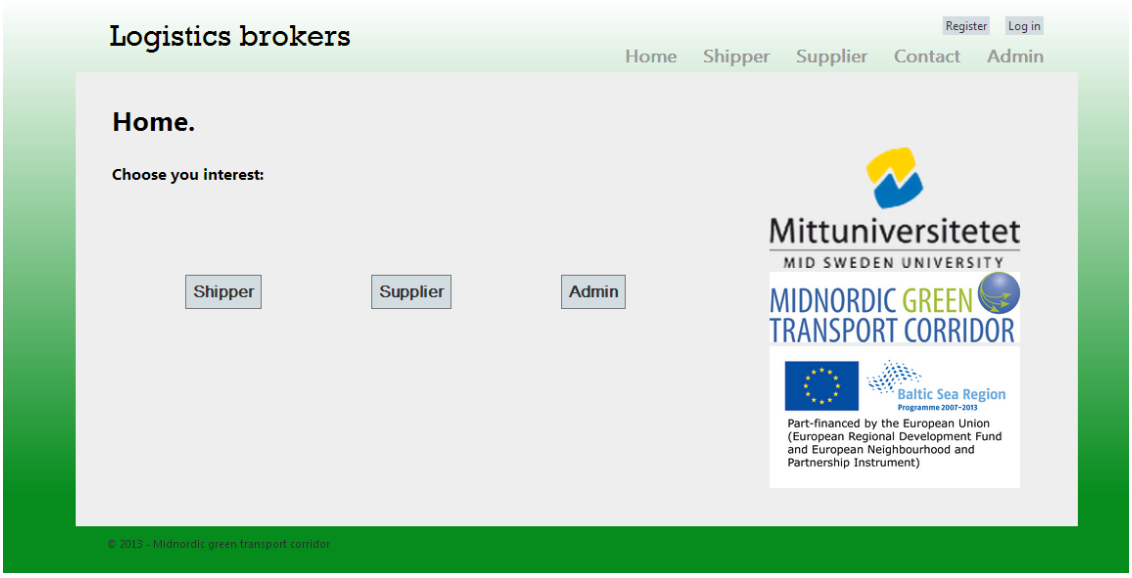
MIDNORDIC GREEN TRANSPORT CORRIDOR
Development project North East Cargo Link II

Baltic Sea Region
Programme 2007-2013
Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

TECHNICAL DOCUMENTATION OF THE FIRST VERSION OF THE ICT PORTAL


Logistics brokers
Register
Log in
Home
Shipper
Supplier
Contact
Admin
Shipper
Supplier
Admin
Mittuniversitetet
MID SWEDEN UNIVERSITY
MIDNORDIC GREEN TRANSPORT CORRIDOR
Baltic Sea Region
Programme 2007-2013
Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

Home.

Choose you interest:

© 2013 - Midnordic green transport corridor

REPORT
2013-03-27

NORTH EAST CARGO LINK (NECL II)
WP 5 Activity 5.4

Mittuniversitetet
MID SWEDEN UNIVERSITY

Authors: Elias Vesterlund
Leif Olsson

Contact: Leif Olsson
Division of information and Communication Systems
Mid Sweden University
85170, Sundsvall, Sweden
Email: Leif.Olsson@miun.se

Web access: www.midnordictc.net

Table of contents

SVENSK SAMMANFATTNING

Den tekniska specifikationen är utförd för att visa hur en prototyp som använder sig av en matematisk optimeringsmodell från Mittuniversitetet har skapats och fungerar. Prototypen används för att uppmärksamma den matematiska kärnans fördelar för transportföretag. Prototypen är uppdelad i fyra olika delar, en databas, en beräkningskärna, en wrapper som innehåller beräkningskärnan samt en webbsida. Webbsidan är till för både transportörer och leverantörer med behov av transporter. Specifikationen går inte igenom den matematiska optimeringsmodellen som finns dokumenterat i ett flertal vetenskapliga artiklar. Några av de viktigaste kraven vid utvecklingen av portalen var att använda verkliga fall, att kunna lägga till transporter samt att kunna visa optimeringsresultaten på ett korrekt sätt. Tekniskt måste prototypen även visa att lösningen fungerar med många olika databaser och att den är sammanhangsoberoende. En fördel är att prototypen kommunicerar med JSON och sockets vilket innebär att annan programvara kan anslutas till wrappern. Det största problemet med prototypen är att det finns en möjlighet att rensa databasen under körning, vilket behövs i demonstrationssyfte men som kan ge upphov till problem om sökningar sker samtidigt. Ett annat problem är att alla kan gå in och använda optimeringen. I slutprodukten måste platslogiken lösas. För att använda den matematiska modellen helt bör det också finnas stöd för multi-hop vägar.

ABSTRACT

The technical specification is designed to show how a prototype that uses a mathematical optimization model from Mid Sweden University has been created and works. The prototype is used to draw attention to the mathematical core benefits for shipping agents. The prototype is divided into four different parts, a database, a calculation core, a wrapper that contains the computing center and a website. The website is for both shippers and suppliers with transportation needs. The specification does not go through the mathematical optimization model, which is documented in numerous scientific articles. Some of the key requirements in the development of the portal were to use real cases, be able to add transportation, and be able to show the optimization results in a correct way. Technically, the prototype must also show that the solution works with many different databases and that it is context-independent. One advantage is that the prototype communicates with JSON and sockets, which means that other software can be connected to the wrapper. The biggest problem with the prototype is that there is an opportunity to purge the database at runtime, which is needed for demonstration purposes but can cause problems if the searches take place simultaneously. Another problem is that anyone can go in and use the optimization. The final product must place the logic solved. To use the mathematical model completely, it should also be support for multi-hop paths.

TERMINOLOGY

Wrapper A program whose main purpose is to call a second program.

Marshalling is the process of transforming the memory representation of an object to a data format suitable for storage or transmissionORM

ORM Object-relational mapping, in computer software is a programming technique for converting data between incompatible type systems in object-oriented programming languages.

ODBC Open DataBase Connectivity, a standard database access method.

1 INTRODUCTION

This technical specification is a work in computer science within the MidNordic Green Transport Corridor. Another part of the project done by Midnordic Green Transport Corridor is to use the mathematical optimization model developed at Mid Sweden University to show how future work could use this mathematical optimization model to evolve the transport market.

The intention is that the portal should be used for booking of freight transports by suppliers using the shipping agents transport capacity in the same manner as we today book our personal transports on the web for trains, flights etc. Today there exist some systems. However, we have not seen anyone that take into consideration cost, time and emissions using joint optimization procedures. The intention is that this should be used by a company that administrates this as a market for freight transports as fourth part logistics service. However, it can also be used internally at a company by, for instance, a shipping agent.

The mathematical optimization program uses cost, time and emissions to optimize the routes. This program will both enhance support for freight planers and also minimize the amount of partially filed transports. This optimization routine using a multi-criteria approach has been published as several scientific papers during the project [1], [2], [3] and will not be considered here.

A prototype was created to show how the optimization model could be used with real-case data and the beneficial outcome. Below the technical computer scientific aspects of the prototype will be described in a broad sense. After that there is a part describing the general and technical requirements followed by the general and technical solutions to the problems. Finally there are some final thoughts and further development to a final product is discussed.

1.1 Overview of the prototype

This prototype programme comes with four separate components. The calculation core developed in the mathematical programming software Lingo [4], the wrapper/TCP-Server, the webpage and a database (Figure 1.1.) The Lingo part and the calculation core will not be examined here in any greater depth, except functions that can be invoked from the core, since this part has already been published.

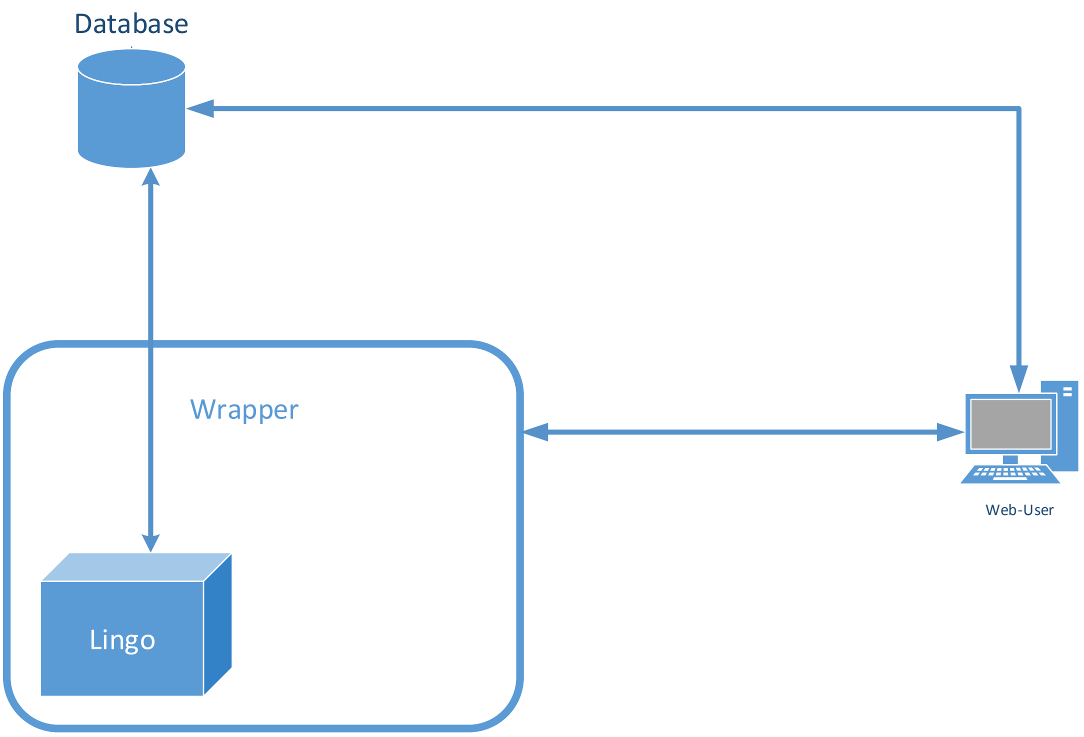


Figure 1.1: An overview of the portals technical structure.

1.1.1 Lingo

Lingo is a comprehensive mathematical tool, written in C, which is used to optimize mathematical functions. In Lingo the mathematical optimization model developed by Mid Sweden University is used to search for the best transport alternatives. In this case it is used to optimize the cost, CO2 or time for transports between locations. The model has support for multi-hop routes but is not implemented in this prototype.

1.1.2 Wrapper

The wrapper is a shell, written in C# (C sharp), above Lingo that handles incoming TCP-requests from the webpage and translates these requests to a type that Lingo understands, through a method called marshalling.

1.1.3 Webpage

The webpage is implemented in ASP.Net MVC webpage using TCP-sockets as connection to Lingo through the wrapper. Much of the communication doesn't involve calculations, like fetching transports list from the database. Therefore it uses Fluent NHibernate to map and fetch data from the database.

1.2 Objectives

The objective of the document is to shortly describe how the prototype programme was constructed and connected to the optimization model developed by researchers at the Mid Sweden University in close contact with staff at a transport company. The prototype programme disadvantages and strengths will be discussed for future work.

1.3 Scope

This technical specification will contain the requirements of the prototype from a computer scientific perspective, final functionality, problem with the prototype and the thoughts about future development.

2 REQUIREMENTS

This part will describe the basic requirements for the prototype and the technical requirements that was semi imposed by the use of Lingo. We will sort these requirements by mandatory, required and desired in part 2.1.

In the part 2.2 general and technical results will be described and finally some thoughts about requirements for the future development will be discussed.

2.1 General requirements

Mandatory:

Requirement 1.1: A website/web interface that could be used to initialize- and display results from a calculation in Lingo, see 3.1.

Requirement 1.2: The prototype will use real-case data, see 2.1.

Requirement 1.3: It should be possible to add new transports between destinations.

Requirement 1.4: To use the all of the functionality from the optimization program multiple transport searches should be possible from the webpage.

Requirement 1.5: The website must have correct banners from Mid Sweden University, EU and MidNordic Green Transport Corridor during the project

Required:

Requirement 2.1: The prototype should be able to rest to the original real-case data.

Requirement 2.2: It should be possible to add destinations

Requirement 2.3: When optimizations don't work due to data in the database it will be marked in red.

Requirement 2.4: The webpage must contain both a part for shipper and supplier where the supplier part is for the company searches for transport and shipper is for the transport company, viewing and adding transports.

Requirement 2.5: A login must be made so that only demonstrators could reset the data and do searches.

Desired:

Requirement 3.1: The website will have a good layout/design.

Requirement 3.2: Destinations should have an auto fill function showing possible destinations when doing searches or adding transports.

2.2 Technical requirements

The technical requirements are few too no one as the project is just a proof of concept. One requirement is though that the technology used to communicate to the wrapper should be usable both from webpage's, mobile applications or ordinary applications on stationery computers.

Another requirement, desired, is that it should work with many kinds of databases.

The use of Lingo as the calculation program sets some restrictions.

1. Lingo can only fetch data directly from a database through an ODBC-connection.
2. There is no way of fetching "linked" data from a database.
3. To communicate with Lingo, set data or fetch data from another application is to use marshalling through their DLL-file.
4. DLL- files only work in windows.
5. Through marshalling the only data type supported is double so all other data types must be converted to double. With the ODBC-connection integer and float values are okay.

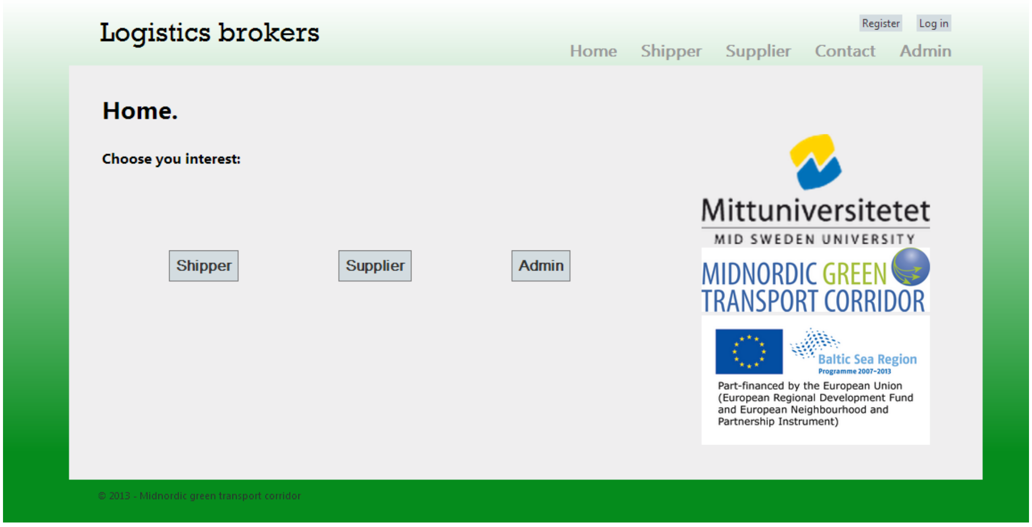
However, there are steadily new releases of Lingo so it will probably not be any problem in the future. Furthermore, this is only a prototype and for a real implementation other software’s could be used since the mathematical model can easily be transformed to other model based languages by anyone that can read scientific research papers in optimization.

3 THE PROTOTYPE

In this part the final prototype will be described in both a general user way and a more technically oriented way. After this there is a section that describes the final thought of improvements needed for a final product.

3.1 Layout and functions

As seen in, Figure 2, there are correct banners on the start page and the page is divided up into shipper and supplier parts depending on what interest the user have.



Logistics brokers

Home.

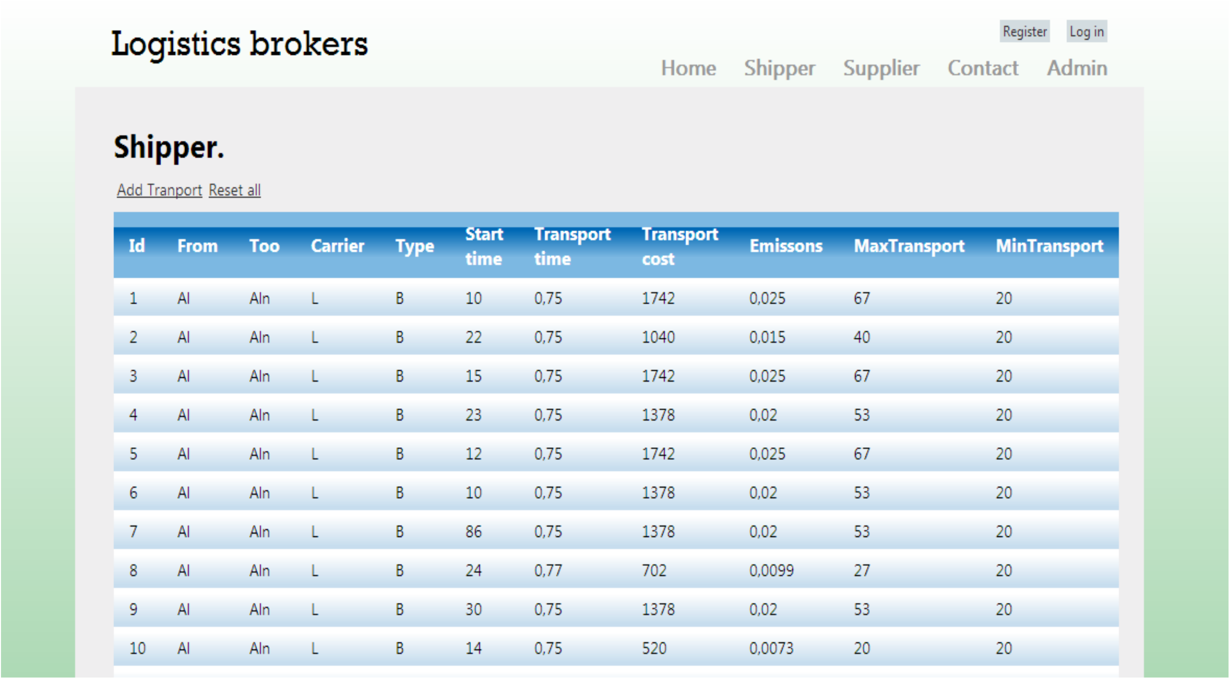
Choose you interest:

Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

© 2013 - Midnordic green transport corridor

Figure 2: The front page with banners and links for shipper and supplier.

Under the first link, shipper, there is a page displaying all transport that gives the possibility to reset the database to the real-case data contained in an Excel-file. There is also the function to add a new transport. See Figure 3.



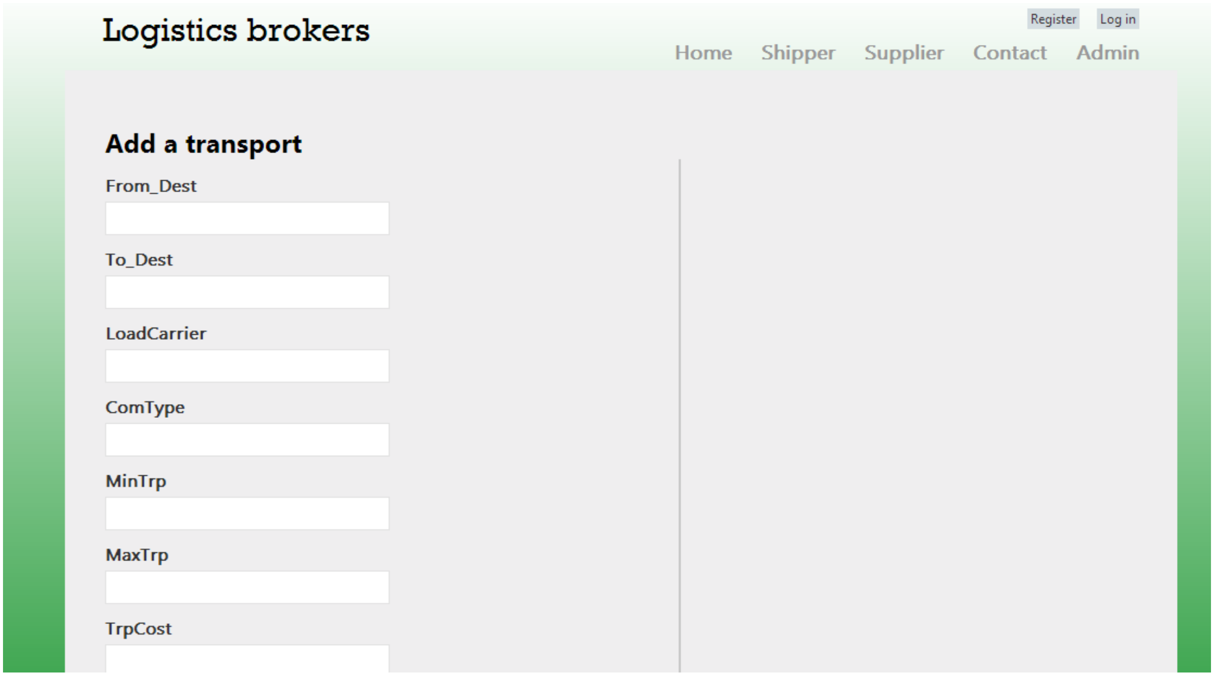
Logistics brokers

Shipper.

Id	From	Too	Carrier	Type	Start time	Transport time	Transport cost	Emissons	MaxTransport	MinTransport
1	Al	Aln	L	B	10	0,75	1742	0,025	67	20
2	Al	Aln	L	B	22	0,75	1040	0,015	40	20
3	Al	Aln	L	B	15	0,75	1742	0,025	67	20
4	Al	Aln	L	B	23	0,75	1378	0,02	53	20
5	Al	Aln	L	B	12	0,75	1742	0,025	67	20
6	Al	Aln	L	B	10	0,75	1378	0,02	53	20
7	Al	Aln	L	B	86	0,75	1378	0,02	53	20
8	Al	Aln	L	B	24	0,77	702	0,0099	27	20
9	Al	Aln	L	B	30	0,75	1378	0,02	53	20
10	Al	Aln	L	B	14	0,75	520	0,0073	20	20

Figure 3: The Shipper page, displaying all transport and the data about them.

When adding a new transport there is an error control demanding certain length of word and value type, for example MinTrp, sees Figure 4, cannot be a char or string. The date/time parameter is just a double describing from how many hours from now the transport will leave. There is no auto-fill/complete function when selecting source and destination.



Add a transport

From_Dest

To_Dest

LoadCarrier

ComType

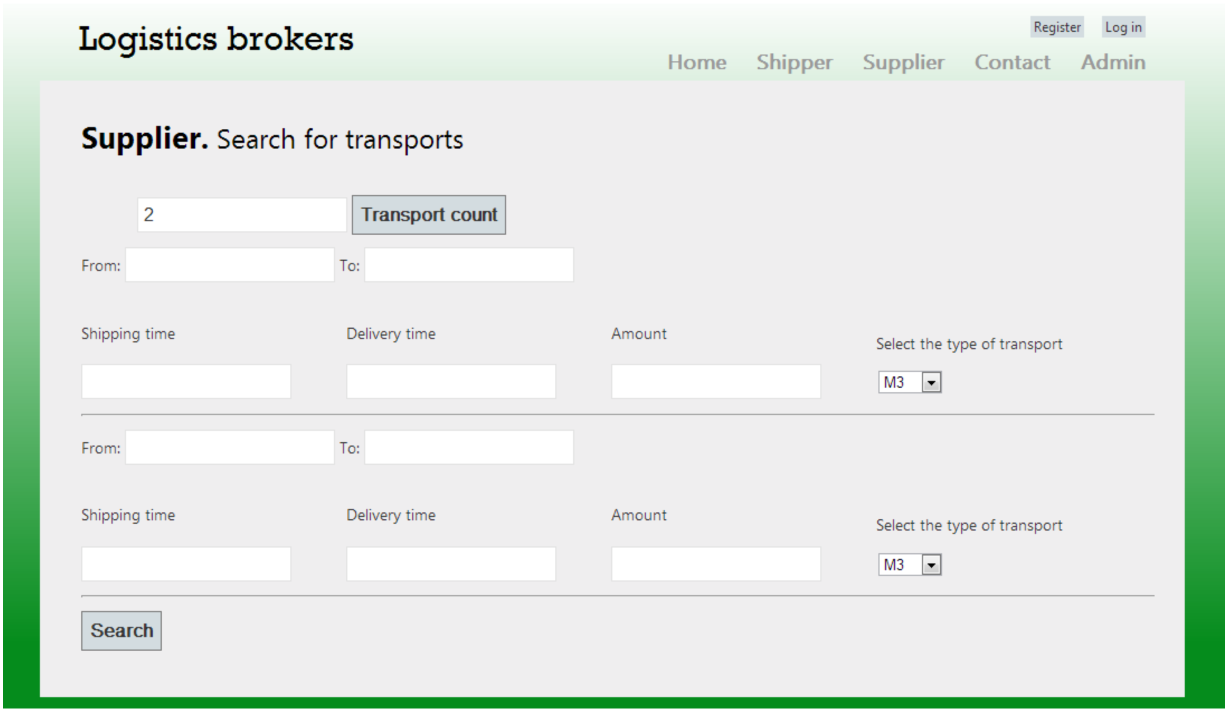
MinTrp

MaxTrp

TrpCost

Figure 4: A minimized overview of the data needed to add a transport.

Under the supplier tab the user searching for transports may choose how many transports the user requires. The user sets its boundaries in regards of start time, end time and amount to be transported (Figure 5).



Supplier. Search for transports

2

From: To:

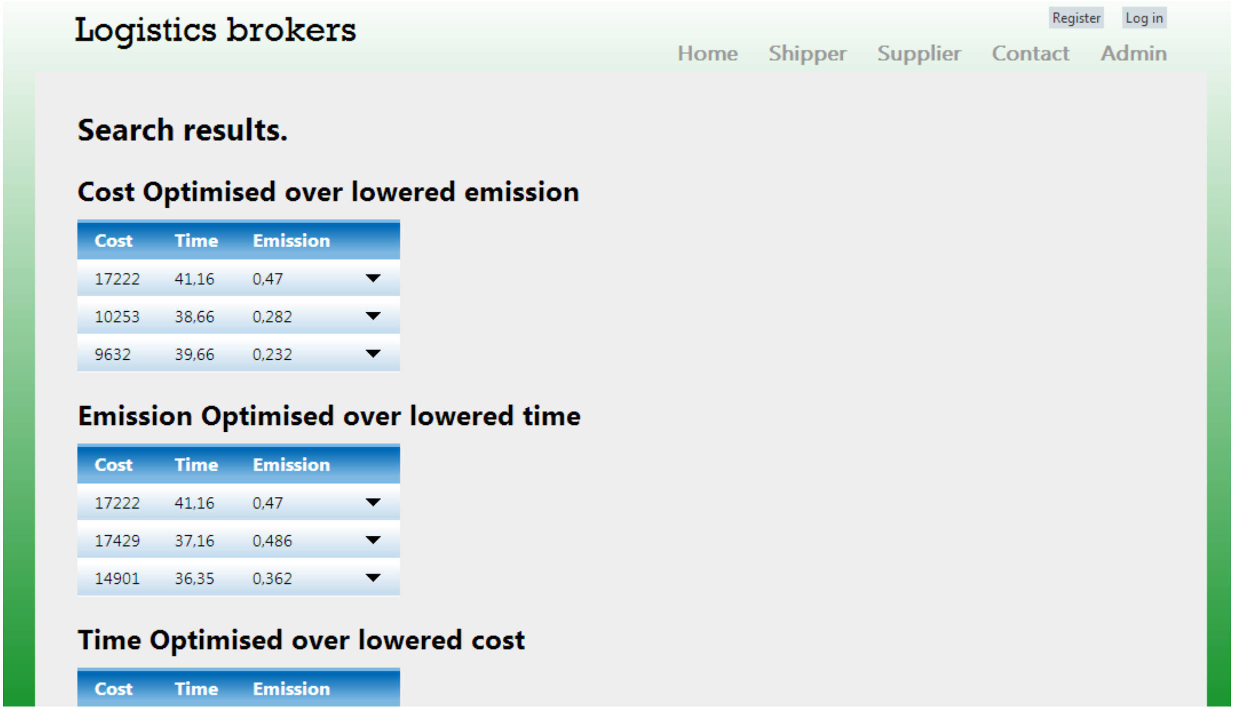
Shipping time | Delivery time | Amount | Select the type of transport: M3

From: To:

Shipping time | Delivery time | Amount | Select the type of transport: M3

Figure 5: The suppliers search interface.

When a user has committed a search the result view is shown. In the prototype there are three standard optimizations. The three optimizations are cost over lowered emission, emission over lowered time and time over lowered cost. Each optimization type is run three times (Figure 6). There are also additional information about every transport besides the total cost, total emission and total time for all specified transports. Furthermore, there is also a red color indicating if the optimization found an alternative that could not solve every aspect (Figure 7). For instance, if not all volume could be sent to the final destination. As described in our research papers [1] and [2] we have developed a routine to automatic weight cost, time and emissions to give automatic weighted results. However, this part is not included in the prototype programme yet, but will be in included as an option during the final case study.



Search results.

Cost Optimised over lowered emission

Cost	Time	Emission
17222	41,16	0,47 ▼
10253	38,66	0,282 ▼
9632	39,66	0,232 ▼

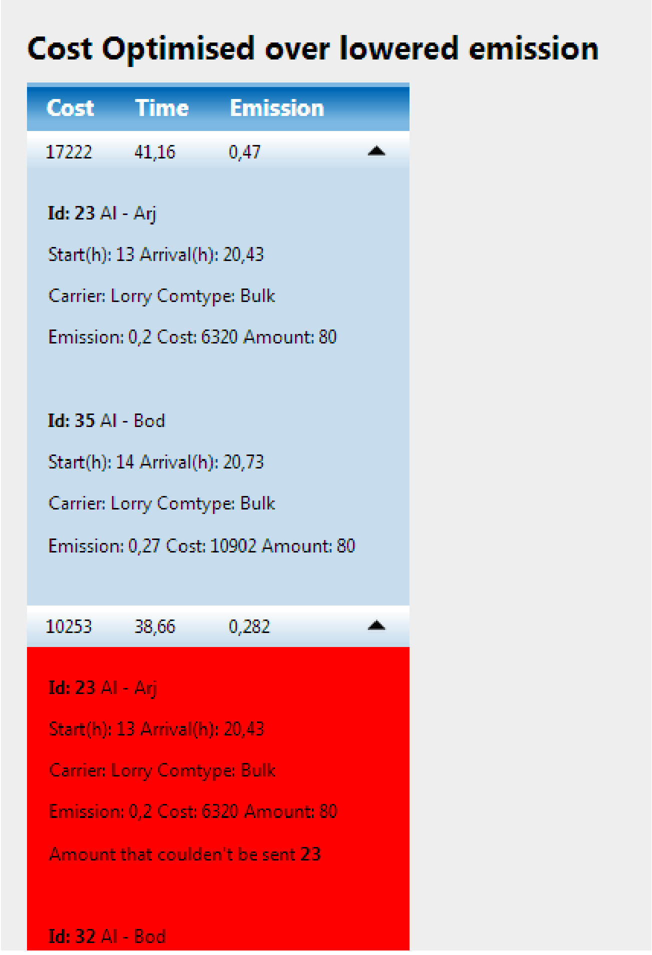
Emission Optimised over lowered time

Cost	Time	Emission
17222	41,16	0,47 ▼
17429	37,16	0,486 ▼
14901	36,35	0,362 ▼

Time Optimised over lowered cost

Cost	Time	Emission

Figure 6: The result from a shipper search with three different optimizations with three results per optimization.



Cost Optimised over lowered emission

Cost	Time	Emission
17222	41,16	0,47

Id: 23 Al - Arj

Start(h): 13 Arrival(h): 20,43

Carrier: Lorry Comtype: Bulk

Emission: 0,2 Cost: 6320 Amount: 80

Id: 35 Al - Bod

Start(h): 14 Arrival(h): 20,73

Carrier: Lorry Comtype: Bulk

Emission: 0,27 Cost: 10902 Amount: 80

10253	38,66	0,282

Id: 23 Al - Arj

Start(h): 13 Arrival(h): 20,43

Carrier: Lorry Comtype: Bulk

Emission: 0,2 Cost: 6320 Amount: 80

Amount that coulden't be sent 23

Id: 32 Al - Bod

Figure 7: The result from a shipper search, showing additional information and error.

3.2 Technical viewpoint

This part will describe the technical setup for the produced prototype. Starting at the database setup and continue to the calculation core/wrapper up towards the webpage. The finished prototype uses the setup from figure 1.

3.2.1 Database

Firstly when doing a calculation in Lingo there is an ODBC-connection to the SQL Express 2008 database, which cannot handle the logic behind keys and links between different tables. So the database only has one massive table containing all the routes and one table containing all the locations. As the connection cannot handle links between tables the table containing the routes has redundant information on the locations.

3.2.2 Wrapper

The wrapper is a C#.net application due to the fact that the Lingo model using a DLL-file that forcing the development to be performed in a Windows environment. C#.net is also very compatible with ASP.net which is our webpage platform.

In the wrapper the Lingo model is semi detached. This is because Lingo needs all data entries, transports and places from the database and the search parameters from the wrapper to perform the optimization. It is not faceable to take all the data from the database through the wrapper. This is because the Lingo program only has a DLL-file with support of marshalling a double into a pointer. Hence, in the Lingo environment it would be unreasonable to marshal a whole database since it would require too much of the memory. It would also mean that all locations, represented as strings, would need a character by character transformation to a byte representation and also need special string formatting to be accepted by the Lingo model.

The wrapper is in short a TCP-socket server receiving synchronous socket connections from the webpage. Giving all request a unique thread that receives incoming data, doing a search and replying with the answer. The data transferred between the wrapper and the webpage is JSON serialized data in byte representation. So for every request there are a serialization and a deserialization.

3.2.3 Webpage

The webpage was developed in ASP.net MVC. This was chosen because Lingo forces development in a Windows environment.

The webpage uses a socket connection to connect to the wrapper. As we do not want to save the socket connections between searches the connection class is of type IDisposable which means that we can dispose of the instance after every call to the wrapper. During the call the data to be sent is JSON serialized and sent byte for byte.

After receiving a search result, viewing transports available or adding a transport/location the webpage directly communicates with the database. This is done through an ORM called Fluent NHibernate. When opening the webpage the Fluent NHibernate session factory is constructed and saved throughout the visit. For the above actions a new session to the database is opened and dropped automatically. When a user exits the webpage the Fluent NHibernate session factory is disposed. This is done by putting Fluent NHibernate in IHttpModule which is handled by the ASP.net MVC page.

To reset the database "the it" clears the database of all data and uses an OleDbConnection to fetch the original real-case data from a static Excel sheet and saves all rows into the SQL-database.

4 PROBLEMS AND FUTURE WORK

Before this prototype can be a finalized product there are kinks that must be solved and some generally needed upgrades. The major problems in the program that have to be solved are:

- Lingo cannot be semi detached from the wrapper. Because Lingo has so bad support for databases/connectivity possibilities which leads to the problem that a whole database cannot be stored in memory for every incoming request.
- Though the connectivity, through Fluent NHibernate, from the webpage requires a lot of supply it also creates thread safety problems when doing updates on the database from the webpage in the same time as someone does a search. But removing the possibility to delete the whole database should solve the problem sufficiently.
- A module on how to authenticate a user between the webpage and wrapper should be done as well as a login to the webpage.

Generally to have a finished product that can be tested at the transport companies these changes must be performed:

- There should be almost complete list of possible locations or a method of entering new locations and validating their validity.
- The destinations must be more complex than just a city.
- A method for actually updating the database with how filled all transports are.
- A way for the shippers to update and change transport in an easy way.
- Support for multi-hop paths to get the maximal out of the optimization program.
- A billing system must be created.
- The design of the webpage needs to be modified to be more user friendly and with a better design.

In the subsection 4.1 we will discuss some usage and security issues that is know with the prototype.

4.1 Outstanding issues

There are some issues that haven't been resolved in the prototype implementation. These have been divided into the subcategories usage related and security related issues

4.1.1 Usage

- The original data that is fetched from the XML-file is containing hours from now. This means its storing an integer and not a date which would be done in a final version.

- When adding positions in the database there are no verification if the naming is "correct".
- When searching for locations a list of matches should be generated.
- The prototype doesn't support multi-hop paths.
- In the wrapper a new thread is generated for each socket connection from the webpage. The threads are not deleted after use and will start using a lot of memory when many requests are sent.
- The socket server is generated in a thread and is believed to be erased by windows garbage collector after a lot of down time.

4.1.2 Security

- In the prototype Lingo may start making calculations, requesting data from the database. In the same time one user might request a rest of the database. This will result in the webpage not being able to display the results correctly or Lingo failing half way through the calculations. As per say, it is not thread safe at all.
- There is no implemented security in the TCP-communication so all malicious attacks are possible. Though the TCP-communication only allows XML-code and will only solve different searches.
- The database might be flooded with information as there are no garbage collections.

4.2 References

[1] Kalinina.M., A.Larsson. and L.Olsson.”Generating of Ordering of Transport Alternatives in Intermodal Logistics in the Presence of Cost, time and Emission Conflicts*” in the IEEE International Conference on Industrial Engineering and Engineering management,* Hong Kong 2012.

[2] Kalinina.M, Larsson. A and Olsson. L. 2013. "Easy-Interactive Ordering of the Pareto Optimal Set with Incomplete Preference Information," *accepted at the International Conference on Operations Research*, France, 2013.

[3] Olsson.L, Larsson.A., Matching of Intermodal Freight Transports using optimization in a decision support system, *in the IEEE International Conference on Industrial Engineering and Engineering management,* Hong Kong 2012.

[4] LINDO Systems Inc., 2011. Lingo user's guide, Chicago, Illinois 60642: LINDO Systems Inc..

Baltic Sea Region
Programme 2007–2013
Part-financed by the European Union
(European Regional Development Fund
and European Neighbourhood and
Partnership Instrument)

MIDNORDIC GREEN TRANSPORT CORRIDOR

Development project North East Cargo Link II

NORTH EAST CARGO LINK II PROJECT

Development project in Baltic Sea Region Programme 2007–2013.
Duration: 2010–2013
Budget: approx. 2,7 M€.
22 partners from all Midnordic regions, Sweden, Finland and Norway.

Expected results

- Close cooperation with national transport authorities and industry and other related projects and transport corridors.
- Affect the infrastructure planning in various countries in the direction of investment promoting the Midnordic transport corridor.
- A fully working operational ICT-system for transport operators and cargo owners.
- Remove border obstacles that inhibit trade and transport between countries.
- A valuable base for environmental efforts towards a transition from road to rail and marine transport, which will improve the environment.
- Better transport service and improved goods transport solutions for region´s existing companies.

www.midnordictc.eu

Länsstyrelsen
Västernorrland

Contact information - Leadpartner
County Administrative Board of Västernorrland,
SE - 871 86 Härnosand, Sweden
+46-611-34 90 00   E-mail: vasternorrland@lansstyrelsen.se