SindhUniv. Res. Jour. (Sci. Ser.) Vol.49 (2) 349-356 (2017)

SINDH UNIVERSITY RESEARCH JOURNAL (SCIENCE SERIES)

Data Transformation with Interoperable Service Utilities in Hetrogeneous Transport Systems

M. A. MEMON, A. SHAIKH* M. H. MEMON**, R. H. SHAH

Institute of Information and Communication Technology, University of Sindh, Pakistan

Received 6th April 2016 and Revised 16thJanuary 2017

Abstract: Nowadays, importance and frequency of transport demands are increasing in the world day by day. To gain more profit and satisfy the customer's requirement, transport enterprises need the help of Third Party Logistics (3PL) which gets the transportation tasks from the suppliers and then takes charge of the whole transportation process until distribution of goods to the final customers. The objective of this paper is mainly about the design and implementation of Interoperable Service Utilities (ISU) and its integration to the existing transportation scheduling system R@MSES. An interoperable model which contains ISU is introduced to be specialized on dealing with interoperable problems. Two parts of the utilities – virtual customer and virtual transporter are also presented. Another transportation system open TCS will be used as an example of 3PL enterprise for simulation.

Keywords: 3PL Enterprise, open TCS, Alignment, Interoperability

1. INTRODUCTION

Today, the rapid economical development stimulate the development of traffic and transportation. So the cost of transportaion will increase with a consequent increase in the cost of raw material and the cost of distribution of final product.Moreover, the cost of transportation is increasing year by year and this also leads to the increase of the cost of final products. More often companies which want to reach the far away customers could not possibly purchase their own fleet of vehicles to transport their goods. These companies choose to contact third party transportation companies to ship their products, same as a courier company. In definition "3PL enterprise involves the use of external companies to perform logistics functions (Transportation, Warehousing, Customer service management, Order fulfilment), that have traditionally been performed within an organization entirely or partly". In that case suppliers can outsource their complete transportation tasks to 3PL enterprises and then these 3PLs take charge of whole transportation process in order to reduce cost and travels number.

In reality, there are many 3PL transportation enterprises.Each 3PL enterprises have their own strategy to execute the transport tasks and they develop the strategy to optimize the cost-effective. A transport order or task could not be finished by one of the 3PL enterprises. It needs the collaboration with several 3PL enterprises. The cooperation involves a good understanding of information transformation between clients and 3PL and between 3PLs, especially about geographical locations, product constraints, transportation type, etc.

But a big problem appears when talking about collaboration with 3PL. These 3PL companies take transport orders from several customers (producer companies) and try to group them for delivery to utilize their resources at maximum. Client will generate their transport orders by their own specific ways, which will not be understandable by 3PLs. There is a need of an interoperable mechanism which can transform the information to 3PLs so 3PLs can understand. The transformation should deliver correct information and without any distortion. Secondly 3PL companies have to collaborate with other 3PL companies for delivery of products, which are to be picked or delivered from places out of the reach of single 3PL due to its limited operational geographic area. This also needs an interoperable mechanism which can transform information without any errors or faults.

Currently, there are not many researchers who work on the interoperable transport scheduling planning system. Raman *et al*. discuss the framework of the national transportation communication for its protocol (NTCIP) family of protocols whose standard is based on the Open Systems Interconnection Reference Model (OSI-RM) of the International Standards Organization (ISO). It attempts to meet the varied communications needs of the existing low speed transportation infrastructure and prepares the transportation industry for evolving to inter- operable Intelligent Transportation

++Corresponding author Email: muhammad.ali@usindh.edu.pk,
raza.shah@usindh.edu.pk, asshaikh@nu.edu.sa, majidhussain@quest.edu.pk ,
*College of Computer Science and Information Systems, Najran University, Najran, Saudi Arabia
**Department of Electronic Engineering, Quaid-e-Awam University Nawabshah

Systems (ITS). Forward-thinking transportation systems (innovative rubber-typed vehicles, some featuring double articulation; interoperable vehicles such as tram-trains) is presented to public administrations and transportation agencies with complicated decisions. It proposes a method of analysis to assist in these decisions by pre-emotively evaluating the actual technical and economic consequences resulting from the introduction of systems of the latest design. Niarki and kim propose an ontology based personalized route planning system using multi-criteria decision. What is a good certain route depends on environmental situations and user preferences. In addition to these criteria, the impedance of road is important in route planning. Impedance factors which can determine the travel time include the volume of the traffic, the type of the road, the road width, number of junctions and turns etc. This approach makes a model with criteria using ontology and implements an impedance function in route finding algorithm to find the personalized route for the user.

In this paper, we present the 3PL enterprise as a good way to reduce the cost of transportation and the interoperability as a good method to solve the problems of collaboration with 3PL enterprise. In section 2, we present the literature review. In section 3, we will review the two parts of ISU in the I-POVES model: virtual customer and virtual transporter. We show how to update the interoperability property into the I-POVES model. In section 4, we will take another transportation planning system openTCS as an example of 3PL enterprise to communicate with the multi-agent planning system R@MSES. A case study is also presented to demonstrate the application of ISU in the R@MSES system. In section 5, we will talk about using ontology to deal with the problems when facing multiple 3PL enterprise. Finally we conclude a summary for all the works in section 6.

2. LITERATURE REVIEW

New era of transportation is based on new trends. (Bozzo, *et al*. 2014) outlined some emerging cases in European public transport system. It will be fair to say that the current transport technology is better than another, but is very essential to explain technology as appropriate.

Fernandez and Ito (Fernandez, 2016) proposed the ontology that uses the SSN to handle the sensor information in efficient transportation architecture. The system is able to manage automatic traffic light system settings to detect and prevent road accidents through optimization.

(Guédria, *et al*. 2014) discussed about the usage general system theory, for interoperability in enterprise. In this work,, the systematic meta-model for enterprise is presented. The model is based on approach which is systematic where an enterprise is named as a complex model. The proposed model provides detail description of enterprise complex structure with its elements that can be problematic. It highlights a point in the model where the problem may occur. In later stages, the problem can be solved with the help proided framework. The results is based on several case studies.

(Li, 2007) discussed about the challenges of modern logistics over industrial locations. The research focuses on modern inventory and supply chain control system since modern logistics drastically reduced for industrial real estate. The method adopted in this research is theoretical, empirical statistical, economic, and comparative analysis. The author relies on empirical analysis because theoretical analysis does not provide clear results.

(Memon, 2013) presented a distributed architecture planning that highlights the activities for transportation for better utilization of resources. These resources can be grouped to improve the orders of transport. In this work the authors have outlined a collaborative transport planning problem and to solve this problem, a framework is proposed which is named as "POVES". POVES is multi agent framework that uses the technique of path finding and ordering agent to resolve the problem of planning.

(Memon, 2014) invented an architecture based distributed and interoperable factors which is named as "I-POVES". It is a framework which is ontology based a collaborative and interoperable. Interoperability is always an issue since every consumer follow its own transportation plan. I-POVES first finds the path and order the agents based on sequential actions. I-POVES is an efficient framework which resolves the issues related to transportation planning.

(Mes, *et al*. 2013) explored the study of the real time scheduling of full truck loading and delivery. In this study the vehicle agents and shipping agents are used as a profit maximising strategies. The primary goal this research is to understand the strategies and their impact over e system-wide logistical costs. The simulation has been used to measure system-wide logistical costs. It has been proved through simulation that the cost can always be reduced by using the look-ahead strategies.

Niaraki and Kim (Niaraki, 2009) presented the study of route planning using multi-criteria decision making technique. The research investigates the implementation of user-centric route planning system. An ontology knowledge based system technique using analytic hierarchical process (AHP) was proposed. The technique can provide benefit of the choice of criterion to select the function in the route finding algorithm.

One of the biggest problem in transportation is the pickup and delivery problem (PDP). (Takoudjou, 2012) proposed multi-start heuristic with path relinking (PR) and variable neighbourhood descend (VND) to resolve the issue of PDP by using local search based on transhipment. This technique can optimize the solution PDP. This work has been tested using several benchmark components from the existing literature.

I-POVES planning mechanism handles the correspondences between these transport resources characteristics and products perish ability constraints in order to facilitate the consolidation of transport orders and fill up the transport resource capacity at maximum, reduce the number of travels. With the reduction in number of transport travels not only yield the reduction of transportation cost but also the reduction of CO2 emission. With the reduction of CO2 emission, will decrease the environmental pollution and will cause positive effect on people's health.

3. <u>I-POVES MODEL</u>

3.1 The description of I-POVES

I-POVES model is inherited from POVES model illustrated in **(Fig-1.b)**. It gets the idea from the SCEP-SOA architecture**(Fig-1.a)**.I-POVES model is inherited from SCEP model, which is well known in research community and have been used for maintenance and production scheduling. With that inheritance, I-POVES too inherits its generic nature. SCEP has been used with success in the context of the distributed production and maintenance planning, where all required services of a project are known in advance (concept of routing) and associated with well-defined production services (turning, milling, etc.) and of systematic, conditional or curative maintenance services (cleaning, repair, oil changes, etc.), realized by (or on) not movable resources (machine, manufacturing cell, etc.). These concepts need to be incorporated with SCEP in order to use it for transportation. SCEP is of generic nature which makes it use for maintenance and production scheduling. That's why, authors chose it to use for Transportation scheduling

I-POVES introduces an indirect cooperation between two communities of agents, virtual customers and virtual 3PL (it is also called virtual transporter). Each virtual customer has the customers who have the same client local ontology and each virtual 3PL has the 3PL enterprises which have the same transport local ontology. A supporting agent "Path Finder" agent which can automatically find and design a route between loading location and delivery location. The data communication between virtual customer and virtual 3PL is performed through the background environment agent E. The supervisor agent S controls the model functioning. Next, we will introduce the main part of I-POVES – virtual customer and virtual transporter.

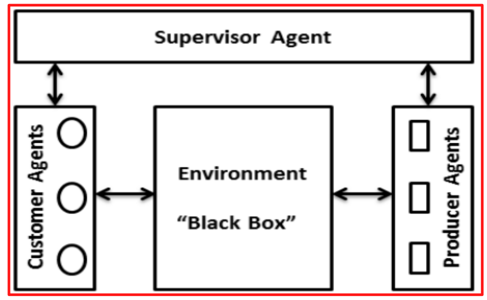

Fig.1.a:I-POVES model

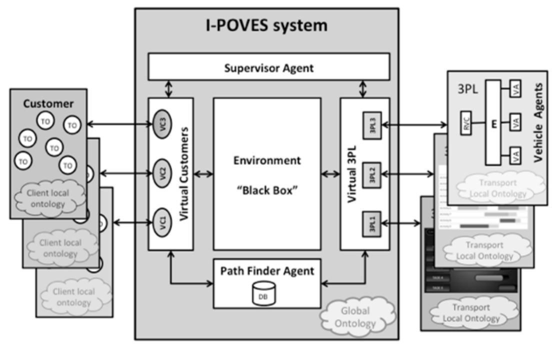

Fig. 1.b: I-POVES model

3.2 Virtual Customer

In I-POVES, virtual customer (VC) presents an ISU that will match and translate the enterprise's "Customer local ontology" terminologies to global ontology terminologies. VC will receive and manage transport orders from customer enterprise in form of local ontology terminologies and will translate it to global ontology terminologies. It will take charge of whole planning of TO starting from finding route by Path finder to planning of all tasks of the TO. When TO is planned it will translate back the planned schedule in to local ontology of customer and send it to the customer enterprise. VC will interact with the customer only in the start and end of the planning process. **(Fig-2)** shows the overview of virtual customer process.

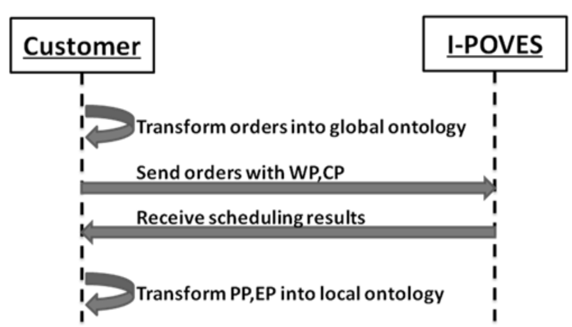

Fig. 2: Virtual Customer process

3.3 Virtual Transporter

Similar to VCs, I-POVES also have virtual 3PLS (VT) as ISUs for 3PL transporters. VT knows both the 3PL local and global ontology and alignment of concepts between them on common semantics. It matches and translates the 3PL local ontology terminologies to global ontology' terminologies. VTs will also translate the elementary activities of each 3PL and their vehicle parameters and send them to Path Finder to update its database before commencement of the planning process, each time Path Finder agent is activated by supervisor agent.

There are actually two types of VTs in I-POVES for 3PL transporter enterprises. First type of VT is for those 3PLs, which don't have their local planning system as shown in **(Fig-3)**. VT retrieves the tasks from environment. These tasks are represented in the form of global ontology standard and VT translates them and sends them into the format of local ontology for respective 3PLs. When 3PLs finish their planning cycle, VTs send back to the environment potential and effective dates received by 3PLs after translating them from transporter's local terminologies to global ontology. Interaction between VT and 3PLs continue cycle by cycle until all the tasks of the all the TOs are confirmed.

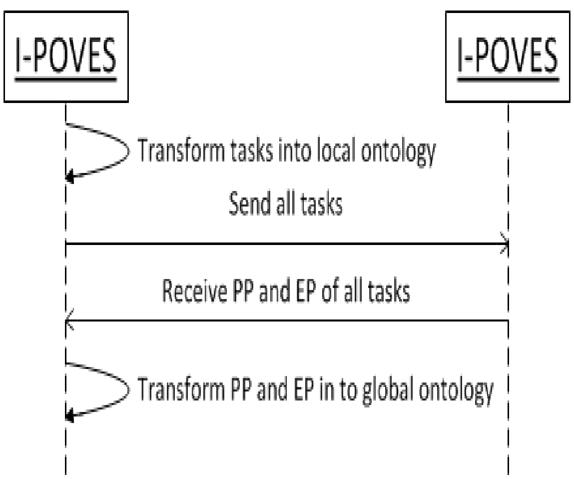

Fig. 3: Virtual Transporter process (same ontology domain)

Second type is for 3PL enterprises that have their own planning systems. If they want to connect to I-POVES for collaboration with other 3PL enterprises, they don't calculate potential dates (PSD, PED), they just propose only effective dates (ESD, EED). Their effective dates after planning corresponds to effective dates of I-POVES model. However I-POVES planning mechanism functions on both potential and effective dates. So in this condition VT will not only be responsible for translation of tasks collected from the environment from global to local ontology of transporter. But in order to integrate 3PLs system with I-POVES potential dates have to be calculated by VT. Potential dates concern only the planning of individual task without considering rest of the tasks. According to the number of the transport tasks, we have proposed two methods to solve each kind of the problem. If there are a lot of transport tasks we need to schedule, we use the method as **(Fig-4)**. To achieve PDs, when VT receives all the tasks from the environment, if first forms different groups of these tasks. Each group contains the tasks with the same origin and destinations and forms a list of these heterogeneous tasks. This list does not contain tasks from the groups that either have similar origin or similar destination. It forms several lists like that consisting of a representative task from each group until it covers all the groups. VT then sends each list to 3PL system for planning. When 3PL system finishes planning of all the tasks in the list, it sends effective dates to VT. After receiving effective dates, VT sets potential date of all the tasks of a group to the effective date of their representative task from list. Then VT sets potential date of all the tasks of a group to the effective date of their representative task from list. Then VT asks 3PL system to undo or delete the planning of all the tasks of list as like they were never planned. It repeats the same process of planning and undoing the planning of all the tasks of all the lists. When it sets potential dates of all the tasks, VT then sends all the tasks together to 3PL system to get effective dates. This time it sets effective dates of all the tasks to effective dates it receives from 3PL system. This is how VT for I-POVES, be able to get both potential and effective dates from a 3PL system which has its own planning algorithm. If we don't have too much transport tasks especially in this thesis study, we propose the method as **(Fig-5)**. When VT receives all the tasks from the environment, it first designs a specific algorithm to find the earliest task from all the tasks. When we get the earliest task, we transform it from global ontology to local ontology and send this task to the 3PL for scheduling. When 3PL system finishes planning of this task, it sends effective dates to VT. After receiving effective dates, VT sets potential date for this task. Then VT will delete this task in the list of all the tasks and start to find another earliest task. After all the tasks are scheduled, we get the potential date of all the tasks. Then VT sends all the tasks to the 3PL to get effective date. After we get the scheduling result, we get the EP and PP of all the tasks. Actually the first idea as **(Fig-4)** is not easy to implement in the R@MSES system, so we propose to consider the second idea **(Fig-5)** as the research content and implement it in the multi-agent planning system R@MSES. Next we will present the simulation of the ISU between the transporting systems R@MSES and openTCS.

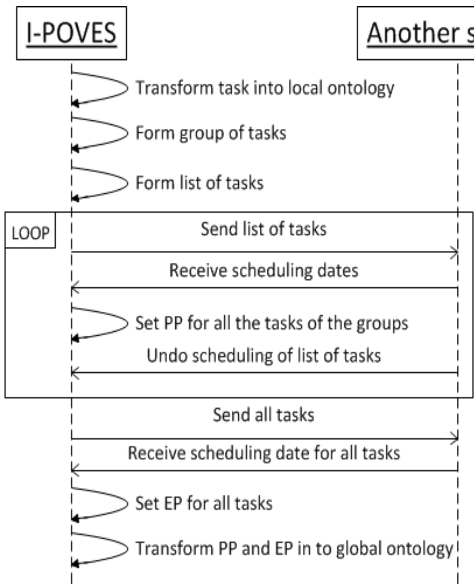

Fig. 4: Virtual Transporter process (first idea)

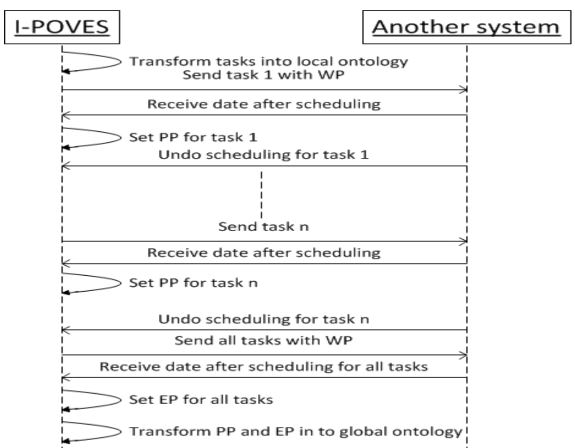

Fig. 5: Virtual Transporter process (second idea)

4. DESIGN AND IMPLEMENTATION

In this section, we will describe the design and implementation of ISU in the R@MSES system. As explained in section 2, interoperable service utilities are combined with virtual customer and virtual transporter. First we will talk about the design of virtual customer. (**Fig-6)** shows the main process of the virtual customer. It first starts from the radio in the GUI of R@MSES, when the client sends the transportation command to the R@MSES server. R@MSES gets a lot of customer orders and then creates one class of customer for each of the orders. This list of customers is stored in the class of control. Then we pick up each of the customer. According to the different ontology domain, we put the customer in the associated list of the virtual customer. The ontology classification is based on the difference between different customer local ontology. Until now we get several virtual customers which contain several customers. Virtual transporter will communicate with these virtual customers in the scheduling circles.

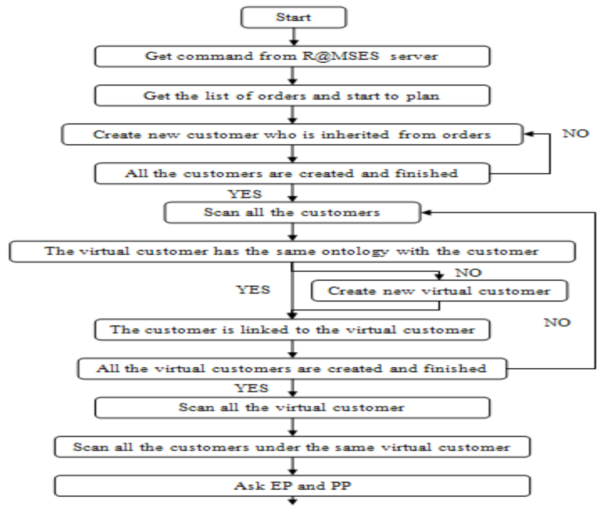

Fig. 6: Virtual Customer flow chart

In the virtual transporter side, we take a case study: we use openTCS as an example of 3PL transporter enterprise. We open several openTCS with different transport models which represents different business domains. The **(Fig-7)** shows the whole architecture of virtual transporter. Next we will introduce it step by step.

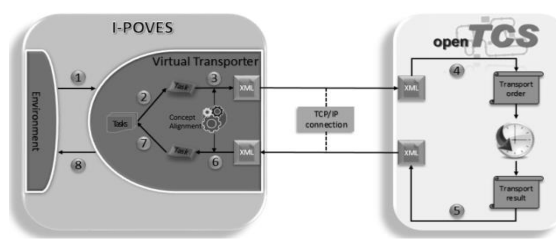

Fig. 7: The structure of virtual transporter

The first step is to create one virtual transporter for each one openTCS. The virtual transporter gets the wished position and confirmed position from the environment and puts them in the list of tasks same like a cache. The list of tasks comes from the customer orders and is classified by different 3PL transporter. Each task in the list will have a confirmed signal whether it is before scheduling or after scheduling. Virtual transporter needs to find the corresponding 3PL who can take charge of these tasks.The second step is to get one task from the list of tasks which are not confirmed each time. Here there is an algorithm which can choose the earliest start time from the list of tasks. After all, this earliest task will be sent to transform to XML.

Table 1 Concept alignment

I-POVES	openTCS
Transport task	Type=transport
Identity	Torder-number
Activity	Path
Vehicle	Intended Vehicle
Load capacity	Current energy
Situation	Initial position
Location	Point
Start location	Location Name
	Operation=Upload
Finish location	Location Name
	Operation=Unload
Start time	Time
	Status=BEING_PROCESSED
End time	Time
	Status=FINISHED
Estimated time	Length/maximum velocity

The third step is to transform the task from global ontology to local ontology. This transformation submits the concept alignment as shown in Table 1. The task is divided into several parameters and transformed. And then a new XML telegram file is created by using TinyXML. **(Fig-8)** shows an example of the XML file. This part is the most important process to ensure the correct of the scheduling. In the XML telegram, we need to set the deadline, the number of the transport task. The transport task always has the start location and the finish location. We set the start location with the operation upload and the finish location with the operation unloads. After the XML telegram is created we open a socket which is connected with openTCS with the correct port via TCP/IP. We send this XML file to the openTCS. Meanwhile, we create a thread which makes the connection with openTCS and receives the status message from it.

```
<?xml version="1.0" encoding="UTF-8" ?>
<tcsOrderSet xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
<order deadline="2014-10-30T12:14:48.717+01:00" id="TransportOrder-01"
xsi:type="transport">
<destination locationName="tarbes" operation="Upload"/>
<destination locationName="auch" operation="Unload"/>
```

Fig. 8: XML transport telegram

The fourth step is that openTCS receives the XML telegram and transform it to transport orders. **(Fig-9)** is the structure of openTCS. The purpose of the openTCS kernel is to provide an abstract driving course model of a transportation system/plant, to manage transport orders and to compute routes for the vehicles. The main functions work in the kernel and manager can change the configuration and running strategies. The plant overview is used for medeling and visualizing the course layout. Arbitrary clients can also use the kernel to communicate with other systems. When openTCS recieves the XML telegram, it will create the transport orders. **(Fig-10)** shows an execution of transport orders in the plant overview. If the communication failed, there will be a report shown in the statistic of openTCS with error analysis. OpenTCS is an independent system and it can automatically choose the vehicle and dispatch the path. In the modeling mode of openTCS, client can edit the driving course models. According to the google map in the reality and 3PL enterprise strategy, client design and build the transport model with several parameters. Each path will have the length and vehicle speed. Each point shows the towns or cities which are linked with transport stations. In the kernel's plant operation mode of openTCS, the vehicle will be displayed and client can visualize the driving course and the processing of transport orders.

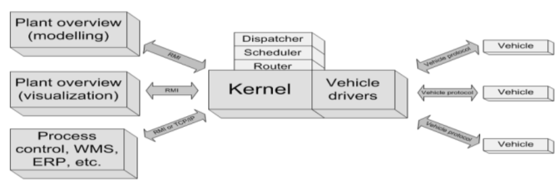

Fig. 9: The Structure Of Virtual Transporter

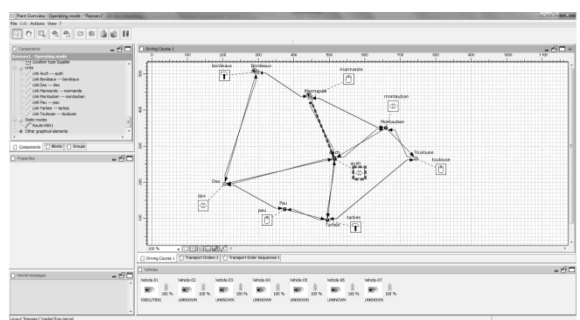

Fig.10: The execution of Transport Orders In The Plant overview of openTCS

The fifth step is to transform the transport result and send back to I-POVES. Whenever the state of a transport order changes, an XML telegram will be sent to each connected client, describing the new state of the order. There are many kinds of the status message but what we consider about are “being processed” and “finished”. The first status means the task starts to execute and another one means it is finished. When the thread is open to receive status messages in the I-POVES, the status message will be sent to an algorithm function first which can catch the useful information and complete XML message from them as the message is always mess. This algorithm will also catch the destination of each status message to identify the correctness of the message. As soon as the message is refined, I-POVES will get the XML status message.

The sixth step is to transform the XML status message from local ontology to global ontology. This is the opposite process as the third step.This transformation also submits the concept alignment as shown in **(Table-1)**. When I-POVES gets the status message in the fifth step, it will catch the data of status and the time from it. It will also catch the destination and compare it with the current one for confirmation. Then the start time and the finish time of the task which I-POVES sends to openTCS for scheduling will be modified. Finally we get the effective position.

The seventh step is to set potential position and send back to the list of tasks. In I-POVES, we set the potential position by designing an algorithm. This algorithm will get the wished position first. Meanwhile, I-POVES will scan all the tasks which are not confirmed and find the earliest time. If the wished time is earlier than this time, it will be changed. If not, we will send the effective position directly to the potential position. This algorithm will execute after we get the effective position. There is a situation that the effective position may not be the same as the wished position because the scheduling in the openTCS is independent and it may give a different result. It confirms the situation in reality. After we set the potential position, we set the signal of the task in the list to be confirmed. So when we start to find another earliest task, this confirmed task will be skipped. **(Fig-11)** shows one of the transport results which contains wished position, effective position and potential position with the associated places.

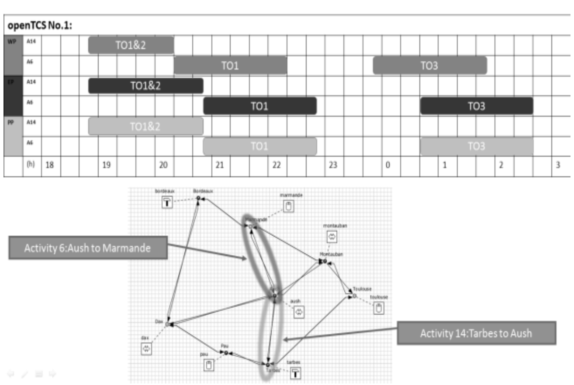

Fig. 11: Transportation result between Auch, Tarbes and Marmande

The eighth step is to send the potential position and effective position to customer. After several loops and the entire task in the list is confirmed, we send them back to the environment which will be sent to customer for confirmation. If the customer is not satisfied with this result, it will be sent back to the virtual transporter for scheduling.

5. THE ENRICHMENT OF ONTOLOGY

To achieve the goal of interoperability, we not only need the ISU to transform the data between different areas, but also we need the ontology to provide a shared vocabulary which can be used to model a knowledge domain. This will be the main objective for the future work. Transporters following the same standards but residing in different countries will also express things differently like each country has their way of defining geographical divisions. For example in France there are regions and departments and in China there are provinces and autonomous regions. Furthermore, transporters operating even in the same region to their customers have heterogeneous way of using locations name. Transporter components which are on the right of model represent 3PL companies. Each 3PL company manages a fleet of vehicles for transportation and each vehicle has been assigned a specific route to travel by their respective 3PL manager. As these 3PLs are specialized in transporting food products, their transporting vehicles are equipped with necessary equipment to carry the different types of food products. Some vehicles are equipped with refrigeration facility or some with high freezing temperature. Some are partitioned in to different compartments to carry different type of products at the same time. So each 3PL will have their own vehicles' parameters, routes, timetable and the features of the products. All of these vehicles, parameters, geographical locations and activities are defined with the terms used by their respective local transport ontology. In summary, we propose two methods to help to enrich the ontology in the ISU:

- Make a deeper understanding of R@MSES and find the similar transportation scheduling software widely. Enrich the ontology based on these systems.

- Design an interface which can quickly modify and enrich the local ontology for the future development.

6. CONCLUSIONS

In this paper, authors propose the interoperable service utility which can be integrated into the existing scheduling system R@MSES to solve the interoperable problem. R@MSES comes from a multi-agent framework called POVES (Path finder, Order agent, Vehicle agent, Environment, Supervisor). The original opinion is to use R@MSES to handle with transportation planning problems. Now the POVES model is developed to the I-POVES model. It is specialized for transportation scheduling and integrated with the ISU.

In reality, customers propose to send the transport order to R@MSES for scheduling. But there are many kinds of the customer orders, in another word, the customer local ontology is different. Now the virtual customer is used as the part of ISU to transform these orders into the same global ontology. Each virtual customer in the R@MSES is classified by different local ontology and it contains the list of the transport orders which come from the same domain.

R@MSES also needs the help from several 3PL transport company. In this paper, the openTCS is the best choice of the 3PL transport software. Virtual transporter selects the tasks from the whole tasks and transforms them into the openTCS ontology based on the concept alignment. OpenTCS is an independent scheduling system and the process of scheduling is visualized when the system receives the transport orders. As soon as the scheduling in the openTCS finishes, virtual transport transforms back to the R@MSES ontology and get the scheduling result. For the future, the enrichment of the concept alignment is necessary to solve the problem of interoperability. A more comprehensive and complete transport scheduling system R@MSES need to be designed and improved to accept more challenges.

REFERENCES:

Bozzo, R., M. Canepa, C. Carnevali, R. Genova, G. Priano, (2014). Method for analysis and comparison in planning urban surface transport systems. Public Mobility Systems, vol. 3, 63-66.

Ballini, F., R. Bozzo, C. Carnevali, R. Genova, (2011). A comparison of methods in planning urban transport networks, considering new perspectives in interoperable systems[J]. In Integrated and Sustainable Transportation System (FISTS), 2011 IEEE Forum on 278-282. IEEE..

Fernandez, S., T. Ito, (2016). Using SSN Ontology for Automatic Traffic Light Settings on Intelligent Transportation Systems. In Agents (ICA), IEEE International Conference on agents 106-107. IEEE.

Guédria, W., Y. Naudet, (2014). Extending the ontology of enterprise interoperability (OOEI) using enterprise-as-system concepts. In Enterprise Interoperability VI 393-403. Springer International Publishing in I-ESA Albi-France (Conference on Enterprise systems and applications)

Ishak, K., B. Archimede, P. Charbonnaud, (2008). Enhancing interoperability between enterprise planning applications: An architectural framework. In Digital Information Management, ICDIM. Third International Conference on 298-303. IEEE.

Li, Y., (2007). Impact of modern logistics on industrial location choice and property markets. Thesis (Ph. D.), Massachusetts Institute of Technology, Dept. of Urban Studies and Planning.

Marasco, A., (2008). Third-party logistics: A literature review International Journal of Production Economics, 113(1), 127-147.

Memon, M. A., B. Archimède, (2013). A Multi-Agent Distributed Framework for Collaborative Transportation planning. IFAC Proceedings Vol. 46(9), 1370-1375.

Memon, M. A., and B. Archimede, (2013). Towards a distributed framework for transportation planning: A food supply chain case study. In Networking, Sensing and Control (ICNSC), 2013 10th IEEE International Conference on 603-608. IEEE.

Memon, M. A., A. Letouzey, M. H. Karray, B. Archimède, (2014). Collaborating Multiple 3PL Enterprises for Ontology-Based Interoperable Transportation Planning. Proceeding of I-ESA-(Conference on Enterprise systems and applications) Albi- France. Enterprise Interoperability VI, 319-329. Springer International Publishing.

Mes, M., M. vander Heijden, P. Schuur, (2013). Interaction between intelligent agent strategies for real-time transportation planning. Central European Journal of Operations Research, 21(2), 337-358.

Memon, M. A., B. Archimede, (2013). Towards a distributed framework for transportation planning: A food supply chain case study. In Networking, Sensing and Control (ICNSC), IEEE International Conference on 603-608. IEEE.

Niaraki, A. S., K. Kim, (2009). Ontology based personalized route planning system using a multi-criteria decision making approach. Expert Systems with Applications, 36(2), 2250-2259.

Takoudjou, R. T., J. C. Deschamps, R. Dupas, (2012). A hybrid multi-start heuristic for the pickup and delivery problem with and without transhipment. In Proceedings of international conference of modeling, optimization and simulation Bordeaux, France . 233-242

Zbib, N., B. Archimede, P. Charbonnaud, (2012). Interoperability service utility model and its simulation for improving the business process collaboration. In Enterprise Interoperability V, 403-413.