Implications of mobile devices on ITS freight roadmaps ahead

Magnus Andersson
Viktoria Institute, Gothenburg, Sweden, and
Henrik Sternberg
*Division of Engineering Logistics,
Department of Industrial Management and Logistics,
Lund University, Lund, Sweden*

Abstract

Purpose – The purpose of this paper is to examine the growing importance of generic mobile computing for ITS (Intelligent Transportation System) development and governance. Specifically, building on theories of open innovation and pertinent examples, the paper aims to inform future ITS policymaking.

Design/methodology/approach – Using a wide range of national, regional, and industry roadmaps together with scientific reports on the impact of specific ITS services, conclusions for ITS governance and policymaking are drawn.

Findings – This paper finds that it is imperative to proactively embrace the rapidly expanding generic mobile computing service industry and critically reassert investments in dedicated ITS-infrastructure. This is of equal importance for developed and developing countries.

Research limitations/implications – Previous literature has mainly dealt with ITS in terms of mobility of people. This paper addresses ITS in a freight context, an area that has received scarce attention in the literature.

Practical implications – This paper presents important insights for infrastructure policy makers on opportunities to take advantage of freely available data in improving freight mobility.

Social implications – The trend of producing and consuming data simultaneously (so called "prosuming") is currently re-shaping the ITS landscape and will in the near future affect millions of daily commuters.

Originality/value – The paper gives an account of current worldwide ITS policies in context. The assessment of services is intended to inform both industry and policymakers.

Keywords ITS, Policymaking, Mobile computing, Transportation, Mobile technology

Paper type Research paper

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Introduction

An Intelligent Transportation System (ITS) is a key enabler for the sustainable development of high-capacity road networks worldwide (European Commission (EC), 2008; Crainic *et al.*, 2009). Governments and authorities in developing and developed countries alike are well aware of this and are striving to alleviate a number of challenges posed by increased pollution and increasing fuel costs by employing a wide range of information technologies specific to the traffic domain (The World Bank, 2011).

The purpose of this paper is twofold. First, we investigate current trends and extrapolate future developments in ITS governance with a focus on freight transport. As powerful smartphones proliferate, the ITS area is merging with generic ICT. This has a profound impact on how ITS will be governed in the future. We will discuss some of the salient forces of change and indicate some consequences for governance of ITS on the national level. Second, we have conducted a review of the effects of a number of ITS services. ITS is a wide concept and we have looked specifically at freight-related ITS services, an area often overlooked in both science and practice (Crainic *et al.*, 2009; Lindholm and Behrends, 2012; Sternberg and Andersson, 2012). This investigation builds on a study of ITS policy and implementation worldwide. We have conducted a study spanning 63 countries searching for policies on ITS in general and freight in particular. Based on the preliminary results from this study we will draw conclusions for the adoption of a number of freight ITS services.

The term Intelligent Transportation Systems, or ITS, has various definitions. Sussman (2005) states that ITS applies "[...] well-established technologies of communications, control, electronics and computer hardware and software to the surface transportation system". Crainic *et al.* (2009) describe ITS as "tomorrow's technology, infrastructure, and services, as well as the planning, operation, and control methods to be used for the transportation of persons and freight" (p. 541). Simply put, it is management and coordination by means of information, applied in a traffic setting. "Intelligent" is in this context not related to process capabilities, but rather to potential processing of available information. The European Commission (EC) describes ITS as follows: "Intelligent Transport Systems (ITS) are advanced applications which without embodying intelligence as such aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated and 'smarter' use of transport networks" (European Commission (EC), 2011, p. 1).

ITS has been promoted as a means of extending the capacity of current physical infrastructure, thereby avoiding costly or even impossible construction work and its associated sustainability drawbacks (Crainic *et al.*, 2009, p. 541). A visible example of ITS, automated road tolls, are becoming commonplace. One sample is the congestion pricing ITS in Singapore, based on toll gantries, in-vehicle units with cash cards and video cameras. The system resulted in an almost 50 per cent reduction in traffic, 25 per cent reduction in crashes, 20 per cent increase in public transportation usage, and 80,000 kg of CO_2 emissions were saved. The system generates approximately $40 million/year in net profits and ROI was reached after three years (The World Bank, 2011).

However, without a supporting policy, ITS will have little or no impact on the sustainable growth of the economy (Sternberg and Andersson, 2012). Historically, the ITS domain is associated with a centralized road net operator perspective (Andersson and Biding, 2011). Using the physical infrastructure as a point of departure, solutions are often designed and implemented by one or a select few actors to solve local problems. This perspective is supplemented by cooperative systems, a collection of system components (mainly vehicles and road side ITS) that collectively realizes various types of benefits. However, the proliferation of smartphones and high-speed telecom infrastructure is rapidly becoming a crucial ITS component (Andersson and Biding, 2011). This expanding service sector is built on a different foundation, involving global markets and multiple stakeholders. Creating incentives for openness and easily available data are vital to realize the full potential of this development (van de Ven and Wedlock, 2011). Hence the purpose of this paper is to establish some antecedents for policy makers and organizations structuring and planning ITS in developing and developed countries.

ITS governance

In several developing countries there is currently a focus on getting new ITS technologies from laboratories into action, addressing the general challenge with ITS technology adoption (EC, 2008, 2011). While EU initiatives such as EasyWay (2012) have promoted the introduction of ITS, there has been a constricting lack of business models supporting such actions. The introduction of ITS is usually imagined as a public venture rather than a profit-driven enterprise. However, services that generate substantial value for organizations outside of the traditional ITS industry are growing rapidly (van de Ven and Wedlock, 2011). This section highlights two interrelated trends fuelling an interest in mobility-oriented digital services in society: open data and digital complementary assets.

Open data

Broad research has shown that open innovation is a prerequisite to capturing the full potential of a modern society (Chesbrough, 2003; West and Gallagher, 2006). A single actor cannot create nor use the sum of all potential innovations using their available resources by themselves. To expand into new areas, they need to grant access to information resources to external parties and make them a part of their innovation process, to the benefit of all parties. In this vein, a growing number of public actors worldwide are opening their access to digital resources. Helsinki (HRI, 2011), Paris (Open Data Paris, 2011), Munich (München Betriebs-GmbH and Co. KG, 2011), Manchester (Manchester City Council, 2011) and the Basque region of Spain (Gobierno Vasco, 2011), to name a few cities, have recently opened up access to public data repositories for use by third-party innovators. This is endorsed and highly encouraged by the European Parliament (Share-PSI.eu, 2011).

As an example, the Swedish initiative Trafiklab is dedicated to open traffic related data. It centres on a web portal (www.trafiklab.se) where relevant application programming interfaces (APIs) are linked and discussed. Through such APIs, various data sources can be tied together and utilized by service developers. This increases the innovation potential to a (for the publishing organization) very modest cost. The Swedish public transport sector, cities, and the transport authorities are some of the current contributors (Trafiklab, 2011). Authorities contribute real time traffic data including location data on accidents, road works and other events.

ITS as part of an ecosystem

Trends within other IT domains have a profound influence on ITS and to understand the development of ITS, it is crucial to include societal trends in general and IT trends in particular. Ever more capable mobile phones are being used by a growing part of the population in many countries, e.g., by 27th of December 2012 Samsung passed the 10 million mark in India for its smartphone Samsung Galaxy (Jagran Post, 2012) and recently an African smart phone named Elikia is offered in African countries (www.latribune.fr/technos-medias/20121229trib000739801/le-premier-smartphone-africain-fait-son-apparition-au-congo.html). However, the explosive development of the smartphone segment was not the work of traditional operators or phone manufacturers, but originated from a different domain: the internet.

A crucial component for internet-based service innovation has been the relative openness of that domain. An innovator can easily combine information from several sources, bypassing many obstacles commonly found in, for example, manufacturing or traditional service industries. An increased access to complementary information resources will likely increase the number of commercially available digital services. The ongoing digitization has created a large number of digital aggregation points, services that collect a specific type of data, and the number is still growing. There is a near infinite number of possible types of data, but some well-known examples are photos (including services such as FlickR and PhotoBucket), music (e.g. Spotify, Rdio), and geographic information (e.g. Google maps, OpenStreetMap). These digital services form complementary services to other innovations in the shape of digital services, which in turn can be easily used by yet other service innovators. Complementaries are crucial for all forms of commercial activity, such as "transport capacity" and "market channels" to generate profit from a product innovation (Teece, 1986).

The growth of digital ecosystems can then be explained by the ease with which external developers can acquire information resources (Rosemann *et al.*, 2011). Another important component is the social media development. If digital complementaries can be conceptualized as an aggregation of a specific type of digitized information, social media services consist of digitized people and their social relations. Facebook and other global giants are examples of such aggregation points. For these organizations, the user is the primary resource; data on other components is secondary. While striving to increase usage, such actors attract a plethora of other digital aggregation points. This has a number of consequences. For instance, content becomes cheaper. Music is one such example where mp3 encoding and more recently streaming media has lead to a drastic reduction of revenue for that type of digital content. Another example is geographic information. In 2008, Nokia bought Navteq – a major global player in navigation services and geodata – for 8.1 billion US dollars (NAVTEQ, 2008). Barely two years later, Nokia supplied smartphones with services based on Navteq data at no extra cost. Nokia did not manage to increase profit margins on their smartphones neither to defend their market share during this period. The price on geographic information has sunk to very low levels following the growth of Google maps, which competing telephone makers utilized to their benefit. As Google increased the price of their services, there was an immediate increase in activity in open source based initiatives such as OpenStreetMap.

The user is the primary resource in the social net and this indirectly affects the ITS area. For instance, car sharing services of various kinds often use social media as part of their business models. As a specific example, the navigation service Waze (www.waze.com) uses user-generated content to build their entire service. There is reason to believe that this development will strengthen over time and to an increasing degree complement or ultimately replace centralized, often national sources as a base for ITS service.

Freight-related ITS services

Several countries have prepared national strategies for promoting and supporting implementation of ITS on various levels and locations in the infrastructure – in general without considering ITS as a part of an ecosystem. In addition, several research, development and technology diffusion projects have developed, synthesized and tested various freight-related ITS services. This section will outline the implications of the strategies and projects analyzed[1]. Most national and regional strategies analyzed typically aimed at increasing mobility for both movement of people and commercial vehicle operations (CVO). Naturally general ITS generate larger tangible benefits than specific best practice freight-transport technology (Logistics for Life, 2011a), generally referred to as ICT for freight transport.

The global climate group assumes ICT for freight transport can potentially reduce freight transport emissions by 16 per cent, without going into detail of how the figure was calculated (The Climate Group, 2008). There is to the authors' best knowledge no scientific study on the full potential of ICT in freight transport, although some studies on the effects of, for example, in-vehicle systems exist (Baumgartner and Leonardi, 2004; Baumgartner *et al.*, 2008; Sternberg *et al.*, 2012). In supply-chain management, a trade-off between centralized and decentralized control of transport is made, i.e., centralized transport planning needs more information, is more expensive than decentralized transport planning, but is relatively more efficient and generates less environmental impact. Studies on central collaborative planning and coordination spanning over organizational borders show clear improvements in the performance of transport planning (Janssen, 2004) and Esper and Williams (2003) showed that collaborative transport management (CTM) increased transport efficiency more than 10 per cent and stated: "Overall, CTM through information systems improves the operations and efficiency of all entities involved in transport planning" (p. 9).

Improving rail and short-sea shipping operations to enable intermodal operations and move freight transport away from roads is the focus of several European initiatives. Several major stakeholders from the transport industry are showing great interest in the Green corridor concept, which holds a promise of combining improved transport sustainability with retained freight-transport performance (SuperGreen, 2012). In order to make Green corridors an attractive alternative, public and private stakeholder commitment is necessary. As outlined in the L4L roadmap (Logistics for Life, 2011b), technologies exist, but semantic standards for intermodal freight transport are needed. Transport operators willing to be forerunners in implementing semantic intermodal standards should receive full support in their collaboration and recognition from the society. Implementing the e-Freight messaging infrastructure is likely to be the preferred staring point of a semantic adoption. Swedish Cassandra/Port Pilot Gothenburg demonstrated the feasibility and is one of the few projects quantitatively indicating a large potential efficiency increase by electronic freight documents (e-Freight concept). Hence, the Green corridor concept, requiring collaboration and information sharing between different actors and stakeholders, was not addressed as a freight specific ITS. Increased unitization, i.e., moving freight in container systems, improves competitiveness of intermodal transportation. Supporting actors willing to implement, for example, Smart-CM/Integrity solutions is a measure that would ease container transport (Logistics for Life, 2011a).

Analysis of ITS freight applications re-occurring in strategic documents included the two areas in Table I: Ecological footprinting and intelligent access program (IAP). The analysis is based on documents published before February 2012.

The subsequent sections test the feasibility and applicability of the derived freight specific ITS in the light of statistics and published research. Experts from various fields assisted with information from projects and contributions from recent and on-going research (Sternberg and Andersson, 2012).

Environmental footprinting

For logistics environmental performance to become a decisional factor in planning, comparison and acquisition of logistics services (in particular transport), a common emission calculation methodology and standard is needed covering the entire transport chain (McKinnon, 2011). Existing green house gas (GHG) standardization initiatives such as from ISO 14064 on corporate carbon foot printing and CEN/TC 320/WG 10 on "Energy consumption and GHG emissions in relation to transport services" should publish their final results in 2012. Other major initiatives as the GHG protocol (2011) and the Carbon Disclosure Project (2011) have to be taken into account as general frameworks to assess and communicate environmental performances (Logistics for Life, 2011b).

Following the previously outlined trend of consumers becoming increasingly aware and interested in the environmental impact of the goods they are purchasing, together with the societal demands for reduced environmental impact from transportation, environmental reporting becomes a societal priority (Piecyk and McKinnon, 2011). Recent small-scale tests of carbon footprinting in Finland have shown the concept of feasibility, but also revealed lacking willingness to pay for carbon footprinting (Liimatainen and Nykänen, 2011). Several projects, for example, the e-Freight project, provides a standard for reporting environmental impact as an integrated part of the information sharing (e-Freight, 2012).

IAP

Australian IAP is a simpler version of GoodRoute (2012), i.e., an off-the-shelf in-vehicle system is used to communicate with the Australian road authority (Transport Certification Australia, 2012). The intelligence is represented by the vehicle's ability to connect with the infrastructure and transmit characteristics about itself and the freight it is carrying. The term IAP is used as a definition of dynamic access control of freight transports deviating from general regulations, for example, over-sized freight (as in construction elements) or extra or extra-long trailers. IAP is also used to denote dynamic access to infrastructure for dangerous goods transports or other types of transports needing additional attention.

Area	Nation	Other strategic initiatives	Consulted research projects	Summary
Ecological footprinting	1	5	5	Environmental footprinting is mainly pushed forward by strategies presented by various stakeholder and interest groups
Intelligent access program	3	3	2	IAP is outlined in strategy documents from nations as well as interest groups

Table I. Footprinting and intelligent access in policies

As in the case of evaluating secure parking, safety aspects of dynamic access control to the infrastructure are difficult to measure. Considering countries such as Cambodia, Iran and Sweden (freight transportation in these countries was studied by the authors), the relatively low number of tunnels in the road infrastructure make studies on, for example, ITS safety applications in Alp-passages, applicable only to a small extent.

The second aspect to consider is efficiency. Dynamic access programmes can be used to monitor "High Capacity Transports", i.e., truck and trailer combinations exceeding the national and international standards. According to a recent report aggregating Swedish trial experience in the area, trucks with a total weight of 90 tonnes save approximately 20 per cent of fuel by increasing the amount of goods carried from 42 to 65 tonnes (Berndtsson, 2012). Trials with trucks weighing 74 tonnes have similarly resulted in approximately 10 per cent savings (Berndtsson, 2012). OECD/ITF's study of heavy vehicle issues states: "With more flexible regulation and enhanced compliance systems for safety, environmental and asset protection rules, simultaneous improvements in safety, sustainability and productivity of the heavy vehicle fleet can be achieved. Appropriate use of higher capacity vehicles, assessed against performance standards, subject to route restrictions and enhanced road access and safety compliance regimes will lead to improved productivity and sustainability" (International Transport Forum, 2010, p. 11).

Several independent studies exist that have advised against long vehicles (Knight *et al.*, 2008), but as quoted from the No Mega Trucks association: "Longer and heavier vehicles (LHVs) have been permitted in Finland and Sweden for some time. But Scandinavia's spacious, relatively sparsely populated regions with little road traffic cannot be compared with the rest of Europe, where the dense networks of heavily used roads are not suitable for mega trucks. After joining the European Union, Finland and Sweden's LHVs were given special protection and are permitted to continue operating within their own borders. However, they are not allowed to cross into other European countries. But the anti mega trucks campaign is not against the Scandinavian vehicles […]" (No Mega Trucks, 2012). The 2001 truck maximum allowed weight raise in Great Britain revealed that the predicted model on modal shift was wrong and illustrated the importance of policy instruments (McKinnon, 2005).

Conclusions

There is a strong consensus on both the positive effects of ITS and that large potential improvement in the area remains (Crainic *et al.*, 2009). In the light of new trends (e.g. "prosumers" and new digital aggregation points), some general recommendations can be made:

- continue to invest in infrastructure that complements and feeds data into emerging private services as well as services infrastructures;
- improve policy and traffic monitoring, taking into account the changed traffic flows caused by emerging innovations; and
- organize operations to be able to collaborate, collect and share data with existing and emerging stakeholders.

Given that current ITS trends continue, services in road ITS will to a large extent be developed by private actors, making transnational cooperation even more important.

That calls for continuous public and private collaboration and involvement in European projects related to short-sea shipping, rail and air. A major cost in intermodal transport operations stems from handling activities, i.e., loading, unloading and related administration. A majority of both EU initiatives and national projects depart from an assumption that increased information sharing results in a higher fill rate. As pointed out in the Logistics for Life Roadmap (Logistics for Life, 2011b), the assumption neglects the current state of transport operations, i.e., the operational issues (cost/theft/damages) in freight handling that prevents an active control of freight operations. These issues present a challenge and an opportunity for the general society and in particular the transport industry to tackle the issues and develop solutions.

Considering the monitoring challenge implicit in the setup of transnational Green corridors, implementing e-Freight is recommended. To make that happen, society must collaborate on data sharing while all involved public and private stakeholders have to be committed. Presently, the e-Freight project represents an adequate semantic platform necessary for both implementing e-Freight and at the same time initiating large-scale environmental reporting. Society plays an important role in setting rules and enforcing environmental reporting. There is no perfect reporting methodology, but due to the societal importance, a system with some room for improvement is probably better than none at all.

The current trend of infrastructure increasingly becoming available through private mobile infrastructure creates an opportunity for developing and developed countries alike. Developed countries typically have data collection infrastructures in place (in particular in urban areas), whereas developing countries are now looking into infrastructure investments. Taking into consideration the trend of mobile devices providing data, developing countries can more effectively aim their investments into ITS infrastructure and take advantage of "free" data in the evolving IT ecosystem. Future research on ITS for developing countries should be aimed at investigating frameworks for how that should be made, in order for developing countries to avoid investing in an infrastructure they can get for free (a mistake often made by developed countries).

As of today, intelligent access control has two main uses: safety (dangerous goods control) and efficiency. Safety is difficult to investigate and should be subject to macro-economic analysis. Previous reports on high-capacity transports have provided varying environmental impact results, but combined with policies to ensure that rail is not losing competitiveness negative effects of longer and/or heavier vehicles can be overcome as proven in Great Britain (McKinnon, 2005). Considering the rapid development of smartphones and integration of the vehicle into the transport infrastructure, we recommend an open solution, where society controls the backend and commercial actors develop stand-alone access on generic multipurpose nomadic devices or incorporate it into already existing in-vehicle systems. Research evidence shows that an ITS/ICT investment justified on an individual level results in incremental use at later stages (Arthur, 2009).

Note

1. For the full outline of all analyzed projects and strategies we refer to The ITS Freight Roadmap of the Swedish ITS Council, written by Sternberg and Andersson (2012) and published by the Swedish traffic administration.

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