Improved Selection Support of Transport Services in Intermodal Transportation

Computer Science: Master Thesis Final report

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Spring semester 2011
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Abstract

In intermodal freight transport context, the selection process of appropriated transport services that fit with user requirements is a big challenge, this master thesis project analyze different alternatives to improve that process based on reputation information of transport providers. Reputation is a social abstract concept which is analyzed in this research establishing a categorization of reputation parameters in the freight transportation context. Using this categorization is proposed two different architectures of reputation systems to manage the sources and processing of this kind of data. This project is based on a framework to develop generic system architecture for intermodal transport management based on previous European efforts.

Keywords: freight, transportation, reputation, architecture, service selection.
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List of Acronyms

FWF: Freightwise Framework
EU: European Union
QoS: Quality of Service
QoE: Quality of Experience
TSD: Transport Service Description
ATSD: Abstract Transport Service Description
PnP: Plug and Play
TCM: Transport Chain Management
MAS: Multi Agent System
P2P: Peer to Peer
Chapter 1

Introduction/background

This master thesis project is framed in the intermodal freight transport subject, this term is used to describe the movement of goods in one and the same loading unit or vehicle which uses successive, various modes of transport (road, rail, water) without any handling of the goods themselves during transfers between modes (Macharis & Bontekoning, 2004). This topic has been for a long time investigated by different institutions and governments (Ferreira & Sigut, 1995)(Tapiador, 2010) and their contributions have improved not only the development of freight transport but also the interurban passenger transport systems.

The FREIGHTWISE project is an integrated project within the EU’s 6th Framework Programme that aims at bringing together three different sectors, Transport Management, Traffic and Infrastructure Management and Administration. FREIGHTWISE specifically aims at supporting intermodal transport by advanced management tools and an open IT architecture (Källström, Gustafsson, Poersch, & Fischer, 2006).

The target of this project is to improve the suggestion process in the transport services selection within the framework of intermodal freight services, using reputation systems. In freight transportation the transportation is performed using the concept of “chains” in intermodal transportation, these chains are provided by different transport providers. The identification of the best transportation chain is a problem that has been studied for many years in different frameworks and academic works. This selection process is the central problem in this work, trying to provide to a transport user a different perspective to perform the choice using parameters like the experience of a transport provider, the reliability in the delivery process, etc. Different researches had developed techniques to improve the selection of services, using mathematical approaches to select the best timing chains, or using the price like parameter of selection. In this master thesis is analyzed a different alternative to perform this selection process, using reputation information which is close related with the quality of the service information.

First is analyzed all the parameters that can be used in the improvement of the selection process, then is analyzed the management of this parameters in different architectures of information and is presented alternatives of improving of the transportation chains.
Research questions
Based on the state of art, it is identified the following research main question and four sub-questions are generated:

- How to improve the suggestion process in the transport services selection within the framework of intermodal freight services, using recommendation systems?
  
  o How to use reputation information to suggest Transportation Services based on Social Networks architectures, based on the FREIGHTWISE framework in order to select trusted socially transport services?
  
  o How to model an architecture to share information of reputation of Transport Providers using models of Social Networks?
  
  o How to define methods to obtain subjective and objective reputation in the framework of freight transportation?
  
  o What techniques or logical tools are needed for to use the methods to obtain subjective and objective reputation using as foundation the FREIGHTWISE framework?

Goals

- To create a reputation system model to suggest Transportation Services to a Transport Users based on Social Networks architectures, using as foundation the FREIGHTWISE framework.
  
  o To model an architecture to share information of reputation and subjective and objective concepts about the transport services using models of Social Networks.
  
  o To define methods to obtain subjective and objective reputation in the framework of freight transportation.
  
  o To adapt techniques or logical tools to use the methods to obtain subjective and objective reputation using as foundation the FREIGHTWISE framework.

Expected Results

- A reputation system model to suggest Transportation Services to a Transport Users using information of reputation based on Social Networks architectures.
  
- A model of an architecture to share information of reputation and subjective and objective concepts about the transport services using models of Social Networks.
- Theoretical methods to obtain subjective and objective reputation in the framework of freight transportation.
Chapter 2

Related Work
Two main subject areas are related in this thesis project, the first one is the freight transportation topic and the second one is reputation taking into account the context of this research. The following is the state of art for each of these topics.

Freight transportation
This master thesis project uses as foundation the Freightwise framework (FWF). The main purpose of the FWF is to simplify the phases of planning, executing and following up a Transport Execution Plan between a Transport User and a Transport Service Provider. Therefore, aim of Freightwise is to identify Information Packages and also validate the processes between the roles in the planning, execution and completion of freight transport (FREIGHTWISE, 2006).

FWF describes the overall processes that are taking place during the three main phases in Freightwise: Planning, Execution and Completion, these business processes are:

- **Transport planning**: the selection of a transport chain between an origin and a destination.
- **Transport execution**: the physical movement of the freight between an origin and a destination.
- **Transport completion**: confirmation of receipt of goods in good order and invoicing for the transport service provided.

FWF also defines a set of actors (roles) that create and modify different data set at some point in the entire freight transportation process, these roles are:

- **Transport Users**, by providing similar interfaces to all transport modes for efficient transport planning.
- **Transport Service Providers**, to reduce costs and increase efficiency through systems integration, optimization and re-use of information. The FWF will also provide a common way of publishing information about a service, independent of transport mode or service category.
- **Traffic Network Managers**, to publish information about infrastructure and traffic condition in a common way.
- **Transport Regulators** (at both a national and international level) by providing basic guidelines and standards for Information Packages that support the planning, execution and completion of transport.
- **Software developers**, to specify business models and solutions for transport related tasks by any mode of transport.
- Policy-makers to implement environmental policies by encouraging alternative transport options to all-road transport and cost savings for the EU economy through more efficient transport planning and transport execution. The FWF will also facilitate the collection of statistical data on intermodal transport movements, which can be used by policy-makers for improved policy-making.

The first four roles are involved directly in the business phases and they have to exchange transport related information between them in some defined processes as is presented in the FWF process diagram in the figure 1:

![Figure 1. FWF Process Diagram](image)

In figure 1, there are represented all the interactions between the participant actors in each phase of transportation process. The packages that are exchanged between processes are also defined and provide a common format to interact between processes and actors. The packages involved in the planning phase are TSD and TEP which are described below:

**TSD: Transport Service Description**
This package defines all the information required to publish information about a transport service. TSD contains information about the service provider, and detailed information about the service: service area, service points, charge for the service, etc. as is depicted in figure 2.

**Figure 2. Transport Service Description**

**TEP: Transport Execution Plan**

This package contains a plan established between a Transport User and a Transport Service Provider. There will be one TEP for each Transport Service. In other words this is a contract between the Transport User and the Transport Provider that that establish information of the terms of the service, the service timing, service location, etc. as is depicted in the figure 3.

Summarizing, TSD allows to Transport Service Providers to advertise their services to Transport Users in a common format, in terms of a schedule and a freight rate published in a standard format, and TEP provides is the contract plan to establish the guide of the transportation service.
In (Davidsson, Holmgren, Persson, & Pedersen, 2010) is described a **Plug and Play Transport Chain Management** (PnP TCM), this focuses on collaboration for developing transport solutions, for activity coordination, and for administrative information transactions, improving some phases of FWF and defining an architecture based on agents to exchange transportation information between the actors. The aims of PnP TCM are:

- Making information about the available transport services easily accessible
- Providing support for finding the “best” set of transport services for a particular transport, including a match-making functionality that makes it easier for potential transport chain actors to find each other and negotiate with potential collaborators
- Supporting the negotiation and collaboration between the actors in a transport chain
- Lower the entry barriers for small-sized companies to participate in highly integrated transport chains by providing low cost and easy-to-use software tools.

The approach described in (Davidsson, Holmgren, Persson, & Pedersen, 2010) use different software clients on Transport Users and Transport Providers, each one of these software clients
have different tasks to develop and are made using an M.A.S\(^1\) approach. In figure 4 is presented these software clients. The circles represent different tasks that a Transport User or Transport Provider or other actor have to perform.

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Figure 4. PnP TCM software clients of the Transport User

Figure 5. PnP TCM software clients of the Transport Service Provider

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\(^1\) M.A.S Multi-Agent System
In the software client of the Transport Users (figure 4) there is a task (a MAS) called Optimizer that filters out a set of relevant TSDs from a possible huge amount of available TSDs, and uses the selected TSDs to create a number of candidate end-to-end paths based on approximated average characteristics of TSDs. This part of the client software is most interesting to the development of this master thesis project, because the Optimizer searches and selects a set of transport services (TSDs) that fit with the information defined by a Transport User in the TEP. The Optimizer performs these tasks in three main steps:

Step 1.1: is an initial filtering process, disregarding all TSDs that are incompatible with the specified type of goods or have irrelevant timing.

Step 1.2: in this step the authors filters the TSDs using geographical information, this step is made using an ellipse that contains both the origin and destination of the TEP to disregard those transport services that do not support any service in the elliptic area.

Step 1.3: this step creates a network of scheduled transport services represented as abstract TSDs (ATSDs) defining terminals inside of the geographical eclipse.

Step 1.4: this step is optional in (Davidsson, Holmgren, Persson, & Pedersen, 2010) and analyze the paths outside of the geographic area and try to find different terminals and determine if are suitable to include those paths in the “solution plan”.

Step 1.5: the connection between origin and destination is performed in this step, and have two sub steps: first, generate ATSDs that represent non-scheduled (typically road) transports directly from the origin to the destination of the TEP. These transports somehow represent backup solutions that can be used in case no other, probably cheaper, solution can be found. And the next sub-step: generate ATSDs, corresponding to non-scheduled TSDs that connect the origin and destination, respectively, with n closest terminals.

Step 1.6: in the end of the step 1, the transportation networks are connected with the scheduled information of paths and terminals.

Step 2: includes the computation of approximated costs and traveling times of the scheduled ATSDs to select the most suitable path, and have different alternatives to consider depending of the priority of some parameters, like price, time, etc.

Step 3: is a selection optimization step of ATSDs, in this process is used an optimization algorithm considering some actions:

- Pickup and delivery outside the specified time windows should not be allowed. Instead, infeasibility that is caused by a too restrictive TEP should be handled outside the Optimizer (i.e. in a loop where the TEP manager decides what should be done).
- Time based transportation costs and capital costs should not be considered.
- Add the possibility set a maximum time for transport (i.e., from pickup at the origin to delivery at the destination).
In (Davidsson, Holmgren, Persson, & Pedersen, 2010) the Optimizer creates a number of candidate end-to-end paths based on approximated average characteristics of TSDs and this selection process is made using parameters already defined in the TSDs and TEPS, like prices and times, but there exist other important information that is not analyzed in the selection process of (Davidsson, Holmgren, Persson, & Pedersen, 2010) not even in (FREIGHTWISE, 2006), this information is related with the trust and reputation of the Transport Providers. This is new perspective to help the Transport Users in the selection process of Transport Services.

**Reputation**

Reputation and trust are terms with different meanings depending of the application area, in this document the term reputation follow the very general definition of (Randall Farmer & Glass, 2010): *reputation is information used to make a value judgment about an object or a person; reputation is context dependent and is necessary establish boundaries to apply this concept in the process of service transport selection.*

Reputation and trust are linked in this master thesis project to the evaluation post-facto of a Transport User of a service from a Transport Service Provider. The term, post-facto means that in this case is not important the evaluation (subjective or objective) that a Transport User has of a Transport Service Provider before to use a service.

Reputation and trust are close related to the interaction between two persons or more in general between peers. Reputation is associated with *Social network* analysis, and used in different reputation researches using agents (informatics agents) for instance in marketplaces (Sabater & Sierra, 2002), *Small-world Networks* with agents (Venkatraman, Yu, & Singh, 2000a), and reputation management in *electronic communities* (Yu & Singh, 2000), *Internet communities* (Davidsson, Holmgren, Persson, & Pedersen, 2010), etc. In all of these works the mechanism of calculation, use, and exchange of reputation is definitely context-aware.

It is necessary in this point to create a boundary between trust and reputation in order to define what of these terms to use. There is a general consensus between some authors like: (Audun Jøsang, Ismail, & Boyd, 2007), (Yao Wang & Vassileva, 2007), (Malik & Bouguettaya, 2009a), (Sherchan, Loke, & Krishnaswamy, 2006b) (Sherchan, Loke, & Krishnaswamy, 2006a)(Sherchan, Loke, & Krishnaswamy, 2006a)that exist two categories of value judgment about an entity (entity could be a person, an agent, etc.). The first one is a *subjective* perception and is related with a personal concept and reflect the individual opinion about an object or person and is close to the definition of *trust*; on another hand, if exist a collective and general opinion of an entity this is related with the term *reputation*. *Trust* is created by the previous direct experiences with an entity, but *reputation* is an *objective* point of view of an entity and is created by many interactions with a determinate entity.

Using the approach of (Davidsson, Holmgren, Persson, & Pedersen, 2010), (Sabater & Sierra, 2002), (Venkatraman, Yu, & Singh, 2000a) and (Yu & Singh, 2000), working with network of agents, in this master thesis is defined a network of Transport Providers, Transport Users and
other actors that participate in all the transportation process depicted in figure 1 and using the packages defined in (FREIGHTWISE, 2006).

There are different models and methods to define and calculate reputation. In (Sabater & Sierra, 2002), the authors define three dimensions of reputation in an e-commerce environment:

- **Individual dimension**
- **Social dimension**
  - Witness reputation: based on the information about the target agent coming from other agents.
  - Neighborhood reputation: uses the social environment of the target agent, that is, the neighbors of the target agent and their relations with it.
  - System reputation: it is a default reputation value based on the role played by the target agent.
- **Ontological dimension**: is an integrated meaning of reputation.

In (Sabater & Sierra, 2002), authors use three different kinds of reputation, close related to elements in e-commerce: price, quality and delivery date.

An important point is the work of (Yu & Singh, 2000), where the authors analyze the reputation (trust) of an individual with regard to others (neighbors) and define four properties of trust: Symmetry, Transitivity, Self-reinforcement and Propagation. The point to highlight in this work is the definition and analysis of the “gossip” process between agents. This work is very similar to (Venkatraman, Yu, & Singh, 2000a) only difference is the definition of “pivots”, these are nodes of an agent network that have “weak ties” and analyze the reputation methods using clusters of these nodes.

There is a long list of reputation systems approaches to improve mechanisms of search/discovery of services using Web services and semantic Web and in general in different contexts. In (Z. Xu, Martin, Powley, & Zulkernine, 2007) reputation is aggregated of QoS information to improve the process Web service discovery. Similar works that did work with reputation to improve the discovery and composition of Web services are: (Bianculli, Binder, Drago, & Ghezzi, 2008) and (Yao Wang & Vassileva, 2007).

Another field that uses reputation systems is in reputation of members in experts networks, trying to analyze what person have a greater academic influence than others. In (Pujol, Sangüesa, & Delgado, 2002), the authors use the out-going edges and out-going academic profile network nodes to determine which person have more academic reputation.

Different mathematical treatment to calculate or measure the reputation are used, graph algorithms (Pujol et al., 2002), (Venkatraman, Yu, & Singh, 2000a), continuous multivariate probability distribution (Josang & Haller, 2007), fuzzy analysis (Sherchan, Loke, & Krishnaswamy, 2006b), matrices, etc. The main techniques to analyze is the mathematical graphs, this is
because the mathematical graphs represent the main characteristics of a network and consequently a social network tool (Villa, Dkaki, Gadat, & Truong, 2009) (Villa et al., 2009)

Given that the obtaining of user information, specifically reputation information about services is important to create mechanisms of "soft security" (social control mechanisms) (Josang & Haller, 2007), then it can be said that the architectures that make social networks are suitable for sharing reputation information between users of transport services.

Many factors influence the parameters for creating a "social network": structural issues, the exchange of information between peers / elements, security issues, etc.
Chapter 3

Research Methodology
This thesis project propose different alternatives to improve the selection of transport services in the freight context based on a reputation system, in this work is propose two architectures of reputation systems and an approach of reputation parameters conforming a categorization tree. All these alternatives are based on the FREIGHTWISE project which is a not completely tested framework that intends to develop generic system architecture for intermodal transport management based on previous European efforts; therefore the models and architectures proposed in this thesis are a pure theoretical development, establishing theoretical models without necessarily linking them to practice, based on a inductive reasoning (Dawson, 2005).

This theoretical analysis is developed using a state of art of different areas that involves alternative points of view and allows state theories without prove.

The time was a drawback in this project because was not possible to build a prototype to prove the theories and alternatives proposed, therefore the prototype step of this research is part of the future works. Prove all these theories is a complex challenge because the foundation of the project is a framework without a provided evidence and the transport actors network that is proposed here needs interaction and integration in different levels not only the technological also the business communication.

This thesis project is considered a first phase of an ambitious project to create a network of transport actors which is also the goal of (Davidsson, Holmgren, Persson, & Pedersen, 2010) and (FREIGHTWISE, 2006; 2008).
Chapter 4

Reputation Parameters Classification

Reputation is a dispersed phenomenon that is to be found in the beliefs and assertions of an extensive number of other individuals. Reputation is part of the social environment but uniquely referenced to a specific person (Craik, 2009a); in this chapter it is defined a general categorization of reputation parameters in the context of freight transportation.

First is described the relationships that exist between Quality of Service (QoS) and reputation parameters and the relation between QoS and Quality of Experience (QoE); then is presented the reputation parameters model proposed.

QoS and reputation

There exists a close relationship between the fulfillments of QoS parameters (Service Level Agreement - SLA) by a Transport Provider and the satisfaction of a Transport User implying a relationship with reputation, this approach is analyzed in (Sherchan, Loke, & Krishnaswamy, 2006b). The authors argue that the deviation from the SLA can be calculated and be used for detecting deception, validating ratings, detecting collusion, identifying user preferences and providing recommendations to users. In freight transportation using FWF the SLAs are defined using the TEP packages which define a contract between Transport Provider and Transport User and it is possible analyze the deviations such as is established in (Sherchan, Loke, & Krishnaswamy, 2006b), using information feedback in the end of the transportation process.

A similar approach, establishing a relationship between QoS and reputation in the context of Service Oriented Computing (SOC), analyzing the QoS of Web services and establishing a close relationship with the reputation of Web service provider. Some examples of this approach are (Crapanzano, Milazzo, Paola, Re, & Dipartimento, 2010), (Malik & Bouguettaya, 2009b) and (Z. Xu, Martin, Powley, & Zulkernine, 2007).

In the context of this master project, process like publishing, composition, defined interfaces are similar between transport services and Web services, there are of course a different point of view of the execution, but assuming a general view perspective is possible to use some considerations of QoS that are used in Web services and transportation services; keeping this principle in mind, in this master project is used the approach of (Malik & Bouguettaya, 2009b) that defines the quality of a service (QRef) as a mapping between a set of quality parameters and a set of values or ranges of values. Examples include a services’ response time, invocation fee, availability, accessibility, reliability, etc. In this work authors define three types of QRef: provider-promised QRef (QRef_p), consumer-expected QRef (QRef_r) and service-delivered QRef (QRef_d). QRef_p values are those that are advertised by the service provider, QRef_r represents the preference of the service consumer for each quality parameter and QRef_d represents the actual values that are mapped to the different quality parameters after the consumer interacts with the provider. In the context of this master project and specifically in an approach using FWF, QRef_p might represents some conditions of the freight transportation service publish using TSD.
packages, QRef, might represent the parameters that Transport User expects and is represented using the TEP package and QRef, might represent the feedback information in the end of the transport model. Using this approach between QoS of services and freight transportation parameters is established a classification of QoS-reputation parameters to represent all possible parameters that might define the reputation in freigh transportation context and therefore establish metrics of each parameter in order to measure (if is possible) the reputation of a Transport Provider. Based on this classification is possible build a reputation system in freight transportation context.

A similar analysis of QoS in the semantic Web services context is presented in (Tondello & Siqueira, 2008) differencing the same three kind of quality of services, as is shown in the figure 6.

Reputation and QOS parameters in freight transportation context

There is not a consensus about QoS parameters in freight transportation context, different authorities define some parameters but is not possible assume and categorize all of them. The Department of Transportation of USA\(^2\) defines a list of indicators of productivity and efficiency in the movement of commercial goods by motor vehicles; these indicators are related with the QoS directly. The indicators are:

1. Cost of highway freight per ton-mile
2. Cargo insurance rates
3. Point-to-point travel times on selected freight-significant highways
4. Hours of delay per 1,000 vehicle miles on selected freight-significant highways
5. Crossing times at international borders
6. Customer satisfaction

Some of these parameters (1, 3, 4, 5, 6) could not be part of a reputation measure directly, but the indicators “Cargo insurance rates” and “Customer satisfaction” might be part of an analysis of reputation.

In (FREIGHTWISE, 2006) are defined the TSD and TEP packages. TSD packages have a list of parameters that a Transport Provider publishes. TEP packages are contracts between Transport Providers and Transport Users. Using these two packages is possible establish a general list of parameters of QoS-reputation that a transport service must fulfill.

Other important aspect of reputation is form environmental point of view, in (Michail & Wooldridge, 2008) is presented an analysis of interactions between transport systems and the environment parameters and identifies the responses of the major players and operators in intermodal transport chains. The parameters identified in (Michail & Wooldridge, 2008) as key points in freight transportation in Europe (Table1) is taken in this master project as foundation to examine the set of environmental parameters that could be used in the measure of reputation services and therefore reputation Transport Providers.

On the another hand, there are other parameters that are not part of FWF and neither of categorization made by US Dept. Transportation, are related with human interaction and perspective. The experience of a Transport Provider is a subjective analysis of a Transport User and deals with the reputation on the basis time of a transport service or a Transport Provider. The experience of a Transport Provider it’s associated with the reliability and confidence that a Transport User experimented in previous interactions or the previous interactions of other users. This parameter is most related to the concept of Trust than the concept of Reputation, as was defined previously and as is analyzed in: (Audun Jøsang, Ismail, & Boyd, 2007) trust is close related with personal interaction and the performance is not always monitored and where failures are forgiven rather than sanctioned, this means that the weight of trust in comparison with other parameters could be more important but is not easy to measure or quantify.

Different works had tried to establish categorizations of QoS parameters in different fields like in Web services: (Yao Wang & Vassileva, 2007) (Papaioannou, Tsesmetzis, Roussaki, & Anagnostou, 2006). (Papaioannou et al., 2006) present a QoS ontology language and framework; the authors identified a rich set of requirements, such as expressiveness, robustness, flexibility, accuracy, scalability, performance, completeness, user and developer-friendliness and interoperability which are close related with the QoS information of Web services but might be an alternative to analyze the reputation and QoS information in freight transportation context in future works.
<table>
<thead>
<tr>
<th>Transport Modes</th>
<th>Air</th>
<th>Water Resources</th>
<th>Land Resources</th>
<th>Solid Waste</th>
<th>Noise</th>
<th>Risk of Accidents</th>
<th>Other Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine transport</td>
<td>Emission of sulfur dioxide (SO2)</td>
<td>Modification of water systems during port construction and dredging</td>
<td>Land taken for infrastructure</td>
<td>Vessels withdrawn from service</td>
<td>Bulk transport of fuels and hazardous substances</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inland water transport</td>
<td>Modification of water systems during canal cutting and dredging operations</td>
<td>Delegation of obsolete facilities</td>
<td>Vessels and barges withdrawn from service</td>
<td>Bulk transport of fuels and hazardous substances</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rail transport</td>
<td>Land taken for rail infrastructure</td>
<td>Delegation of obsolete facilities</td>
<td>Abandoned lines equipment and rolling stock</td>
<td>Railway noise and vibration</td>
<td>Transport of hazardous substances</td>
<td>Spatial separation effects (wildlife habitats, Emmislands, urban areas) Amenity and severance</td>
<td></td>
</tr>
<tr>
<td>Road transport</td>
<td>Local air pollution (CO, NOx, HCs, VOCs, Pb, particulates) Global air pollution (CO2, CFCs)</td>
<td>Pollution of surface and groundwater due to runoff from roads</td>
<td>Runoff from roads</td>
<td>Discarded vehicles</td>
<td>Noise and vibration</td>
<td>Transport of hazardous substances</td>
<td>Congestion Spatial separation effects (wildlife habitats, Emmislands, urban areas) Amenity and severance</td>
</tr>
<tr>
<td>Air transport</td>
<td>Air pollution (CO, NOx, HCs, VOCs) Global air pollution (CO2) Depletion of ozone due to aircraft emissions in the stratosphere</td>
<td>Modification of water tables, river courses, and field drainage due to airport construction</td>
<td>Land taken for infrastructure</td>
<td>Airlift withdrawn from service</td>
<td>Noise</td>
<td>Transport of fuels Barrier to wildlife migration in the case of aboveground pipelines</td>
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<tr>
<td>Pipelines</td>
<td>Pollution of surface and groundwater due to oil leakages</td>
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</table>

Table 1 Significant environmental aspects of the different transport modes [taken from (Michail & Wooldridge, 2008)]

It has been identified different parameters using transport services information published by Transport Providers (using for example TDS packages in FWF), the information expected by Transport Users (in an agreement or contract or using TEPs in FWF) and information from QoS parameters that could be extrapolated from other fields. But in the context of transportation services these factors are not enough to evaluate or establish a subjective reputation of a Transport Provider. There are other aspects that must to be analyzed and are related with human relationships point of view; in (Bennett & Gabriel, 2001) is presented an analysis of reputation in the context of the interaction between transportation customers shipping firms and seaports in UK; in this work is presented the results of a survey about the importance of relationships between these two actors. In this research it is taken into account pure human related information to evaluate the reputation of a seaport like the experience, this is a parameter that is included also in (Bagheri & Ghorbani, 2006) that present an analysis of
propagation of reputation in multi-context environment and defines nine different elements of reputation:

- Role Fulfillment
- Relationship
- Knowledge
- Experience
- Credential
- Competence
- Honesty
- Favorability
- Faith

These nine elements establish a different perspective of reputation and define an extra category or dimension. The proposal in this master thesis project is a classification of reputation parameters using dimensions to categorize all the parameters that could be used in a freight transportation context. The first dimensions are taken from the QoS parameters extrapolating some of them from different context to transportation field, others from humanistic point of view like in (Bagheri & Ghorbani, 2006) and using the environmental categorization of (Michail & Wooldridge, 2008). This categorization defines families of parameters (dimensions) as is presented in figure 7. The dimensional array of reputation parameters helps to analyze the different nature of the reputation and provides a base to design new models of reputation system in the freight transportation context.

In figure 7, the Reliability dimension is associated with the difference between the publish values and the real values, these parameters are called Deviations and are calculated using the values before and after the delivery.

The Performance dimension measure the number of deliveries taking into account a time unit, for instance the number of deliveries that a Transport Provider made in a specific year or in other unit of time. This parameter could be important to a Transport User because is possible to analyze the experience of a Transport Provider in a defined pathway. In the same dimension is also defined the parameter: Type of Deliveries per Time Unit, this is a specification of the Total of Deliveries per Time Unit and establishes the number of deliveries of a defined transport service type, as is defined in table 2 taken from the Generic Elements package (FREIGHTWISE, 2006).
Reputation parameters in freight transportation context using FWF

Figure 7 contains a general set of proposed parameters that correspond to the reputation of a Transport Provider, this category of parameters divided by dimensions (Environment, Human related, Security, Financial, Performance, Reliability) it’s thought to analyze the reputation information in a freight transportation context and might be useful to design reputation systems. In the same graphic the dimensions Performance and Reliability (orange parameters) contain a subset of parameters that is possible define and calculate using information of TEP package of FWF described in (FREIGHTWISE, 2006).
The deviation parameters in the *Reliability* dimension could be obtained using the differences between a real parameter (feedback data) and information in the contract signed between Transport Provider and Transport User using the TEP package.

In this thesis project is proposed a calculation method of the parameter *Delivery Time Deviation* that would be defined by:

\[
\text{DeliveryTimeDeviation} = \text{Max. DeliveryTime} - \text{RealDeliveryTime}
\]

Equation 1

The parameter *Max.DeliveryTime* is obtained from the *ServiceTiming* class included in TEP package, as is presented in figure 8. Being *Max.DeliveryTime* computed as:

\[
\text{Max. DeliveryTime} = \text{EarliestStartTime}_{\text{TEP}} - \text{LatestEndTime}_{\text{TEP}}
\]

Equation 2

The parameter *RealDeliveryTime* is the feedback information that could be obtained from the Transport User using a direct communication (for instance a survey) or using an automatic feedback using client software like in (Davidsson, Holmgren, Persson, & Pedersen, 2010).

![Figure 8 Detail of TEP package of FWF, the ServiceTiming class.](image)

The parameter *Contract aspects Deviation* has the same approach than *Delivery Time Deviation* parameter; using information of *Terms* class from TEP package and feedback information (manual or automatic) is possible evaluate differences between the contract terms signed by Transport Providers and Transport Users in the *Planning* phase using FWF and the real information obtained in the end of the delivery process. Let be:
the equation that defines the deviation of contract aspects using the Term data from TEP package and real feedback.

The *Performance* dimension contains parameters to measure how many times a transport service of a Transport Provider has been performed per time unit. This parameter measure in a subjective way the expertise of a Transport Provider; it’s a subjective measure because even the repetition of a task could be indicator of knowledge, this does not means that failures could not exist. The *Total Deliveries per Time Unit* could be obtained using a repository that automatically stores the number of times that a transport service is performed by the same Transport Provider; this measure could be using a unit of time like years, semesters or months.

The *Type of Deliveries per Time Unit* parameter in the *Performance* dimension uses the same approach of *Total Deliveries per Time Unit*; in this case is stored the number of times that a transport service is performed by the same Transport Provider but specifying the type of cargo that is transported; this parameter could be important in the selection of transport services because a Transport User can get a subjective measure of the expertise of a Transport Provider in a specific type of transportation (dangerous materials, cooler or refrigerated cargo, etc.).

In conclusion, in this chapter is established a categorization of reputation parameters in freight transportation context (figure 7), this categorization is made using *dimensions* these are subsets of parameters that contains specific similarities. The proposed categorization of reputation parameters also contains dimensions (*Reliability* and *Performance*) that could be obtained in architectures based on the FWF, in these kinds of approaches parameters like deviations are obtained using data of TEP packages and feedback information from the user.

In the next chapter will be analyzed how to manage the information of reputation parameters taking into account different approaches of reputation system architectures.
Chapter 5

Reputation System to Improve the Selection of Transport Services Using FWF

In chapter 4 were defined the parameters that conform the reputation data and were established boundaries between reputation and trust. In this chapter it is analyzed the methods how to calculate and exchange reputation information between the different actors in a freight transportation architecture and will be defined the main characteristics of a reputation system that might manages the reputation data.

First is necessary to define the actors that take part in the exchange of information in freight transportation; in this master thesis is followed the approach of (Davidsson, Holmgren, Persson, & Pedersen, 2010) and (FREIGHTWISE, 2006) which defines different kind of actors (as were presented in Chapter 2) Transport Users, Transport Service Providers, Traffic Managers and Transport Regulators; with regard to the reputation concept in freight transportation could be other types of actors, like:

- Environmental regulators: these are organizations that monitor and generate politics or rules in transportation, like European Environmental Agency and the International Organization for Standardization.
- Security standards organizations and insurance companies: these organizations dictate rules and politics in freight transportation.
- Financial organizations: in this category of actors are included, banks, loan organizations, etc.

The previous actors are independent organizations different than the main actors (defined in chapter 2); from now in this master thesis will be called Third Party actors.

The next sections present the develop of the reputation system, first describing different alternatives to establish a architecture of reputation systems, then is presented the set of parameters to define and calculate the reputation of a Transport Provider; after establish the parameters that conform the reputation metric of a Transport Service is presented the different approaches to calculate the reputation and how is stored, updated and communicated.

Reputation system architectures

The architecture considerations such as method of dissemination, store, calculation, etc. of the reputation information have important implications in Web reputation systems as is confirmed by: (Hoffman, Zage, & Nita-Rotaru, 2009) (Audun Jøsang, Ismail, & Boyd, 2007), in these works and in (Randall Farmer & Glass, 2010) the authors define two types of main architectures, centralized and decentralized. This two categories have different variations, in (Backx, Wauters, Dhoedt, & Demeester, 2002)(J. Walkerdine, Melville, & Sommerville, 2002) there are a
comparison between different approaches of P2P architectures, in the first one the authors presents three kinds of P2P architectures in heavy traffic content distribution networks context, these approaches are presented in a more detailed analysis in (J. Walkerdine, Melville, & Sommerville, 2002).

Below is presented the analysis of different architecture approaches to support a reputation system in the context of freight transportation. At this point, is necessary to say that is impossible to establish which architecture alternative is the best to use in a reputation system, because reputation information is context aware therefore the reputation system architecture also depends of the nature of the context; but is possible to analyze different key points that could be useful to choose an alternative, in the section “Parameters to analyze reputation system architectures in freight transportation context” will be defined those parameters.

Centralized architecture approach

In a centralized architecture approach and in the context of freight transportation the reputation information is managed in a central module or unit (in huge architectures this concept could be not exact, because in huge data store the cloud paradigm is not necessary centralized). This central unit obtains the reputation information from each party calculating the reputation of an entity, in this context the reputation of a Transport Provider.

In this approach all the Transport Users that have direct interaction with a Transport Provider can contribute with the reputation measure. The central unit obtains the subjective reputation of each Transport User and calculates the objective reputation, which is a common measure of reputation.

The central unit is also responsible for the dissemination of reputation information, in a centralized approach is necessary in order to spread this information to have a reputation framework that handle with message routing or with a set of interfaces (API\(^3\) set, Web service or Rest module) to obtain from Transport Users or Third Party actors the reputation value of a Transport Provider in the process of selection.

One of the most important points in the central unit of reputation is the updating module, this module verify the status of the reputation of each Transport Provider updating the reputation not only with the information of Transport Users also with the third parties actors and the time variable. Reputation value of a Transport Provider is dependable of the time this is because in other contexts the reputation of an entity is stable or invariable on the time if no more updates are made, because the entity is not variable on the time. In freight transport context, on another hand, the transport services offered by a Transport Provider could be variable on the time, because the charges, routes, regulations, etc. might not be constants; for this reason are necessary that exist updating models in the reputation systems taking into account the time variable.

---

\(^3\) API: Application Programming Interface
In figure 9 is presented a possible architecture of a reputation system in freight transportation; in this figure the central unit obtains the subjective reputation from Transport Users and third party actors and calculates the objective reputation of a Transport Provider.

Figure 9 Centralized architecture of a reputation system in freight transportation

Decentralized architecture approach
In an approach decentralized all the functions of the reputation system are distributed in the different entities, in the context of freight transportation functions like storing, updating and calculating reputation information are distributed in the Transport Users, Transport Providers and third party actors. There are different approaches of how to deal with all these functions depending of strategic and technological factors.

Peer to peer (P2P) architectures are networks with entities with double functionality: server and client at the same time. A core component of a P2P system is its network architecture, which represents how the peers within the system are connected together. These can range from topologies that are particularly centralized in their operation (typically using some form of central hub), to fully decentralized topologies in which there is no set structure and all peers are considered equal (Hughes, James Walkerdine, & Coulson, 2010).

In (Backx et al., 2002) is presented an analysis of P2P architectures in a heavy traffic content distribution networks context; the authors present a three different kind of P2P architectures: mediated, pure and hybrid that are also analyzed in a more detailed categorization in (J.
Walkerdine, Melville, & Sommerville, 2002) which present two categories of P2P architectures with different variations, as is presented in figure 10.

![P2P architectures](image)

Figure 10 P2P architectures (J. Walkerdine, Melville, & Sommerville, 2002)

In (Davidsson, 2001) is made an analysis of artificial societies using different parameters to cauterize them: openness, flexibility, stability, and trustfulness. The author of this article present two main classes of societies (agent societies), open and close and proposes two subclasses of them: semi-open and semi-close. The author argues that semi-open societies have a much larger potential for providing stability and trustfulness. That argument is taken in (Davidsson, Holmgren, Persson, & Pedersen, 2010) to create the called Plug and Play Transport Chain Management (PnP TCM) architecture. Based on these arguments of architectures design and extrapolating that knowledge to analyze reputation systems in the freight transportation context, in the next section is presented an analysis of the main parameters to evaluate the benefits and drawbacks of each approach.

**Parameters to analyze reputation system architectures in freight transportation context**

Using a similar approach to (Hoffman et al., 2009), in this thesis project is presented an analysis of architecture design parameters to create and use a reputation system to improve the selection process of transportation services. The aim of this collection of parameters is evaluate the different alternatives to implement a reputation system in freight transportation using for instance a framework like FWF.

In (Hoffman et al., 2009) all the parameters that conforms the structure of a reputation systems are divided in three parts, the dimensions of formulation, dissemination and calculation, but in the work of Hoffman, the authors are focused in the parameters of security of reputation systems. For this reason in this thesis project that framework is modified and is focused in the
sources (*formulation* dimension) and in the architectural parameters like different methods of storing, transmitting and share reputation information (*dissemination* dimension).

A more general analysis of important parameters of reputation system is made in (Randall Farmer & Glass, 2010), describing key points of the reputation systems in Web contexts. In this work, Randall defines six key parameters to evaluate and analyze:

- Reputation calculation method: static or dynamic
- Scale: small or huge
- Reliability: transactional or best-effort
- Complexity: simple or complex
- Data portability: Shared versus Integrated
- Messaging method: Optimistic/Fire-and-Forget or Request-Response/Call-Return

In this thesis project it’s extended the framework of (Hoffman et al., 2009) and expanded with the work of (Randall Farmer & Glass, 2010) but in the context of freight transportation. The modified framework is presented in figure 9. The modified framework of (Hoffman et al., 2009) contains two main parameters *Formulation* and *Dissemination*, these two parameters are considered key points because they are related with internal and external interactions of the entirely system, *Formulation* is associated with the internal management of the information inside of the reputation system and *Dissemination* is related with the exchange process of this information.

Below is presented an analysis from the point of view of the architecture of the reputation system, taking into account the evaluation parameters presented in figure 7, in the context of freight transportation systems.
Figure 11 Framework of reputation system parameters in a freight transportation context.

Formulation

Information sources

In freight transportation context the information sources to use in a reputation system could be divided in two main sets, objective and subjective; the last one category comes from the analysis of trustworthiness (in the sense of the reliability) based on the referrals or ratings from members in a community. An individual’s subjective trust can be derived from a combination of received referrals and personal experience (Audun Jøsang, Ismail, & Boyd, 2007), meaning that different agents (persons or agents in computer science context) can derive different trust in the same entity (A. Jøsang, Bhuiyan, Y. Xu, & Cox, 2008).

On another hand, objective reputation measures are defined by the consolidated rating between entities, in the context of this project, with the set of reputations measures of Transport Users and third party actors. An advantage with objective measures is that the correctness of ratings can be verified by others, or automatically generated based on automated monitoring of events (Audun Jøsang, Ismail, & Boyd, 2007).
SUBJECTIVE SOURCES

As is presented in figure 11, Subjective reputation sources in freight transportation could be divided in feedback and social reputation measures.

Feedback information

Feedback information from users about a service or product is applied in many fields, in freight transportation there are some examples, TRANS European Freight Exchange⁴ is an internet platform where users exchange information about available loads and vehicles from all over Europe, in that tool users of transportation services can evaluate the contractor of the service using a scale: positive neutral negative service and is possible write a free comment that could be checked by other users.

In (FREIGHTWISE, 2006), the phase of Transport completion has a sub-processes to manage transport performance information, after completion of a transport service, information about the transport process may be gathered for statistics reasons. Using FWF is possible to model a feedback process to exchange reputation information. In figure 13 (red lines and modules) is add a feedback process upgrading the FWF process adding two actors, the Reputation System and the Reputation Third Party, the first one represent a reputation system to manage all the trust and reputation information of Transport Providers and the last one is a third party actor that can give a qualification about a defined parameter or context. The package used in feedback process in FWF is defined using the same packages of Completion phase because the feedback process follows the same functional model of this phase as is analyzed in the Collect transport data of the Functional Model in the figure 12.

Figure 12. Collect transport data of the Functional Model

In (Pujol et al., 2002), (Koren, Bell, & Volinsky, 2009) and (Hoffman et al., 2009) is analyzed the importance of automatic and manual feedback; in the first one, the reputation information is collected with no human intervention (called implicit reputation feedback by (Koren et al., 2009)) and allows the calculation of reputation metrics when the qualifier entities (Transport

⁴ Trans: [http://www.trans.eu](http://www.trans.eu) [last visit on 10 of May 2011]
Users) do not want to rate manually (explicitly) a service (or a Transport Provider); in these cases is possible create an automatic feedback using for instance FWF in freight transportation context, using the information of the contract signed by a Transport Users and a Transport Provider (TEP package) in order to obtain time and charge data like arrival, departure and pick up times in Service Points (Service Areas) and price of the service and to compare this “theoretical” information with “real” information that is possible obtain from an automatic feedback in the Completion phase.

![Figure 13. Upgraded process model of FWF](image)

**Social information**

In decentralized architectures each entity needs modules to store, process and exchange information even if this architecture use cloud storage or multi-processing models. In contrast with a feedback process to get reputation data, in decentralized architectures like *artificial societies* each entity has a data store of reputation database with information of previous interactions with other entities, for instance Transport Providers which means that if a Transport User does not have previous interactions with a Transport Provider he/she cannot reach the
information of transport services and cannot access to a central repository to analyze the reputation of that provider. In this case the alternative is the exchange of reputation data between peers or entities that have previous interactions (connections).

A network model of reputation generates conceptual innovations that have systematic implications for such diverse disciplines as network theory and social network analysis (Craik, 2009b).

Social data to obtain reputation information is used in different works: (Pujol et al., 2002) (Malik & Bouguettaya, 2009b) (Jyun-cheng & Chiu, 2008) (Randall Farmer & Glass, 2010) (Sabater & Sierra, 2002), in all of them are applied approaches used in Social networks context. From architectural point of view, social network analysis is close related to distributed architecture systems and in particular to P2P architectures (Sabater & Sierra, 2002), (Jurca & Faltings, 2005).

In the freight transportation the use of Social networks architectures is not an extended practice, in Trans is used a topology of P2P to create a network of users and providers of transport but is mainly a system to communicate actors of transportation. In (Davidsson, Holmgren, Persson, & Pedersen, 2010) is analyzed the advantage of use a P2P network in the context of freight transportation, the authors mentions the concept of Internet community which is the set of actors (transportation actors) using Internet as telecommunications foundation, this concept is close related to Social networks and is possible use approaches of this communities to spread or share reputation information.

From the informational (or logical) point of view in the context of freight transportation, P2P and social networks share many concepts in common. For example, they are both distributed networking structures; a peer in a P2P network can be viewed as an analog of a node in a social network; a link in a P2P can be viewed as an analog of a relationship tie in a social network (Yang & Chen, 2008). But from the point of view of the architecture (or physical) the differences could be substantial. In P2P networks like (Davidsson, Holmgren, Persson, & Pedersen, 2010) every peer or node (or transport entity in the context of the article) contains part of the hardware and software structure, all the nodes have the possibility of store and manage data, but in (virtual) social networks like Facebook, Twitter, MySpace, etc., each peer or node (a client or user) does not have the possibility to store or process information.

P2P and social networks could share different approaches (from the logical or informational point of view) like security and privacy politics or rules works like (Yufeng Wang, Nakao, Vasilakos, & Ma, 2011), (Zhou & Hwang, 2007), clustering of peers (Venkatraman, Yu, & Singh, 2000b), (Sabater & Sierra, 2002), information discovery processes and share rules.

OBJECTIVE SOURCES

In order to calculate the *objective* reputation is necessary to use different mathematical approaches depending of the nature of the reputation information, the sources, time properties of the information (*transient, permanent*) and the architecture of the reputation system.

In centralized reputation systems the calculation process couldn’t be a major problem because the engine of calculation could be robust and this process not represent any technological problem to another entity (Transport Users). On another hand, in decentralized (for instance P2P architectures) topologies the calculation is made in each entity and if the reputation system calculation model is complex the time to obtain the *objective* reputation could be increase.

Exist different approaches to calculate the *objective* reputation, below is presented a list of the main mathematical approaches to use.

In (Hoffman et al., 2009) the mathematical approaches are divided in three sets, binary, discrete and continuous and it is simpler than the classification made in (Audun Jøsang, Ismail, & Boyd, 2007) which divide the mathematical approaches in:

- Simple summation or average of ratings
- Bayesian systems
- Discrete trust models
- Belief models
- Fuzzy models
- Flow models

This thesis project does not try to analyze or compare all of these approaches because is not the aim, but it is necessary understand that some of them like *simple summation or average of ratings* offer a much better solution in reputation systems with a decentralized architecture like P2P networks.

**Information Types**

*Subjective* reputation is context aware and depends on the nature of the system, in the freight transportation scope to measure reputation of a Transport Provider is possible to “measure” this parameter with different metrics, scale from 0 to 10 like Google PageRank (Langville & Meyer, 2008) (in the context of rank as reputation) or feedback text comments like in YouTube services. There are different types of metrics to recommend products or services, in (Ruohomaa & Kutvonen, 2007) are analyzed eleven reputation systems and are compared some parameters included the type of information; in table 3 is presented part of this analysis and is detailed the information type that each system manages in the column *Value*.
Table 3 Reputation systems comparison (Ruohomaa & Kutvonen, 2007)

<table>
<thead>
<tr>
<th>System</th>
<th>Rating / opinion</th>
<th>Opinion aggregation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>eBay</td>
<td>rating</td>
<td>-1 / 0 / 1</td>
<td></td>
</tr>
<tr>
<td>Unitec</td>
<td>opinion</td>
<td>unspecified</td>
<td>anything</td>
</tr>
<tr>
<td>FuzzyTrust</td>
<td>rating</td>
<td>$x \in [0, 1]$</td>
<td></td>
</tr>
<tr>
<td>REGRET</td>
<td>opinion</td>
<td>weighted avg.</td>
<td>$x \in [-1, 1]$</td>
</tr>
<tr>
<td>NICE</td>
<td>opinion</td>
<td>unspecified</td>
<td>$x \in [0, 1]$</td>
</tr>
<tr>
<td>MDNT</td>
<td>opinion</td>
<td>CCCI metric</td>
<td>$n \in {0, \ldots, 6}$</td>
</tr>
<tr>
<td>PeerTrust</td>
<td>rating</td>
<td></td>
<td>$x \in [0, 1]$</td>
</tr>
<tr>
<td>Managing Trust</td>
<td>rating</td>
<td>existence</td>
<td></td>
</tr>
<tr>
<td>MLE</td>
<td>rating</td>
<td></td>
<td>0 / 1</td>
</tr>
<tr>
<td>EigenTrust</td>
<td>opinion</td>
<td>exp. difference</td>
<td>$norm(p - n)$</td>
</tr>
<tr>
<td>Travos</td>
<td>opinion</td>
<td>exp. counters</td>
<td>$p, n \in \mathbb{N}$</td>
</tr>
</tbody>
</table>

In this master project is follow the classification of (Randall Farmer & Glass, 2010) of reputation information type and dividing all the set in two kinds: qualitative and quantitative:

**Qualitative reputation**

In this, the system takes *subjective* reputation from the user in two kind of feedback:

- **Text comments**: this is the free text that a user writes giving her/his opinion, this kind of feedback is used in different kind of services online or not. In the context of freight transportation reputation systems is possible obtain this feedback in the end of the entirely process, for instance, in FWF is specified a module and packages for this purpose in the *Completion* phase; in *Trans*\(^6\) is possible to send a text feedback to the transport contracts using that tool, like is presented in the figure 14; in other context like social, the user can use free text feedback in services like YouTube as is shown in the figure 15.

- **Media uploads**: this kind of response or feedback using media formats (pictures, videos, documents, etc.) is used in different context, in a freight transportation scope this kind or reputation feedback might be used in multiple scenarios like, a Transport User replying a certified of complacency for the service or a Transport User sending a complaint with a picture or video of the damaged cargo.

The aim of these two kinds of reputations is to create a feedback human readable and is not precisely easy or valuable to quantize. This is an idea contrary to that presented by (Hoffman et al., 2009) says that is necessary convert these qualitative to quantitative metrics in order to create only one *objective* reputation.

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\(^6\) Trans: [http://www.trans.eu](http://www.trans.eu) [acceded 17 of May 2011]
Figure 14 Text feedback in Transtool [image taken from http://www.trans.eu/en/index.php?option=content&task=view&id=421]

Figure 15 Text and video feedback in YouTube [taken from: http://www.youtube.com/watch?v=Dl9THt4Vgs]
Quantitative reputation

There are different representations of quantitative reputation, in (Randall Farmer & Glass, 2010) is presented a category of three classes of quantitative metrics:

- Normalized value: is a normalized value is always expressed as a floating-point number in a range from 0.0 to 1.0. Examples of this representation are: (Schmidt, Steele, Dillon, & Chang, 2007) and (Xiong & Liu, 2004).
- Rank value: this kind of metric it is used for instance in Google PageRank, Ebay, etc.
- Scalar value: a scalar value is a type of reputation claim in which a user gives an entity a “grade” somewhere along a bounded spectrum (Randall Farmer & Glass, 2010). Examples of this metric are Facebook Like button system, Ebay stars metric or Google +1 button experiment.

Dissemination

Distribution method

The architecture plays a big role in the information transmission in networks. In freight transportation reputation systems the dissemination reliability of reputation data depends mainly of the architecture model and the number of entities (peers or Transport actors). In architectures with a huge scale (centralized or decentralized) the reputation information is not a priority because the predominant traffic is of service and the reputation metric of one user is not considered crucial to the average or the final reputation computation, in this kind of scenarios the transmission method of reputation information must follow a best effort method, for instance using protocols without handshaking dialogues for providing reliability.

On another hand, in smaller or reliable context when is necessary that all the reputation metrics from the users must be taken into account is necessary to use protocols with handshaking methods or reliable paths using transactional communications.

In freight transportation context, the number of transport services and the number of actors that could be involved are huge, as is evidenced by the number of users that tool Trans manages: more than 200.000 users in Europe and 100.000 offers daily; this means that in the freight transportation scope is necessary to think in big architectures.

7 Like button: http://developers.facebook.com/docs/reference/plugins/like/
8 Ebay stars metric: http://pages.ebay.com/help/feedback/scores-reputation.html
9 Google +1 button: http://www.google.com/experimental/index.html
10 Statistics from the Trans portal http://www.trans.eu [data taken 17 of May 2011]
Storage method
Centralized architectures of reputation information must be modules to manage all data that comes from the entities (Transport actors in this context), the storage process in this case must be permanent this means that the system must have modules to deal with roll-up (Randall Farmer & Glass, 2010), update and log operations, these are functions close related with the storage choosing. In centralized architectures the upgrade of the foundation technology might be “transparent” to the entities capabilities (performance: storage and computation).

Transient storage is related with data management technologies that are used in the storage procedure (also in the calculation process) of decentralized architectures (P2P networks for instance), is transient because operations like roll-up, update, historical analysis might not exist in this kind of approaches because the calculation process is made in “run time“ obtaining the objective reputation from neighbors entities as in (Golbeck & Hendler, 2004), (Pujol et al., 2002), (Venkatraman, Yu, & Singh, 2000a) and (Yu & Singh, 2000).

Reputation system architectures using FWF
Follow, are proposed two reputation system architectures using FWF. With the previous analysis of reputation parameters and the different types of architectures in the freight transportation context here is established the high level parameters and modules of this architecture and are also defined some design recommendations. The first proposed architecture is a centralized approach, using as foundation the Yahoo! Reputation Platform analyzed in detail in (Randall Farmer & Glass, 2010). With base on (Davidsson, 2001), (Davidsson, Holmgren, Persson, & Pedersen, 2010) and social networks approaches, is defines a decentralized architecture using P2P models.

Centralized reputation system using FWF
With the previous literature analysis in figure 16 is defined the centralized architecture proposed.
All the process starts when the Transport Provider and the Transport User interacts each other based on FWF; this interaction produce a TEP package which is obtained by the reputation system trough of Listener module. This is the compatibility layer for messaging. Different listeners can have different semantics. For example, some listeners can be implemented to understand asynchronous messages of different data formats, such as XML or JSON\footnote{JSON: JavaScript Object Notation \url{www.json.org}}. They may be hand-coded function calls to do last-moment data transformations, such as turning a source or target identifier from one context into an identifier from another context. Another common listener enhancement is to add a timestamp to, and/or to write a log of, each message to aide in abuse mitigation or model testing and tuning (Randall Farmer & Glass, 2010). The TEP package is stored in a TEP Data base or repository, this is useful to analyze previous interactions between Transport Providers and Transport Users, also is necessary as internal log of processes.

In the end of a transport service process a Transport User generates a feedback or the reputation system obtains this feedback automatically with information of some parameters (see Figure 7 Reputation parameters in freight transportation context), this data is collected in a Feedback data base or repository in order to registry all the reactions, comments or responses from the Transport User.
With the information of feedback and the TEP packages, the Subjective Reputation Manager calculates the subjective reputation using the equations 1, 2 and 3 (see Reputation parameters in freight transportation context using FWF). The Objective Reputation Calculator estimates the value of the objective reputation (final value) and stores that value in the Reputation Data Base.

The Objective Reputation Calculator module computes the reputation value using historical information from Reputation Data Base, from Third Party actors information and using the subjective reputation data.

The Dissemination module allows the distribution of the reputation module to other actors (Transport Users and Third Party actors) and is the responsible of the data privacy and security, this module control the access to reputation information.

In this centralized approach the analysis of reputation taking into account the reputation sources could be represented as is shown in the figure 18, where the feedback process might contain the major quantity of parameters, and the social analysis in this case could be not useful, because the interactions between Transport Users is almost null.

Figure 17 Reputation sources and their parameters in a centralized approach.

**Decentralized reputation system using FWF**

On the another hand, using as foundation a P2P approach each peer (transport actor) must have the ability to process and store reputation data, for instance using agents (Davidsson, Holmgren,
Persson, & Pedersen, 2010); in previous analysis is argue the importance of peer interactions using virtual social networks, in this approach, the discovery of transport services is improved using direct interaction with other peers like in (Golbeck & Hendler, 2004; Pujol et al., 2002; Venkatraman, Yu, & Singh, 2000b; Yu & Singh, 2000), this interaction imply that the rules of security and data privacy must to be in each peer software and controlled by each peer.

In the figure 18 is presented the proposed decentralized architecture of reputation. The interactions between Transport Providers and Transport Users are managed by a software agent in each peer (green cube in the figure 18), this software has essentially the same functions of the centralized architecture but in a smaller scale, but additionally the interaction processes between peers (social network interaction) must be administered by a module that controls the privacy and security data rules (for instance the privacy and interaction rules of the Social Graph that use Facebook or Google social API), these extra modules are depicted in figure 18, which are the main modules that are necessary in the agent software of reputation system in a decentralized architecture.

![Figure 18 Decentralized reputation system using FWF](image)

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12 Facebook Social Graph: [http://developers.facebook.com/docs/reference/api](http://developers.facebook.com/docs/reference/api) [page acceded 29 May 2011]

13 Google Social API: [http://groups.google.com/group/social-graph-api](http://groups.google.com/group/social-graph-api) [page acceded 29 May 2011]
In figure 19 is added the Social Interaction Manager module, this has the privacy and security rules to share information between peers and stores all the information related with social activities in the Peer Data Base. The Listener modules in this approach have the responsibility of allowing or not interaction with other peers obtaining information from Peer Data Base.

The Feedback and TEP databases are important in P2P approach because they represent the historical data of previous interactions with other peers, for instance is stored information of past transport services and contracts (TEPs) established between Transport Providers and Transport Users.

In the figure 18 is depicted also a software agent in the Transport Providers, this is important because each provider can access (if the Transport User allows) reputation information of the Transport Users. Also it is possible that Transport Providers established interaction using the same reputation software agent, to analyze reputation information, in this case is very important the module Social Interaction Manager due to the security and privacy issues that this kind of interaction represent.

The interaction between peers (figure 18) start with a Transport User (Transport User 3) trying to find reputation information of a Transport Provider (Transport Provider 2). Without information of previous interactions the Transport Users 3 analyze the information in the Peers Database to search close peers (friends or connections in Social Networks language). With this information asks to other Transport Users about the reputation of Transport Provider 2 and in this way is shared the reputation information. In other researches is analyzed not only the “first hand”
information but the information of different peers without connection with the Transport User 3, in (Pujol et al., 2002; Venkatraman, Yu, & Singh, 2000b; Yu & Singh, 2000) is analyzed this possibility, they argue that in Social Networks the reputation has a property called Transitivity (figure 20) that allows trust in the judgments of another peer (Audun Jøsang, Ismail, & Boyd, 2007).

![Figure 20 Trust transitivity principle (Audun Jøsang, Ismail, & Boyd, 2007).](image)

After a transport service process using FWF a Transport User rates the reputation of a Transport Provider this information is stored in the Feedback database that in comparison with TEP package defines the deviation of that parameters, following the process of centralized architecture.

The sources of reputation parameters in the case of decentralized architectures vary because the feedback process is not a common process. In the figure 21 is presented an analysis of reputation sources and their parameters in a decentralized approach. In this case the social dimension is more important than in the centralized approach, because from the point of view of Social networks is possible obtain reputation information (different parameters) from close peers and probably from peers with connections with the close peers.
Figure 21 reputation sources and their parameters in a decentralized approach
Chapter 6

Discussion and Conclusion

In this master thesis project were analyzed the different strategies to improve the selection of freight transport services using reputation information of Transport Providers. The foundation of this work was the Freightwise framework (FWF) (FREIGHTWISE, 2006)(FREIGHTWISE, 2008), the work of freight transport networks using an approach P2P (Davidsson, Holmgren, Persson, & Pedersen, 2010) and different approaches using reputation information in Social networks, semantic Web and P2P networks.

In this project was analyzed first, the different characteristics of reputation parameters, from diverse point of view and was proposed a categorization of these parameters (Figure 7 Reputation parameters in freight transportation context) in the same categorization was indicated the parameters that can be obtained using the FWF (orange parameters in Figure 7).

An analysis of each parameter and the definition of a metric to measure them is difficult; using FWF that metrics were established using feedback information from the Transport User and information of the TEP package, this information (deviations) is useful to analyze the reliability of a Transport Provider.

In the chapter 5 were analyzed different types of architectures that are possible to use in reputation systems. Centralized and decentralized approaches have advantages and drawbacks, depending of the context and different parameters of an architecture that manage information has. The outcome of this analysis allows creating a framework of reputation system parameters in a freight transportation context (Figure 11), which established the main key points to analyze in the implementation of a reputation system in this context. Based on this framework and the previous analysis of reputation parameters were proposed two architectures, with two different points of view.

The first architecture proposed was based on centralized approach which is presented in the figure 17 and an analysis of the reputation sources using this architecture in the figure 18.

The second architecture was a decentralized reputation system (figures 18, 19), using as foundation a P2P network, also was presented a reputation sources analysis using this architecture in the figure 21.

Benefits of the proposed framework

The analysis of reputation systems in freight transportation can improve the selection of transport services and establish different mechanisms of interaction between transport actors. Reputation is a key point in the selection of service providers in different areas, in freight transportation is a field with little analysis and could be definitely a key part in the creation of transportation networks.
The reputation parameters categorization proposed (figure 7) is important because after an analysis was established a link between quality of service parameters and reputation, this is a very important point of view because allows to align with the same importance performance and human related parameters for instance.

The extension to FWF allowed creating the proposed architectures; both of them take advantage of this framework and reuse packages to measure and establish reputation metrics.

The proposed architectures were created from a modular point of view, reusing rules and processes used in Social networks.

**Limitation of the proposed framework**
The interaction with peers, sharing information in artificial networks generate different issues related with security and privacy, this analysis from the point of view of P2P and centralized architectures must to be detailed. Current Social networks has different approaches to tackle this issue, in this master thesis a limitation was the analysis of security in both proposed architectures.

**Future work**
Based on the both proposed architectures is possible to define different mechanisms to improve the security and privacy in artificial networks in the context of freight transportation. Other future work could be the analysis of hybrid kind of architectures, with centralized point of view but using P2P processes for instance to improve the discovery and sharing of reputation information.
References


