Achieving ITS services when turning a waybill into an e-waybill

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Abstract

The focus of this paper is to present potential electronic waybill (e-waybill) solutions for a traditional waybill with the potential for supporting different Intelligent Transport System (ITS) services, such as, identification of freight, automating the exchange of content-related data for regulatory or commercial purposes, etc. At present there are some initiatives, for instance, by the International Air Transport Association (IATA) and the e-Freight framework, for achieving solutions that can handle e-waybills. Both these solutions focus on actor-to-actor communication, however we hypothesize that the storage of a waybill's data both locally and centrally (i.e. actor-to-actor as well as goods-to-actor communication) can support more services than only central storage of the waybill's data. Further we look at the information required and possible communication links between different actors in order to identify different ITS services that can be achieved through an e-waybill solution. We then map this information on to the e-waybill solutions that we have proposed, which will allow us to identify which services are supported by the different e-waybill solutions.

Keywords: waybill, electronic waybill, e-waybill, intelligent transport systems, ITS services

1. Introduction

The e-Freight concept focuses on the vision of a paper-free, electronic flow of information associating the physical flow of goods with a paperless trail built by information and communication technologies [1]. It has been argued that due to the rapid development in areas like e-commerce, security, certification and authentication systems there is a potential to evolve paper based solutions into electronic solutions [2-4]. A waybill is an important document in international transport since it follows a consignment and is a proof of a transport agreement and its conditions. One way to achieve a paperless flow of information is to replace the traditional paper waybill with an electronic waybill (e-waybill). This ensures "a single transport document for the carriage of goods", which is an integral objective of the e-Freight project that was launched by the EU on January 1, 2010 [5].

In addition to achieving the wish of a paper free flow of information we hypothesize that e-waybill solutions should also be able to support different types of ITS services, such as, dynamic track and trace of freight, identification of freight, automating the exchange of content-related data for regulatory or commercial purposes, etc. [1]. The focus of this paper is on the electronic replacement of the waybill by automatic and electronic information handling and on the potential to support different ITS services. Since there exists no standard solution for replacing the waybill with an e-waybill, we look at different conceptual solutions and their support for ITS services. We limit our scope to waybills used in road transportation since we see our work as the starting point for investigating possible e-waybill solutions. Another reason for focusing on waybills used in road transportation is that the ITS services discussed in this paper have the potential to be used mostly in road transportation. The main contribution in this paper is an analysis of different e-waybill solutions regarding how data can be stored and updated and of how different ITS services can be supported by these solutions.

In the sections to follow, we will first (in Section 2) introduce the current use of a traditional waybill (as a paper document), and then (in Section 3) we will look into different existing e-waybill solutions for different modes of transportation. Later on in Section 4 we will introduce five conceptual solutions for an e-waybill. In Section 5 we discuss connections between the information available on an e-waybill and different ITS services, and we analyze the e-waybill solutions and their potential to support different ITS services. Finally, in Section 6, we end the paper with a conclusion part based on the analysis section.

2. The traditional waybill

A waybill has several names, such as a consignment note and a CMR document, it follows the cargo/consignment and it is a proof of an agreement of a transport and its conditions [6]. A waybill is a proof of collection at the consigner and a proof of delivery at the consignee, and the proofs are by stamp and signature of the consigner, carrier and consignee. Moreover, a copy of the waybill should by law follow the goods during transport [7, 8]. The waybill primarily concerns the following actors:

- **Consigner** is the sender of the consignment and is often the transport buyer.
- **Consignee** is the receiver of the consignment.
- **Carrier** is the actor that is responsible for providing the transport service for the consignment.
- **Customs** is the law enforcement agency responsible for checking the legality of the consignment.

Moreover, a number of additional authorities, such as police, 3rd Party service providers etc., may also be of interest. We can summarize a waybill in the following way:

- It is a non-negotiable contract between transport buyer (consigner or consignee) and the carrier for the carriage of goods,
- It has information about the consigner, carrier, consignee, goods and the loading in/out site,
- It has information for the customs/police authorities, and
- It has information about the transport/goods relevant to different actors (depending on their roles).

2.1. Information on a waybill

One important document regulating the waybill is the CMR (Convention relative au Contrat de transport international de Marchandises par Route) convention, which is a U.N. Convention signed in Geneva on May 19, 1956 [7, 8]. The CMR Convention suggests the following information to be present on a waybill:

(a) Date and place for when and where the waybill was created.
(b) Name and address of the consigner, carrier and consignee.
(c) Place and date of taking over the goods and the place designated for delivery.
(d) Description about the nature of the goods and the method of packing, and, in the case of dangerous goods, their generally recognized description.
(e) Number of packages and their special marks and numbers.
(f) Either gross weight of the goods or their quantity.
(g) Charges relating to the carriage (carriage charges, supplementary charges, customs duties and other charges incurred from the making of the contract to the time of delivery).
(h) Required information for customs and other formalities.
(i) A statement that the carriage is subject, notwithstanding any clause to the contrary, to the provisions of the CMR Convention.

Where applicable, the consignment note shall also contain the following particulars (according to the CMR convention):

(j) A statement that trans-shipment is not allowed.
(k) The charges that the consigner undertakes to pay.
(l) The amount of "cash on delivery" charges.
(m) A declaration of the value of the goods and the amount representing special interest in delivery.
(n) The consigner's instructions to the carrier regarding insurance of the goods.
(o) The agreed time limit, within which the carriage is to be carried out.
(p) A list of documents handed to the carrier.

Further, the parties may enter any other particulars that they may deem useful. From examples of waybills we have identified that the following may also apply:

- Unique identity of the document (and shipment).
- Signatures of consigner, carrier and consignee.

3. Related work

In this section we discuss a number of existing e-waybill solutions for air, sea and road transportation.

3.1. e-Air Waybill (for air transport)

The International Air Transport Association (IATA) has implemented an e-waybill model known as e-Air Waybill for cargo transport by air [9]. The model by IATA was designed to replace the paper documents, which are attached with each air shipment, with electronic messages. The IATA has set the condition that both the shipper and the consignee must have signed either a Montreal Protocol no. 4 (MP4) agreement [10] or a Montreal Convention (MC99) agreement [11], and the local custom must be willing to accept the electronic version of a standard air waybill. The IATA also emphasize that all involved stakeholders must have signed an Electronic Data Interchange agreement (EDI) in order to replace the standard air waybill with the e-Air Waybill. Although the e-Air Waybill proposed by IATA is a comprehensive one, it still has some limitations with respect to our work. The main limitation is that it is more focused on the consigner and carrier while paying less attention to the other stakeholders, such as custom authorities and the consignee. Moreover it resembles a centralized solution where the consigner maintains a centralized database and the stakeholders have access to that database. Another limitation of IATA's e-Air Waybill solution is that it is aimed for transport systems with a rather limited number of actors/terminals (compared to road based transport) as it requires EDI and MP4 or MC99 agreement to be signed by the stakeholders.

3.2. E-BOL (electronic bill of lading for sea)

A waybill used in trade by sea is known by the name of Bill of Lading (BOL). Various researchers, such as Mei & Dinwoodie [2], have argued on the electronic version of Bill of Lading (E-BOL). The authors emphasize the need for E-BOL because of the fraud factor associated with the traditional paper based BOL, and because of the late arrival of a paper based BOL to the consignee. The authors in [2] have presented the concept of "internet-based, third-party internet service provider (IBTPISP)", which refers to a third party responsible for handling the E-BOL. The focus of IBTPISP is on institutional based trust which ensures to protect the interest of all the stakeholders involved in one specific institution. Similar to the e-Air Waybill, E-BOL is also a centralized solution where a third party actor maintains the E-BOL centrally and hence it has limitations with respect to our work.

3.3. e-waybill (for road)

One example of an e-waybill used in trade by road is used by the company DHL [12] and it is known as DHL Express Waybill [13]. DHL acts as a carrier (transport service provider) that requires the consigner to fill out an electronic version of a waybill before transporting goods to the intended consignee. DHL provides the service of "e-Track" [14] for real time tracking of the consignment for the consigner and consignee. The e-waybill used by DHL has some limitations (compared to our work) regarding the storage and access to the e-waybill. DHL's e-waybill is stored centrally and access to the e-waybill is done via actor-to-actor communication.
The information models used by the e-Freight framework v1 have several information packages that have information relevant to the information present on a waybill [15]. These packages include TEP, GII and TES. The information present in these packages is scattered, (i.e. some of information is present in one package while some can be found in another one). Apart from this we were also unable to find the use of signature by the transport users or transport service provider. Finally we conclude from the e-Freight framework that the focus is more on a centralized solution and actor-to-actor communication rather than goods-to-actor communication. Hence we can say that the e-Freight framework has the potential to transform the paper waybill into an electronic waybill that can function in the same manner as a paper waybill. However, as discussed above, this solution for an electronic waybill would emphasize more on actor-to-actor communication with little or no relation to the function of the paper waybill process.
A waybill is the contract of carriage as well as it contains information about the goods. Hence investigating and analyzing an e-waybill solution, which can support different ITS services, has a strong connection to the e-Freight project.

4. e-waybill solutions

In this section we suggest five potential solutions for an e-waybill that can support ITS services. We make the following assumptions:

- There are 6 stakeholders in a trade activity (consignee, consigner, carrier, customs, roadside stakeholder (e.g. patrolling police and terminal handler, local service providers) and back-office stakeholder (e.g. road administration and service providers).
- At any particular point in time there are exactly one carrier and exactly one consigner and receiver.

- The consigner is responsible for requesting the shipment of goods, i.e., being the transport buyer.

Based on the information present on a waybill, on the stakeholders involved and on our assumptions, we suggest a number of different potential solutions for an e-waybill. For an e-waybill, we have identified six different properties with respect to storage, read and write functionalities i.e.,:

1. The e-waybill is stored centrally with identity id/tags on goods.
2. The e-waybill is stored locally with identity id/tags on goods.
3. The e-waybill readable centrally with access control.
4. The e-waybill readable locally with access control.
5. The e-waybill is updated (write) centrally with allowable update/write.
6. The e-waybill is updated (write) locally with allowable update/write.

Based on these 6 properties, there are $2^6 = 64$ possible solutions. Out of these 64 possibilities 59 are unrealistic, e.g., due to cases where the e-waybill is not stored centrally/locally but it is read/updated centrally/locally. Hence, this gives us 5 realistic possibilities, which are represented in Table 1.

Table 1: e-waybill solutions

No.	Central Storage	Read Central	Write Central	Local Storage	Read Local	Write Local
1	1	1	1	0	0	0
2	1	1	1	1	1	1
3	1	1	1	1	1	0
4	1	1	0	1	1	1
5	1	0	0	1	1	1

From Table 1 it can be concluded that solution 1 corresponds to the solution that was proposed by IATA, however we will consider it for comparison with other solutions in order to figure out which ITS services are supported by different solutions. It is important to note here that in all potential solutions the consigner asks the carrier (via an electronic message) for carriage of goods. The carrier can either agree or disagree with the consigner. The carrier may disagree with the consigner and they can settle the matter through negotiations or the carrier may agree. Hence we argue that only one actor (i.e. the consigner) is responsible for creating the e-waybill. Throughout the rest of this section we describe the five e-waybill solutions that are listed in Table 1.

4.1. Solution 1

One potential solution is the storage of a waybill centrally, which is similar to the E-Air Waybill model proposed by IATA [9]. Since the e-waybill is stored centrally any stakeholder who wants to read/write to it will have to do it by accessing the e-waybill centrally. The read/write capability to the e-waybill is with access control hence we assume only authorized organizations/stakeholders can read or write to the e-waybill. Further we also assume that the level of read/write access for a stakeholder is determined by the access control. Different stakeholders have different responsibilities regarding writing to an e-waybill such as the consigner can write majority of the information needed by an e-waybill while the receiver only have to sign the e-waybill. Hence some actors need more privileges than others to write to an e-waybill.
The advantage of this solution is that a consignee can see the waybill information before the actual arrival of goods, while in a traditional waybill the consignee can see the waybill once the goods have arrived.

4.2. Solution 2

In this solution the e-waybill is stored centrally as well as locally on the vehicle with synchronization. The e-waybill is readable centrally as well as locally with some kind of access control and it can be written centrally as well as locally with allowable updates only. Thus if a (allowable) change is made to the e-waybill locally, then this change should also be visible at the e-waybill stored centrally. Similar to the previous solution, the read/write capability to the e-waybill is with access control hence we assume only an authorized organization/stakeholder can read or write to the e-waybill. It is also assumed that the level of read/write access for a stakeholder is determined by the access control.

4.3. Solution 3

Another potential solution resembles the previous solution, i.e., the e-waybill is stored centrally as well as in the vehicle; however, it is stored locally on the vehicle for read only purposes. In order to write to the e-waybill it should be updated centrally. Thus (allowable) change is made to the e-waybill centrally. Similar to the previous solution, the read/write capability to the e-waybill is with access control hence we assume only an authorized organization/stakeholder can read or write to the e-waybill.

4.4. Solution 4

This potential solution is the opposite of solution 3 in terms of updating the e-waybill. In this solution, instead of writing to the e-waybill centrally, it is updated locally. The e-waybill is stored centrally as well as locally, and it is readable centrally as well as locally with access control; however it can only be updated locally with allowable updates.

4.5. Solution 5

Lastly one potential solution can be the storage of a waybill locally (the consigner can retain a copy of the e-waybill centrally with no read/write access), which is similar to the paper waybill. In this model the e-waybill is stored locally and any stakeholder who wants to read/write to the e-waybill will have to do it by accessing the e-waybill locally. The read/write capability to the e-waybill is with access control hence we assume only an authorized organization/stakeholder can read or write to the e-waybill and we also assume that the level of read/write access for a stakeholder is determined by the access control. The advantage of this solution is that it is the exact copy of a paper waybill but in electronic format.

5. Services connections to e-waybill

In this section we list a number relevant ITS services (at different levels) and analyze the e-waybill solutions based on the services supported. We have used the ITS services that were identified in projects Mobil IT [16] and Intelligent goods [17] to compile a preliminary list of ITS services potentially relevant for integration with an e-waybill. For each service it needs to be specified if it uses any of the information available on a traditional waybill and whether any additional information needs to be added in order to support that service. In Table 2 we present the identified services and their relevancy to the information available on a waybill. The "Information Available on Waybill" column represents the presence of required information, while the "Additional Information Required" column specifies what additional information needs to be added to a waybill in order to achieve a particular service.

Table 2: Intelligent Transport Services and information on a Waybill

No	Intelligent Transportation Services	Information Available on Waybill	Additional Information Required	Solutions Supporting the service
1	Accident Warning Information		Current goods location	2, 3, 4 and 5
2	Dynamic Traffic Information	Goods origin, goods destination	Current goods location	1, 2, 3 and 4
3	E-call	Goods nature	Current goods location	2, 3, 4 and 5
4	En-route Driver information	Goods origin, Goods destination,	Current goods location	1, 2, 3 and 4
5	Dynamic Estimated Time of Arrival	Goods origin, Goods destination	Current goods location,	2, 3, 4 and 5
6	Freight Mobility	Goods weight, value, nature, origin, destination	Current goods location,	1, 2, 3 and 4
7	Goods Identification	Goods nature, marks, weight	Goods id,	2, 3, 4 and 5
8	Info about infrastructure repair & maintenance	Goods weight	Vehicle information	1, 2, 3 and 4
9	Information on XXL Cargo Transportation	Goods weight, Goods dimensions		1, 2, 3 and 4
10	Information on Truck Parking	Goods destination	Current goods location,	1, 2, 3 and 4
11	Navigation through a route Network	Goods origin, Goods destination	Current goods location,	2, 3, 4 and 5
12	On-board Safety and Security Monitoring	Goods nature	Goods status	1, 2, 3 and 4
13	Real time Track and trace of Goods	Goods origin, Goods destination	Current goods location	2, 3, 4 and 5
14	Remote Declaration	Goods nature, origin, destination	Goods id	2, 3 and 4
15	Road hindrance Warning	Goods origin, Goods destination	Current goods location	1, 2, 3 and 4
16	Road User Charging	Goods dimensions, origin, destination		2, 3, and 4

17	Route Guidance	Goods origin, destination	Current goods location	2, 3, 4 and 5
18	Sensitive Goods Monitoring	Goods nature, origin, destination	Current goods location	2, 3, 4 and 5
19	Transport Order handling	Goods origin, destination, Sender info		1, 2, 3 and 4
20	Vehicle Follow Up	Goods nature, weight, volume		2, 3, and 4
21	Weight Indication	Goods weight, volume		2, 3, 4 and 5
22	Notify goods to unload	Goods destination	Goods (to unload, id)	2, 3, 4 and 5
23	Notify goods to load	Goods destination	Goods (to load priority, id)	2, 3, 4 and 5
24	Notify Missing/surplus goods	Goods quantity	Goods (to unload/load)	2, 3, 4 and 5
25	Notify Goods current location	Goods nature	Goods id, Goods status	2, 3, 4 and 5
26	Notify Goods physical status	Goods nature	Goods id, Goods status	2, 3, 4 and 5
27	Notify Goods waiting	Goods nature	Goods id, current location	2, 3, 4 and 5
28	Notify Actual Arrival of Goods	Goods destination	Goods id, current location	2, 3, 4 and 5
29	Notify lost goods location	Goods destination	Goods id, current location	2, 3, 4 and 5
30	Notify Goods unwanted location	Goods nature	Goods id, current location, status	2, 3, 4 and 5

From examining Table 2, we can conclude that a very common information type required by ITS services but which is not available on a traditional waybill is “Current goods location” and “Goods id”. In addition to performing an analysis based on available and required information, it is also relevant to analyze the information sharing based on the availability of the e-waybill’s data at different locations, i.e., centrally and locally. Here we will assume that the e-waybill carries the information given in the columns “Information Available in Waybill” and the “Additional Information Required” in Table 2. The services can be categorized into three main categories based on where they need read access, i.e.:

a) Services requiring read access at local level (i.e. on a vehicle).
b) Services requiring read access at central level.
c) Services requiring read access at central as well as local level.

Out of 30 identified services, there are 18 such services that require goods-to-actor communication and access to information locally, i.e., Accident Warning Information, E-call, Dynamic Estimated Time of Arrival, Goods Identification, Navigation through a route Network, Real time Track and trace of Goods, Route Guidance, Sensitive Goods Monitoring, Weight Indication, Notify goods to unload, Notify goods to load, Notify missing/surplus goods, Notify goods current location, Notify goods physical status, Notify goods waiting, Notify actual arrival of goods, Notify lost goods location and Notify goods unwanted location. As these services require goods-to-actor communication they can be supported by solution 2, 3, 4 and 5 where the e-waybill can be accessed locally.
There are nine such services that require actor-to-actor communication and access to information centrally, i.e., Dynamic Traffic Information, En-route Driver information, Freight Mobility, Info about infrastructure repair & maintenance, Information on XXL Cargo Transportation, Information on Truck Parking, On-board Safety and Security Monitoring, Road hindrance Warning and Transport Order handling. These services can be supported by solution 1, 2, 3 and 4, in which the e-waybill can be accessed centrally.
Services that require actor-to-actor and goods-to-actor communication needs access to information locally as well as centrally. These services are 3 in number, i.e., Remote Declaration, Road User Charging and Vehicle Follow Up. Hence these services can be achieved by solution 2, 3 and 4 where the e-waybill can be accessed centrally as well as locally.
When analysing the information on a waybill and the additional information required in achieving a service, it is important to note that adding some information, such as, “Goods id” and “Current goods location” can help to achieve most of the services.

6. Concluding remarks

The main objective of this paper was to investigate possible solutions for an e-waybill and their connections to ITS services in order to identify solutions for an e-waybill in terms of potentially supporting different services. We first discussed what a traditional paper waybill is and what information is available in it, and we discussed different previous initiatives for an e-waybill in air, sea and road transportation. We then presented five potential solutions for an e-waybill based on the dimensions of where the e-waybill is being stored (centrally or locally) and from where an e-waybill can be accessed or updated. Later on we analyzed these solutions in terms of how different ITS services are supported. From the analysis we conclude that apart from the already existing information in a paper waybill, it will be good to include some other information such as Current location of

goods, Goods id, Goods to load and unload information, etc. This will allow more ITS services to be supported by an e-waybill. It can also be concluded from the analysis that different choices of e-waybill solutions influence the potential support of services. Further, the analysis suggests that solutions that can provide access to the e-waybill locally (i.e. solutions 2, 3, 4 and 5) can support most of the ITS services whereas solutions 2, 3 and 4 potentially can achieve all 30 identified services.

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