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MONITORING OF THE STATE CONDITIONS OF RAILWAY VEHICLES BY SATELLITE COMMUNICATION

The quasi-online surveillance of the state conditions (position, speed, temperature, running behaviour) is an actual demand of advanced logistics and telematics in railway vehicle operation. In recent years satellite communication has appeared as an adequate facility to comply with these requirements.

In the mutual EUREKA-project Trancelog Safety (E! 2635) partners of the three countries Poland, Ukraine and Germany made joint efforts to develop such a solution using geostationary INMARSAT satellites. It was successfully demonstrated on a travel of the PESA designed, new sleeping car (PKP), riding from Warsaw to Sewastopol and back, that at the control center position and speed (by implemented GPS) and other sensor data were available and could be monitored on a digital map, displaying the railway lines and the actual course of the sleeping car.

MONITORING WARUNKÓW STATUSU POJAZDÓW KOLEJOWYCH ZA POMOCĄ KOMUNIKACJI SATELITARNEJ

Nadzór warunków statusu quasi online (pozycja, prędkość, temperatura, zachowanie w czasie jazdy) jest rzeczywistym wymogiem zaawansowanej logistyki i telematyki w pracy kolei. W ostatnich czasach komunikacja satelitarna okazała się odpowiednim urządzeniem do spełnienia tych wymogów.

We wspólnym projekcie EUREKA Trancelog Safety (E! 2635) partnerzy trzech krajów – Polski, Ukrainy i Niemiec wspólnymi wysiłkami opracowali takie rozwiązanie za pomocą satelitów geostacjonarnych INMARSAT. Zostało ono z powodzeniem zademonstrowane na jeździe zaprojektowanego przez PESA nowego wagonu sypialnego (PKP), na trasie z Warszawy do Sewastopola i z powrotem. W tymczasowym centrum sterowania dostępne były do monitorowania na mapie cyfrowej pozycja i prędkość (za pomocą wdrożonego GPS), oraz inne dane z czujników, wyświetlając trasę na torach i rzeczywisty kurs wagonu sypialnego.

1. INTRODUCTION

Nearly unnoticed the satellite mobile communication has developed during the last two decades parallel to the terrestrial GSM mobile communication ("Handy"). Originally pushed by the developers of rockets and satellites as a space technology, the satellite communication has become a self-contained field of business, disclosed to a plurality of terrestrial

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applications. Whereas the GSM communication relies upon terrestrial cells, which partially can not be erected (eg at oceans), there are also a lot of land areas, which will wait a long time for GSM installation, if at all. This is especially true for mobile data communication, which is important for logistic application of goods transport.

Dr. Tułecki of the institute of railway vehicles of the Technical University of Cracow, who deals since many years with problems of logistic in the railway traffic, proposed the EUREKA-Project TRANCELOG SAFETY E! 2635, which was jointly executed by members of the partner countries Poland, Ukraina and Germany. The German contribution was the aspect of *Safety and Monitoring,* mainly the tracking of vehicles and the monitoring of their status, the representing company was IAT, Ingenieurgesellschaft für Angewandte Technologie mbH, Starnberg.

2. INMARSAT

As one of the first in the field of satellite communication the international organisation INMARSAT was founded (1978) with its headquarter in London. The prior goal was at that time the improvement of safety at sea, as already the name indicates. INMARSAT operates four geostationary satellites, which are positioned equatorially over the four ocean regions overlapping the whole earth surface. (Fig.1)

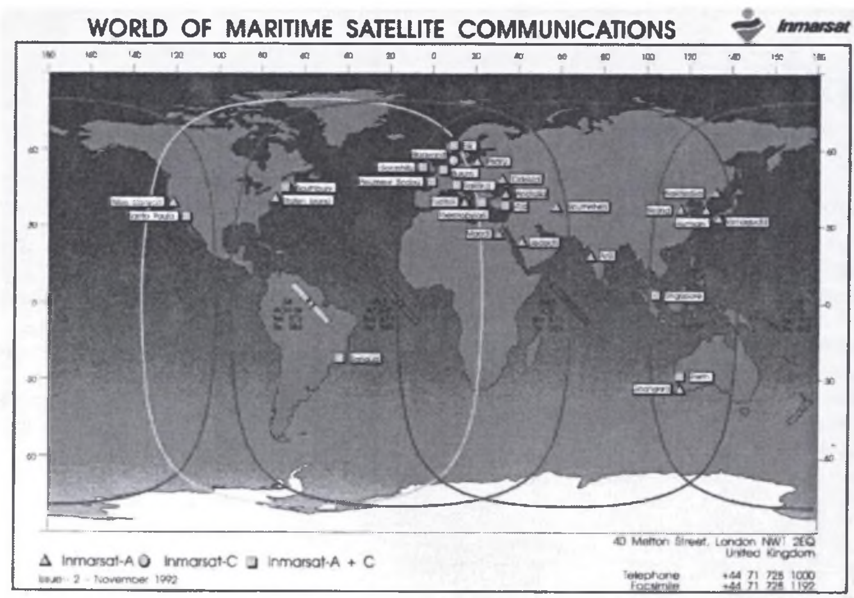

Fig.1. Position and coverage of the four INMARSAT satellites

The principial functionality of the INMARSAT Data services (example INMARSAT D+) is shown in Fig. 2: A "message" may be generated in a computer and ought to arrive at a "mobile" (ship, railway vehicle, lorry,...). For this purpose the message is transferred to a Land Earth Station LES and carried forward in the S-band (6.4 GHz) to the satellite. Then the satellite transmits the message in the L-band (1.6 GHz) over its coverage area. If the mobile transceiver moves together with its mobile in this (compared with the GSM cells) huge territory, it receives the message by its transceiver and gives notice to the mobile, if required.

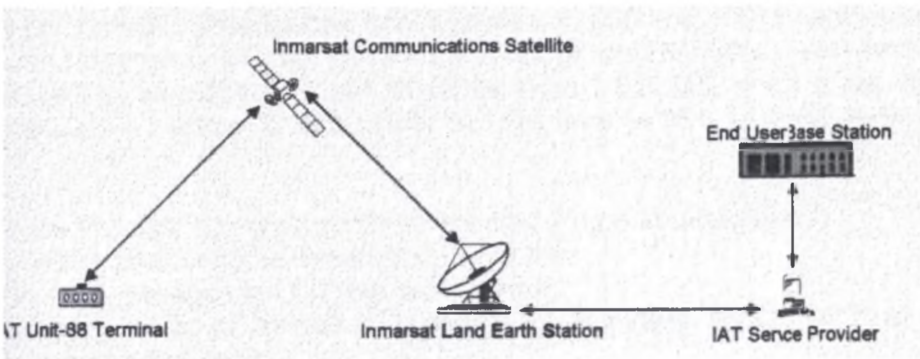

Fig.2. Transmission chain of an INMARSAT D+ message

Similar is the procedure, if the mobile may transfer a message (eg. sensor data) to its Control Centre (user base station). The transceiver in the mobile transmits in L-band the message to the satellite, the satellite in the S-band to the LES and the LES by terrestrical means (eg. ISDN) to the computer in the Control Centre, which displays the message. The system-theoretical affinity to the GSM communication is evident, but the patch of the coverage is much bigger in the case of satellite communication, furthermore the satellite communication is already available and must not be fully installed as eg. GSM in Ukraina.

3. MOBILE INMARSAT D+ TRANSCEIVER

The INMARSAT D+ unit consists of a transceiver and an antenna (Fig.3):

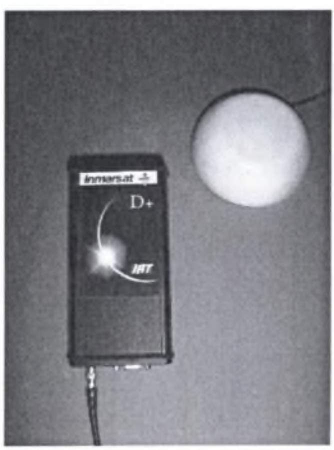

Fig.3. D+ INMARSAT D+ Transceiver with antenna (IAT Unit 88)

The terminal has the following features:

- Very low power consumption
- Small size of the transceiver and its antenna
- Large link margin, no direct line of sight is necessary
- Robust design, insensitive against environmental impacts
- RS 232 interface
- Autonomous mode of operation
- Several analogue and digital inputs
- Separate processor for application programming

Actually this terminal is tested for application in the US space shuttle.

The terminal is installed into the mobile (including a GPS-module), in our case a railway vehicle (example Fig.4, 5):

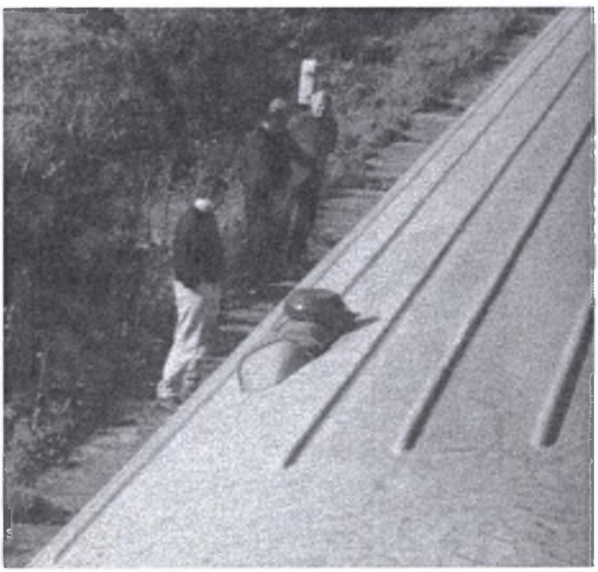

Fig.4. Installation of the IAT-Terminal in a newly designed PESA-sleeping car (PKP), the antenna is visible on the roof of the vehicle

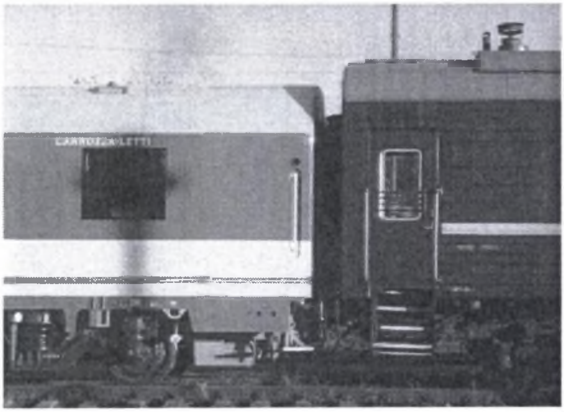

Fig.5. PKP-sleeping car, supplied with satellite tracing (GPS), antenna and sensor monitoring, coupled to a sleeping car of Russian design, on its travel from Warszawa to Sewastopol

It may be accentuated, that contrary to other “satellite tracing”, using GSM as means of data transmission, here in fact not only the position determination (GPS), but also the sensor data transmission occurs by satellite (INMARSAT).

4. TEST TRAVEL FROM WARSZAWA TO SEWASTOPOL AND BACK

In September 2003 the equipped PKP-sleeping car runs its test travel from Warszawa to Sewastopol and back. The monitoring system, using satellite communication, worked during the whole journey well and demonstrated its low power consumption. By the way at the Polish/Ukrainian border the change of the gauge took place without any difficulty (Fig.6):

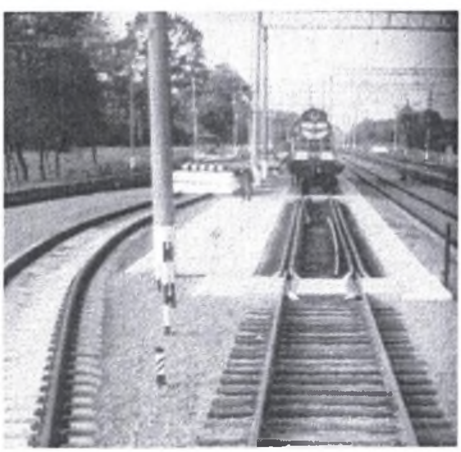

Fig.6. Change of gauge at the station of Granitza

As a result of the test a map was displayed, showing the position of the PKP sleeping car (Fig.7):

Fig.7. Position monitoring of the sleeping car in Ukraina

5. SENSOR MONITORING OF RAILWAY VEHICLES

Under preparation is a quasi-online monitoring of the rolling performance of railway wheelsets, for evaluation of the wheelsets and tracks, together with position determination of the vehicle on certain “events” (Fig.8):

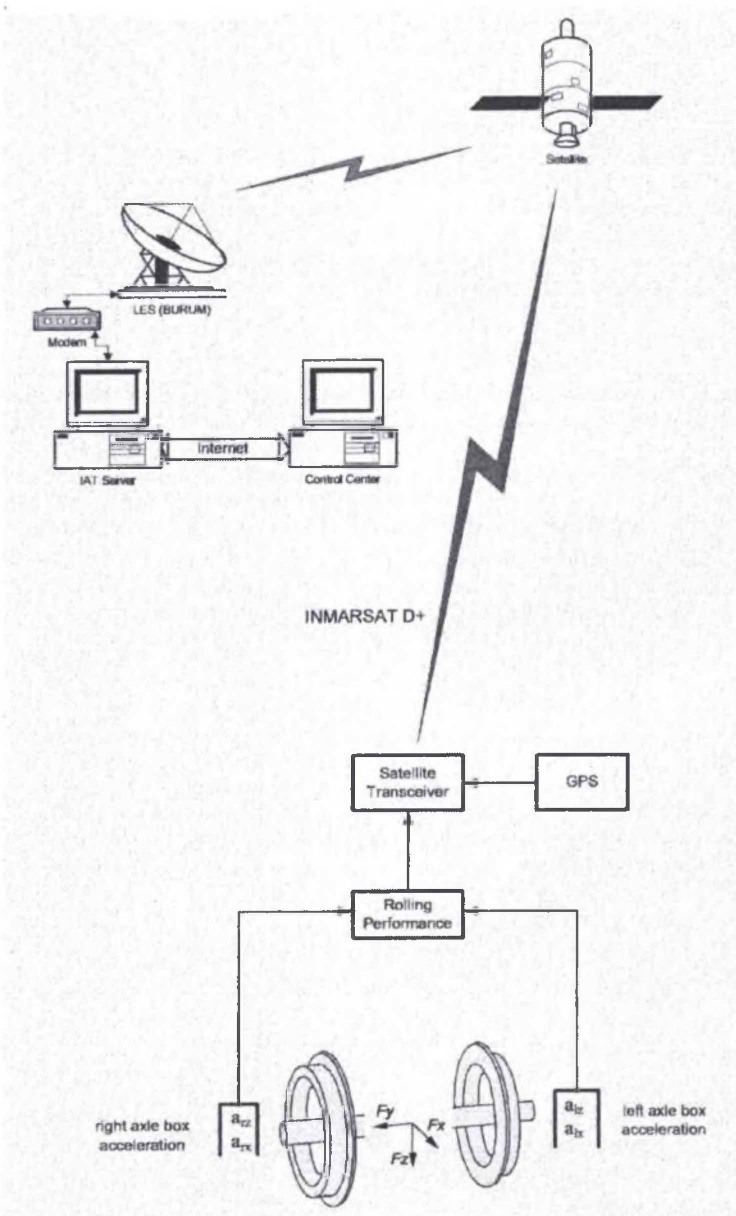

Fig.8. Event monitoring of the rolling performance of wheelsets

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