Integration of telematics for efficient management of carrier operations

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Abstract

The use of telematics promises many potentials for improving the efficiency of carrier operations. Tracking & tracing functionalities, an improved information exchange between dispatchers and drivers, and an improved fleet management are the main fields of application. The information gathered by off-the-shelf fleet telematics systems, however, can often not be sufficiently utilised as the telematics systems cannot be readily integrated into the existing IT infrastructure. Especially small motor carriers cannot afford to replace their IT systems by such systems that already support telematics functionalities. As a result, off-the-shelf telematics systems are often of only limited use. In this paper we present a concept for integration of an off-the-shelf telematics systems into the carrier's IT infrastructure. We show how the information flow, as well as processes can be reorganised to exploit the potentials of the use of telematics.

Keywords: Fleet Management, Telematics, Intelligent Transportation Systems

1. Introduction

Due to globalisation, liberalisation of markets, deregulation, and the increasing commitment to the just-in-time philosophy, competition between motor carriers and expectations on punctuality, reliability, flexibility and quality of transportation services have increased significantly and will increase even more in the future. Rapid development of mobile communication and information technology allows the use of telematics to cope with those challenges and to increase the efficiency of carrier operations. [7] identified the major potentials of telematics systems in the fields of information exchange between dispatchers and drivers, tracking & tracing, fleet management, and planning of handling activities. According to [5] an information exchange realised by voice communication leads to delays in the information flow and is error prone. Furthermore, the information which is spatially distributed cannot be sufficiently utilised which results in problems in identifying incidents and initiating countermeasures or modifying the schedule. Vendors of telematics systems promise that their systems can exploit the various potentials and most telematics systems on the market allow the communication with drivers, configuration of on-board units, and visualisation of vehicle positions. Although off-the-shelf telematics systems can significantly improve the availability of timely and reliable information, the full potential of telematics can only be exploited when the telematics systems are integrated into the carrier's IT infrastructure. Prior to the deployment of a telematics system, motor carriers usually have some kind of IT system in use, which supports the management of orders and vehicle fleet. In many cases this IT system is not prepared for the integration of telematics functionality. Off-the-shelf telematics systems on the other hand, usually cannot provide any functionalities beyond those mentioned above, as they would require more knowledge about the specific use case. Thus, despite of the reasonably low cost of off-the-shelf telematics systems, the return on investment of those systems is very limited if they cannot be integrated into the existing IT infrastructure.

In order to exploit the potentials of telematics systems the motor carrier has two possibilities: to replace the current IT system by a system supporting the integration of telematics systems or to extend the functionalities of the current IT infrastructure. A replacement of the current IT systems is often impossible or not affordable as those systems often are very complex and new software cannot easily be customised to the carrier's needs. In this paper we show how to extend the carrier's IT infrastructure by integrating an off-the-shelf telematics system. We show how the communication can be monitored and analysed and how unexpected incidents, information about the state of vehicles, drivers, trips and the progress of serving the orders can automatically be identified. This relieves dispatchers from tasks which can be automated and allows them to concentrate on those tasks which require human action. Eventually, we discuss some of our practical experiences of such an integration for a german motor carrier.

2. System architecture

The use of information technologies for motor carriers has been under investigation in [3] and a very detailed description of a typical IT infrastructure is presented. In figure 1 we illustrate such an IT system using the Unified Modeling Language, see [2]. The Order & Fleet Management System (OFMS) has the central role concerning the management of orders and vehicles. Other systems like Billing System, Cost & Performance Analysis System, and Freight Exchange System are connected to the Order & Fleet Management System.

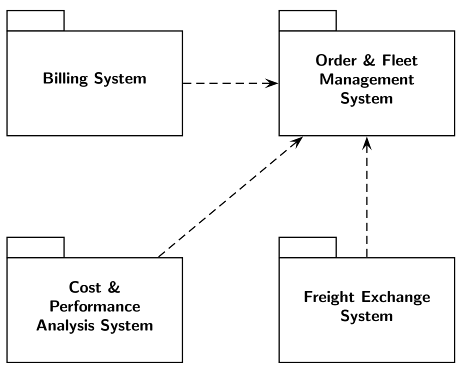

Figure 1. IT-infrastructure

Without a telematics system the entire communication between drivers and dispatchers is realised by mobile phones. To keep a log of all exchanged information the dispatchers have the possibility to enter the minutes into the OFMS. It is possible to change the state of transportation requests to indicate whether a driver has been instructed to serve the transportation request and to enter actual data like arrival and departure times.

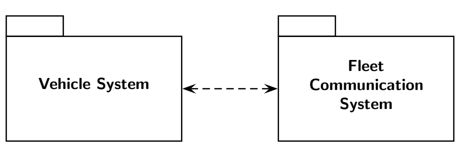

Figure 2. Fleet telematics system

Fleet telematics systems consist of mobile Vehicle Systems (VS) and a stationary Fleet Communication System (FCS) as illustrated in figure 2. Dispatchers can send messages to the drivers using the FCS and can access all information sent by the VS. We assume that the communication is asynchronous, which is the case for many off-the-shelf telematics systems which communicate using the Short Message Service (SMS) provided by the Global System for Mobile Communications (GSM). If the fleet telematics system is not integrated into the OFMS all data has to be manually transfered between both systems. This results in additional effort, is error prone, and can cause considerable problems, for example, if information about pickup and delivery is transfered incorrectly. Furthermore, the fleet telematics system is a rich source of information relevant to the OFMS and it is impossible to manually transfer and analyse all relevant information.

To overcome those weaknesses and to exploit the resulting potentials the fleet telematics system has to be integrated into the existing IT infrastructure. This can be realised by a Messaging & Fleet Monitoring System (MFMS) as illustrated in figure 3. We take into account that usually neither the Fleet Communication System nor the Order & Fleet Management System can be modified easily. It is however assumed, that all the relevant data is accessible from outside the systems. This is often the case, as these systems usually have a client/server architecture and necessary interfaces exist.

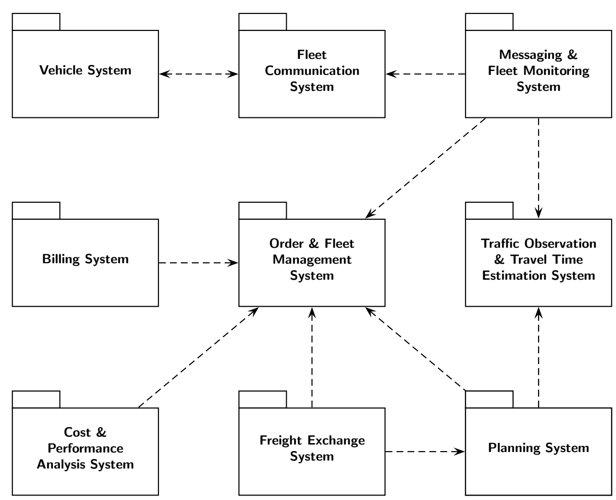

Figure 3. Integrated IT-infrastructure

The MFMS exchanges information between the FCS and the OFMS, monitors the communication between dispatchers and drivers, extracts relevant information, and puts the resulting data in context to the data stored in the OFMS. Exact arrival and departure times can be detected and stored in the OFMS. This data may, for example, be used to generate invoices by the Billing System without the need to wait for the way-bill to be handed over. The current vehicle positions can be used to calculate estimated arrival times.

This can be done considering current traffic conditions with the help of a Traffic Observation & Travel Time Estimation System. The estimated arrival times and tracking & tracing functionalities can be provided in electronic freight markets by the Freight Exchange System, see [1] for an overview of services which can be provided by electronic freight markets. The lack of information used to be a major problem for successfull deployment of real-time planning systems, see [8]. With the improved supply of reliable information a Planning System can be used to calculate new tours dynamically. The development of algorithms for dynamic routing is an active research field and several algorithms have been proposed recently, for example [9] and [6]. The algorithms presented in [6] also take into account the actual traffic conditions provided by a Traffic Observation & Travel Time Estimation System.

3. Analysing incoming messages

The MFMS analyses all incoming messages and tries to extract important information as illustrated in figure 4.

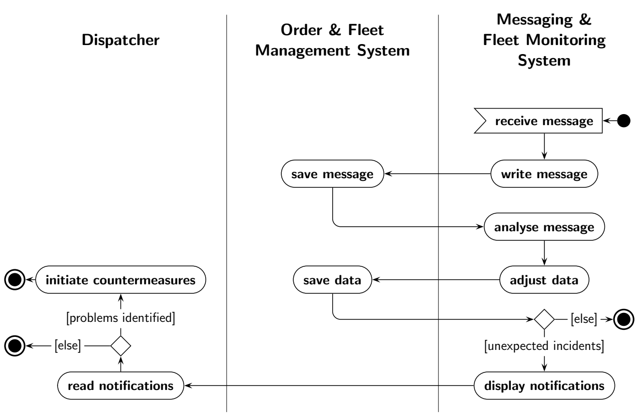

Figure 4. Analyse message

When an incoming message is received, it is stored in the OFMS. Depending on the use case and the telematics system used, different data is sent from the drivers or vehicle systems to the dispatching office. The messages are analysed according to their potential content. GPS (Global Positioning System) data can be used to match vehicle positions with the planned itinerary. Other sensor data can give important information regarding the security, reliability and quality of the transportation services. CAN bus data for example may give information about engine problems. Sensors in the cargo body can give important information, like e.g. the temperature in the cargo body. This makes it possible to proof that temperature sensitve shipments are properly cooled throughout the transportation process. Drivers may give important information by transmitting the status of driver, trip, vehicle and shipments.

All this data is analysed automatically and the extracted information is stored in the OFMS. Furthermore, incidents can be detected and the dispatchers are automatically notified in case of detected incidents or when messages cannot be interpreted automatically. Thus, the dispatchers can concentrate on those messages which cannot be automatically interpreted or where unexpected incidents were identified. Countermeasures can be initiated by the dispatchers if they identify any problems.

Just as an incoming message can give information about possible problems, the nonappearance of messages may indicate that some unexpected incident occurred. At each arrival at and departure from a pickup or delivery location a message is expected in order to store exact arrival and departure times. If such a message is not received by the time it is expected this may indicate some delay. If a driver doesn't confirm the receipt of an instruction sent to him this may indicate that he hasn't received or read the instruction. In figure 5 the monitoring of such events is illustrated.

The OFMS publishes all changed data. These changes are analysed by the MFMS which keeps an event schedule. If the changed data is of no relevance to the event schedule nothing has to be done. Otherwise, the event schedule and the corresponding timer are updated. When the updated timer sends a timeout signal the MFMS checks whether the event is overdue or whether it has occurred before. If an event is overdue a warning message is generated and stored by the OFMS. Eventually, this warning is shown to the dispatcher.

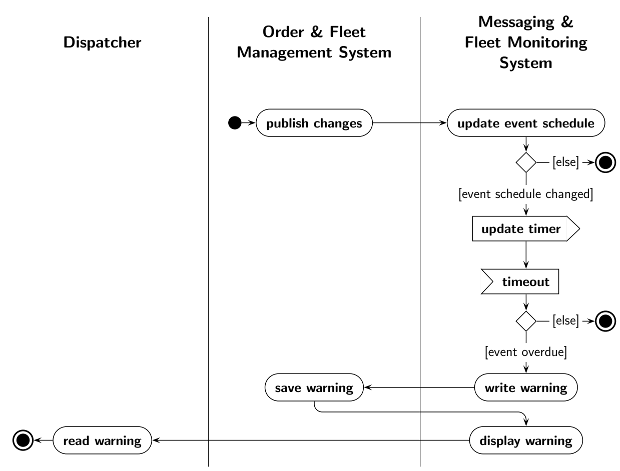

Figure 5. Monitor events

4. Communication

With the FCS information can be sent to the drivers. To be sure that drivers have received and read the messages, they are instructed to send a reply message. If a reply is not sent in time the MFMS observes, as described earlier, that a scheduled event has not occurred and warns the dispatcher.

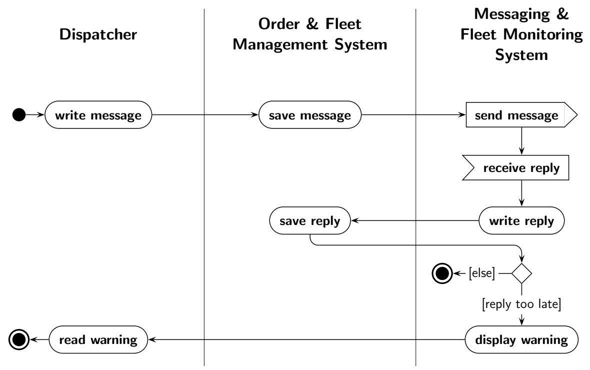

Figure 6. Inform driver

The MFMS controls the information flow as illustrated in figure 6. A message, which is composed and stored in the OFMS by the dispatcher, is sent to the driver by the MFMS. The MFMS monitors all incoming messages, checks whether a reply was sent and stores it in the OFMS. If the reply was sent too late the dispatcher is warned as he might have already assumed that the message was not read by the driver.

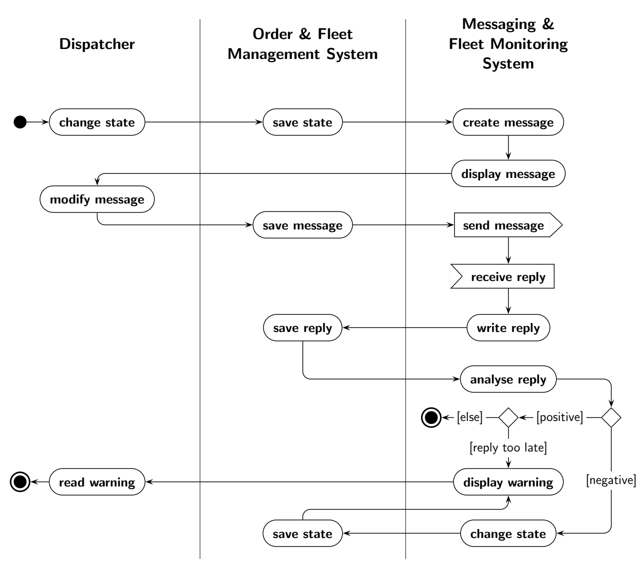

Figure 7. Instruct driver

The MFMS has access to all the data available in the OFMS. To instruct a driver to serve a transportation request all relevant data about pickup and delivery locations and times as well as prefered routes have to be sent to the driver. The workflow for instructing a driver to serve a transportation request is illustrated in figure 7. The dispatcher changes the state of the transportation request to indicate that the driver is instructed. This is observed by the MFMS which generates a message template with all the relevant data. The dispatcher can modify this message and save it. The message is then sent to the vehicle by the MFMS. The incoming reply is stored in the OFMS and analysed to determine whether the driver accepts the task or rejects it. If the task is rejected the MFMS changes the state of the transportation request to indicate that no driver has yet been successfully instructed to serve the transportation request. A warning is generated and displayed to the dispatcher. If the task is accepted the MFMS checks whether the reply is received early enough and otherwise warns the dispatcher.

5. Practical experiences

Georgi Transporte GmbH is a german motor carrier specialised in the road transport of so-called air-cargo. The carrier operates 140 vehicles between European airports. Due to increasing expectations by the shippers and the hope to improve the efficiency a fleet telematics system was deployed. Georgi Transporte GmbH invested 1.09% of a yearly turnover to equip the vehicles with mobile *fleetec III* systems (datafactory AG) and to integrate the stationary *DATAfleet* system (datafactory AG) into the existing IT infrastructure. Before the deployment of the fleet telematics system, the OFMS used didn't have any telematics support. We developed the MFMS, as described in this paper, which is now running for more than one year. After questioning Georgi Transporte GmbH about their experiences with the MFMS they reported that there was a significant increase in the quality of transportation services and the level of fulfillment of customer requirements. The support of the communication process brought a significant relief to dispatchers and drivers, misunderstandings were avoided, and the information flow was improved. A proof of delivery and the identification of the responsibilities of costs were simplified. There were also enhances in avoiding unnecessary times where vehicles were not moving. The cost for voice communication, however, was only reduced by about 5% as instructions for drivers were often communicated via mobile telephones and SMS were supplementary used to relief drivers. As a result, the total cost for communication increased by about 39.6%. Unfortunately, no information about a possible reduction of emtpy mileage and costs resulting from better decisions accompanied with the improved information supply was given to us.

6. Conclusions

The integration of fleet telematics systems into the existing IT infrastructure of motor carriers is essential to exploit the various potentials. Especially small motor carriers don't have the possibility of replacing their existing IT infrastructure or to install a telematics system especially tailored to their needs. In this paper we have shown that off-the-shelf fleet telematics systems can be integrated into the existing IT infrastructure. Carrier's benefit by a faster return on investment as the off-the-shelf fleet telematics systems can be deployed at relatively low costs. There is no need to change the existing IT infrastructure if necessary interfaces exist and dispatchers don't have to get used to a new IT system. New functionalities, as automatic monitoring of events and analysing messages are provided by the Messaging & Fleet Monitoring System presented in this paper. Our practical experiences have shown that the information flow has been improved significantly and that drivers and dispatchers benefit from the improved communication and analysis of information. With our system many of the potentials of telematics systems can be exploited to make the management of carrier operations more efficient. As information is analysed automatically the prerequisites for dynamic planning are provided and a Planning System can be integrated into the IT system. With the use of a dynamic planning system schedules can be optimised and empty vehicle movements can be avoided, leading to further improvements in the efficiency of the carrier's operations.

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