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Characterization framework for road transport telematic services

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ABSTRACT

In order to conduct analysis for the evaluation of benefits derived from Transport Telematic Services (TTS), supporting decisions about architecture design options, it is necessary to establish a characterization framework. This study identifies potentially relevant TTSs for Heavy Goods Vehicle (HGV) Transport, potential users and domain of usage for the services and present these in a useful framework for conducting analysis toward a holistic understanding of telematic services e.g. impact analysis, benefits analysis etc. An illustrative example employing the framework has been presented.

KEYWORDS: transport, heavy goods vehicle, telematic services, framework, categories, analysis

1. Introduction

In order to conduct analysis to gain an insight into the evaluation of Transport Telematic Service (TTS) benefits and evaluation approaches for decisions about various design options, it is necessary to establish a framework to characterize TTSs. This is because the present approach for describing TTSs does not provide any suitable framework for conducting analysis. There is a need for establishing the values of different TTSs to society together with their functional connections for assessing resource sharing (synergies). Such analysis can lead to the assessment of potential Transport Telematic Application Systems (TTASs) for the deployment of efficient multiple coexisting TTSs. Basically, a TTS consist of a product or activity targeted at a specific type of ITS user [9]. The phrase "Transport Telematic Service" is suitable because it conveys the fact that services are offered using telematic applications to users for addressing transportation challenges. This covers terminologies such as ITS User services, Value Added Services or Added Value Services for road transport etc. Against the background of numerous surface transportation challenges, the EU midterm review of the 2001 White Paper, Keep Europe moving – sustainable mobility for our continent, a work program was designed to bring about significant further improvements in the quality and efficiency of transport in Europe by 2010. Electronic Fee Collection (EFC) systems based on interoperable technologies built into a network of interoperable toll booths emerged to be an interesting focus area. Thereafter, the Eurovignette directive established common rules related to distance-based tolls and time-based user charges for goods vehicles over 3.5 tones [3, 6]. Following these developments the Swedish Governmental Commission on road taxes proposed a distance based charging system (a "kilometer tax") that covers all public roads, and all HGV's with a maximum laden weight exceeding 3.5 tons [18]. To that effect, a proposition was eventually discussed in the Swedish parliament to further investigate the potential of a distance based Road User Charging (RUC) system [13, 16].

Previous research work then addressed the importance of TTSs in relation to the Swedish RUC system and pointed out their potential to improve benefits (by sharing start up cost), to attract the attention of multiple transport stakeholders and to mobilize support for RUC application [19]. While TTSs may be developed on any existing platforms such as e-call [21] or intelligent speed adaptation [4], an EFC platform has a potential for hosting co-existing TTSs [19, 12] in order to return synergies of cost reduction benefits. As such the future of EFC systems in Sweden (and Europe) provide a potential base for developing TTSs. Since then further research work has continued within the Swedish Mobile IT project to identify and demonstrate in the 16th World Congress on Intelligent Transport, how TTS can be integrated with a Swedish EFC system. Additionally, a nation-wide demonstration of a GNSS-based road pricing hosting several TTS is due to take place in the Netherland within the GINA (GNSS for INnovative road Applications-GINA) project [7].

Such a common platform for TTSs is hard to achieve without a suitable analysis of TTSs that will influence how the system should be designed to maximize the value and benefits of the services. For internet services, one way of maximizing such benefits has been to consider the cognitive ability, cultural background etc of the targeted users and to segment the services according to user groups with common denominators [14]. There is a significant difference in TTSs targeted toward organizations. One way to assess the extent to which existing services meet the needs of organizations is by studying how TTSs affect the stakeholders that are using such services. For Telematic Service Users (TSUs) – individuals or organizations that receive and act on TTSs data [10] – the value associated to a service differs based on the usage of TTS. For providers and investors, implementation takes unnecessarily long time windows and with a limited budget the investment decisions are difficult. A good framework can provide users (e.g. governmental organizations) the opportunity to compare the impact of different TTSs.

The article aims at identifying important parameters for characterizing TTSs, use these parameters to suggest a framework of relevant TTSs in the context of HGV transport. The strategic purpose is to support a more detailed analysis of TTSs as a potential input to assessing the value of different services. In addition, attention is given to services considered relevant for HGV transport from a Swedish perspective thus providing a collective understanding of various TTSs (existing and conceptual) and potential users of such services which can serve as a basis for assessing the advancement of TTASs vis-à-vis HGV transport challenges. TTS are offered by Telematic Service Providers (TSPs) to different users (organizations and individuals). TSPs could be commercial, public or public-private organizations. We identified services relevant for HGV transport by making a preliminary assessment of problem domains (especially at the operational level) vis-à-vis the issues addressed by different services and synergies (based on shared functionalities) between the applications for various services. A framework has been suggested and an illustrative example employing the framework has been presented.

2. Motivation for a framework in transport telematic services

Various TTS specifications [1, 8, 11] emphasize the importance of meeting users' needs. For a user, a TTS may serve more than one purpose e.g. emergency call (E-call) can be used to notify rescue unit in case of an accident or indicate the presence of road network interruption to a dispatcher. Depending on the user and usage, each TTS may offer more than one possibility. In addition the availability of one service to a user influences the value derived from other services. TTSs value and hence benefit thus depends on the usage. A framework for evaluating TTASs requires the identification of stakeholders and their objectives together with system functionalities [22]. Such objectives can help to identify the intended usage which can be classified in terms of the domain of application such as a driver support, vehicle management etc where each domain is supported by a number of services in providing different solutions. The user and "usage domain" relationships address how each stakeholder relate and interact with other stakeholders in a transport chain, the services and their users describe different interesting deployment possibilities while the functionalities and services specify possible system design options (fig. 1).

Under ideal conditions a good service should be flexible enough to meet possible scenarios of it usability. Due to limited resources it is difficult to achieve such services. Therefore understanding the different options of a service, value and benefits for different users and domains of usage

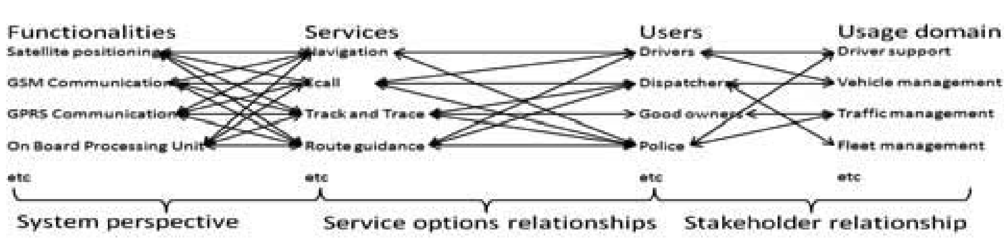

Fig.1. Example of functionalities, services, users and user domain alternatives

is important to decide on which services to offer from an investment perspective, thus improving the investment decisions by potential investors such as governments. Further the functionalities shared by various services can influence the platform for designing such services and thus provide an input to system designers. This work will focus on the services, users and "usage domain" in the context of HGV transport.

3. Framework analysis of transport telematic services, a review

Since TTSs have seen a rapid growth in the number and type over the previous decade, a number of schemes have been established in different regions to attempt formalization of services into common understandable categories [2, 8, 10, 11]. Several reasons exist for formalizing services. One reason is to achieve a holistic view that provides a common operational picture in order to improve the efficiency of traffic and transport management activities [23], hence improving the investment decisions for services that will effectively address such issues. The transportation of goods using HGVs involves a wide range of actors with different needs giving room for such scenarios as one truck making an equivalent distance in exactly the opposite direction where another truck is heading to pick up a package due to prevailing business structures. In the first half of 2006, of 79 million tons goods that were transported by 55779 Swedish registered HGVs, 22% was empty mileage accounting for about 145 million traffic work done on empty mileage [17]. Such operations amount to significant losses to society. Implementation of TTASs has the potential to increase economic benefits and re-organise logistic structures [20]. To address these concerns, services have targeted key segments of transport operations such as drivers, vehicles, goods, road infrastructure, and back office activities [8, 11]. The interest on the vehicle side for TTSs is seen to come from the automotive industry in the area of driver assistance, anti-collision avoidance, monitoring of fuel consumption and emergency assistance which have all been demonstrated in different ways [20]. An intelligent speed adaptation has also been widely researched and even considered for it suitability as a platform for hosting a collection of TTSs [4]. On the infrastructure side attention is given to route network utilisation, special infrastructure utilization such as bridges [5] and several techniques have been developed for improving the management of infrastructure and networks e.g. monitoring traffic and detecting incidents, network visualization [20, 23] etc. TTSs are offered to users with different characteristics of interaction compared to interactions between systems e.g. that two systems providing two or more services can technically allow information exchange is not sufficient that the users of the services are willing to exchange such information. Thus, making it necessary to study the effects of different TTSs on different users e.g. individuals (drivers), commercial companies, Governmental agents and TSPs [20]. At the operational level, most services in Europe are targeted toward real time or dynamic activities such as track and trace of goods under transport [5]. At the tactical level the data is collected and archived for improved decision making related to planning activities while at the strategic level the investment decisions are addressed through services that collect and store data on a long term basis [5].

The resulting TTSs addressing the above issues are numerous and to avoid the risks of redundancies and achieve a common operational picture, the International Standard Organization (ISO) has provided a set of standards at different levels to be followed [9, 10]. In spite of these there still exist different approaches to formalising and classifying services that hinder analysis approaches for assessing service performance. 33 TTSs have been identified and categorize into "service bundles" based on the problem addressed as well as on the technology [8]. Categories include travel and traffic management, public transportation management, electronic payment, commercial vehicle operations, emergency management, advanced vehicle safety systems, information management, and maintenance and construction management. The aim has been to develop a TTSs repository and hence the framework is less helpful from an analysis point of view. In another case TTSs have been categorized based on functional characteristics to facilitate the design of the system [2]. Categories considered included demand management, traffic operation and control, travel and traffic information services, tolling, electronic payment and booking, collective transport systems, commercial vehicle operations and advanced vehicle safety systems. The development area/application domain of the service has been used to categorize services in [11]. Some 22 TTS are characterized into 9 development areas/application domains. All 22 TTS are then systematically decomposed into 172 sub-services to support implementation work. Further 32 TTSs have been identified and classified into 8 categories including traffic management, traveler information, vehicle, commercial vehicle, public transport, safety, emergency, electronic payment [10]. This has been extended in the new ISO ITS taxonomy of TTSs to 11 categories adding freight transport, weather and environment conditions, disaster response management and coordination, and national security [15].

In the above schemes no detail approaches were suggested that enable analysis (except in [11]) e.g. of benefits associated with different users. The transport of goods by HGVs merits consideration for several reasons e.g. frequent boarder transit, high infrastructure impact etc. While all these issues are not explicitly addressed in this study some inputs for TTSs analysis involving users and usage domains are provided e.g. benefits analysis.

Operational Characteristics of HGV Transport domains and Telematic Services

The technical interoperability between services is not the same as the interoperability between transport actors. Thus to understand dependencies between different stakeholders including their usage of TTSs and how these may influence interactions between services, the following important operational domains in HGV transactions need to be considered.

- A. Driver Support: This category of services is important with respect to the needs of drivers e.g. planning and execution of a transport operation, safety etc. The overall aim is to improve driving operations including driver safety and also to minimise other traffic risks connected to driver activities. Existing advanced control systems for driver support are mostly locally implemented in the car e.g. cruise control systems, collisions warning etc. Yet a number of TTSs require positioning functionality modelled externally from local vehicle systems. Services related to the navigation, delays, road information etc all require positioning.
- B. Administrative Support: These are supporting activities such as staff management, education, organizational welfare etc. Staff might be the most critical resource of most enterprises. Management of mobile personnel is a lot more delicate than of the staff operating on site. The area of administrative support includes planning, supervising, documentation, follow up and other tasks, involving commercial, legal and salary issues that are vital for several demand groups. Most of the work in this domain can be considered as a back office and plays an important role in enabling transport operational activities.
- C. Fleet Management: Vehicles constitute an important resource for commercial transport companies. Good management strategies of HGV fleet are vital for the competitiveness of a transport company. Fleet management has an impact on revenues, costs as well as efficiency of the operations. With many services addressing the performance of an HGV as an entity, it is important to consider services that address overall performance of a fleet. There are several benefits that maybe realised through fleet management services e.g. efficient dispatch of fleet to meet customer needs, improve response time to driver and staff etc.
- D. Transport Management: Transport management covers services which directly address activities that take place in moving goods from one point to another. They constitute the core activities of transportation. Such activities include locating and picking up the right packages, assigning vehicles to packages, reducing empty mileage etc.
- E. Traffic Management: These are services with the aim to improve the overall traffic flow in various ways. Major emphasis is put on traffic safety as well as on mobility. This category is important because efficient traffic flow is not only important for traffic planners but affects the rest of the traffic actors. Thus, key services provide advisory measures (recommendations) to traffic planners and road users or in some cases corrective measures (interventions).
- F. Infrastructure Management: Road infrastructure cost is high both economically and environmentally. Further, depreciation of existing infrastructure and the utility gains can be influenced by the utilisation efficiency. Thus, TTSs that address how to maximise the utility of this infrastructure as well as to sustain its availability will be considered in this category.
- G. Environmental Management: Road transport constitutes a significant portion of environmental problems including emissions. In addition, roads construction significantly deforms earth surface structures. Therefore services aimed at improving the utilisation of existing route infrastructure and reducing emissions from vehicles are important to consider.

5. Transport telematic services, a proposed framework

Large amount of data is generated in the transportation of goods by HGVs. The data can be about the vehicle, goods, road, traffic conditions or environment. The data is used for monitoring transport operations before, during and after an operation by different transport stakeholders. The data itself is of less value and often the information resulting from the data is of interest and is provided in real time as TTSs to stakeholders involved in transportation. One way of developing TTSs is by studying problems that stakeholders face in transportation and addressing these with appropriate TTSs. The nomenclature for TTSs isn't standard but in most cases reflects the problem addressed by the service e.g. intelligent speed adaptation. In other cases names are used to reflect the technology e.g. geo-fencing etc. A service label is attached to each service, which should be unique to avoid confusion with other services. Different

Table 1. Framework structure for TTS

TTS Label	Needs	Functionalities	Users	Options	User Domain
Name of TTS, unique and reflects usage	Problem addressed by TTS	Possible functionalities for developing TTS	Primary users of TTS	TTS options based on targeted primary user.	Operational areas of TTS usage within road transport

names may be used in different regions targeting the same type of problem due to cultural and policy differences e.g. electronic toll collection service as in Japan, road user charging service as in Sweden both target the charging and collection of road fares etc. Such ambiguity maybe minimized by focusing on the usage of the service rather than the technology. The needs of a TTS are closely related to the users and usability. The information about users and usability can help to analyze the impacts of a service on society and to assess the effectiveness of transport solutions provided by such services. Each TTS option can therefore be identified from it usage. The table 1 provides important aspects of a TTS potentially useful for analyses e.g. benefits analysis, impact analysis, architecture design analysis etc.

Table 2. Relevant TTSs for HGV Transport (KEY: A-Driver support, B-Administrative support, C-Fleet management, D-Transport management, E-Traffic management, F-Infrastructure management, G-Environmental management)

TTS Label	Users	Options	User Domain
Road User Charging	Drivers, billing agents, road infrastructure providers	Data processed by billing agent (thin client) or at driver terminal (thick client)	F
E-call	Drivers, road traffic inspectors, rescue agents, accident statistic agents, local authorities, good owners	E-call as a network interruption report, E-call detail report.	A, D, E
Navigation	Drivers	Static Dynamic	A,G
Weight Indicator	Drivers, bridge infrastructure providers, goods owners	Goods only Total weight	A, E
Intelligent Speed Adaptation	Drivers, traffic inspectors, police, dispatchers, insurance companies	Enforcement possibility, Recommendation only.	A, E
Accident Reporting	Drivers, traffic inspectors, police, dispatchers, accident statistic agents	Detail information Statistically (interruption)	A, D, E
Automatic Driver Logs	Drivers, police, staff or personnel managers		A, B,
Staff Monitoring	Commercial Fleet operators		B
Transport Resource Optimization	Commercial Fleet operators, road infrastructure providers	Fleet Scheduling, Road utilization, Driver planning	B, C, F
Vehicle Follow-up	Dispatchers, HGV fleet owners and operators		C
Remote Monitoring	Dispatchers, vehicle fleet owners	Fault prediction Fault detection and repair	C
Goods Identification	Customs, good owners, terminal operators		D
Real Time Track and Trace	HGV fleet operators, police, goods owners		C, D, E
Sensitive Goods Monitoring	Goods owners, Goods quality control inspectors, customs	Dangerous goods only All goods	D
Traffic Information	Traffic controllers, drivers, dispatchers, road and bridge infrastructure owners	Prognosis Real time	E
Route Guidance	Drivers, drivers in transits, intervention units e.g. police, emergency	In transits, non-transit, sensitive segments	E, G
Theft Alarm	Vehicle fleet owners, drivers, goods owners, police		A, C, D
Geo-Fencing	Vehicle fleet owners, infrastructure owners, gate operators, vehicle parking operators, loading/unloading units	Mobile Corridors and gates	C, D, F
Transport Order Handling	Dispatchers, good owners, drivers		B, D
Pay as You Drive	Insurance companies, vehicle fleet owners, environmental controllers		E, G
Variable Speed Limit Road Signs	Traffic controllers, police	Report speed violations Determine speed limit	E, F
Driver Planning	Dispatchers		B

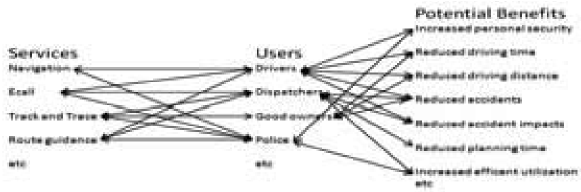

Fig.2. Example of analysis relating services, users and potential benefits

If TTSs can be described based on the proposed framework, their influence on transport stakeholders e.g. drivers, traffic controllers, and dispatchers can be analyzed. Relevant TTSs for HGVs were identified within the project Mobil IT. Following the framework proposed above these services are presented with focus on user-options-user domains (table2).

Potential analysis: By expressing services as in the framework above, one potential analysis is to identify and quantify the benefits of different services for different users. (fig 2). Identification of potential benefits is a preliminary step in evaluating the impact of services on society such as reduction in accidents, driing distance, time etc on HGV units.

6. Conclusion

This article has conducted a qualitative study to point out the need for a framework in the analysis of TTSs. For organizations faced with investment decisions such as governmental agents, there is a need for a common operational view on transport processes and how to improve such processes with the help of TTSs. A framework provides a preliminary step into supporting high level analysis of services that support investment decisions. One such framework has been proposed and illustrated, and TTSs identified and classified within the context of the Swedish HGV transport. In the future, this framework can be validated through various analyses of TTSs following suggestions presented in the framework.

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