SATELLITE TRACKING OF TRANSPORTS - TRANSNUCLEAIRE'S EXPERIENCE

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SUMMARY

Transnucléaire carries out transports of nuclear materials at each stage of the fuel cycle:

- from mine to reactor: yellow cake, U_3O_8, natural or enriched hexafluoride UF_6, fresh fuel for research and power reactors,
- from reactor to reprocessing: spent MTR or LWR fuel,
- to storage: low, medium, and high level waste.

Moreover, Transnucléaire transports nuclear materials for laboratories, research centres, universities... In 1996, about 3000 shipments - including empty packagings - were performed by Transnucléaire. These shipments involved all the main transport modes: road, rail, sea, air, separately or combined. Frequently, between 20 and 30 shipments organised by Transnucléaire are underway at the same time.

Currently, the transports of sensitive materials are already tracked by the competent authority on French territory, as part of the national security - or physical protection - requirements.

However, Transnucléaire decided to implement its own tracking system in order to improve:

- safety for routine service by checking the specified itineraries and managing delays in advance,
- safety in emergency conditions by detecting incidents or accidents,
- public acceptance management by gathering a maximum of data that could be released to the public if needed.

DEVELOPMENT

The development started in 1995 by a feasibility study based on the main following specifications:

- a single system for all transport modes,
- an international network,
- a simultaneous transmission,
- a two-way data transfer.

At this time, the position of the shipments was reported by the following means:

- road transport: by phone with the driver,
- rail transport: by the French railways,
- sea transport: either by phone with the captain or by the shipping company,
- air transport: by the airline.

For road and rail transports, a comparative test was carried out between:

- Euteltracs system:
- Argos system,
- GPS + Inmarsat system,

The first system was found to lack confidentiality and international coverage. GPS + Inmarsat system offered several advantages compared to the Argos system, in particular that the positions are given at regular intervals, and that data can be collected continuously from the control room.

PRESENT SITUATION

This comparative test led to the selection of the Inmarsat C/GPS equipment which is now in operation (see figure 1).

The Global Positioning System (GPS) is a satellite-based navigation system which enables accurate position and speed measurements. The position is determined by calculating distances using at least 3 different GPS satellites, but up to 24 GPS satellites can be used.
Inmarsat C is a satellite-based world-wide communications system, providing two way-data transfers between vehicles and offices. The Inmarsat C/GPS uses these two technologies and so offers two methods of communication and position reporting.

Data are transmitted from the vehicle to a land station by the Inmarsat C satellites and then by telephone lines to Transnucléaire's tracking room.

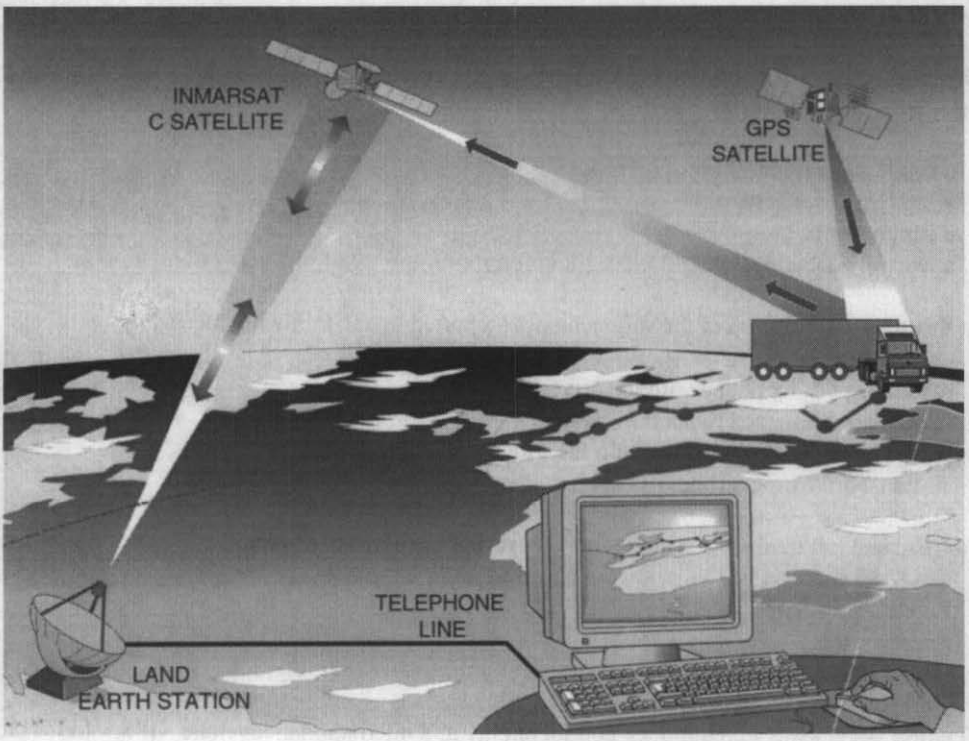

Figure 1 : Operating scheme of the Inmarsat C network

Equipment

Two main components are used in this application: an Inmarsat C/GPS receiver and a PC card, both integrated in a small box which is easily installed on board trucks and wagons (see figure 2). A similar equipment is used for tracking sea shipments.

The aim of the PC card is to collect information from the vehicle, record and transmit this data, through the Inmarsat satellite network.

The PC Card has been chosen for its reasonable cost and the possibility to add several peripherals. It will soon be possible to transmit additional information such as identification of the transported cask, temperature or vibration level during transportation.

Today, a fleet of 29 wagons, 46 trucks and 2 ships have been equipped with the tracking system.

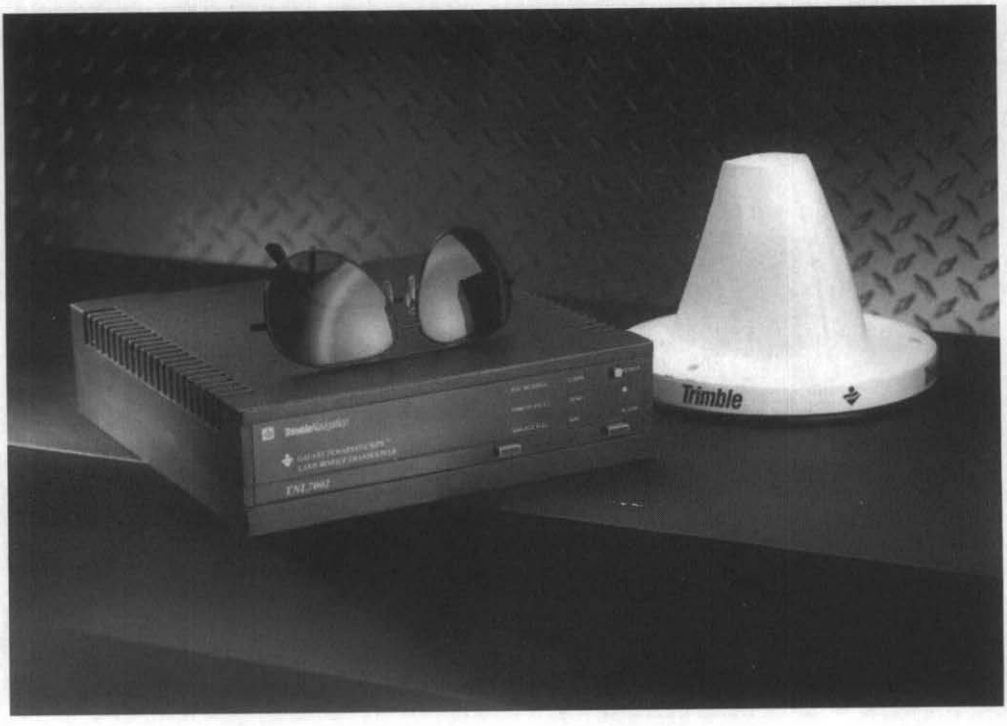

Figure 2: An Inmarsat C/GPS Transceiver

Software

A software has been developed to collect at any time data from the vehicle, and record data on board.

The data transmitted from the vehicles include:

- mobile references,
- date and time of the position,
- position (latitude, longitude),
- speed of the vehicle,
- programmed period of position reports,
- excess above maximum speed,
- various information on the vehicle (stops, engine...).

Data reports are programmed every 30 minutes. Data are also recorded on board at a higher frequency (about every two seconds) on a disc. If more accurate information is needed, the data recorded on board vehicles can be transmitted by Inmarsat. In the event of accident, the disc would be removed from the vehicle to be submitted to a detailed examination.

The data reporting period can be modified, for instance to track sensitive materials, and the shortest period that can be programmed is about two minutes.

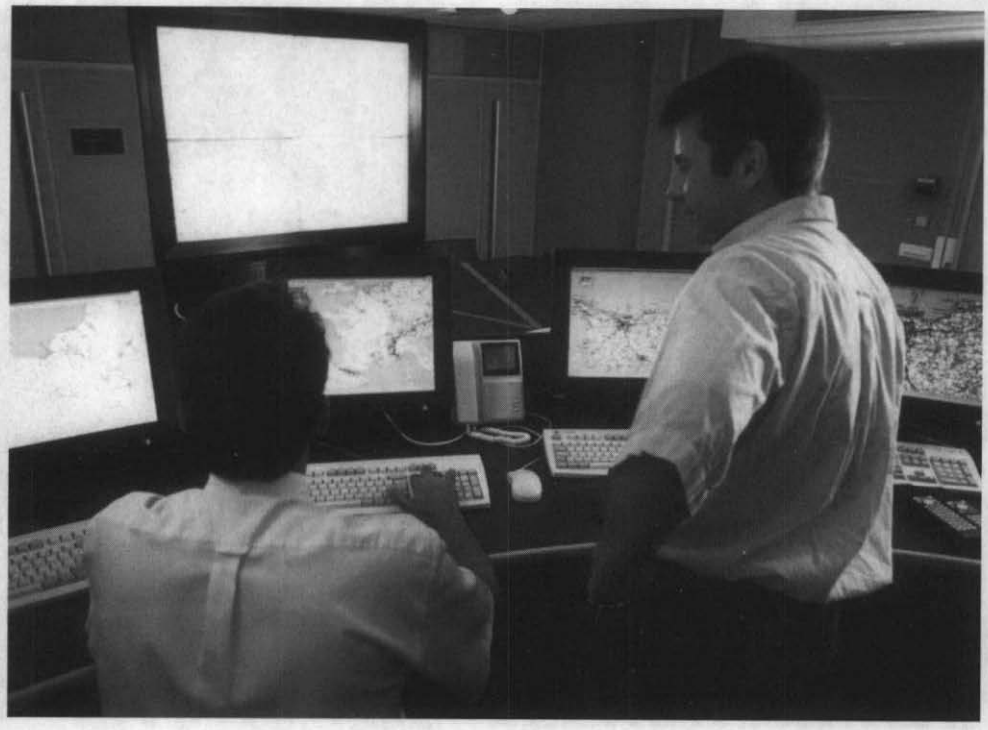

Figure 3: Displays in Transnucléaire control room

Dedicated control room (see figure 3)

A dedicated room has been fully equipped for this particular use, and a team of operators has been trained to perform these operations.

In order to track 20 to 30 transports per day, the positions of the vehicles are displayed on four different screens. This allows the operators to :

- track one transport on a particular screen,
- monitor all the vehicles positions on another screen,
- track one kind of conveyance (truck, wagons, ships) on a particular screen.

A large display (2m x 1.5m) is also used to give an overall view of the situation.

Operations

Each week, the transport schedules are handed over by the transport managers to the operators, including:

- date and time of departure,
- date and time of arrival,
- name and address of consignor,
- name and address of consignee,
- itinerary,
- references of the conveyance,
- references of the packagings.

In case of incidents such as itinerary deviations or time schedule modifications, the operators keep the transport managers informed. When a transport is completed, a report is supplied to the transport managers, including a map showing the real itinerary.

FUTURE TRENDS

Additional developments aimed at further improving safety are under study:

- data processing to identify automatically itinerary and time schedule deviations,
- shock and fire detection,
- better links with Transnucléaire's emergency transport plan.

CONCLUSION

Because of its psychological impact on the public, even a limited incident during the movement of nuclear materials might involve deep public opinion reactions. To reduce this risk, particular attention is paid to the quality of these transports and especially to their safety. By tracking most of its transports, Transnucléaire contributes to the continuous improvement of their safety conditions.