

# A Conceptual and Technical Approach for Transportation of Dangerous Goods in Compliance with Regulatory Framework

Adnan Imeri <sup>1\*</sup>, Abdelaziz Khadraoui <sup>1</sup>, Djamel Khadraoui <sup>2</sup>

<sup>1</sup> Institute of Service Sciences, University of Geneva, Geneva, Switzerland.

<sup>2</sup> Luxembourg Institute of Science and Technology (LIST), Luxembourg.

\* Corresponding author. Tel.: +41 76 703 4801; email: a.imeri@live.com

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**Abstract:** The transportation of dangerous goods (TDG) remains one of the main challenges to manage for the stakeholder who provides such services. The process of TDG is complicated by itself due to the fact that several local and international regulation frameworks should be considered. The process of TDG enlists several difficulties for the stakeholders, in managing, monitoring, and validation the process of TDG with the regulation framework. This paper aims at presenting a conceptual and technical approach for designing and developing a sustainable solution for the process of TDG in compliance with the regulatory framework.

**Key words:** Compliance, regulatory framework, transportation of dangerous goods.

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## 1. Introduction

The trade and marketplaces are strongly depended on the transport process [1]. An efficient transportation process is an indicator of the economy growth [2]. The transport sector presents one of the main relevant elements in the European economy, because it is directly responsible for moving millions of people and goods around European countries and beyond [3]. This division uses several transportation modes like railways, roads, aviation and pipelines [3]. While considering the process of transportation we should also take into account risk and other procedural issues which follow this process. Especially the complications rises when we are making the TDG and this process should consider with high attention. The TDG involves many risks and it is considered as threat for the drivers, persons around mechanism of transportation, population and also for the environment [4]. Reasonably, this process should be regulated by specific regulatory framework<sup>1</sup>. This regulatory framework should cover all the modes of transports [4].

The issues of complying with regulatory framework are one of the main challenges for the service providers<sup>2</sup> in the transportation process. Besides the procedures, which they should follow on packing, organizing and adapting the time for transportation of specific goods, they should also consider the regulation framework of the other states where they are linked for organizing the transportation process.

Through this research, we propose a conceptual approach for managing the compliance issues with the regulatory framework for the process of TDG. This approach intends to facilitate the process of TDG and it is

<sup>1</sup> With regulatory framework we refer the set of laws, which are applicable.

<sup>2</sup> The service providers and service consumers in the TDG process are known also as "Contractors".

supported also by a software application. Besides, managing the issues of compliance this approach will support the service providers and service consumers. These services will give them better surveillance on this process by giving them the opportunity to trace the current “goods” which are in transportation, and then they can also audit this process by focusing on needs.

This outcome in this research paper is organized as follows. Section 2 is an introduction to the related work for the TDG. Section 3 presents the problem and main issues to consider by our research approach. Section 4 presents our methodology approach for the process of TDG in compliance with the regulatory framework. Following we present Section 5 which introduces the technical approach. Finally, we present Section 6, which shows conclusion, and our next target research works.

## 2. Related Work Studies

There are several indicators, which presents the relevance of TDG. The economic dependencies on this process are present in our daily live [2]. We have oriented the research presented in this section in two fields. In the first subsection we present the official statistics for TDG in European countries, while in the second subsection we present related works in the scientific and information systems fields.

### 2.1. The Statistics over TDG in the European Countries

Each European country has enormous activities in the TDG. Fig. 1 presents the information for the TDG in each European Union countries. The statistics are related to the transportation of dangerous goods like “Gases” and the measurements for this type of dangerous goods are done in “million tonne-kilometers<sup>3</sup>”.

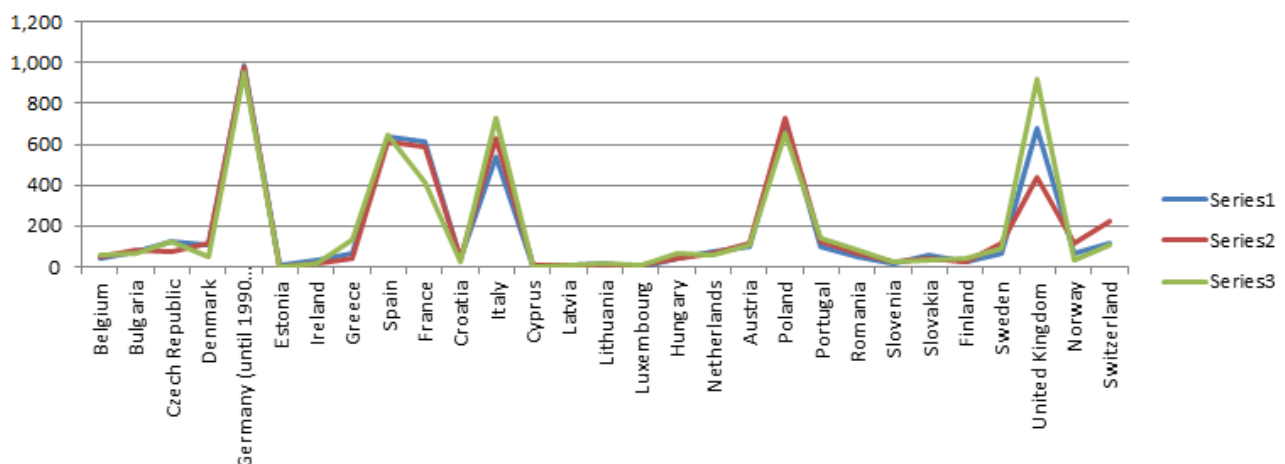


Fig. 1. TDG by European countries for years: 2013, 2014 and 2015. Source: Eurostat.

By comparing these statistics we see that the process of TDG variate at some points with a tendency to increase. In the Fig. 1, we compare the statistics from three consecutive years 2013 (blue line), 2014 (red line) and 2015 (green line) for transportation of “Gases” in each European country and we noticed that the process remains sustainable in most of the countries but it increases at some of them<sup>4</sup>.

### 2.2. The Scientific Approaches and Information Systems for TDG

An extensive research is presented for the issue of TDG. The literature review shows the efforts of the research by proposing several scientific approaches for TDG. Many research organizations have provided a

<sup>3</sup> The datasets for TDG: <http://appsso.eurostat.ec.europa.eu/nui/setupDownloads.do>

<sup>4</sup> Road freight transport of dangerous goods:

[http://ec.europa.eu/eurostat/statistics-explained/index.php/Road\\_freight\\_transport\\_by\\_type\\_of\\_goods#Road\\_freight\\_transport\\_of\\_dangerous\\_goods](http://ec.europa.eu/eurostat/statistics-explained/index.php/Road_freight_transport_by_type_of_goods#Road_freight_transport_of_dangerous_goods)

solution for managing the process of TDG. Table 1, shows several research materials in the field of the TDG.

Table 1. The Scientific Approaches and Research Project for TDG

Research Document / Research Project	Description
Monitoring Dangerous Goods in Container Yard Using the Internet of Things [5]	The framework presented in this paper uses the Internet of Things (IoT) approach for managing the dangerous goods. As a framework it provides the functionalities like "Container Information Forecast" which allows the owners to have the information for containers in advance; "Gate-in and Gate-out" functionality which provides information for entrance and exit of containers; "Environment Monitoring" which allows monitoring of the environment where the dangerous goods are hosted in order to avoid any risk of explosion, firing etc. and "Fire Fighting" which presets different method (water, sand, carbon dioxide) in case fire on dangerous goods.
A risk assessment for road transportation of dangerous goods: a routing solution [6]	The traffic flow and the frequency of accidents are the main analysis in this research paper. This research analysis the road accidents where the dangerous goods are involved. Making this analysis lead to the reason of leakage of hazardous materials. It proposes a methodology for routing solution by identifying the hazardous accidents and by risk assessment in road transportation of dangerous goods. In general, this research identifies the components, which are in correlation with the risk of transportation of dangerous goods by roads.
Total safety by design: Increased safety and operability of supply chain of inland terminals for containers with dangerous goods [7]	This research highlights the needs for an appropriate design for inland terminals for containers with dangerous goods. It studies and implements the specific criteria for designing inland terminals in order to avoid risks. It applies the multi-decision theory and it includes several criteria simultaneously. Among the new criteria discovered for the designing of inland terminals, the criteria related to safety and security, environment maintenance and information and communication technology (ICT) are part of this study in order to consider concurrently all these criteria for extracting the best solution. The method here is composed by "Analysis" which defines the problem and the criteria to be considered, then by "Synthesis" which propose a development model, and finally the "Evaluation" which shows results and conclusion.
Route selection for dangerous goods based on D numbers [8]	This research proposes to use the theory of D numbers for selection the route for transportation of dangerous goods. This approach takes into account the "cost" if transportation while selecting the specific route, the "risk" which exposes while transportation is done by the route, and "response-ability" in the case of accidents. These are the main criteria this approach uses to evaluate the routes and it uses a specific algorithm to find the optimal route. A real case study is showed in this research by presenting the results of selection the optimal route in specific.
Decision support systems for assessing risks involved in transporting hazardous materials: a review [9]	This research paper treats the risks, which are involved in the process of transportation of the dangerous goods. It makes a review for the existing decision making systems, which are developed recently. This review made for decision making systems like: HAMER; HAMER PATH Spatial DSS; TrHaM; TrHazGis; TRAT- GIS 4.1; DESTINATION Project 2014 – SIIG

### 3. The Problem Scope

Since we have several stakeholders which cooperate together in the field of TDG, there are identified several difficulties on the organization of the process of TDG. A highlighted problem is that the stakeholders who provide TDG services are hosted in different countries, which in fact oblige them to respect their own local legal rules, which are relevant for this process [10]. The stakeholder should comply with the legal rules specific for TDG. The problem here is that in each country there are different regulatory frameworks for different types of transportation [10], [11]. The issue arises when the dangerous goods should cross the border in order to arrive at a specific destination, the regulatory framework changes based on the country context, also on the transport type [10]. Furthermore, this process should follow the new safety protocols, which are applicable in the country where the destination of dangerous goods is predicted to be. Among several issues, through the process of TDG, there is a need for a constant communication between the service providers and service consumer also for the authorities<sup>5</sup>. This provides enormous amount of data which at some point are considered sensitive during this data exchange channel. For this issue, these data should not be transparent for all parties involved in the process based on the laws for data protection, which are applicable in different countries.

The transportation process should adapt the new regulatory frameworks in order to overcome the mentioned problems above.

In the section below, we will present our conceptual methodology approach to manage the compliance of TDG process.

### 4. Conceptual Methodology Approach

The methodology approach presented in this paper permits to support the design and the development of services which provides many facilities in the process of TDG is composed of three different levels:

Level I: Composition of the regulatory framework for the TDG;

Level II: Semantic analysis and legal rules specification for the process of TDG;

Level III: Specification of services related to TDG and the compliance analysis in overall ICT platform.

These levels are strongly linked. The methodology approach presented as follows is inspired from our previous research work showed in [12]-[14], in the context of scenarios<sup>6</sup> design and development in compliance with legal and ethical issues. In the context of this research paper, we redesign our methodology by providing new contextual situations, extending and providing new components, which represent the added values in our meta-models, showed in the levels of methodology.

#### 4.1. Composition of the Regulatory Framework for the Transport of Dangerous Goods

There is an extensive set of legal information applicable for the process of TDG. This set is composed of regulation and laws, international directives and any other internal or external policy proposed by business partners. The official legal documents are provided by countries and also by international organizations. We compose the set of legal documents under the name “regulatory framework” for the process of TDG. For gathering and composting the regulatory framework for the case of TDG, basically, we initially determine some basic concepts related to TDG. These concepts are showed on the meta-model<sup>7</sup> presented in Fig. 2, which is composed based on our previous research work presented in [15]-[17] and [12].

From the meta-model presented in Fig. 2, we see that the main entity is “TRANSPORT (TDG)”, which determines the targeted case on this model. This concept is related to entity “TRANSPORT MODE”, which

<sup>5</sup> The “authorities” are the police department, cross-border departments or the department of transportation.

<sup>6</sup> With scenario we refer business processes

<sup>7</sup> The model showed in Fig. 2, is modeled by using UML modeling language.

determines the mode of transport in terms of movement mode, and also with entity “TRANSPORT TYPE”, which determines the type of transport in terms of geographic area. The entity “TRANSPORT (TDG)” is also related with entity “STAKEHOLDERS”, which provides services for transportation<sup>8</sup> of dangerous goods. Basically, the service providers for TDG are hosted in a specific country as headquarters and with operational offices in other countries. This relation is determined by linking the “STAKEHOLDERS” with the entity “LOCAL CONTEXT”. Following, the legislature which is applicable in each country for the process of TDG, we have the entity “REGULATORY FRAMEWORK” which presents the set of regulations which govern the process of TDG. This entity is the base for the compliance with legal issues, standards and policies, for the services provided by “STAKEHOLDERS” for the TDG. The instances, which assure this compliance with the regulatory framework, are presented by the entities “Regulation and Laws”, “Standards and International Directives” and “Internal or External Policy”, “Security Measurements” and “Data Exchange Regulations”. The entity “Regulation and Laws” gives all attributes of laws and regulations, while the entity “Standards and International Directives” presents any international standard or directive which should be considered in the case of TDG beyond the borders of any country. The entity for “Security Measurements”, gives the security provisions<sup>9</sup> and guides in case of accidents and also it deals with the training of the drivers to control the vehicles who carry dangerous goods. The entity “Data Exchange Regulations”, presents one of the most sensitive components in this process. The issues stem from the fact that during the process for TDG, there is sensitive information, which should not be exposed to the unauthorized parties in the process because this would present a permanent risk in the field of security. So, the “Data Exchange Regulations”, oblige us to respect the data protection policies in each country. The entity “Internal or External Policy”, presents any set of regulation provided by collaboration partners in the business field [13], [14].

In order to define the first level of our approach, the meta-model showed above guide us in the composition of the regulatory framework for the TDG. Through this meta-model, we follow the process of TDG by concepts presented in Fig. 2. There is an evident link, which shows that in order to perform any TDG we should consult regulatory framework, which provides us the necessary legal information in order to perform the compliant business process. This indicates the needs to have all necessary legal sources, which should be consulted in advance before starting the process of TDG. Initially, this implies on the particular gathering of the legal documents for the process of TDG [14].

In the first component, the process of selecting the legal document and composing a set of legal documents for the case of TDG of the legal document is done based on the transportation type (see Fig.2), e.g. *if the TDG is local or international*. The legal documents for this case are specific to each country in case of the transportation is local, and they are general in case of international, e.g. *Directive 2008/68/EC*<sup>10</sup>. The second component of selection of the legal document, we consider the transportation mode which clearly determines the mode of transportation and following this we select the specific legal documents, e.g. *for TDG by roads we have the “European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)”*<sup>11</sup>. The “STAKEHOLDERS” as presented in Fig. 2, can make business deals locally or globally by operating with their services in other countries. According to ADR<sup>12</sup>, the entrance of the dangerous goods in other territories may be the subject of imposing a specific legal regulation and prohibition for the reason of safety during transportation [18]. Following this issue we face the situation to consider two different legal

<sup>8</sup> An example of organization who transport dangerous goods:

<https://www.streck-transport.com/en/about-us/mission-statement/>

<sup>9</sup> [https://ec.europa.eu/transport/road\\_safety/sites/roadsafety/files/pdf/dangerous\\_goods/industry\\_security\\_guidelines.pdf](https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/dangerous_goods/industry_security_guidelines.pdf)

<sup>10</sup> The Directive 2008/68/EC, available on link: <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32008L0068>

<sup>11</sup> ADR is available on link: [https://www.unece.org/fileadmin/DAM/trans/danger/publi/adr/adr2017/ADR2017e\\_web.pdf](https://www.unece.org/fileadmin/DAM/trans/danger/publi/adr/adr2017/ADR2017e_web.pdf)

<sup>12</sup> See Chapter 1.9, section “Transport Restrictions by the Competent Authorities”

bases, which are applicable in different countries, *e.g. Switzerland and Italy*. The third component is gathering and separation of legal sources for neighbor countries for the case of TDG. We proceed to this step by making several sub-sets of the legal source in order to manage correctly the specificity of each legal source and continuously show an interoperable process in this step. The fourth component is the classification of legal sources based on the classification of dangerous goods. According to [18], we have several classes<sup>13</sup> of dangerous goods, *e.g. explosive, chemical material, toxic substances, gasses, etc.* In this step, we proceed further to the analysis of this classification, association and clarify the relevant legal sources, which govern the process of transportation for any of these classes of dangerous goods. Further, we have the situation where security measurements are required as presented in “Security Measurements” as a fifth component, and this presents and requires several administrative requests to fulfill. The process of TDG produced an extensive amount of data, which should be exchanged between Stakeholders involved in this process. These data mostly are considered confidential and the access and processing of these data should be done in compliance with laws for data protection which operate in each host country of stakeholders. The sixths components for the composition of the legal framework for the TDG are presented in the Fig. 3.

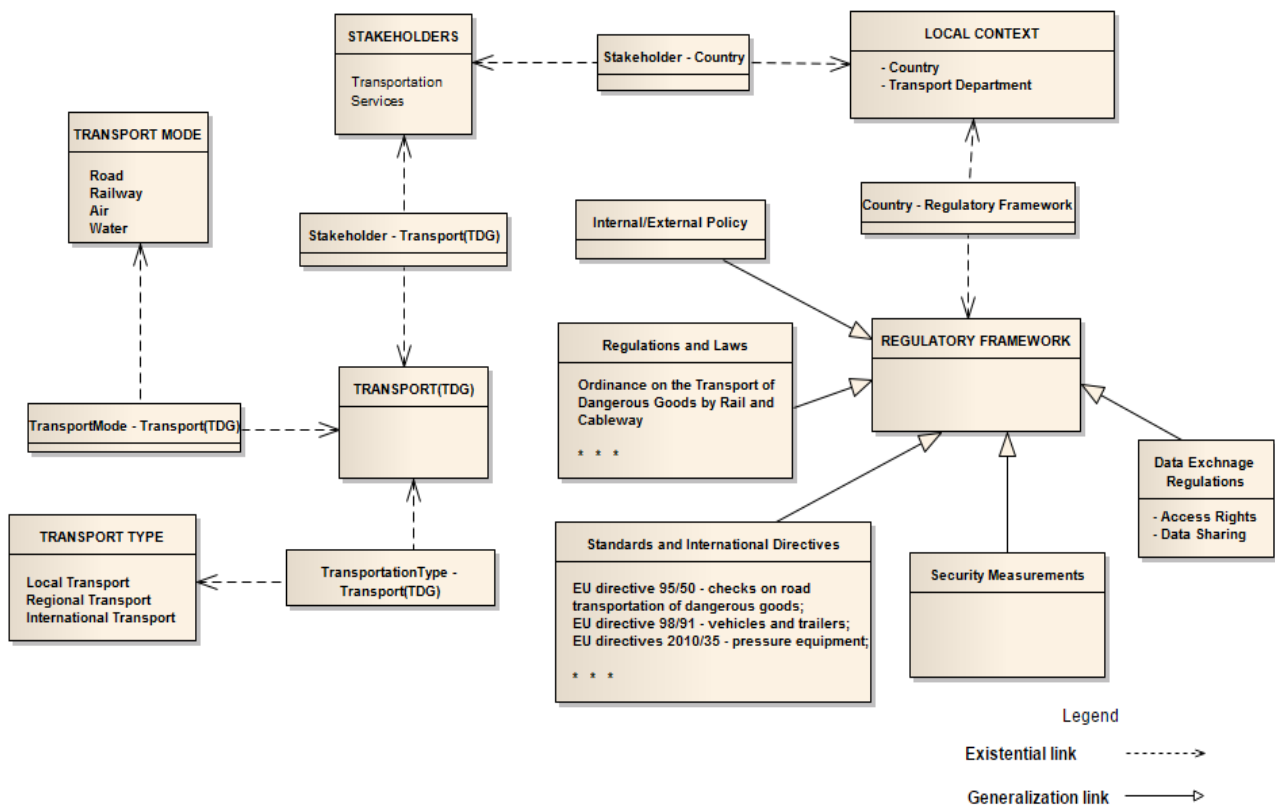


Fig. 2. The meta-model to support the first level of the proposed methodology [13].

For the purpose of the organization of a sustainable solution for the process of TDG we tend to keep the mentioned components for the composition of the regulation framework as standard ones. Initially, this process is done manually then we develop mechanisms to maintain those components for the purpose of automation of the process of compliance of service of TDG with legal issues. This mechanism will update

<sup>13</sup> See Chapter 2.1, on link: [https://www.unece.org/fileadmin/DAM/trans/danger/publi/adr/adr2017/ADR2017e\\_web.pdf](https://www.unece.org/fileadmin/DAM/trans/danger/publi/adr/adr2017/ADR2017e_web.pdf)



automatically the each set of legal documents by crawling data from official legal sources<sup>14</sup>. This mechanism and the other ones related to automation of the compliance with legal issues for the process of TDG will be presented it on our next research.

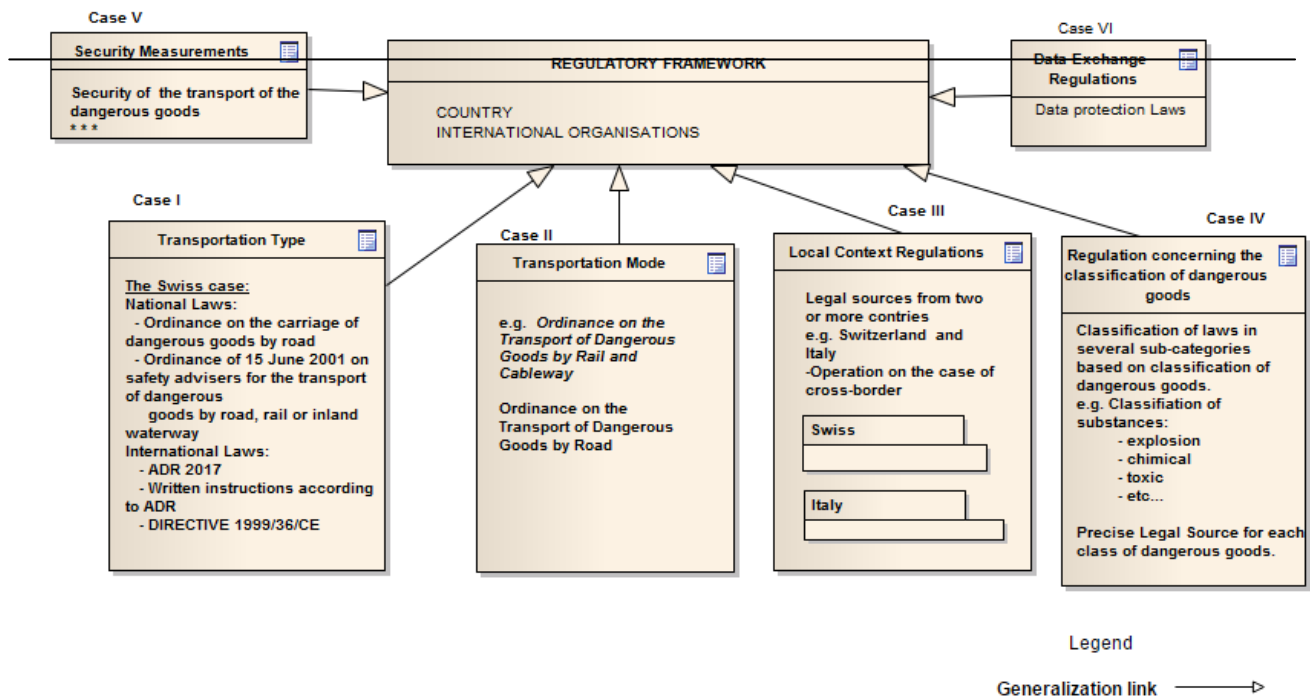


Fig. 3. The composition of regulatory framework for TDG.

#### 4.2. Semantic Analysis and Legal Rules Specification for the Process of Transportation of Dangerous Goods

We perform semantic analysis over legal documents in order to extract the legal rules, which will govern the process of transportation of dangerous goods. As an initial step, we select a specific document based on the categorization made on the first level of our methodology. The semantic analysis allows performing ontological analysis over legal documents and this process produces for us the extraction of ontological concepts such as: "Concepts", "Role", "Business Rules/ Legal Rules", "Business Activity", "General Legal Rule" [15]. For the modeling of these concepts we extend the meta-model from the previous level. This model is presented in Fig. 4.

In the table below we present the description of each concept presented in Fig. 4, also we give some examples for each of the concepts to have an idea about the semantic of them in this process.

Table 2. Semantic Elements Used for Determining the Legal Rules for the Process of TDG

Ontological concept	Description	Presentation by examples
Concept	"Is a general and abstract representation of an object or a set of objects" [15].	"Person","Goods", etc.
Hyperconcept	A Hyperconcept is composition of set of concepts which address precise semantic unit [15].	"Authorization Process for TDG"

<sup>14</sup> The official legal sources are considered the websites of the countries, e.g. <https://www.admin.ch>

Business Activity	"Is defined as a unit of work that produces, transforms and consumes information" [16].	"the process of transportation of dangerous goods"
Role	"Represents a set of necessary responsibilities, expressed organizational contexts, to perform the execution of the activities of the development process or to watch the execution of the activities performed by the other roles" [16].	"Stakeholder", "Examiner"
Business Rules/ Legal Rules	"Are used to help the organization to better achieve the goals, communicate between principals and agents, between the organization and interested third parties, demonstrate fulfillment of legal obligations, operate more efficiently, perform analysis on current practices. Business rules are constraints on the business activities. One business rule can be associated to one or more business activities, and, inversely, one business activity may be associated to one or more business rules" [16].	"transportation of dangerous goods can be transported only during specific day"
General Legal Rules	"Is set of rules which stem from policy documents, ethical issues documents and standard and international norms"[16]	"it is not allowed to transport dangerous goods before comply with regulatory framework"

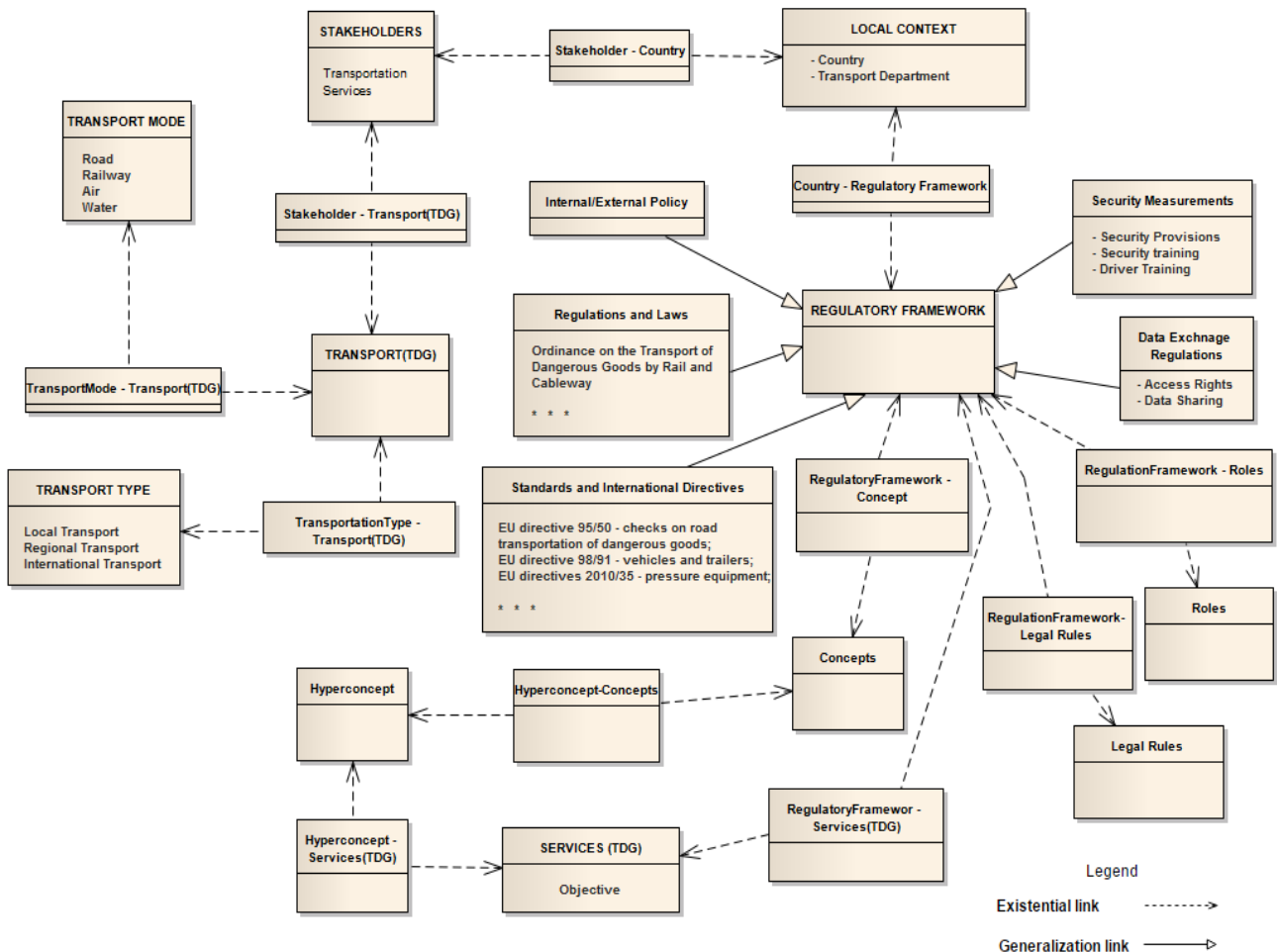


Fig. 4. The meta-model to support the second and the third level of the proposed methodology. Inspired from [16].

The semantic analysis over the legal document is that it allows us to determine the legal rules which



govern the process of TDG. The process of composing those rules besides service engineers it engages also the legal officers, which proof that these rules are correctly mapped.

Fig. 5, present the process model for composing these rules, which determine the process of TDG. From the Fig. 5 we see that we have the set of legal documents, which is defined, in the previous level of the methodology. Then as a service engineer, we perform the semantic analysis, which allows us to extract and formulate the sets of the semantic concepts. The definition of all semantic concepts allows us to compose the legal rules in a way to be suited for mapping<sup>15</sup> into programming language<sup>16</sup>.

In order to clarify this process, we present a concert example. From the documented in [18], which contains the main legal information for TDG by road as transportation mode, the Article 2 defines the authorization for TDG. Following the conceptual schema presented in Fig. 4, now we extract and define the “Semantic concepts” as below:

**Concepts:** International (or Local); Dangerous; Use of packing (UseOfPacking); Use of procedures (UseOfProcedures); Testing; Approval of use Packing and Tanks (Approval); Mean of Transport.

**Roles:** N/A.

**Business Activity:** Authorization for transportation of dangerous goods.

**Business Rules/Legal Rules:** In order to get the authorization for TDG in international level, there are several conditions to be fulfilled. These condition are as follows: a classification of dangerous goods; the packaging should fulfill the required standards; for specific liquids, there should use the tanks for transportation; providing the information and specific documentation of the material; the testing and approval of packaging should make and the specific means of transport should be used [18].

**General Legal Rules:** N/A.

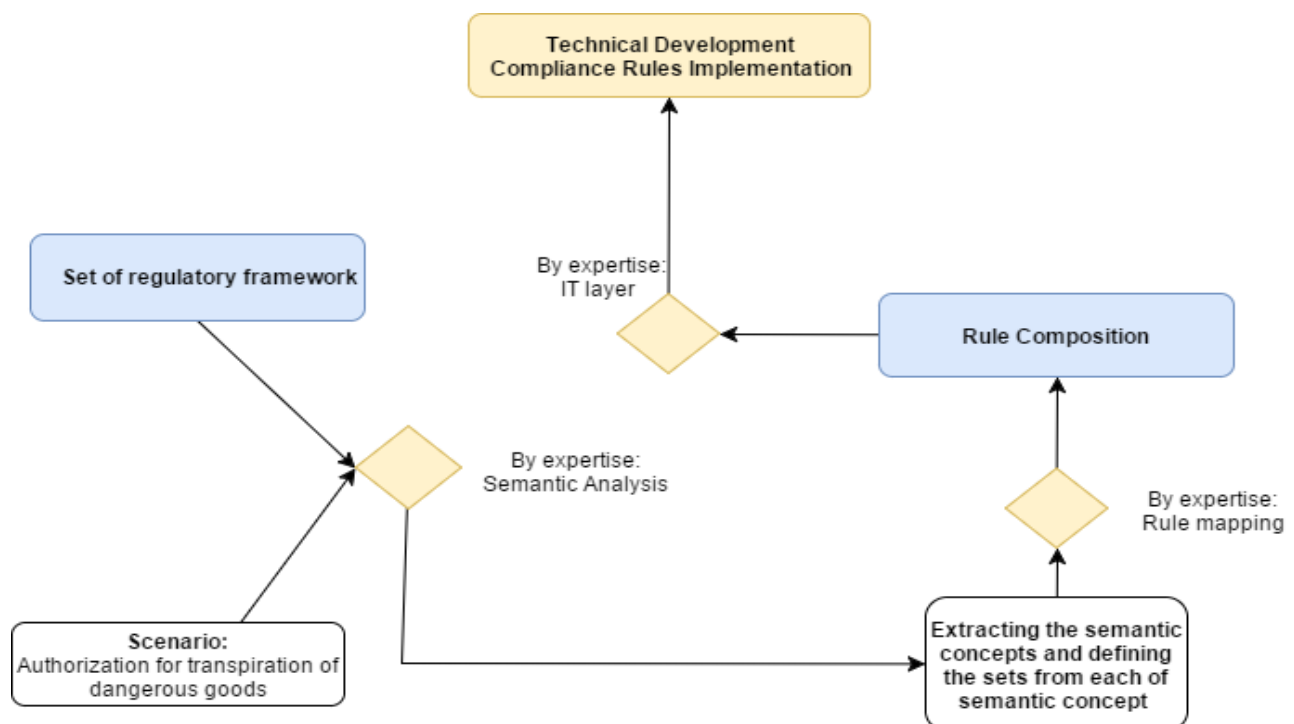


Fig. 5. The process of rules extraction and composition [13].

After having all these information we proceed with rules specification and finally, this process produces

<sup>15</sup> With rule mapping, we refer the process of developing technical needs for making these rules implementable

<sup>16</sup> We use any programming language which has all possible features to achieve our goals in this process, e.g. Java.

rules which govern the authorization of transporting dangerous goods as presented in Article 2, from [18], [12]:

**International** Transportation\_of\_Dangerous\_Goods is **Authorized** **if** ( UseOfPacking and UseOfTanks and UseOfProcedures and TestingApproval and MeansOfTransport)

This way of expression of the legal rules facilitates the process of rules mapping into the technical level. The monitoring of compliance with the transportation process of dangerous goods from the service providers (Stakeholders) is easier while the main legal rules are integrated and the interconnection between them from any country is already defined. This interconnection is supported by these services, which have all the necessary information to comply with the regulatory framework for the process of TDG at the international level. The set of services that deal with compliance issues for the process of TDG are presented in the following section.

#### 4.3. Specification of Services Related to Transportation of Dangers Goods and the Compliance Analysis in Overall ICT Platform

In this section we precise the characteristics of our services, which will be part of the development of the ICT platform, which are explained more in details in Section 5. The service which we provide here manages the issues of compliance with “Regulatory Framework”, as it is linked with entity “SERVICES (TDG)”, see Fig. 4. This relation assures that any activity over ICT platform should respects the rules and regulation which comes from “Regulatory Framework”.

Among several other services, which allow the end-user to operate with ICT platform, we express the services which will be integrated into the ICT platform and they are designated to validate several tasks related to the governance of the process of TDG. The methodology’s step presented above allows us to specify these services, their characteristics and the two previous levels serves as base to compose this level. The services and their characteristics are presented in Table 3.

Table 3. Specification of the Services for Compliance Management in Transportation of Dangerous Goods

Service name	Characteristics	regulation framework and composition
Management of the access rights	Manages the access rights over specific information for dangerous goods.	it follows the same procedure of composition as presented in section 4.1 and 4.1, but with other legal sources.
Regulatory Framework: Laws and Regulations	Validate the compliance issues in real time for the process of transportation of dangerous goods.	follows the sections 4.1 and 4.2 respectively.
Traceability	Allows tracing the transportation process from the begging of the action until the end. This process flows specific legal rules when the region or county (see section 3, for the problem definition) is changes by applying different legal rules.	follows the sections 4.1 and 4.2 respectively with additional technical components.
Auditability	Follows and stores all the elements in the process of transportation of dangerous goods in accordance with legal framework	follows the sections 4.1 and 4.2, with additional processes for auditing.

These services are engineered by technical development part and their functionality will have preventive focus in several situations. This means that in case there is any tendency to violate the legal rules the service will prevent this by denying the further processing of tasks, *e.g. deny the authorization certificate for international TDG*.

## 5. Technical Approach

In this section we will explain the main characteristics of the ICT platform, its usability and the architecture of service for TDG.

### 5.1. Target Functionalities of the ICT Platform

We propose a general ICT platform solution, which could be adapted and customized from any “Stakeholder” who carries the services of TDG and for them who requires such a services. This service will help them to work efficiently by assuring them that the regulatory framework is considered and all the processes are in compliance with the regulatory framework in real time. Beside this, this service will help Stakeholders to trace the movement of the dangerous “goods” on their way to destination. A considering added value here is the contextual change of the region where different legal rules will be applied for transport of the dangerous goods, and the service will detect this automatically and notify the Stakeholder on real time. This will allow an adaptation of the conditions for TDG.

The context of sharing of information between “Stakeholders” and the “Competent authorities”, is showed in Fig. 6., is fixed in a way that only the specific information can be showed, as supported by laws *e.g.* “data protection law”, international norms, *e.g.* “ISO ISO/IEC 27002”, or by any internal policy between pairs in communication.

The architecture of the service (ICT platform) is organized in a classic approach by following three different levels [19], [20]:

- **User Interface Layer**, which allows the users to interact with ICT platform, by making possible inserting of information, reading information and reacting related to needs for the required by a specific tasks.
- **Data Access Layer**, stands as a middle layer in the architecture, which makes processing of the information (requests) in terms of parameter from user interface layer, transfers these request into database layer then it returns the results according the requests made by end user. Several algorithms for processing of analytics, processing of information and policy control are implemented in this level.
- **Databases Layer**, which allows inserting, storing and operation over data needed by the services of the ICT platform. It enables also the implementation of several algorithms for data integrity, security and validation.

### 5.2. The Usability of the ICT Platform

For the usability of the ICT platform which carries the service for transportation of dangerous goods, and the compliance verification for this process with the regulatory framework we have identified several “Stakeholders” which are interested in using such ICT platform. As a “Stakeholders” we have the set of “Service Providers”, which provide service for TDG, the set of “Service Consumers” which needs services for TDG, and the “Competent authorities” which are official departments which govern and control the process of TDG. So, our solution with this ICT platform brings together in a common place the competence-offering and competence-demanding in the context of TDG, and facilities the process of interaction between them and assure them that the compliance with the regulatory framework is achieved in the overall process of TDG.

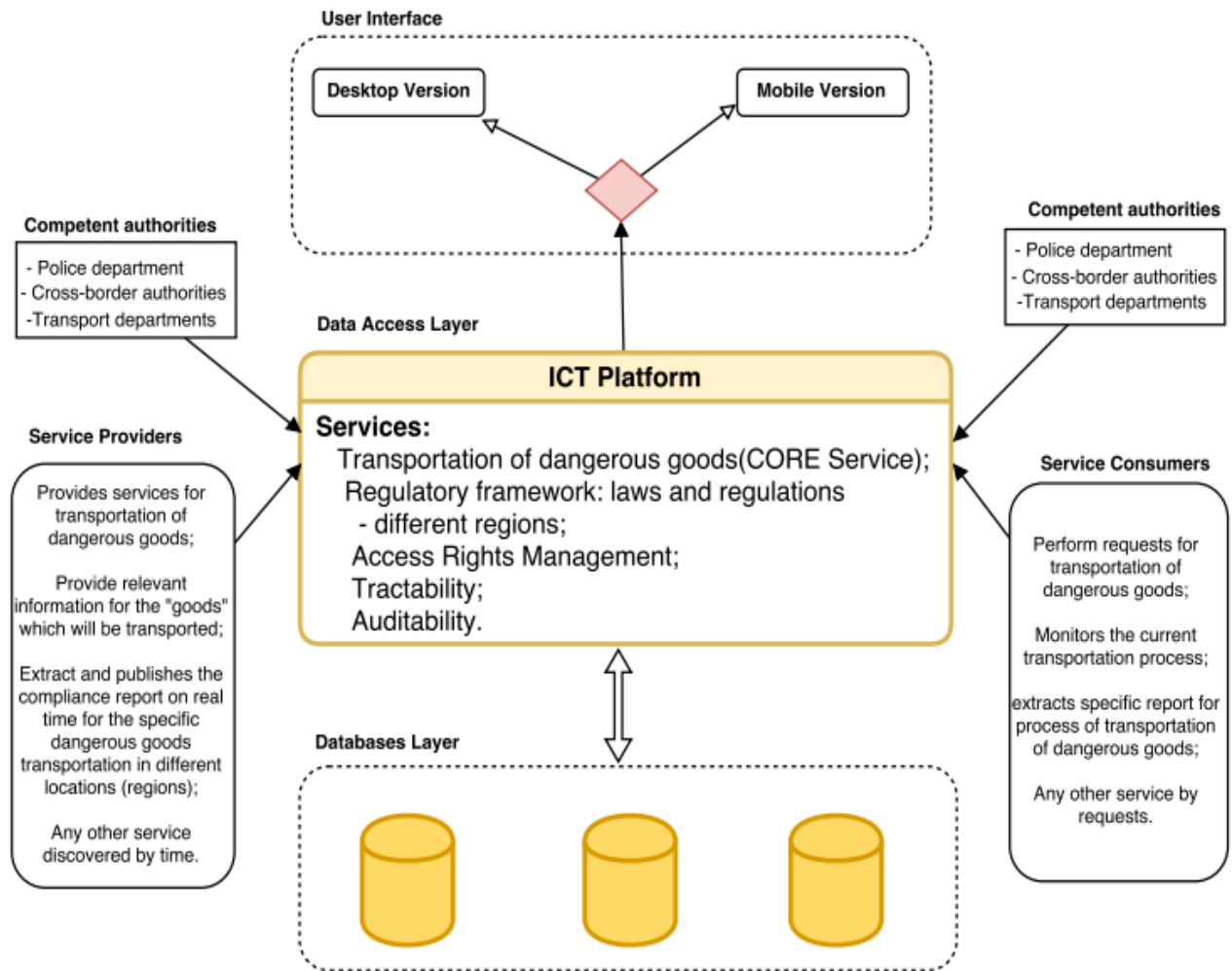


Fig. 6. The architecture of services for TDG [19].

## 6. Conclusion and Future Work

The challenge for managing the regulatory framework for the process of TDG is considered as a very complex task. This complexity is highlighted due to the fact that there is a large set of regulation, which should be considered while carrying out services for TDG. Furthermore, there is a high probability that these regulations evolve by time, which makes even more complex the process of compliance with the regulation framework. In this paper, we presented an initial idea for managing the compliance issues for TDG in an automatic way. The purpose of automation of compliance in TDG shows an added value in terms of the efficiency of this process, avoids the risk of acting non-compliance; provide necessary information for restrictions, precaution and specific condition for other regions where the process of TDG will be executed.

For the level of automation of compliance for the process of TDG, we will continuously extend this research by giving more conceptual and technical details in our further research. We will involve the Machine Learning (ML), smart algorithm for adaptation and validation of information, distributed technology databases, which will enable the sharing of information with authorized parties on this process.

## References

- [1] EU transport policy - European Union website, the official EU website - European Commission. (2017). *European Union website, the official EU website - European Commission*. Retrieved 29 March 2017, from [https://europa.eu/european-union/topics/transport\\_en](https://europa.eu/european-union/topics/transport_en)

- [2] Contribution of transport to economic development. (2017). Retrieved 29 March 2017, from <http://www.transport.govt.nz/assets/Uploads/Our-Work/Documents/edt-contribution-of-transport-lit-review.pdf>
- Transport sector economic analysis - EU Science Hub - European Commission. (2017). EU Science Hub. Retrieved 29 March 2017, from <https://ec.europa.eu/jrc/en/research-topic/transport-sector-economic-analysis>
- [3] "Dangerous goods," in United Nations Economic Commission for Europe (UNECE), Retrieved 27 March 2017, from <http://www.unece.org/trans/danger/danger.html>
- [4] Ding, L. H., Chen, Y. F., & Li, J. T. (2016). Monitoring dangerous goods in container yard using the internet of things. *Scientific Programming*.
- [5] Conca, A., Chiara, R., & Enrico, S. (2016). A risk assessment for road transportation of dangerous goods: a routing solution. *Transportation Research Procedia*.
- [6] Molero, G. D., Francisco, E. S., Pablo, A. B., & Juan-Pascual, P. F. (2016). Total safety by design: Increased safety and operability of supply chain of inland terminals for containers with dangerous goods. *Safety Science*.
- [7] Wang, N. K., Huang, X. Z., & Wei, D. J. (2016). Route selection for dangerous goods based on D numbers. *Proceedings of the Control and Decision Conference (CCDC)*.
- [8] Torretta, V., Elena, C. R., Marco, S., & Paolo, V. (2017). Decision support systems for assessing risks involved in transporting hazardous materials: a review. *Safety Science*.
- [9] Transport — UNECE [Internet]. Retrieved 18 March 2017, from [http://www.unece.org/trans/main/danger/competent\\_authorities.html](http://www.unece.org/trans/main/danger/competent_authorities.html)
- [10] EUR-Lex - 32008L0068 - EN - EUR-Lex. (2017). *Eur-lex.europa.eu*. Retrieved 18 March 2017, from <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32008L0068>
- [11] Imeri, A., & Khadraoui, A. (2015). The implementation of compliance: Legal and ethical aspects into ICT platforms. *International Conference (IACETI)*.
- [12] Imeri, A., Khadraoui, A., Rifaut, A., & Nicolas, D. (2016). The new strategy to develop scenarios in compliance with legal and ethical issues. *Advances in Computer Science: an International Journal*, 5(2), 73-82.
- [13] Imeri, A., Khadraoui, A., Le, Dinh, T., & Khadraoui, D. (2017). Personalization of legal and ethical information in ICT platforms: The approach of legal decision tree. *Computer and Information Science*, 10(1), 77.
- [14] Khadraoui, A., Arni-Bloch, N., Léonard, M., & Ralyté, J. (2005, September). Laws-based ontology for e-Government information systems. *Proceedings of the 2nd International Conference on Innovations in Information Technology (IIT'05)*.
- [15] Khadraoui, A., & Feltus, C. (2012). Service specification and service compliance: How to consider the responsibility dimension?. *Journal of Service Science Research*, 4(1), 123-142.
- [16] Khadraoui, A., Opprecht, W., Léonard, M., & Aidonidis, C. (2011, May). Service specification upon multiple existing information systems. *Proceedings of the 2011 Fifth International Conference on Research Challenges in Information Science*.
- [17] European Agreement concerning the International Carriage of Dangerous Goods by Road. (2017). *unece.org*. Retrieved 21 March 2017, from [https://www.unece.org/fileadmin/DAM/trans/danger/publi/adr/adr2017/ADR2017e\\_web.pdf](https://www.unece.org/fileadmin/DAM/trans/danger/publi/adr/adr2017/ADR2017e_web.pdf)
- [18] Data Layer Guidelines. (2017). *Msdn.microsoft.com*. Retrieved 22 March 2017, from <https://msdn.microsoft.com/en-us/library/ee658127.aspx>
- [19] Buecker, A., Ashley, P., Borrett, M., Lu, M., Muppidi, S., & Readshaw, N. (2008). *Understanding SOA*

*Security Design and Implementation.*

- [20] Molero, G. D., Francisco, E. S., Pablo, A. B., & Juan-Pascual, P. F. (2016). Total safety by design: Increased safety and operability of supply chain of inland terminals for containers with dangerous goods. *Safety Science*.



**Adnan Imeri** is a graduate student from the Faculty of Science, directorship of Computer Sciences at the University of Geneva. His research interest is in the field of software engineering, information science, artificial intelligence and data analytic. As employed in Institute of Service Sciences at the University of Geneva, his current research work is characterized on Compliance of Services with legal and ethical issues in design layer and in the implementation layer.



**Abdelaziz Khadraoui** is a senior researcher at the University of Geneva. He is undertaking teaching and research activities since 2003, at the Institute of Services Science. Dr Khadraoui's research relates to the engineering of IT-based services with a specific focus on the engineering of e-government services and information systems. He frequently collaborates on IT projects with the Geneva administration. He is member of several international conference committees. He is author or co-author of several contributions and publications in the field of e-government services and institutional information systems

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**Djamel Khadraoui** received his PhD in vision for robotics (1996) from University Blaise Pascal (France). He is currently the head of unit - Trusted Service Systems at LIST (Luxembourg Institute of Science and Technology). He was at CRP Henri Tudor since 2002 as a program manager of Mobility activities. He is lead R&D manager and active in the areas of eMobility and Critical Infrastructures Protection. His main scientific interests are intelligent and adaptive systems, distributed systems (multi-agents systems), software engineering, trust and security in IT Infrastructures. He is EU expert and DC COST member in the domain of ICT. He was a general chairman of AISTA'04

(IEEE International Conference in Advances on Intelligent Systems) and UBIROADS'09. He is also involved in many conferences and workshops as a member of technical committee. He coordinated the publishing of a book entitled: Advances in Enterprise IT Security in coordination with IDEA Group Publishing. He has a strong experience in industrial R&D. He mainly participated and coordinated several national and EU projects: STIMULATE (AAL), MEDIATE (AAL), SPONSOR (AAL), MICIE (FP7), COCKPIT-CI (FP7), LINKALL (FP6), Jules Vernes (EUREKA), BUGYO (EUREKA), CARLINK (EUREKA), RED (EUREKA).