Study on the Application of Telematics in Dangerous Goods Transport

German Research and Development Project of the Federal Ministry of Transport, Building and Urban Development

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Summary of Project Results

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and Urban Development

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1. Document Attributes

1.1 Purpose

This is a documentation of main findings and recommendations of the research project "Study on the Application of Telematics in Dangerous Goods Transport" of the Federal Ministry of Transport, Building and Urban Development (BMVBS).

1.2 History

Version	State	Cause	Date	Reviser
00-01-00	released	Submission to the WG on Telematics	11.01.2012	Lüpges

1.3 Project Team

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2. Introduction

The Transport of Dangerous Goods is a matter which is subject to long-standing and evolving regulation. In order to ensure consistency between regulatory systems, the United Nations has developed mechanisms for the harmonization of hazard classification criteria and hazard communication tools (GHS) as well as for transport conditions for all modes for transport (TDG). The UNECE administers regional agreements that ensure the effective implementation of these mechanisms as far as transport of dangerous goods by road, rail and inland waterways is concerned. For Europe these are, amongst others:

- ADR – European Agreement concerning the International Carriage of Dangerous Goods by Road;
- ADN – European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways;
- RID – the regulations concerning the International Carriage of Dangerous Goods by Rail.

As technologies emerge and gain market acceptance the regulators, administrators and practitioners undertake periodic reviews to consider what opportunities and potential benefits may arise from technology deployment. The Transport of Dangerous Goods is no exception. The growing relevance of telematics systems[1] to support the technical, organizational and administrative processes for Dangerous Goods Transport has warranted further investigation.

Therefore the Joint Meeting of the RID Committee of Experts and the Working Party on the Transport of Dangerous Goods established a working group (referred to as *Working Group Telematics* throughout this report) on the initiative of Germany and the European Commission. Part of the terms of reference for the Working Group Telematics are to:

1. Consider what information provided by telematics enhances the safety and security of the transport of dangerous goods and facilitates such transport. In particular, consider who might benefit from the provision of such information and in what way, having regard, inter alia, to: consignors, transport operators, emergency responders, enforcers, regulators;

2. Consider necessary parameters for telematics systems, and examine if existing systems meet these parameters and what further developments might be necessary;

From the perspective of the Ministry of Transport, Building and Urban Development (BMVBS), such systems offer a great potential for improvement of both, the safety and security of such transport.

Therefore, the BMVBS launched a study on the *Application of Telematics in Dangerous Goods Transport*. The project started in April 2010 with scheduled project duration of 20 months. Amongst other aspects this research study sought to identify transport telematics standards that could be used, through regulation, to enhance the safety and security of the

[1] It should be noted that telematics applications applied to transport are commonly known as Intelligent Transport Systems (ITS). This is the term that is used interchangeably with "transport telematics" throughout this report.

transport of Dangerous Goods. The research study's reference group is the Working Group Telematics.

The prime contractor, AlbrechtConsult GmbH, with a team of specialist subcontractors, developed a general approach (WP 100) that is intended to fuse the outcome of four dedicated work items:

- Analysis of relevant standards (WP 200);
- Identification of certification structures (WP 300);
- Approach of an IT security concept (WP 400); and
- Modelling of identified data and processes (WP 500).

Figure 1 provides an overview of the project plan, its workpackages and its major milestones.

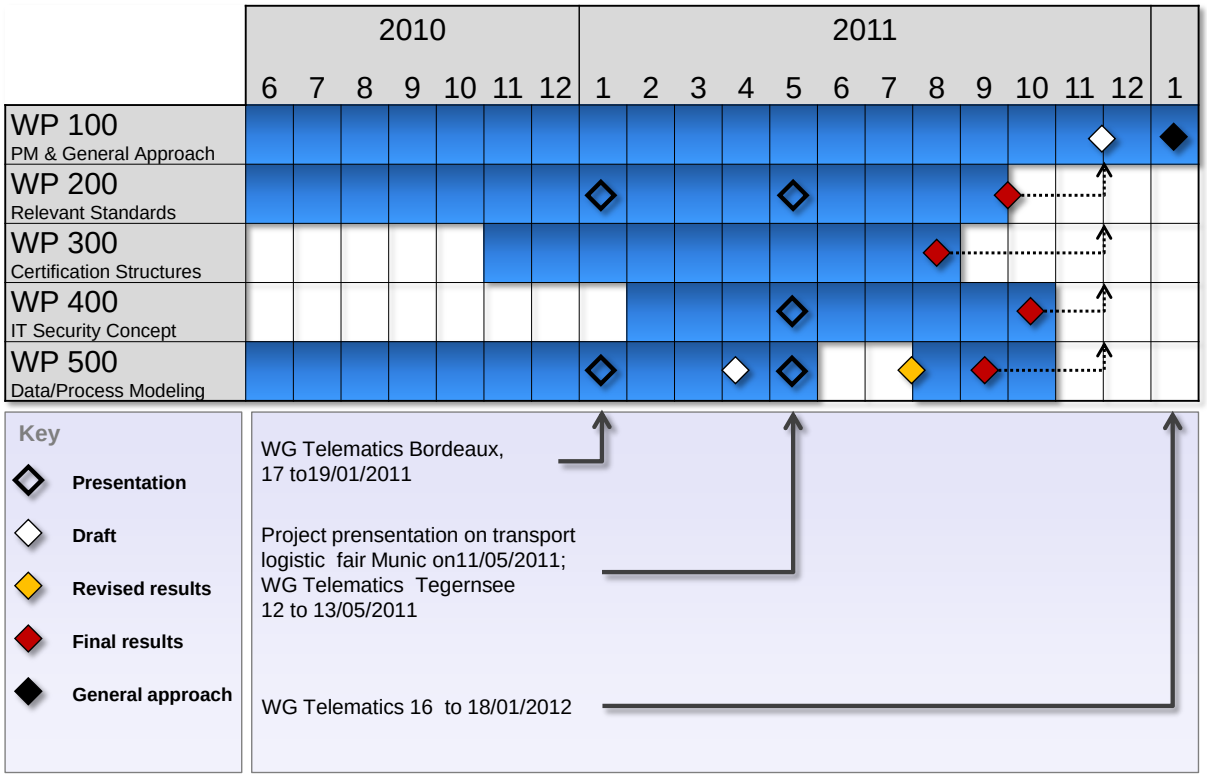

Figure 1 – Time Schedule and Work Package Structure

This report briefly presents the work undertaken and main findings of all workpackages in the context of this study.

3. Relevant standards (WP 200)

WP 200 was structured to address two specific and conflicting requirements. The requirements sought to:

- Provide a broad overview of intelligent transport system standardisation activities that have relevance to the transport of dangerous goods; and
- Provide more focussed and detailed analysis of priority areas identified by the client, BMVBS.

The initial task set about defining the boundaries of the scope of investigation. As the scope of the workpackage is to address intelligent transport system applications it was necessary to define the generally accepted scope of intelligent transport systems and which areas of standardisation are relevant especially where these relate to dangerous goods transport. In addition a range of use case domains was examined where the processing of dangerous goods transport information is undertaken.

Each of these use case domains was then reviewed and the information about relevant standardisation activities identified.

This Procedure specifically sought to provide a broad overview of the landscape of standardisation for intelligent transport systems relevant to the transport of dangerous goods. It was not intended to undertake detailed and in-depth analysis of any specific topic at this stage.

Following consideration BMVBS then defined the direction of the second and third tasks within WP 200 through the selection of topics of key interest.

Standardisation activities within the identified priority areas were further investigated. Particular emphasis on emergency notification and incident response was requested. Subsequently, these findings have been presented and discussed with the client, BMVBS.

Finally recommendations were derived for further actions that BMVBS may wish to promote the development of standards to support intelligent transport system applications for the transport of dangerous goods.

4. Certification structures (WP 300)

The need for this investigation is due to the difficulty that in future in the highly-regulated dangerous goods transport domain innovative telematics systems of from different manufacturers will be deployed. Therefore it is necessary that the interfaces between components are standardised. However, a definition of interface standards is not sufficient since it is required that compliance with the standardised specifications were verified by independent sources (conformity evaluation).

A further and more innovative element of viewing represents the interface standards to ensure interoperability between systems. While existing requirements for non-ICT-based dangerous goods transport systems primarily consist of electro-mechanical, physical or chemical requirements, specification techniques of information and communications technology must be used for the future regulation of the interoperability of telematics systems. Those describe the interaction between systems using mathematical and technical procedures more or less formally.

This is the starting point of WP 300. It was examined, which institutions may certify standardised specifications in dangerous goods transport domain and which requirements must comply with.

Starting the investigation the work package tried to develop an overview of existing domain certification possibilities. Domain experts were identified and interviewed to collect the requirements of marked players.

Based on these requirements further recommendations for action could be derived.

5. IT security concept (WP 400)

The considerations in WP 400 based on the generic process model, which was developed in WP 500 to describe the processes in dangerous goods transport domain.

To restrict the effort in this study, the considerations had to be defined analogue to the work of WP 500 on two concrete communication patterns.

Nowadays for telematics in dangerous goods transport and its concrete expression in patterns of communication nearly no binding standards exist. Therefore a few further assumptions and constraints had to be taken into account to describe specific processes and IT security mechanisms setting protection targets.

The following findings were worked out:

- Appointment of objectives and specific requirements for data protection and data security for telematics in dangerous goods transport;
- Introduction of different data types and a role-based access control matrix as a basis for a protection target compliant use of collected and processed data in the framework of the transport;
- Description of basic security mechanisms and their application in the generic process model;
- Introduction of a procedure of distributed trusted instances (trusted parties) to distribute dangerous goods information in these instances. This method reflects special protection needs of the data from the perspective of the economy and of crime prevention;
- Model studies for selected communication patterns
  - Examination of security mechanisms for the production and deployment, updating, retrieval and deletion of data;
  - Presentation of three different data retrieval options and evaluation of their implementation;
  - Classification of the models into existing projects EUCARIS and eCall.

6. Data and process modelling (WP 500)

As a result of WP 500 a data model for dangerous goods transport has been delivered that can serve as a reference model for future specifications. This reference model could either serve as a starting point for future considerations of regulations regarding telematics applications and interfaces in the ADR, ADN and RID themselves, or it could be used as means of communication with other relevant specification and standardisation processes. Such 'external' standards could potentially also become a source of reference for future versions of the regulatory frameworks, very much in the way that technical norms and standards in other domains are already quoted in them.

The proposed data modelling effort has used stat-of-the-art methods from the domain of Information and Communication Technology (ICT), in particular the Unified Modelling Language (UML). The DATEX initiative – developed for creating the CEN/TS 16157 family of Telematics standards for Traffic Management, with first three specifications being published by CEN in October 2011 – provided a good starting point with the following features:

- UML profile suitable for this type of modelling effort;
- Defined mapping to XML schema definitions (incl. Software Tool);
- Detailed (technical) part of the resulting model can be fed back to DATEX for CEN standardisation, providing alignment of future versions of the interface standard for traffic management.

Starting point for the aspect of data modelling (WP 500) was the WHO DOES WHAT spreadsheet (WDW table) of the WG on Telematics.

Based on the table and other external information a rudimentary process model for the transport of dangerous goods was developed by using the Business Process Modelling Notation (BPMN). The aim was to get elementary data artefacts as an input for data modelling and an overview of the possible use cases. A UML-based modelling approach (DATEX II) was chosen developing a data structure and modelling data artefacts based on the project's particular focus on two use cases: "accident" and "enforcement". In relation to the WDW table the relevance of the content of section A for these use cases was obvious, since this section deals with exactly the information that is needed by emergency responders appearing on the site of an accident and it is also the subject matter of enforcement.

It was much more difficult to assess the relevance of the content of section B of the table. Some entries here are similarly obvious, e.g. the tank certificate and the test report for packaging, at least for the enforcement scenario. For other entries it might however be questioned whether they need at all to be included in such a model, e.g. it was not clear whether the model actually needs to describe labels and markings. One might argue that these are only visualisation aids in the sense of non-electronic communications channels. Therefore part B was completely modelled except for elements No. 36 to 42.

New information listed in part C was also taken into account in the model. Part C contains in particular dynamic information that is currently not regulated in RID/ADR/ADN. Hence, considering elements of part C (48-60, 64 and 69) in the model is a proposal that has to be discussed in the Working Group on Telematics.

7. Recommendations

7.1 Relevant standards

7.1.1 General recommendations

- It is recommended that BMVBS promote further analysis of costs and benefits of potential regulated applications in an iterative process with the assessment of the availability of suitable telematics standards and the deployed base in the field. Such an approach is likely to focus on the most promising future regulated applications and reduce the risk of abortive effort;
- To create alignment between standards making reference to Dangerous Goods Transport BMVBS, in consultation with Working Group Telematics, may wish to investigate suitable means to promote the creation and maintenance of a reference data model for Dangerous Goods Transport. This data model should be maintained to ensure alignment with the current regulations;
- Continuing the theme of the previous recommendation it is important to consider the wide range of Dangerous Goods Transport services collectively as part of a structured programme within a coherent architecture, rather than a number of discrete isolated applications or services. Many forms of architecture exist but an approach that supports deployment of several applications and services in an extensible manner through a single on-board platform within a vehicle could provide a valuable support for future deployment. ISO 15638 *Framework for collaborative telematics applications for regulated commercial freight vehicles* should be investigated further as it may offer this opportunity;
- Given the communities of interest developing standards which have some relevance to the Transport of Dangerous Goods, to support reasonable alignment of standards both to one another and to the regulations it is recommended that BMVBS and the Working Group Telematics consider a programme of engagement with relevant bodies to ensure greatest efficiency and collaborative working are achieved;

7.1.2 Recommendations - Freight and Commercial domain

In relation to the Freight and Commercial domain it is recommended that:

- The BMVBS, with the support of the Working Group Telematics, review and if necessary comment upon UBL 2.1 as an industry de-facto standard of growing importance, to ensure that UBL 2.1 is as a minimum capable of transmitting the required information concerning the Transport of Dangerous Goods between interested parties, where applicable;
- BMVBS encourage the e-Freight cluster of projects through the European Commission take heed of the regulations for the Transport of Dangerous Goods such that the technical products of the cluster are capable of supporting the required information concerning the Transport of Dangerous Goods between interested parties, where applicable;
- If the data modelling work of WP 500 is considered to be of value by BMVBS and the Working Group Telematics, that wider communities of interest should be encouraged to use, comment and aid improvement to the data model to promote its widest use, where appropriate, as a common reference model for other forms of specification and standard when they concern the Transport of Dangerous Goods. This encourages the alignment of other standards and specifications defining applications concerning the Transport of Dangerous Goods;

7.1.3 Recommendations - Monitoring and Enforcement domain

In relation to the Monitoring and Enforcement domain it is recommended that:

- BMVBS retaining a watching brief on both the developments of the SCUTUM and RESTORE technical specifications to ensure that emerging standards are tested for relevance against the requirements of the regulations for the Transport of Dangerous Goods;

7.1.4 Recommendations - Incident Notification and Emergency Response domain

In relation to the Incident Notification and Emergency Response domain it is recommended that:

- A review and recommendations exercise be undertaken to improve ISO 16787 capability to carry information required by ADR. It is known that this input would be welcomed by ISO TC204 Working Group 7. However this analysis would have to be undertaken in the context of other related approaches to support incident notification and emergency response;
- BMVBS, in conjunction with the Working Group Telematics, nurture and strengthened the dialogue with CEN TC 278, its Working Group 15 and any other relevant Working Group, to promote consistency of approach to the embedment of requirements supporting applications in relation to the Transport of Dangerous Goods. The *eCall additional optional data set for heavy goods vehicles* Work Item is one good example where timely intervention creates opportunities to ensure that existing and near-future telematics deployments can be leveraged to create opportunities for the use of such deployments to support the objectives of the Working Group Telematics;
- BMVBS, in conjunction with the Working Group Telematics, consider the potential to utilise ISO 15638 *Framework for collaborative telematics applications for regulated commercial freight vehicles* incident notification application to promote consistency of approach to the embedment of requirements supporting applications in relation to the Transport of Dangerous Goods;
- Efforts should be made to ensure the incident notification technical solutions for road and rail are aligned as reasonably practical;
- There is scope for harmonisation and standardisation of the data exchange of incident and response related information for incidents involving Dangerous Goods between PSAPs and road operators and additionally between PSAPs and the emergency services. Further work on these topics could be beneficial for the promotion of harmonised emergency response across jurisdictions.

7.2 Certification

7.2.1 Accreditation

Together with subordinated authorities the BMVBS is formally equivalent to an accreditation body. In the context of the implementation and use of the concept developed in WP 400 according to the requirements of the German Dangerous Goods Transportation Law (GGBefG) the BMVBS might accredit certification bodies. The design of the accreditation framework including the establishment of the evaluation criteria should be performed in the context of a professional multidisciplinary workshop series. Recommendations for the design of the accreditation framework can be found in the appropriate standards.

7.2.2 Continuous development of standards for the certification

Caused by the rapid development of technology there is the need for a continuous development of the dangerous goods transport regulations. This also means that the standards, the basis for a certification, must be constantly developed to face the advanced regulations and the technical innovations.

To ensure a continuous development, it is necessary to ensure that the external and internal cooperation of responsible units for various modes of transport of the BMVBS, the Federal Network Agency, the Federal Office for security in information technology, the Federal Institute for materials research, the German Commission for electrical engineering electronics information technology and the federal transport offices (KBA, EBA, LBA, WSV) will be implemented in the existing national, international and European bodies.

If the implementation should be deployed sustainably, it is recommended to set up an expert committee with the participation of the mentioned partners, which is equipped with sovereign competences. This is a possibility how to face rapid technology development especially in the field of information technology.

7.2.3 Recommendation with regard to data storage

System stability is seen as a potential risk, as negative experience already has been gained. To minimize this risk, data centres should be certified according to SAS 70.

Als ein mögliches Risiko wird die Systemstabilität gesehen, da hier bereits negative Erfahrungen gesammelt wurden. Um dieses Risiko zu minimieren sollten Rechenzentren nach SAS 70 zertifiziert sein.

7.2.4 Recommendation with regard to eCall

In the case of eCall, for data transmission a vehicle component is used. This can be certified on the EC operating approval process.

7.3 IT security concept

7.3.1 Overview

Regarding defined assumptions the present WP 400 research have developed communication patterns and implemented security mechanisms that demonstrate a feasibility of the requirements under certain conditions. Necessarily the worked out results based on assumptions, because aligned objectives as a framework for system design does not exist in many fields. Therefore, the recommendation on the further course of action is divided into three parts:

- Alignment of the technical assumptions in the context of the WG on telematics,
- Embedding the approach into existing projects, notably eCall HGV
- Development of necessary standards for deployment of the project.

7.3.2 Discussion in the WG on telematics

For further discussions in the WG on telematics it is recommended to delve into the following technical issues:

- Alignment of the assumptions used for the communication models, particularly in the light of End2End workflows, transhipments and partial unload;
- Concretisation of the access control list in terms of roles and data types;
- Further analysis, evaluation and decision on the draft proposal for the establishment of separate trusted instances TP1 and TP2;
- Definition of the required procedures for the procedures for the vehicle identification (also in alignment with the project eCall HGV);
- Determination of communication patterns to be supported in principle;
  - Scenario 1: Local Interface between OBU and handheld
  - Scenario 2: Direct communication between handheld and background application (Trust Party 1)
  - Scenario 3: Communication via control centre and background application (Trust Party 1)
- On this basis: Determining whether an OBU (and what functions) is part of the procedure.

7.3.3 Link to eCall HGV and EUCARIS

After setting the desired communication patterns in the WG on telematics an alignment with the eCall HGV project should be made for the use of the communication scenario 2. Hence, following issues should be discussed:

- Alignment with eCall HGV in order to use the channel for the transmission of the VehicleID, as well as harmonisation of the used vehicle identification data within the procedures;
- Role of the PSAPs as a control centres in the sense of communication pattern 3 or forwarding of the VehicleID from PSAP to another control center.

7.3.4 Standardisation

In case of a project implementation following standardisation is necessary to ensure interoperability:

- Format and content specifications for documents to be transmitted (Vehicle-ID, metadata, DG data, ...);
- Public key infrastructure for managing keys, certificates and attributes, in particular, use multiple PKIs from several countries:
  - Content of certificates for people and equipment;
  - Definition of used encryption, signature and hash algorithms;
  - Certificate policies and certificate practice statements for creating and managing certificates.
- Interface protocols to access the trusted instances TP1 and TP2;
- Physical channel and communication protocol between OBU and handheld, device interfaces (e.g. WLAN) when using the local data retrieval scenario.

7.4 Data and process modelling

7.4.1 General recommendations

The development of a dangerous goods transport data model in the context of data and process modelling is faced with the following issues and challenges. Regarding the recommendations for action this should be discussed and aligned with the dangerous goods experts:

- The modelling experts are no dangerous goods experts and are overwhelmed by the width and depth of information. Therefore, the model prone to errors and inconsistencies. Also, a thorough review of the extensive UML model takes considerable time. We recommend to review the model and to define an aligned approach with the WG on telematics.
- Some metadata cannot be derived systematically from ADR, ADN & RID or the WDW table. Therefore not all tagged values can be filled from this source. A definition is mandatory and needs to be agreed with the Working Group on Telematics. Annex A gives an overview of all classes and attributes that require an aligned definition.
- Data type modelling – Enumerations in particular – is a powerful tool, but implies maintenance to keep aligned with the regulations. In addition, there might be a need in the future to change the structure of the ASR/ADN/RID to better support the link to modelling. It is recommended to define a strategy in collaboration with the AG telematics.

7.4.2 Specific recommendations on review of the data model

In case of transporting dangerous goods by rail it is possible to get information about the composition of a train, single rail wagons and the load they have according to 1.4.3.6 RID. The latter information is realized by a reference to single entries of transport documents. The initiative e-RailFreight and the TAF-TSI specifications are an example for this mechanism.

Regarding elements No. 48-60 of the WDW table no alarm systems were specified, but the possibility was created to transmit alarm information in terms of vehicle and load. A load alarm may be referred to a single entry (dangerous good) of a specific transport document.

The mechanisms mentioned above arise from opportunities offered by data modelling. Whether this can be implemented in reality the dangerous goods experts should discuss.

7.5 Recommendations for discussions on the edge of the project

At the time of reporting a position paper has submitted by UK to the *Sub-Committee of experts on the transport of dangerous goods*, which proposes the indexing of the table(s) in chapter 3.2 of the regulations.

The project team understood that these considerations have arisen from the eCall context. For the transmission of an incident notification eCall uses a limited bandwidth. Therefore, the dangerous goods information (a combination of different attributes) now should be grouped or compressed by an index.

The German Ministry of Transport, Building and Urban Development and the project team have the opinion, that these indexes will be obsolete when a background application (as it was presented in WP400) would be introduced. In cases of emergency and enforcement

unique and comprehensive information of a transport of dangerous goods could be retrieved e.g. by fire and police control centres. The data between the background application and a control centre would be exchanged via a broadband data channel (backbone) with high transmission rates. Among other things, the data in the background application would be provided by the electronic transport document. In case of an emergency the eCall system would transfer only a reference to the complete dangerous goods information (e.g. Vehicle-ID or an automatically generated Transport-ID during initialization of the transport).

An index is useful only in case of a transmission of limited dangerous good information by the restricted eCall mechanism.

The advantages and disadvantages of both options should be compared and examined. An example is the following table.

Indexing of the table(s) in chapter 3.2 of the regulations		**Implementation of a background application**	
Context: eCall		**Context: Study on the application of telematics in dangerous goods transport**	
Transmission channel with limited bandwidth		Broadband data channel (backbone)	
Mechanism		**Mechanism**	
Direct addressing of individual rows in the table in Chapter 3.2 of the regulations		Addressing the comprehensive dangerous goods information via Vehicle-ID or an automatically generated Transport-ID during initialization of the transport	
Pro	**Contra**	**Pro**	**Contra**
Minor system complexity	-	-	Major system complexity
-	Obsolete, in case of a background application	-	-
-	Maintenance of indexes within the regulations	No maintenance. Use of existing Vehicle-ID or an automatically generated Transport-ID during initialization of the transport	-
-	Transmission of a limited number of dangerous goods information (restricted data volume within the MSD)	comprehensive dangerous goods information (electronic transport document)	-
-	Data transmission via mobile telephony	Data transmission via backbone connection between background application and a control centre	-
-	Availability of the dangerous goods information usually only in cases of emergency	Availability of the dangerous goods information in cases of emergency and enforcement	-

-	-	-	Critical situation, if there is no access to the background application

Annex A

A.1 Classes without aligned definition

The classes represented here require an aligned definition. It is not given by the WDW-table but it is mandatory and needs to be agreed with the Working Group on Telematics.

Relation	Package	Class/Identifiable/Enumeration	Definition
-	DangerousGoodsTransportArtefacts	DGFolder	???
		DGCarryingVehicle	???
WDW table Part A	ClassDetails	DGDescription	???
		DGDescriptionADR	???
		DGDescripionRID	???
	DangerousGoodsTransportDocument	DGConsignmentDescriptionStatic	???
		Address	???
		CarriagetIAWEnum	chapter numbers for carriage in order with specific ADN/ADR/RID regulations
		DGTDocumentEntry	???
		DGTDocument	???
WDW table Part C	DangerousGoodsDynamicInformation	DGVehicleInformationDynamic	???
		DGLoadInformationDynamic	???
		DGVehicleAlarm	???
		DGLoadAlarm	???
		DGTDateTime	???
		PointCoordinatesExtended	additional information provided by means of EGNOS CS and EDAS based services

Table 1— Classes without aligned definition

A.2 Attributes with proposed definitions

The following new (meaning not from WDW table) attributes have proposed definitions that are not aligned with the WDW-table. They need to be agreed with the Working Group on Telematics.

Relation	Class/Identifiable	Attribute	Definition	Source
WDW table Part A	DGTDocument	carriageIAW	chapter number for carriage in order with specific ADN/ADR/RID regulations	
	Address	name	name or legal identity as part of an address	IATA eFreigt
		pOBox	post office box number as part of an address	
		street	street name and number and as part of an address	
		department	company department name or number	
		zipPostalCode	ZIP/Postal Code corresponding to the street address	
		regionName	name of the region within a country specific code to this address. Used to hold the state in US addresses. The code related to the name can be identified in the UNECE Recommendation N 16 - LOCODE	
		cityName	name of the city. The code related to the name can be identified in the UNECE Recommendation N 16 - LOCODE	
		countryCode	ISO Country Codes ISO 3166-1/1998, UNECE Recommendation N 3 - Code for the Representation of Names of Countries	
		countryName	name of the country	
	DGConsignmentDescriptionStatic	environmentallyHazardousSubstance	ADN/ADR/RID 5.4.1.1.18 - ???	
WDW table Part C	PositioningInformation	speed	a value of speed expressed in kilometres per hour.	DATEX II
	PointCoordinatesExtended	hpl	horizontal protection level, radius of a circle centred on the position, projected on a plane tangent to the WGS84 ellipsoid	SCUTUM
	DGTDateTime	currentDateTime	current date and time of a dynamic vehicle or load information	
	DGRailWagonInformation	dgtDocumentEntry	reference to a specific entry in the transport document	
	DGLoadAlarm	loadAlarm	alarm that can be reported for a load	
	DGLoadAlarm	dgtDocumentEntry	reference to a specific entry in the transport document	

Table 2— Attributes with proposed definitions