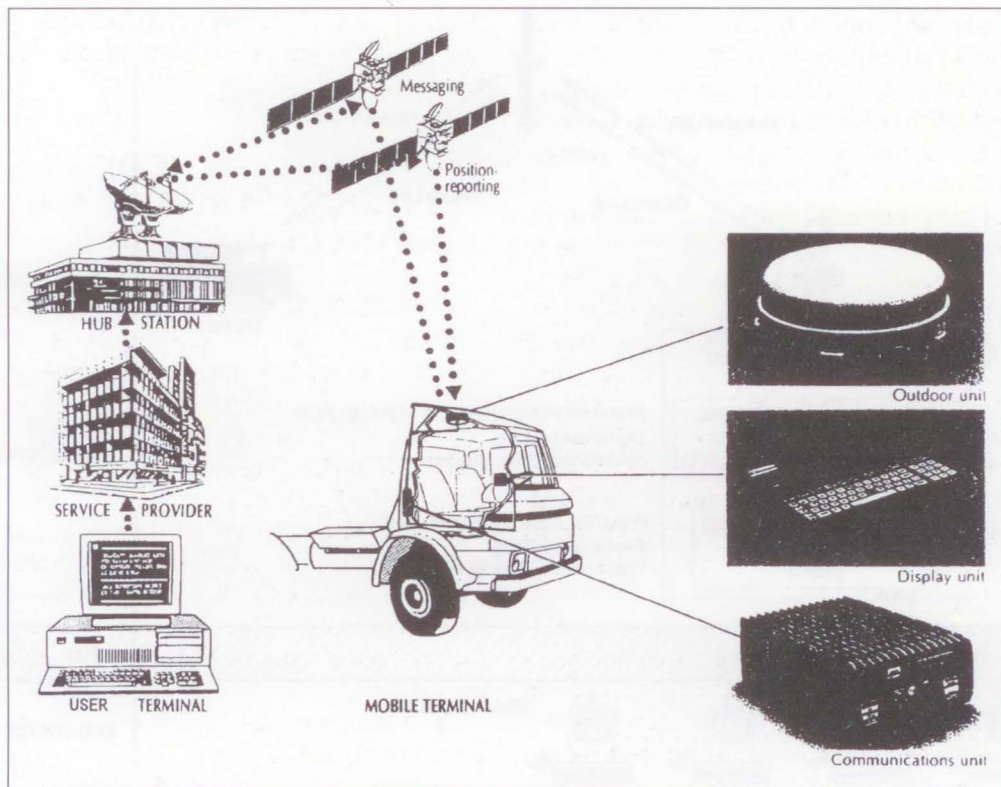

Figure 2 - Basic Structure of the EULTRACS System

– a *Display Unit* installed in the cab and comprising a compact, 69-key keyboard and adjustable 4-line x 40 character display unit;

– a *Communication Unit*, stored below the seat and measuring only 32 cm x 23 cm x 11 cm;

– an *Outdoor Unit* installed on the cab roof and comprising the tracking antenna, power amplifier, diplexor and converters.

The subscriber terminals are connected to the system by a terrestrial line (usually the PSTN – Public Switched Telecommunications Network or a leased line) to a Network Management Computer (NMC) (Figure 3).

When a message is sent by a subscriber to a mobile or a group of mobiles, this NMC has the function of processing the incoming transactions. Messages are then sent to the mobiles by a HUB station via a Ku – Band satellite transponder. This is referred to as the forward link (HUB stations to land mobiles).

The return links (messages transmitted by the mobiles to the HUB) use an orthogonally polarised transponder on the same satellite and are received by the HUB station. The return link messages, once processed by the NMC, are made available to the subscribers through terrestrial connections.

The Mobile Position Reporting (MPR) system is based on a separate LORAN-C receiver (a unit of the terrestrial LORAN-C positioning network) in the mobile. It logs the position information and transfers it to the OmniTRACS Mobile Communications Terminal (MCT) which can send this position information back to the HUB via the message service return link.

3.1. Subscribers' Terminal

This terminal consists of a standard Personal Computer (PC) and the software which provides all the necessary functions for the message and position-reporting services. Software controls the different means by which the subscriber can create messages (up to 2000 characters per message transmitted in either direction), define groups of mobiles, identify the mobiles (or group of mobiles) to which the message should be sent, create predefined messages, query about mobile positions, read messages transmitted by mobiles and positioning reports with accuracy to within 300 metres for any point in Europe.

The detailed road maps with precise bearings on vehicle locations are available to the fleet dispatcher's PC (Figure 4). Vehicle databases store details of vehicle position histories for later trip monitoring and cost analysis. There is on-screen vehicle overview for the fleet controller, with detailed positions of all the fleet vehicles in relation to any chosen point on the map, and showing vehicle load status ("empty" or "with cargo") etc.
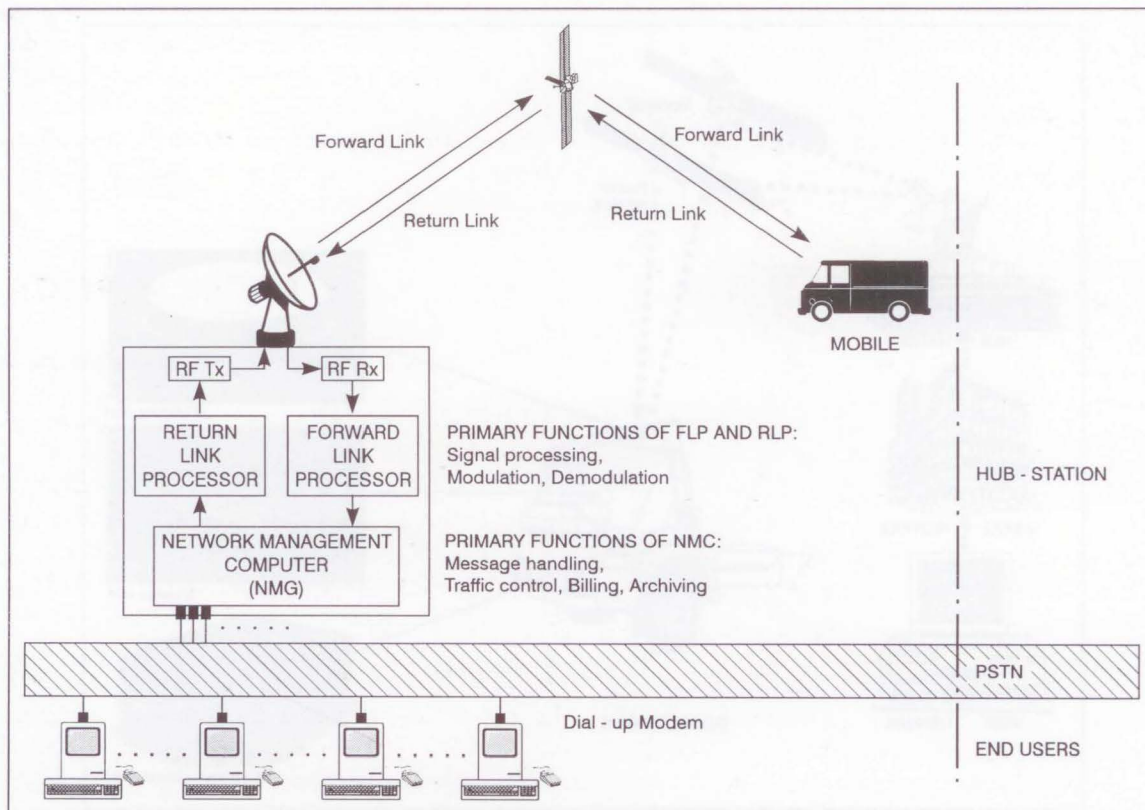

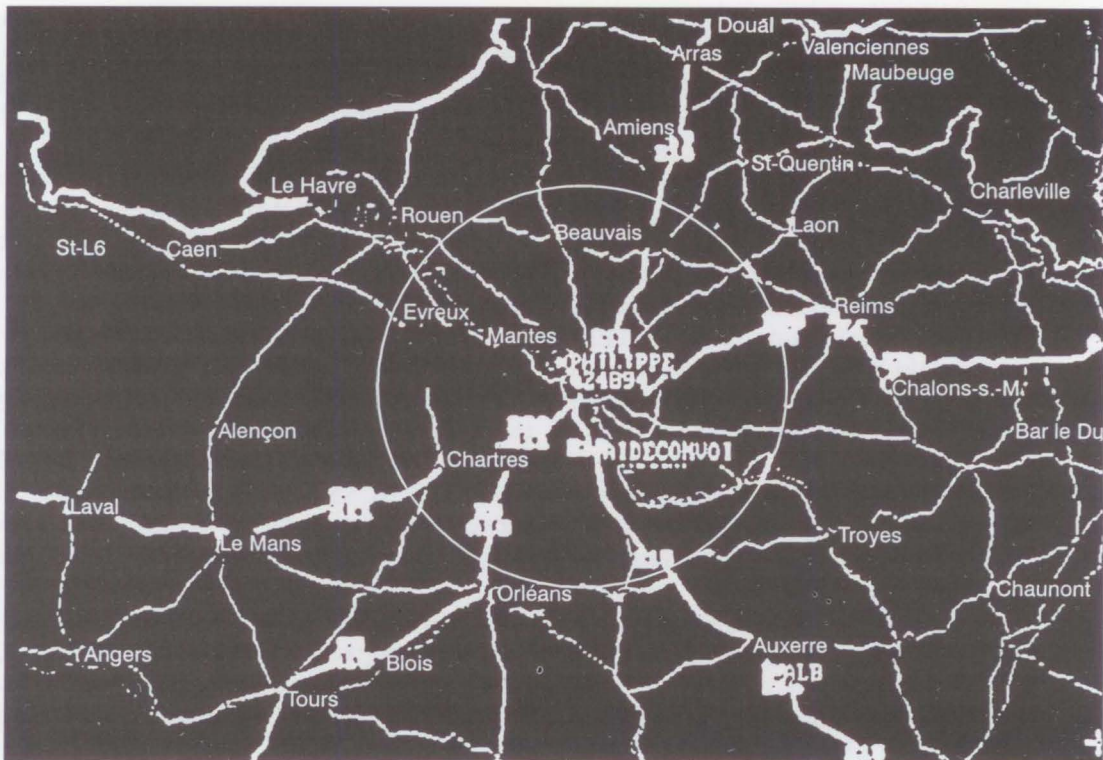Figure 3 - Connection of Terminals to a Network Management Computer

Figure 4 - Computerized Road Map

3.2. Link to the Network Management Computer

This link is usually made in a conventional manner by using PSTN or Service Provider Network Management Centre.

After a message or a position request has been initiated at a subscriber terminal, a link through the PSTN is established by means of dial-up modems between the subscriber's terminal and the HUB station NMC.

Subscribers with a high volume of traffic would, in general, have a fixed leased connection from their dispatch centre to the HUB. The subscribers can therefore have access, in real time, to the received messages, as the line between their terminal and the HUB is always active.

3.3 Network Management Computer (NMC)

NMC is connected to two processors, one takes care of the forward link transmissions and is called Forward Link Processor (FLP), and the second processor takes care of the return link transmissions and is known as the Return Link Processor (RLP). These processors have essentially the functions of channel encoding and decoding respectively (interleaving and de-interleaving, forward error correction encoding and decoding), and modulation (FLP) and demodulation (RLP).

Data messages enter the system from the subscriber's terminal. After the subscriber's identity has been verified, messages are accepted, verified, formatted and stored in queues for transmission. The NMC then provides the message in packet form to the FLP for transmission over the satellite link.

Acknowledgements from Mobile Communication Terminal (MCT) are received in NMC via the Return Link Processor (RLP).

4. EUTELTRACS OPERATING RULES

EUTELTRACS service operates as a system using satellites. In this case two EUTELSAT satellites are used and a national permission for this kind of service is necessary.

EUTELTRACS service is offered by ALCATEL QUALCOMM company in France. The company was created in 1990 by joint venture agreement between QUALCOMM company in San Diego (USA) and ALCATEL, France.

After the national permission for the use of satellites has been issued, the interested service provider in the country has to sign a Confidentiality Agreement before ALCATEL QUALCOMM releases all technical and commercial information.

Any user of the service is a subscriber to an authorised EUTELTRACS service provider.

In the frequency usage plan, EUTELTRACS service operates in the frequency band between 14.0 and 14.25 GHz (up-links) and in the frequency band 10.95-11.20 GHz, 11.45-11.70 GHz and 12.50-12.75 GHz (down-links).

It should operate as a secondary service on a non-protected and non-interference basis. Consequently, the service must not impose any constraints on the existing services or on the future development of the primary services in the aforementioned frequency bands. CEPT administrations performing the EUTELTRACS service should have an agreement with EUTELSAT requesting the necessary measurement for the elimination of harmful interference, should this occur.

Individual licences for OmniTRACS terminals are not required in the majority of CEPT countries, because it is impractical for truck operators to obtain individual licences for their OmniTRACS terminals every time they need to enter any country for just a short while, typically for a few hours to a few days at a time.

Therefore, a CEPT Circulation Card has been established as a declaration which has to be signed by the responsible CEPT administrations to allow Free Circulation of OmniTRACS terminals.

Each terminal should be tested and should carry EUTELSAT type testing certificate and should be designated by the EUTELSAT logo.

For good operation of the EUTELTRACS service which should be fully effective, the CEPT Recommendation concerning EUTELTRACS regulation matters has to be implemented in as many countries as possible, both CEPT and non-CEPT countries.

5. CONDITIONS FOR POSSIBLE IMPLEMENTATION OF EUTELTRACS SERVICE IN CROATIA

Better customer service, increased revenue, reduced operating costs etc. should be taken into account in the Croatian international road transport companies as well.

The quality of service they can offer to the integrated European market will be of great importance in the future, because they are faced more and more by the competitive market at the Pan-European level.

For those companies it will be increasingly important to have an integrated fleet management system like EUTELTRACS, especially for those, who are the owners of larger fleet transports, which might be more than 10 trucks for international transport (major European countries apply this criterion).

After having analysed the data of transport licences in Croatia for the international road carriers is-

sued by the Ministry of Maritime Affairs, Transport and Communications (available data from May 1998), for 3650 licensed companies, it was found that 80 road transport companies have a fleet of more than 10 trucks. It is a number of approximately 2.2 % (e.g. Portugal has implemented EUTELTRACS service for 4 % of such road transport companies).

It is to be noted that the initial condition for Croatia has been fulfilled; namely Croatia has been a member of EUTELSAT since 1992.

The EUTELTRACS service provider may be either the Croatian telecommunication operator HPT (Croatian Post and Telecommunications) or any other telecommunications company having a licence issued by the Telecommunications Council. Namely, the EUTELTRACS service, being a land mobile satellite service may be operated by any licensed company under the provisions of Croatian Telecommunications Law.

The service provider should also sign the Confidentiality Agreement with ALCATEL QUALCOMM company, and get a permission for the use of EUTELSAT satellites issued by the Croatian authority.

All the users of the EUTELTRACS service should be subscribers of service provider who will take care of the telecommunication lines for data traffic between subscriber' s terminal and vehicles. Also, the service provider should take care of the accountancy matters regarding subscribers traffic and of the payment of debts for international traffic.

6. CONCLUSION

Among the options of the mobile communications available to the road transport carriers today, it is only the EUTELTRACS service which offers two-way messaging between trucks and dispatch centres, as well as an automatic, integrated position-reporting service throughout Europe, North Africa and parts of the Middle East.

The EUTELTRACS commercial service was opened to customers in January 1991.

EUTELTRACS provides a benefit to drivers, dispatchers and transport companies and improves working conditions and company performance.

The companies can communicate with their drivers and know the exact position of their trucks and cargoes all over Europe. In the European competitive market, just-in-time delivery is of great importance for the international road carriers.

So, they can let their customers know immediately if there are any problems or delays. Customers, whose carriers use satellite-based messaging and position-reporting systems, like EUTELTRACS, know that the information they receive on arrival times and ship-

ment status is as accurate as possible. They can call in for position information and when they need to make a change, confirmation is possible in minutes as opposed to hours.

The quality of service is the goal of transport companies and their survival in the European market will depend on it very much in the future.

The EUTELTRACS service, therefore, should be of great interest for the Croatian international road carriers as well.

Among the 3650 licensed international road carriers in Croatia, there are 80 companies, which own more than 10 trucks each, which is an experimental percentage limit in Europe for use of EUTELTRACS service. For implementing the EUTELTRACS service in Croatia, the necessary conditions have been fulfilled.

Satellite communications and real-time position-reporting provide benefit to carriers and their customers, and thus will become standard for the industry.

SAŽETAK

KOMUNIKACIJA I ODREĐIVANJE POLOŽAJA PUTEM SATELITA U SUSTAVU MEĐUNARODNOGA CESTOVNOG PRIJEVOZA

U referatu je opisana tehnologija satelitskih sustava, koja se odnosi na geostacionarne satelite s posebnim osvrtom na sustav satelita u europskoj mreži EUTELSAT-a (European Telecommunications Satellite Organization), koji signalima pokrivaju Europu, Bliski istok i sjevernu Afriku. Time je omogućeno određivanje položaja vozila u sustavu međunarodnoga cestovnog prijevoza na teritoriju pokrivanja satelitskim signalom.

Sustav EUTELTRACS u okviru organizacije EUTELSAT omogućuje ne samo određivanje položaja vozila s točnošću od oko 300 m, već i dvosmjernu komunikaciju vozila s matičnom tvrtkom, što mu daje prednost pred ostalim sustavima za određivanje položaja.

EUTELTRACS usluga spada u kopnenu pokretnu satelitsku službu sa sekundarnim statusom (ne smije stvarati smetnje ostalim radiokomunikacijskim službama i ne može od njih zahtjevati zaštitu). Upotreba frekvencijskih pojaseva je za uzlazne veze 14,0 - 14,25 Ghz i za silazne veze 10,95 - 11,20 Ghz, 11,45 - 11,70 Ghz i 12,50 - 12,75 Ghz. EUTELTRACS sustav pruža usluge putem OmniTRACS terminala, a administracije CEPT-a (Europska konferencija poštanskih i telekomunikacijskih administracija) daju tipska odobrenja, određuju oznake i odlučuju o slobodnom opticaju terminala u skladu sa svojom regulativom.

Posebno je prikazan sustav OmniTRACS terminala i nepokretni dio EUTELTRACS sustava, te satelitski segment sustava.

Svaka prijevoznička tvrtka ima pretplatnički status kod ovlaštenog davatelja usluga EUTELTRACS-a. Usluga praćenja teretnih vozila u međunarodnom prometu diljem Europe i Bliskog istoka dolazi do punog izražaja za veće prijevozničke tvrtke (10 i više teretnih vozila), koje putem EUTELTRACS usluge mogu maksimalno racionalizirati svoju prijevozničku djelatnost.

Za hrvatske tvrtke, koje imaju razvijen međunarodni prijevoz nameće se pitanje ostvarenja EUTELTRACS usluge. Hrvatska je članica organizacije EUTELSAT od prosinca 1992. godine, čime su stvoreni osnovni uvjeti za organiziranje ove usluge. Davatelj usluga može biti postojeći telekomunikacijski operator, u ovom slučaju Hrvatska pošta i telekomunikacije, ili druga tvrtka u suradnji s HPT-om (iznajmljivanje telekomunikacijskih linija, tarifiranje, održavanje i dr.).

U članku je naznačena mogućnost uvođenja EUTELTRACS usluge u Hrvatsku s odgovornošću davatelja usluga za povezivanje bilo kojeg otpremnog centra u Hrvatskoj putem hrvatske telekomunikacijske mreže i međunarodne mreže do glavne pristupne satelitske postaje (HUB) i odgovarajućih geostacionarnih satelita, uključujući pitanja obračuna.

Također je pokazana mogućnost korištenja kompjuterizirane mreže cestovnih karata za precizno praćenje vozila korisničke tvrtke i slobodnog opticaja za OmniTRACS terminale.

LITERATURE

[1] **J. Dutronc** and **N. Colcy** (EUTELSAT), *"Land Mobile Communications in Ku - Band, Results of a Test Compeign on EUTELSAT I – F"*, International Journal of Satellite Communications, VOL.8, 1990;

[2] CEPT/ERC Recommendation T/R 21-09 (Lisbon 1991, revised in Madrid 1992);

[3] Keeping Track January 1993, A newsletter published by Alcatel Qualcomm, 92734 Nanterre Cedex, France;

[4] Keeping Track of Transport Anywhere, Anytime with EUTELTRACS by Kimberly Mock, Alcatel Qualcomm, 92734 Nanterre Cedex, France

[5] **D. Marin**: "Technology of Telecommunications Traffic III", Fakultet prometnih znanosti, Zagreb, 1998