

Cold-Trace: a Mobile-based Traceability Solution Rendering Fleet Management more Effective

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Abstract: Traceability and tracking activity are increasing significantly, since underlying technology such as GPRS/UMTS and satellite positioning is mature and ready for widespread market traceability solutions. This paper focuses on the roll-out of the Cold-Trace solution by Disfrimur, a leading transport company based in Spain. Cold-Trace is a unique, integrated solution based on mobile communications that helps in quality control, traceability and efficiency in the refrigerated transportation industry. It consists in a management tool on board trucks that collects and processes information from a set of sensors distributed throughout the vehicle, and offers an easy-to-use software application that allows truck drivers to manage all administrative tasks performed during the trip. Thanks to Cold-Trace, communication at Disfrimur between fleet managers and truck drivers has improved dramatically, therefore boosting efficiency in execution of their daily tasks. In addition, Cold-Trace is having significant impact on Disfrimur customers (supermarket chains) and consumers in general.

1. Introduction

To cope with new EU traceability regulations [1], the major challenge of the frozen and refrigerated road transport industry is to ensure a continuous 'cold chain' from producers to consumers so that consumers receive perishable goods in prime condition and on time. At the same time, shippers of refrigerated goods need a constant flow of up-to date information on the status of their merchandise, with temperature and truck location being the most important parameters.

This paper addresses the roll-out of the Cold-Trace solution by transportation companies leading in competitiveness. Cold-Trace is a complete and integrated mobile solution for the traceability of the supply chain that was developed, integrated and technically validated in an EU funded RTD project [2]. At present, the market feasibility is being tested and validated on a wide-scale basis under the eTEN Programme [3].

The Cold-Trace solution is a management tool on board trucks that collects and processes information from a set of sensors distributed throughout the trailer, which allows for real time sensor data exchange between several trailer compartments, the driver's networked PDA, the company HQ and other stakeholders [4]. It provides truck drivers with a tool that allows them to manage all administrative tasks necessary during the trip. Information arising in the truck is sent to the truck company headquarters using mobile communications based on GPRS. At the office side, fleet managers receive information

about the position of the truck. Alarms are triggered for instance if a raise in temperature occurs or if the driver detects any anomaly.

The business case presented in this paper describes the installation of Cold-Trace by Disfrimur (Spain), one of the leading companies in the European transportation and logistics industry. Best practice arising from Disfrimur is geared at key players and executives of the transportation sector, logistics, distribution, supermarket chains and other decision-makers interested in traceability and cold chain control. For further exploitation to other sectors, see 'conclusions'.

2. Objectives

The objectives of this paper are twofold:

- To show how an ICT based solution for traceability has contributed to increase competitiveness in the transport and logistics industry, enabling a constant monitoring and control of the cold chain during transportation and reducing operation costs in fleet management.
- To present lessons learnt during the process of innovation and technology transfer, from RTD results to the implementation of a useful and cost-effective mobile-based traceability solution ready to enter the market.

3. State-of-the Art limitations and Cold-Trace innovation

Currently, there are many traceability software solutions available on the market. When comparing the traceability solutions addressing the cold chain monitoring, we can say that there is no complete, integrated solution available today. Competition exists for parts of Cold-Trace services, as there are many “On-Line” GPS Tracking Systems, few “On-Line” Temperature Monitoring Systems and Very few “On-Line” Work Order and Messaging Systems available. Comparison with main competing traceability solutions, such as those offered by Thermoking, Cargobull Telematics, Siemens DVO, Blue Tree or Scania, make Cold-Trace more reliable and more attractive than competitors as Cold-Trace offers:

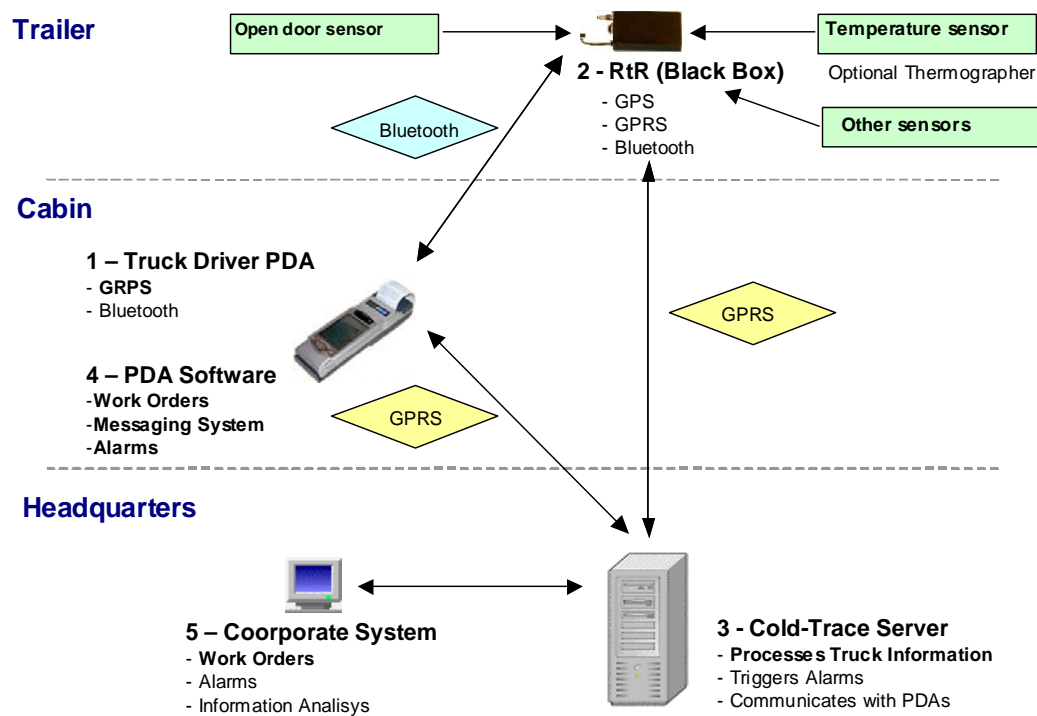
- Complete and integrated functionalities (temperature control + GPS trucking system + work order management system)
- Interoperability with existing corporate management systems (ERP). Cold-Trace bases its external interface on simple XML messages, therefore integration into existing corporate systems are easy and at low cost
- “Live truck” with real-time fleet monitoring (information recorded every 20 seconds and transmitted every 2 minutes)
- Ease of installation (compatible with standard hardware)
- Ease to use (standard PDA for drivers as the core of the mobile system)
- Remote control of cold equipment, which facilitate costs optimisation / reduction in terms of time and human resources allocated. Though technically very simple, implementation of this solution has encountered difficulties with the refrigerator equipment manufacturers. Legal issues and loss of guarantee if equipment is tampered have been the main drawbacks claimed by the manufacturers. Finally, an agreement with the leading manufacturers of cold equipment in Europe allows Cold-trace to offer this service.
- Real-time interaction between truck drivers and headquarters (bi-directional information flow, in contrast with the one-way communication mode characteristic of alternative solutions, such as Thermoking, Minor Planet or Cargobull.

- Safety and control required on drivers time schedules. Cold-Trace provides fleet managers with a summary of data about the number of kilometres and working hours per driver on a daily basis and processes driver load times and route schedules.
- Security of truck loads, as Cold-Trace includes a lock and load tracking systems. If the trailer door is opened outside the collection and delivery points, the alarm triggers.

The innovative aspects of Cold-Trace include the fleet managers and truck driver remote consultation and the update of data through integration of PDAs via wireless communication, database and multimedia techniques; the supply of remote guidance and location-based data retrieval by using GPS technology embedded in the trailer black box, and the management of temperature information from the trailer. From the software technologies point of view, specific innovations developed during the project concern multimedia data representation and compression techniques and XML data structures to interchange information among multiple data management systems [5].

The resulting general system architecture is shown in figure 1.

Figure 1: Cold-Trace Components and Architecture



A concern however is that wireless communication is highly unreliable since the respective signals have to propagate through the heterogeneous physical environment instead of through a homogeneous wire [6]. High transmission quality can be achieved only at a high price. In the Cold-Trace project, this trade-off in communication was reasonably balanced according to the requirements of the users. User requirements indicated that data security is not high priority. Authentication may be necessary - a hacker may intrude into the Cold-Trace system and cause considerable confusion - but increases communication (and development) costs. In accordance with our users, we presumed that encryption of protocol messages is not necessary.

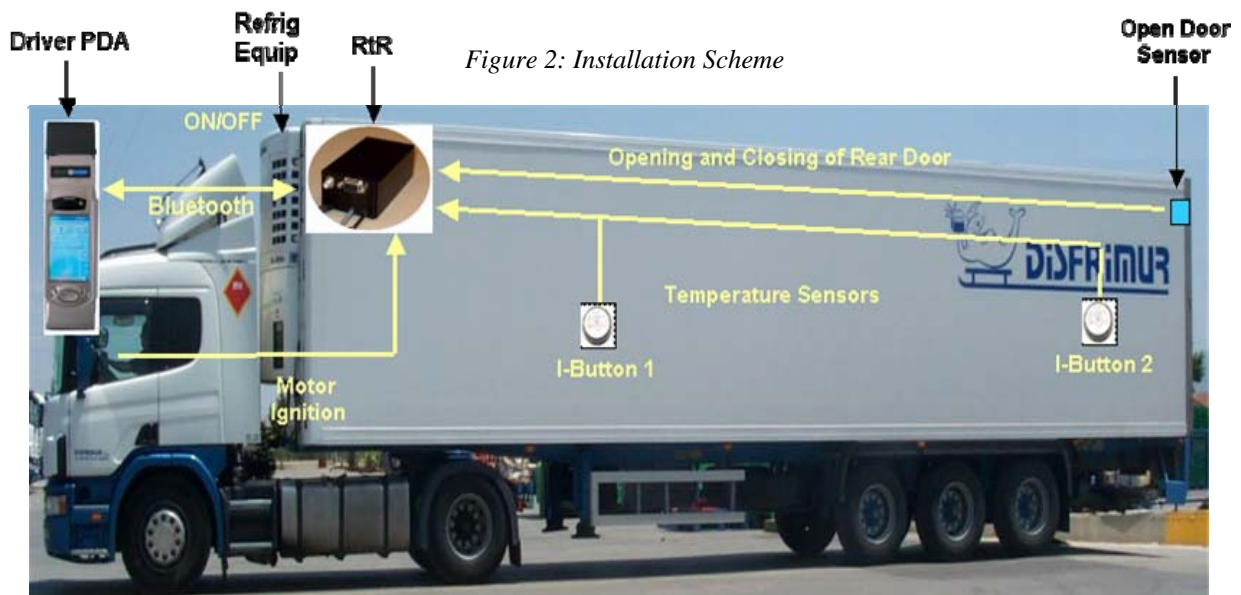
4. Business Case Description

Disfrimur is a transport and logistics company located in Murcia (Spain). Founded in 1997, the company is dedicated to food transportation, specializing in frozen and refrigerated goods. The company owns 500 trucks and has over 800 truck drivers. One of the major problems experienced by this transport company was to guarantee the merchandise traceability and control and proof of the uninterrupted cold chain. The lack of communication between the Central Operation Base and the trucks (cabin and trailer) was yet another difficulty. Disfrimur top managers found that current software solutions available on the market were not easy to integrate with existing fleet management systems, mainly due to their lack of interoperability. Furthermore, for the limited use they were too expensive and only partially fulfilled the business requirements for a flexible and integrated solution providing complete traceability.

As part of the company growth strategy, in 2005 Disfrimur decided to integrate the Cold-Trace solution into the corporate management system and implement the system into their fleet in order to take advantage of the Cold-Trace integral offering: temperature control + GPS tracking system + work order management system. The Cold-Trace system provides GPS and GPRS communications to the Black-Box, offering complete control of the trailer, where the merchandise is carried, with total independence of the tractor and the driver PDA.

Today, over 200 trucks have been equipped with both tractor and trailer components (black boxes and sensors) in all Disfrimur branches (Murcia, Alicante, Valencia, Barcelona) and more than 300 drivers and 10 fleet managers perform daily tasks with the support of Cold-Trace:

1. A multi-functional PDA for truck drivers, that hosts the Cold-Trace PDA application, integrates a mobile phone, and offers navigation facilities. The PDA is used by the truck driver to manage work orders, to access the information gathered from the Black-Box, and to be in touch with headquarter.
2. A “Black-Box” located on trailers that records information on geographic position (using GPS) and data from a set of sensors located in and around the vehicle (temperature, open cargo door, engine data). The Black Box is linked with the headquarters via GPRS/UMTS.
3. A central office server that receives and processes data from trucks and sends information to the driver PDA.
4. A fleet management application that provides the user interface at the office side.



Since installing the Cold-Trace system, Disfrimur's fleet has become "on line". Information is recorded every 20 seconds, offering the company on time/updated statistics on service performance. Real-time interaction between truck drivers and fleet managers in headquarters has also been made a reality and the cold chain monitoring and management is guaranteed. The truck driver may receive a pick-up order from the fleet manager based on his truck's current location, verify the trailer compartment's pre-cooling temperature (reading the sensors' data via Bluetooth), then record (using his PDA's temperature sensor) the initial temperature of the package to be loaded, and send his data via GPRS to the fleet manager. The fleet manager processes this data, and the customer waiting for the shipment may get additional "peace of mind" by confirming online that his merchandise is in a good condition for on-time delivery.

To sum up, Disfrimur found out that Cold-Trace offers numerous advantages to road transportation companies and to their customers.

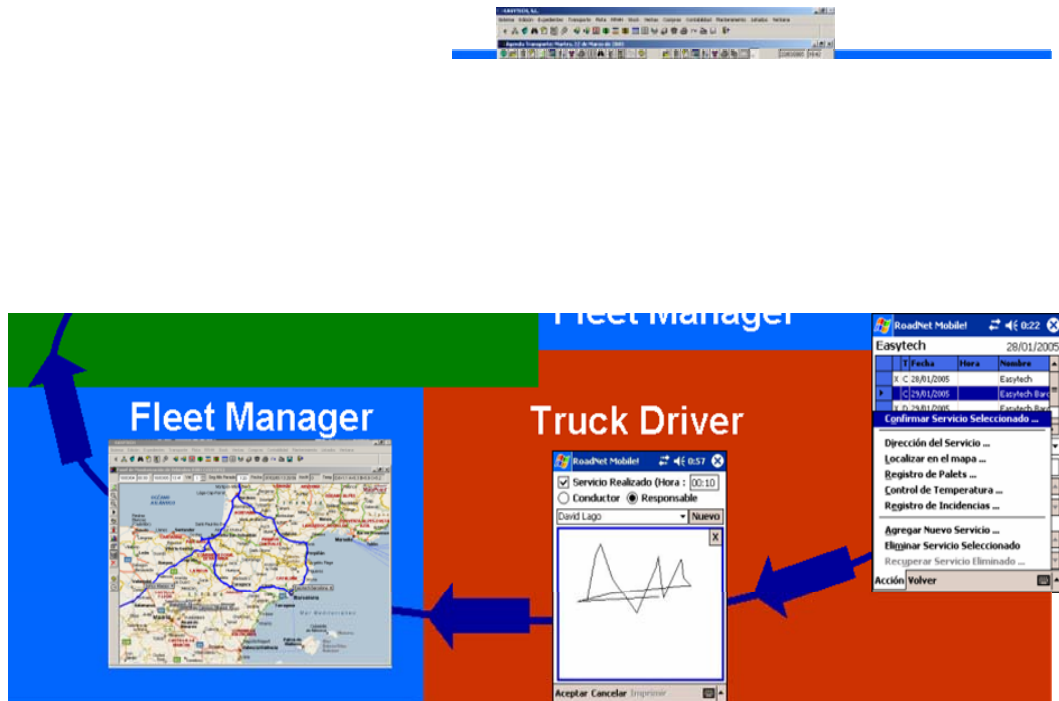
- **Traceability:** the system offers merchandise traceability and a strict control of the cold chain. Any disruption in the cold chain is documented, together with the temperatures reached and the time length of the abnormal conditions, which has become an excellent tool for decision making. European regulations regarding transportation of perishable goods, increasingly strict over the passed years, are perfectly met.
- **Increase of competitive advantage:** The secure control system offers clear benefits to customers and to end users. Therefore, transparent processes in transport logistics does not only increase economic benefits for the primary user (the transport and logistics company, in this case Disfrimur) but reassures users and the public on healthy transport conditions.
- **Operating Cost Reduction:** Tasks that formerly required much time and effort (daily work routines, communication between the customer, the fleet manager, and the truck driver) are now automatised. Due to exact position monitoring via Internet and GPS, cumbersome cross-communication between the stakeholders and insecurities about arrival time and condition are now obsolete. This saves on man/hours as much as on communication costs.

Since the installation of Cold-Trace at Disfrimur mobile phone cost has been reduced significantly, up to 30% (around 7.000 Euro per month for a fleet of 500 trucks). Other important saving costs arise from initiating pre-cooling of trailers compartments remotely. Although the goal is 24-hour truck usage, in practice trucks are stationary for 4-5 hours each night. Trailers are turned on and cooled to a pre-set temperature each morning (30-60 minutes before leaving) by drivers. Cold-Trace enables the remote initiation of pre-cooling by fleet managers, which results in a saving of about 1.100.000 Euro per year for a fleet of 500 trucks.

- **Resource Optimization:** knowing the exact position of all available trucks at any given time, fleet managers can assign new orders to the ideal truck and optimizing resources accordingly. And maximizing trailers loads represents a considerable saving around 2% reduction in Km with trucks unloaded (about 790.000 Euro per year for a fleet of 500 trucks).
- **Increase professionalism:** the system has a significant impact on the professionalism and level of quality of the services offered by the company. By implementing the Cold-Trace services Disfrimur has entered in the e-economy, accessing to e-business solutions and new forms of business and commerce.
- **Enhancement in customer service:** problems affecting quality of service are perfectly documented by the system, claims and the need for legal processes will be reduced and insurance company compensations processes will be speed up.

- **Availability of Precise “On Line” Information:** the advantages of having precise information on the spot at real time results in advantages in practically all aspects of the company and its customer relation.
- **Lower Insurance Costs:** various insurance companies have shown interest in the system and have offered lower premiums for transportation companies that proceed with implementation of this technology.

Figure 3: Cold-Trace Workflow Interaction



5. Methodology Used

The methodological approach for performing RTD first and Market Validation Study of the Cold-Trace solution immediately afterwards, has been the standard project life cycle. However, some tasks and/or the way they were performed proved to be of particular value:

- The early set up of an overall vision of how the system could work and preliminary technical testing of the PDA application and GPRS communications prototypes performed in early stages of the project accelerated the creation process and, boosted proactiveness of the industry users. This experience proved that the integral approach shown through hands-on examples is more convincing than paper work or theoretical approaches.
- Performing user trials of the complete system under “real-world” conditions in two transport companies in Spain and Ireland allowed adjusting the system towards a quick and efficient adoption.
- A critical mass of social and economic actors from more than 60 organisations interested in the traceability solutions and supporting Cold-Trace were mobilised in Special Interest Groups . SIGs involved decision makers from the refrigerated and road transport industry, logistics, food distributor industry, standardisation bodies, insurance

companies, technology solutions providers, local authorities, vehicle management systems, truck manufacturing industry and telecommunications operators.

- User-centred validation was performed during the test phase, according to the highest international standard specifications, including Structured Interviews, Check lists of user requirements, Satisfaction Questionnaires (CPQ, SUMI) and Critical Incidents Technique[7]. State-of-the-art usability methods to assess effectiveness, user efficiency, user satisfaction and information content have proved to be of practical value in the Cold-Trace validation process, in order to test to what extent user requirements are currently met; what kind of training or design modification is required, and what is a reasonable strategy to pursue in the long run to facilitate enlargement of the current client base.

6. Conclusions and future Perspectives

Benefits to primary users: The Cold Trace system guarantees merchandise traceability and a strict control of the cold chain, and thus improves security of truck loads when attacked (lock system and load tracking). Knowing the exact position of all available trucks and remote control of cold equipment facilitate costs optimisation / reduction in terms of time and human resources performance. Operational costs savings are also being significant as a result of fewer voice phone calls. At the same time, by adopting an ICT-based solution like Cold-Trace, professional image of truck-drivers, and ultimately of the transport company is improving.

Benefits to customers and end users: In addition, Cold-Trace is having significant impact on Disfrimur customers (supermarket chains) and consumers in general. By guaranteeing that the cold chain is properly controlled and documented during transportation, Cold-Trace improves the quality of life, health, and consumer protection.

In future work, we intend to extend the Cold-Trace results to other sectors such as biotechnology and pharmaceutical industries where traceability of the cold chain goods distribution and storage needs to be enabled in a potentially even more difficult environment. The quality of drug products that require temperature controlled storage conditions can be adversely affected if they are not carefully managed and distributed within required temperature guidelines. Otherwise authentic temperature-sensitive drug products may become ineffective if exposed to inappropriate temperatures in the supply chain. As a result, environmental storage conditions become a critical component of the track, trace, and authentication technology for cold chain products.

In the USA, the number and volume of temperature-sensitive products is increasing rapidly and the Biotechnology Industry Organization has estimated that the growth in temperature-sensitive products will outpace the rest of the industry with average growth estimated at 15% per year. Hence there is an emerging market for the transport of these goods, and the control and assurance of an adequate delivery cold chain. Thus, the experiences gained in the Cold-Trace project can be transferred to similar circumstances in other sectors than food, i.e. the pharmaceutical sector. The integral approach – traceability, communications, management – and its interoperability at the hardware and software side makes it an ideal tool for SMEs, providing transparency, economy and security at the same time. Its data transfer via GPSR and Bluetooth is less invasive as up-coming RFID solutions that may cause considerable headache in terms of data protection and privacy.

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