Fleet management in railway freight transport: the EU project F-MAN

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Abstract

The paper presents the ongoing results of the project Rail Car Asset Management (hereinafter referred to with its short name, F-MAN). The project started in October 2001 and it is partially funded by the European Union within the “Information Society Technologies” programme. The main goal of the F-MAN research project is to investigate feasibility and benefits related to the development of innovative tools enabling a brand new approach toward the management of the internationally operated fleets of freight wagons. To reach its objectives, the F-MAN Consortium, which brings together partners with expertise in rail freight operation, transport and logistics applications, as well as in communication and information technologies, started its activities with a thorough survey on the current practice and needs of freight railcars management, identifying major problems and limitations toward an improved exploitation of the fleets in the upcoming European rail transport scenario. This allowed us to specify the requirements of a new fleet management approach and to design and develop an innovative system providing a set of tools enabling unprecedented quality, availability and exploitation of the information necessary for an effective management of railcars fleets for national and international freight transport.

Keywords: railway, freight, fleet management.

1 Introduction

It is commonly agreed that rail transports present many benefits for the society with respect to other transport modalities, and especially with respect to road transports: environmental impact (emissions and pollution), citizens mobility (traffic congestion), health and safety issues (air quality and road safety) are...
among the main concerns world-wide, and the migration of freight transport from road to rail is recognised as one of the key factors to their solution (to increase the rail share of goods traffic is among the main objectives of rail stakeholders internationally, as reported in the EC White Paper [1]).

However, such migration will only take place if and when rail transport represents an effective option from both the operational and economical viewpoints. This is even more the case in the new European railway context, with the opening of the market to new Railway Undertakings targeting the national and international transport business. In such a context, the EU project presented in this paper aims at improving the sustainability of rail freight transport by enhancing the competitiveness of Railway Cargo Operators (RCOs), including the new Rail Undertakings, contributing to narrow the gap toward lorries.

2 The EU project F-MAN

2.1 The consortium

The F-MAN project started in October 2001 from a consortium bringing together the experience, expertise, know-how and knowledge of an heterogeneous set of partners including Railway Cargo Operators, developers of Transport and Logistics applications, Information & Communication Technologies experts and Research Institutions. The F-MAN consortium is composed by Università degli Studi di Genova and SCIRO S.p.A. (Italy), Sigma Conseil S.a.r.l. (France), IVU Traffic Technologies A.G. (Germany), European DataComm N.V. (Belgium), Prometni Institut Ljubljana D.O.O. (Slovenia), National Technical University of Athens (Greece), Caminhos de Ferro Portugueses E.P. (Portugal), and carries out project activities with the external support of a Users Group leaded by SNCF Fret (France). The project is co-funded by the European Community under the IST – “Information Society Technologies” Programme (1998-2002) and is planned to reach its final results by the end of 2004.

2.2 Origin and objectives of the project

When fleet management is addressed, almost everyone would expect that information on fleet elements, such as availability or location, is well known and among the basic data the management process relies on. Unfortunately, for fleets of freight railcars, this is not the case, or at least not yet. If some exceptions relevant to national transport are excluded, the information relevant to wagons status, location, availability and so on is often collected by personnel in the field, usually communicated by phone or fax, and mainly handled and processed by fleet managers to their best. And this is not the worst case; when international transports are concerned, what commonly happens is that as soon as a railcar crosses the national border, the fleet manager simply doesn’t know where his wagon is, or when and where it will be available again within his country. This problem is only sidestepped and not solved by trans-national agreements on the
utilisation of railcars for international transports (known as “wagon regimes”) stipulated among former national RCOs. Most of such agreements, which had the merit to allow “uninterrupted” freight exchange across Europe, have become obsolete: on one hand they don’t allow an actual control of the fleets (resulting in poor productivity for the wagon owners), and they were designed without taking into account the new opportunities and needs introduced by European regulations and directives such as the 2001/12/EC [2], which opens the Trans-European Rail Freight Network (TERFN) to “any European Company holding a licence”. As TERFN gives rail freight operators in the European Community access and planning rights to the complete European rail network for international traffic, the possibility to effectively plan direct services across the entire rail infrastructure in Europe has become more and more needed.

The objective of the F-MAN project is to provide nowadays actors of the rail freight transport chain (Wagon Owners, Railway Cargo Operators and Train Operating Companies) with a set of tools enabling an actual, effective and profitable management of railcars fleet, overcoming the barriers deriving from roles and language differences [3,4].

3 Identifying roles, needs and requirements

Identifying roles and needs of the actors involved in the rail freight transport chain is the starting point for the design of a brand new fleet management system for freight railcars, as only the result of such activity can provide the basis for the specification of the system functional requirements.

However, such activities are not trivial when the whole concept of fleet management is somehow new, as the F-MAN concept is in the rail freight transport. Experience and knowledge deriving from fleet management in other sectors, such as lorries for example, only partially helps. Constraints related to the railway network, the operation of trains, the interdependency among the functions of the different actors involved and the specific requirements of the fleet elements have not much in common with other transport modes: a wagon has no driver, its movements have to be organised with one or more Train Operating Companies (TOCs), and TOCs can only operate within the slots granted by one ore more Infrastructure Managers (IMs), only to cite some of the most apparent differences.

The opportunity to manage the fleet also abroad further complicates pre-design activities, as it represents a novelty for the Users themselves. Between the sender and the consignee, i.e. the customers of a freight transport service, several actors have a role to be taken into account: the Order Manager (OM), who represents the interface toward the costumer, passes wagons requests to the Fleet Manager (FM). Than the FM has to find suitable railcars to be delivered to the loading location in due time, also organising the movements of empties and the shipment trip with the Operational Manager (OPM), which represents the interface toward the TOC, i.e. the traction provider. Beside these actors, another key role is represented by the Maintenance Manager (MM), who has a responsibility in determining the technical availability status of wagons.
Targeting the design and development of a system open to the upcoming and future railway scenario, the possibility that each of the above introduced actors belongs to a different company has to be considered.

Once roles have been identified, the functional requirements of the system can be specified by tracing the interactions, communication flows and information which shall ensure an effective completion of all the processes involved.

4 New approach to fleet management in rail freight transport

A really comprehensive and effective translation of users needs into system requirements for a new approach to railcars fleet management in freight transport has been achieved within the F-MAN project by adopting the AFNOR standards for systems functional analysis and specification.

This allowed to obtain a thorough identification of the environment and the processes in which the application is to be integrated, and to clearly describe its requirements in terms of functions and constraints the system has to support and withstand, avoiding the risk of biasing due to a pre-defined architecture.

The list of functions and constraints obtained is briefly reported in Table 1. Satisfaction of requirements and constraints listed in Table 1 implies not only an effective, unambiguous, and reliable information exchange among the involved entities, but also, of course, the availability of punctual and accurate information on wagons, as only information generated by the wagons themselves can be.

Moreover, wagons availability has to be determined based on both their actual and forecasted status and location, so that a railcar which is running loaded in the present is considered available (empty) to satisfy an order in the future if it will be possible to deliver it to the new loading place in due time. This means that the Expected Time of Arrival (ETA) to a given destination must be included among the information data relevant to each wagon.

5 The F-MAN system architecture

The F-MAN interpretation of the requirements and constraints listed in Table 1 is briefly summarised in Figure 1, where the overall architecture of the F-MAN system is shown. F-MAN is made of three main modules, namely the Tracking System Module (TSM), the Data Processing Module (DPM) and the Asset Management Module (AMM).

The TSM is constituted by On Board Terminals (OBTs), to be installed on each wagon of the managed fleet, and a Ground Station (GS). The On Board Terminals collect data on wagons position and status by means of GPS receivers and on board sensors, and transmit such data to the GS by means of GSM terminals.

Communication is SMS based and event oriented in order to comply with the energy consumption constraints deriving from the maintenance free, long life battery providing the power source.
Table 1: Functions and Constraints for the new management approach.

<table>
<thead>
<tr>
<th>F/C</th>
<th>Description</th>
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<tbody>
<tr>
<td>F1</td>
<td>To provide to the FM the OM request of empty wagons</td>
</tr>
<tr>
<td>F2</td>
<td>To provide to the FM alternative sets of Wagons, which satisfy the OM request</td>
</tr>
<tr>
<td>F3</td>
<td>To provide data exchange between the FM and the OPM about the validation of transport feasibility of empty wagons</td>
</tr>
<tr>
<td>F4</td>
<td>To transmit to the OM the FM confirmation regarding the wagons request feasibility</td>
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<tr>
<td>F5</td>
<td>To permit the FM to establish a hierarchy among empty wagons requests, taking into account Contractual Data</td>
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<tr>
<td>F6</td>
<td>To transmit to the OPM the FM order to send empty wagons to loading location</td>
</tr>
<tr>
<td>F7</td>
<td>To provide to the FM the OM modifications to the initial request of empty wagons (changes coming from the customer)</td>
</tr>
<tr>
<td>F8</td>
<td>To update wagons allocation on the basis of real time data provided by the OPM and Wagons and of foreseen path and timetable (by the OPM), and to inform the FM in case of delay detection related to empty booked wagons</td>
</tr>
<tr>
<td>F9</td>
<td>To allow the FM to inform the OM about mismatch between his wagons request and the F-MAN solution</td>
</tr>
<tr>
<td>F10</td>
<td>To provide to the FM the OM modifications to the initial request of empty wagons (changes coming from the customer)</td>
</tr>
<tr>
<td>F11</td>
<td>To update wagons allocation on the basis of real time data provided by the OPM and Wagons and of foreseen path and timetable (by the OPM), and to inform the FM in case of delay detection related to empty booked wagons</td>
</tr>
<tr>
<td>F12</td>
<td>To inform the FM, the OM and the MM about damage on wagons</td>
</tr>
<tr>
<td>F13</td>
<td>To inform the FM and the MM that wagons are arrived in workshop, taking into account event messages sent by the OPM and real time events sent by wagons</td>
</tr>
<tr>
<td>F14</td>
<td>To update wagons allocation on the basis of the MM data about delay during maintenance in workshop and to inform the FM in case of delay detection related to booked wagons</td>
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<tr>
<td>F15</td>
<td>To let the FM release alternative sets of empty wagons following the OPM transport feasibility confirmation</td>
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<tr>
<td>F16</td>
<td>To establish a relation between wagons chosen by the OPM for a precise mission and the related transport request</td>
</tr>
<tr>
<td>F17</td>
<td>To allow the FM and the WO to agree on the way to use wagons</td>
</tr>
<tr>
<td>C1</td>
<td>To connect the FM to F-MAN</td>
</tr>
<tr>
<td>C2</td>
<td>To connect the OPM to F-MAN</td>
</tr>
<tr>
<td>C3</td>
<td>To connect the MM to F-MAN</td>
</tr>
<tr>
<td>C4</td>
<td>To connect Wagons to F-MAN</td>
</tr>
<tr>
<td>C5</td>
<td>To connect the WO to F-MAN</td>
</tr>
<tr>
<td>C6</td>
<td>To connect the OM to F-MAN</td>
</tr>
<tr>
<td>C7</td>
<td>To respect standard and norms</td>
</tr>
<tr>
<td>C8</td>
<td>To resist the environment</td>
</tr>
<tr>
<td>C9</td>
<td>To minimise the impact on wagons</td>
</tr>
</tbody>
</table>

The GS, which is responsible for OBTs originated/terminated data buffering, pre-processing, conversion and distribution, is connected to the DPM through a secure Internet connection. The DPM is the software application responsible to maintain data relevant to the fleet composition (F-MAN Pool), past, actual and forecasted geographical distribution (Tracking&Tracing and ETA), maintenance status (technical availability), and to manage the event messages communication...
procedures toward the OBTs. Orders processing, wagons selection and booking, trips organisation and logging of data for asset management purposes is performed through the AMM. The AMM and the DPM share a common database and are accessible through a Web Application Server. Any involved user connects himself to the system through the Internet by means of a simple browser, and the system recognise his role and access rights by means of the login parameters, so that only the sub applications and fleet elements pertaining to his role and orders are accessible.

6 The F-MAN tools

The F-MAN system provides its users with the so called F-MAN Tools, i.e. a set of user friendly interfaces to the system (automatic multi language support is implemented) assisting and driving the user throughout any task he’s responsible for.

![Figure 1: The F-MAN system’s architecture.](image)

When F-MAN is accessed by an OM, a FM or an OPM, his journal page, i.e. a personalized “To Do” list, is shown. Here, all actions that the user according to
his role has to act on are displayed, and for each of those actions a step by step path to the procedure completion is provided, together with “shortcuts” for repetitive actions and expert users.

In order to provide a general, although not exhaustive overview of the developed tools, a short description of the tasks the different users are assisted in is reported below.

**Order Manager**

- Orders status monitoring: the journal page displayed to the OM lists the status of the wagon orders already entered by the OM himself and forwarded to the FM for processing. This allows to follow each step of the process from the wagons request to the order confirmation. Information includes loading status.
- Orders request creation and transmission to the FM: the OM can add new orders specifying number and type of wagons, place and time for loading and place for unloading. The new order is then sent to the FM for processing.
- Tracing and tracking of shipments: the “last seen” information available to the DPM for a wagon absolving to an owned order can be shown on a map.
- Time of consignment estimation: the ETA information available to the DPM for a wagon absolving to an owned order can be shown.

**Fleet Manager**

- Orders status monitoring: similarly to what described for the OM, but from the FM perspective. Additionally, for the FM an order is seen as multiple tasks to be achieved; basically the delivery of empty wagons to the loading place, and the organisation of the trip from loading to unloading place (and sometimes from the unloading place to a parking place). Each task is monitored in detail. Status information includes loading status, technical availability, running/not running, etc.
- Identification of railcars best fitting order requests: based on current and forecasted railcars position and status, wagons available to satisfy the requests of new orders are identified and ranked according to the expected transport costs calculated for the overall trip, including the necessary empties movements.
- Railcars movement and trip organisation and agreement with the OPMs: after selection of wagons satisfying an order request, all the procedures necessary for the confirmation of transport feasibility are unambiguously performed through the system.
- Fleet productivity monitoring: by logging relevant data such as empty and loaded running time for each wagon, accurate productivity and efficiency indicators can be obtained and utilised to identify most effective management policies.

**Operational Manager**

- Railcars movement and trip agreement and confirmation with FMs.
Communication of events (e.g. damages on wagons): information sensible for railcars management (e.g. delays or damages) and/or maintenance (e.g. type of damage) can easily, timely and unambiguously be notified to the relevant FM or MM.

Maintenance Manager

- Railcars maintenance history documentation: for each wagon, records relevant to maintenance actions are stored through the DPM.
- Preventive maintenance planning (time, mileage or wear based): the DPM automatically updates mileage and km*tons accumulated by railcars. The MM can query the DPM to obtain lists of wagons to be planned for maintenance according to the applicable criteria.
- Corrective maintenance organisation: damages on wagons are notified to the MM who has the possibility to locate wagons and organise repair actions.

As every user operates on a common data set, communication between users is almost real-time, although e-mail notification of specific events is automatically implemented. ETA calculation utilised by the system is based on suitable algorithms utilising information provided by OBTs and statistical data which are updated by the system itself after a first initialisation.

7 F-MAN in action

The validation of the applications developed within the F-MAN project has been accurately planned by the consortium through a set of validation methods which includes functional tests, on field tests and users acceptance assessment to be carried out involving users inside and outside the consortium.

Moreover, since large scale demonstration is not affordable for a research project as F-MAN is, simulation is also planned in order to evaluate the F-MAN approach benefits for fleet’s productivity. At the time this paper is written, most of the functional tests addressing the verification of the implementation of each functional requirement has been successfully performed, and the field tests are ready to start.

The scope of field tests is to assess the behaviour of the F-MAN system in conditions as near as possible to the condition of an actual implementation within the real environment, and to collect information relevant to users perception of the F-MAN system. To this purpose, field tests will be performed by users themselves, by means of OBTs installed on their own wagons, with the Ground Station located in Belgium and the Web Application Server hosted in Germany. Each test operator will perform the verification activities running the wagons in different railway “corridors” across Europe, as described in the following and schematically depicted in Figure 2.

- **Caminhos de Ferro Portugueses (CP)** will utilise a corridor that connects Portugal with Spain.
- **SNCF Fret (SNCF)** will utilise 7 different corridors that connect France with Italy via Modane.
Slovenian Railways (SR) will utilise two different corridors: a corridor that connects Slovenia with Austria, and a corridor that connects Slovenia with middle Europe (Czech Republic, Slovakia, Hungary, Romania).

Given the limited number of OBTs available within F-MAN resources (45 pieces), CP, SR and SNCF will be obviously forced to process orders just as usual, and wagons will be managed accordingly. Nevertheless, it will be possible to have a virtual processing, with the F-MAN system, of the orders which may involve OBT equipped wagons: this means that the users themselves will simulate the process from the input of a new order, through the transport feasibility check, till the transport confirmation. The effectiveness of tracing and tracking functionalities, ETA calculation, delay detection and maintenance related utilities will be tested as well.

Figure 2: F-MAN test sites across Europe.

In order to overcome the limitations to the managing possibilities deriving from the unavailability of an actual F-MAN pool, simulation will be used in order to estimate the effectiveness or performances of a subset of F-MAN application functionalities, in particular as far as the asset management facilities are concerned. Simulations will aim at evaluating the actual effectiveness of the algorithms and procedures implemented by the DPM and AMM when operating on a significant pool of wagons (e.g. thousands of wagons): the scope of such simulations is to gather data enabling a fair comparison of the performances (such as fleet productivity) obtainable from a fleet operated according to the F-MAN concept with respect to those relevant to the nowadays management
practice. The final results of both field tests and simulations, together with the assessment relevant to users acceptance and the evaluation of the impacts expected from a large scale implementation of the F-MAN approach will be available after the project completion in October 2004.

8 Conclusions

The main objectives of the F-MAN project, together with the approach utilised to identify the requirements of a new concept for the management of freight railcars, have been introduced in this paper. The authors also presented the ongoing results of the project with a description of the tools devoted to the actors involved in the railway freight transport chain. The current status of applications validation procedures has been described. Although final results are not available yet, the preliminary results, together with the feed-back and expectations from Users inside and outside the F-MAN consortium is very promising. Further information on the project and its results are regularly added on the F-MAN web site at www.fman.org, so… stay tuned!

References


