# Porting existing Software of *"Confluentic 1"* into Tenneco's Client-Server Environment

(Design and Programmer's Manual)

Diploma Thesis

Jens Drogi

*Supervised by*

Prof. Dr. Klaus G. Troitzsch

*and*

Daniel Schmidt

**Institute for Information Systems Research**

**Department of Computer Science**

**University of Koblenz-Landau**

December 21, 2006

# Erklärung

Ich versichere, dass ich die Arbeit ohne fremde Hilfe und ohne Benutzung anderer als der angegebenen Quellen angefertigt habe und dass die Arbeit in gleicher oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegen hat und von dieser als Teil einer Prüfungsleistung angenommen wurde. Alle Ausführungen, die wörtlich oder sinngemäß übernommen wurden, sind als solche gekennzeichnet.

Die Richtlinien des Instituts für Studien- und Diplomarbeiten habe ich gelesen und anerkannt, insbesondere die Regelung des Nutzungsrechts.

# Statement

I declare, that I wrote this thesis using no other means and sources than those explicitly mentioned.

December 21, 2006 Signature

# Acknowledgement

Along with this I would like to thank everybody for their cooperation, support and help during this project.

Special thanks go to Prof. Dr. Klaus G. Troitzsch and Daniel Schmidt for their very well supervision work during this Diploma Thesis. Especially I want to thank Daniel Schmidt. He spent a lot of time introducing and explaining details of Confluentic 1 to me and gave a lot of good and helpful suggestions to improve this work.

Furthermore, I would like to thank Stefan Dederichs, Andreas Röhncke and Jürgen Kopper for their close and productive collaboration within CATIS, FIONA and Confluentic WEB.

Last but not least I would like to thank all involved Tenneco people - logistics experts and IT-people - who had a close look on this project and gave advise from their practical point of view.

Hopefully this Diploma Thesis is a good basis for the nearby implementation of Confluentic WEB.

# Contents


**1 Introduction** **1**

1.1 Outline . . . . . 1

1.2 Course of action . . . . . 3

**2 Requirements Analysis** **5**

2.1 General project goals of Confluentic WEB . . . . . 6

2.2 Confluentic 1 . . . . . 6

2.2.1 Location, shipment, trip and scenario . . . . . 6

2.2.2 Transport costs . . . . . 7

2.2.3 Inventory cash and costs . . . . . 8

2.2.4 Transport and inventory costs . . . . . 9

2.2.5 Outcome and benefit . . . . . 10

2.3 Business consideration . . . . . 10

2.3.1 Location master data . . . . . 10

2.3.2 Tariffs . . . . . 11

2.4 Technical consideration . . . . . 11

2.4.1 Two-tier architecture of Confluentic 1 . . . . . 11

2.4.2 Criticism . . . . . 12

2.4.3 Three-tier architecture . . . . . 13

**3 Requirements Specification** **15**

3.1 Business requirements . . . . . 15

3.1.1 Location master data . . . . . 16

3.1.2 LMT - Location Management Tool . . . . . 17

3.1.3 Virtual locations . . . . . 17

3.1.4 Real tariffs . . . . . 17

3.1.5 Fall back and generic tariffs . . . . . 18

3.2 Technical (IT) requirements . . . . . 20

3.2.1 Global system requirements . . . . . 20

3.2.2 MVC and Struts Framework . . . . . 20

3.2.3 Visualization . . . . . 22

3.3 Programmer's Manual . . . . . 22

3.4 Transport Wiki . . . . . 23

**4 Design and Programmer's Manual** **24**

4.1 Formal model . . . . . 24

4.1.1 Scenario . . . . . 26

4.1.2 Location . . . . . 26

4.1.3 Shipment . . . . . 27

4.1.4 Trip . . . . . 27

4.2 Use cases . . . . . 28

4.2.1 Create a scenario . . . . . 28

4.2.2 Load a scenario . . . . . 29

4.2.3 Calculate/optimize scenario . . . . . 31

4.2.4 Location Management . . . . . 32
4.3 Database model . . . . . 33
4.3.1 Location master data and default shipments . . . . . 35
4.3.2 Scenarios, scenario locations and scenario shipments . . . . 36
4.3.3 TripSchemes . . . . . 37
4.3.4 User rights . . . . . 38
4.4 Graphical User Interface . . . . . 38
4.4.1 General layout . . . . . 38
4.4.2 Menu based workflow . . . . . 39
4.4.3 Dummy pages of Confluentic WEB . . . . . 41
4.4.4 LMT - Location Management Tool . . . . . 56
4.5 CATIS interface . . . . . 61
4.6 Map server . . . . . 63

**5 Conclusion** **66**
5.1 Summary . . . . . 66
5.2 Prospects . . . . . 67

**A Used applications** **68**

**B Requirements Specification 1.8** **69**

**C UML diagram of Confluentic 1** **79**

**D Use Case diagrams** **81**

**E Database model CATIS, FIONA and Confluentic WEB** **86**

**F Glossary** **88**

**Bibliography** **93**

# List of Figures


1.1 Project life cycle of Confluentic WEB . . . . . 3

2.1 Saw tooth diagram . . . . . 8

2.2 Transport and inventory costs curves . . . . . 9

2.3 Two-tier architecture of Confluentic 1 . . . . . 12

2.4 Three-tier architecture for a improved Confluentic Application . . . 14

3.1 First global use case diagram of Confluentic WEB . . . . . 16

3.2 Web application with Struts . . . . . 21

3.3 Transport Wiki – start page . . . . . 23

4.1 Formal model of Confluentic WEB . . . . . 25

4.2 Use case “create a scenario” . . . . . 29

4.3 Use case “load a scenario” . . . . . 30

4.4 Use case “calculate/optimize scenario” . . . . . 31

4.5 Use case “Location Management” . . . . . 32

4.6 Database model - Confluentic WEB view . . . . . 34

4.7 General layout . . . . . 39

4.8 Menu based workflow of Confluentic WEB . . . . . 40

4.9 Menu of Confluentic WEB . . . . . 41

4.10 Dummy page *create_scenario.html* . . . . . 42

4.11 Dummy page *load_scenario.html* . . . . . 43

4.12 Dummy page *index.html* . . . . . 44

4.13 Dummy page *new_location.html* . . . . . 45

4.14 Dummy page *select_location.html* . . . . . 46

4.15 Dummy page *location_sum.html* . . . . . 47

4.16 Dummy page *new_shipment.html* . . . . . 49

4.17 Dummy page *shipment_sum.html* . . . . . 50

4.18 Dummy page *new_trip.html* . . . . . 51

4.19 Dummy page *new_trip_catis.html* . . . . . 52

4.20 Dummy page *assign_trip.html* . . . . . 53

4.21 Dummy page *active_costs.html* . . . . . 54

4.22 Dummy page *view_map.html* . . . . . 55

4.23 Dummy page *optimize_scenario.html* . . . . . 56

4.24 LMT dummy page *locations_sum.html* . . . . . 57

4.25 LMT dummy page *edit_location.html* . . . . . 58

4.26 LMT dummy page *shipment_sum.html* . . . . . 60

4.27 LMT dummy page *conf_common.html* . . . . . 61

# List of Tables

4.1 Loading mechanisms of Confluentic WEB . . . . . 31

4.2 Possible values of `usageStatus` . . . . . 35

# Chapter 1

# Introduction

This Diploma Thesis arose from the cooperation between the Institute for Information Systems Research[1], Department of Computer Science[2] at the University of Koblenz-Landau[3] (Campus Koblenz[4]) and Tenneco Automotive[5].

## 1.1 Outline

Tenneco Automotive is one of the world's leading producers of Emission Control (EC)[6] and Ride Control (RC)[7] products and manufactures both kinds of products for original equipment (OE) and aftermarket (AM).
The company is a $4.4 billion global manufacturing company based in Lake Forest, Illinois, with some about 19,000 employees and nearby 80 facilities in 24 countries on 6 continents (see [Ten06b]). Tenneco supplies about 30 OE-customers and more than 500 AM-customers spread all over the world.

Due to these facts there is no doubt, that there is an enormous amount of supply relationships between Suppliers and Tenneco plants, between Tenneco plants and Customers and a lot of relationships between intercompany (ICY) sites of Tenneco. Logistics departments are confronted with the task to manage/organize all this and

[1] [Ins06]
[2] [Dep06]
[3] [Uni06a]
[4] [Uni06b]
[5] [Ten06a]
[6] EC-products are usually known as brands like Walker, Gillet, Fonos etc.
[7] RC-products are usually known as brands like Monroe, Fric -ROT, Kinetic etc.

therefore they need auxiliary information systems to ease, reduce and optimize their work.

During the cooperation between Tenneco and the Institute several projects have been set up to enhance Tenneco's logistics workflow:

- Confluentic – Developing a software application for midterm logistics planning, which examines the relationship between inventory and transport costs (see [KLS05])
- CATIS – Implementation of a Carrier and Tariff Information System (see [Kop06])
- FIONA – Implementation of a Freight & Invoice Operations Network Application to provide processing and monitoring of freight bookings in daily business (see [DR06])
- PakMan – Conceptual Development of a Packaging Management System (see [Her05] )[8]

Confluentic calculates cash and cost positions of transport routes between supplier, intercompany (ICY) and customer sites. It is aimed to reduce the sum of transport and inventory costs. The first version of Confluentic[9] was written in C#[10] as a client application, which runs on a local machine accessing a shared database.

The aim of this Diploma Thesis is to help porting Confluentic 1 software into Tenneco's client-server environment. This new version is called **Confluentic WEB**[11].

Therefore this thesis transfers Confluentic 1 from a client application into a client-server architecture and delivers a reengineered design and programmer's manual according to this new IT infrastructure.
Adjacent to the designated aim to keep all existing features of Confluentic 1, this new design enhances Confluentic WEB to work on real tariffs[12] delivered by CATIS. In doing so, Confluentic WEB shall be qualified to deliver realistic and authentic results, which can be adopted in daily business.

[8] Additionally a prototypical web-based implementation was conducted by [Mün05].
[9] Further on, this application is called Confluentic 1.
[10] C-sharp is a programming language by the Microsoft .NET Framework.
[11] The term WEB accrued due to the fact that the new version will be a Web-Application.
[12] Confluentic 1 only works on generic tariffs.

In the following the course of action of the project Confluentic WEB is summarized. Chapter 2 describes the requirements analysis phase concluding in Chapter 3 with the Requirements Specification. Chapter 4 consists of the new design or the Programmer's Manual respectively and Chapter 5 concludes this Diploma Thesis with a short summary and a prospect of the Confluentic WEB project.

## 1.2 Course of action

The whole project *Confluentic WEB* can easily be subdivided and aligned according to the typical phases of the software life cycle (compare [Bal01]).
Figure 1.1 outlines the different phases graphically. Phases are depicted by ellipses and results/documents are pictured by rectangles.

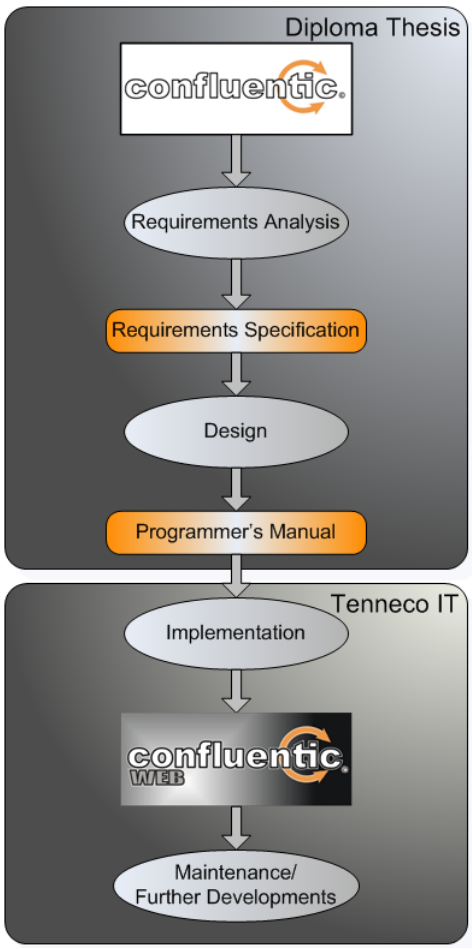



Figure 1.1: Project life cycle of Confluentic WEB

This Diploma Thesis describes the first two phases - requirements analysis and design. The resulting Programmer's Manual is seen as starting base for the later implementation carried out by Tenneco's IT department.

The project has been separated in the aforementioned way to involve Tenneco's IT department as soon as possible, because they have to maintain and to improve the finished application in future.

The analysis phase (see Chapter 2) comprised a close examination of Confluentic 1 and all requirements for Confluentic WEB were worked out in cooperation with Tenneco's logisticians and IT department[13]. The resulting requirements specification were revised multiple times before it was finally signed by both, Tenneco and university (see Chapter 3).

Based on this specification the design phase started. Resulting documents (UML-, E/R- Diagrams etc.) are described in Chapter 4. [14]

During both phases multiple meetings, conference calls and presentations were held between logistics department, IT department and university. In particular, biweekly conference calls between IT and university took place.
This was done to ensure, that the final design or Programmer's Manual respectively is really applicable and represents a good basis for the later implementation by the IT department.

A detailed Project-Timeline including all relevant documents and minutes of meetings can be found in the Transport Wiki [Tra06b].

By handing over this Diploma Thesis responsibility for Confluentic WEB is fully consigned to Tenneco's IT department. Now their task is to implement, maintain and push forward further developments of Confluentic WEB.

[13] Logisticians mainly focused on desired features and properties of Confluentic WEB, whereas the IT department focused on technical aspects and necessities.
[14] Chapter 4 is seen as the desired Programmer's Manual.

# Chapter 2

# Requirements Analysis

Due to the fact that the main goal of this project - to port Confluentic 1 into Tenneco's IT environment - was given as a base frame, the first phase comprised a detailed analysis of Confluentic 1 and the circumstantial determination of all requirements concerning the desired transfer into Tenneco's client-server architecture.

Section 2.1 summarizes the general goals for the development of Confluentic WEB.

Subsequently, section 2.2 will give a brief summary of the general approach and basics of the Confluentic 1 idea[1]. Section 2.3 considers the software Confluentic 1 from the business point of view, whereas section 2.4 examines Confluentic 1 from the technical side.

The requirements analysis phase was finished by signing the final version of the requirements specification by Tenneco logisticians and IT department.
The specification will be described in chapter 3.

[1]For a detailed description of the implementation of Confluentic 1 and an examination of the whole theoretical background, please refer to Diploma Thesis *"Confluentic"* written by Ralf Krechel, Lars List and Daniel Schmidt [KLS05].

## 2.1 General project goals of Confluentic WEB

Beneath the main goal - to port Confluentic 1 into Tenneco's IT environment - following general sub goals were defined:

- transfer Confluentic 1 into a client-server architecture
- port all existing features of Confluentic 1 to Confluentic WEB
- ease and improve maintenance for Tenneco's IT department
- enable Confluentic WEB to work on real tariffs
- avoid redundancies and use one single database for CATIS, FIONA and Confluentic WEB

## 2.2 Confluentic 1

Transport costs as well as inventory costs always play a key role within the context of logistics. Confluentic 1[2] aims to combine these two cost drivers within one tool and allows the concurrent consideration of them with regard of cash and cost savings.

### 2.2.1 Location, shipment, trip and scenario

In particular, Confluentic 1 models the logistic world or supply relationships respectively with the help of three kinds of entities - `location`, `shipment` and `trip`.

Within a determined period of time `locations` are sending and receiving certain amounts of goods (raw materials, individual parts and finished goods) to and from other `locations`[3].
These collections of goods, which are transported from `location` A to `location` B are called `shipments`. More precisely, a `shipment` is the demand of goods at one specific `location` A during a determined time period delivered by another `location` B (also referred to as sending `location`).

[2] The term CONFLUENTIC derives from CONFLUENT, Transport, Inventory and Cost.
[3] According to the demand of the receiving location

Shipments are transported to their destination via trips. Because of the limited capacity of one trip[4], this trip has to be run several times during this determined time period, unless the complete shipment is transported. Each time a trip runs, it delivers only a portion or batch of the whole shipment. The number of transports needed to carry out the whole shipment is called frequency.
A trip itself is defined as a connection between two locations or a concatenation of connections[5]. It describes the route and the distance a truck has to drive[6].

A concrete model of locations, shipments and trips is called a scenario. Scenarios are demand driven models. Meaning that shipments are always associated to their receiving location.

### 2.2.2 Transport costs

Transport Costs (TC) for running a trip are separated in haulier costs and several location costs.

Haulier costs are calculated out of the truckload and driving distance of a trip. The bigger the batch and the longer the distance is, the more have to be paid for a trip. This correlation between truckload and distance is calculated according to specific tariffs[7](see [KLS05], page 47, definitions 4-23 and 4-24).

Location costs are composed of

- LoadingCosts
  Costs, that occur at locations, where a batch is loaded.
- UnloadingCosts
  Costs, that occur at locations, where a batch is unloaded.
- IntermediateStopCosts
  Costs, that occur at locations, which are within a trip.
- CrossDockCosts
  Costs, that have to be paid, if a batch reaches a CrossDock[8].

For further information, please refer to [KLS05], subsection 3.1.1 and definitions 4-15, 4-19, 4-20 and 4-22.

[4] e.g. a standard truck transports max. 20 tons payload or 13 loading meters (ldm) respectively
[5] Concatenation allows to set up a trip like: A to B, B to C, C to D.
[6] Confluentic 1 uses an integrated route planer for geocoding locations and calculating driving distances.
[7] Confluentic 1 allows to set up different generic tariffs.
[8] CrossDockCosts are split in administrative costs and stocking costs.

### 2.2.3 Inventory cash and costs

At regular intervals during the specified time period a `location` is receiving batches of the whole `shipment`. The size of these batches has to be big enough, that they are exhausted when a new batch arrives at earliest. Ideally the batch is fully consumed exactly at the arrival point of the next batch. This time span is called production time or just `Production`.
At the point just before the new batch arrival, only a `Buffer` is still in the stock. This `Buffer` shall take care of transport fluctuations to ensure continuous production.

The sum of `Production` and `Buffer` is the `Days On Hand (DOH)`. This is the maximum time period of continuous production without receiving any further batches of the `shipment`.
When a batch arrives, it is laid on stock and is consumed over time thereafter[9]. At this point of time monetary capital is committed[10]. The sum of these cash positions is called `On Hand Euro (OH€)`.

`Inventory costs (IC)` are calculated by charging the `OH€` against the `inventory cost rate (ICR)`[11]. It is clear, that having less goods in stock results in lower `inventory costs`[12]. Therefore a high frequency is desired from the inventory cost point of view.

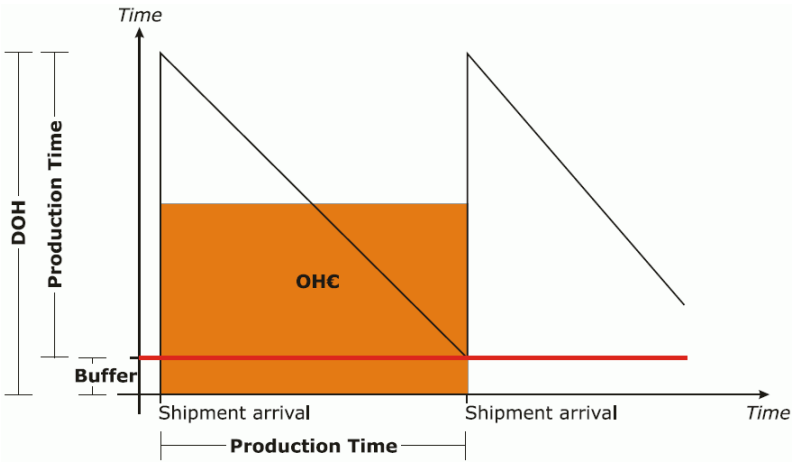



Figure 2.1: Saw tooth diagram

[9] It should be consumed completely a soon as the new batch arrives.
[10] The goods have to be paid and are now laying in stock.
[11] see [KLS05], subsection 4.3.6, definition 4-18
[12] But smaller batches are causing a higher delivery frequency to deliver the whole shipment.

The correlation described above is summarized in Figure 2.1. The saw tooth diagram is taken from [KLS05], page 21. A detailed description of the figure can be found there as well.

### 2.2.4 Transport and inventory costs

Now Confluentic 1 tries to consolidate `transport` and `inventory costs` by the concurrent consideration of both.

Increasing `frequency` decreases the dimension of each batch, since the same quantity of goods has to be delivered in the same period of time[13]. Smaller batches obviously result in decreasing inventory costs.
Minor truck utilization may save `transport costs` for one batch depending on the tariff, but in the same time a higher `frequency` also increases `transport costs` .

The other way round a decreased `frequency` - and thus bigger batches - increases `inventory costs`.
Truck utilization is rising and may cause higher `transport costs`. At the same time fewer batches are necessary, which on the other side will decrease `transport costs`.

In particular Confluentic 1 searches for the optimal `frequency` of each `shipment` to reduce the sum of both cost drivers. Figure 2.2 (taken from [KLS05], page 23) illustrates this concurrent consideration of transport and inventory costs.

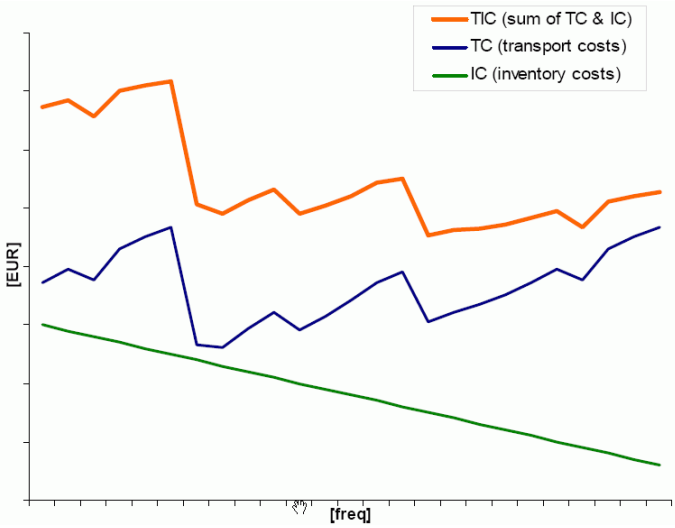



Figure 2.2: Transport and inventory costs curves

[13]The total demand of goods or quantity of a shipment respectively has to remain unchanged.

Usually the resulting cost function (TIC graph) is non-linear and not differentiable[14]. To find the minimum of the cost function anyway, Confluentic 1 solves this problem by iterative processing of each `shipment`. In particular a recursive method is called, which is narrowing down to the optimal `frequency` from both sides.[15]
The exact algorithm is described in [KLS05], page 79ff.

### 2.2.5 Outcome and benefit

With the help of Confluentic 1 logistics experts are enabled to create different `scenarios` of their logistic world. The application delivers detailed information and a global view of all supplying relationships between supplier, ICY and customer sites.
This allows an easy way for the identification of under-utilizations, redundancies and consequently conveys a better synchronization.

By calculation optimized and cost reduced `scenarios` are created automatically and can be compared to their baseline `scenarios` in detail.
Logistics experts can modify all scenarios with the goal of finding the optimum overall solution.

## 2.3 Business consideration

Confluentic 1 has always been seen as a prototype. Tenneco's logisticians worked with the software approximately for one year to identify weak points or possible improvements and to gain experiences with the tool.
Following subsections summarize the main encountered shortcomings from the business side of view.

### 2.3.1 Location master data

Within the software Confluentic 1 no location master data is available[16]. This fact complicates the usage of this tool.

[14] Because tariffs are usually block priced (compare [KLS05], subsection 3.1.3).
[15] This can lead to higher costs at certain locations for specific trips, but point of interest is the total scenario.
[16] Also there is no default master data of shipments, generic tariffs etc.

Each time a new scenario is set up by the user, he has to type in all needed location data by hand. Alternatively, he is able to import location data from spread sheets (excel files).

Beside the fact, that both ways of getting location data into a scenario are time consuming and complicated, each user has to care for the correct and up to date location data by himself.
There is no centralized, managed and maintained location master data within Confluentic 1.

### 2.3.2 Tariffs

During practical work with Confluentic 1 another shortcoming emerged. Tenneco's logistics experts complained that Confluentic 1 is not working on real tariffs.

Indeed, Confluentic 1 allows to create and to edit several generic tariffs[17], which are used for calculation of `transport costs`[18]. But due to the very huge amount of existing tariffs from different hauliers based on various contracts, Confluentic 1 is not capable to reproduce or even to keep up to date these complex relationships and constraints.
Therefore all calculations of Confluentic 1 do not reflect transport costs precisely enough and consequently results of optimized `scenarios` can not be transferred to the real world.

## 2.4 Technical consideration

As mentioned in the introduction, Confluentic 1 was implemented as a client application. This Confluentic 1 client was written in C# code within the Microsoft .NET framework [Mic06c].

### 2.4.1 Two-tier architecture of Confluentic 1

In particular this client comprises the Graphical User Interface (GUI), the complete application logic and performs all necessary processing self-contained.

[17]. see [KLS05], subsection 5.2.4
[18]Again these data is not held centralized and have to be maintained for each scenario.

This *fat client* accesses map&guide mapserver 4 - a third party Geographical Information System (GIS) - for geocoding, routing and drawing maps[19] [map06]. This GIS is also installed on client side and Confluentic 1 is accessing needed GIS components via using the component object model (COM) (compare [KLS05], section 5.4).

Data storage was realized by using a centralized Oracle 9i database, where all data is saved [Ora06].

According to this infrastructure Confluentic 1 is classified as a two-tier client-server architecture. Figure 2.3 illustrates it graphically. Please note, that the Confluentic 1 client and the GIS mapserver are installed on client side, whereas the database runs on a single centralized server.

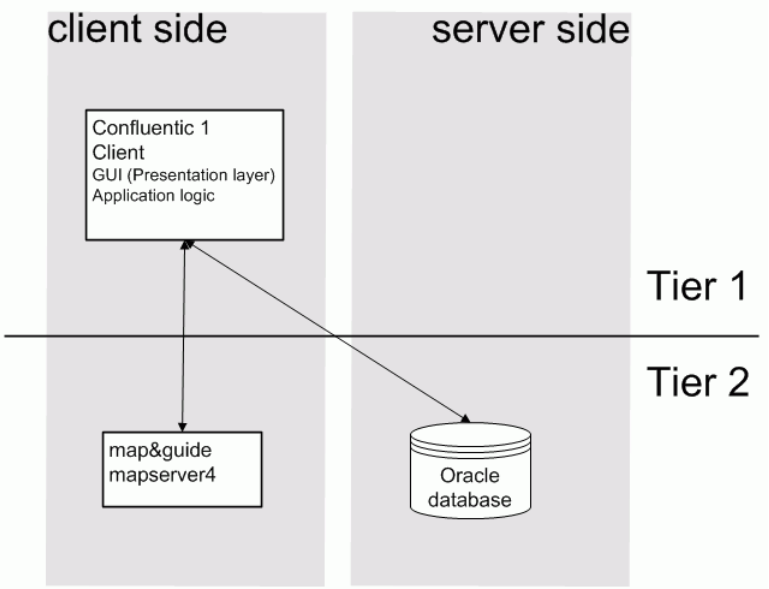



Figure 2.3: Two-tier architecture of Confluentic 1

### 2.4.2 Criticism

Beside the experience, that Tenneco's IT department is not familiar with the .NET framework and therefore a lot of problems occurred in the course of installing, setting up and maintaining[20] each Confluentic 1 version, the aforementioned two-tier architecture of Confluentic 1 has got following disadvantages concerning maintenance effort.

[19] In particular the GIS is used for the visualization of all supply relationships.
[20] In fact maintenance, bug fixing etc. is only done by university and Daniel Schmidt respectively.

The Confluentic 1 client and the map&guide mapserver, have to be installed on each PC, where Confluentic shall be run. Consequently maintenance, updating and installing new versions etc. have to be carried out on each of those computers too.

Another disadvantage is the usage of a fat client for Confluentic 1. Beside locating the presentation layer (GUI) on client side, also the complete application logic is condensed on this client. For example each time something within the application logic is fixed or modified, the whole client and in particular all installed clients on each computer have to be updated too.

### 2.4.3 Three-tier architecture

To decrease the described maintenance effort, two possible improvements for the architecture of Confluentic 1 have been recognized:

1. Move the mapserver to the server-side.
   Thereby only one instance of a map server has to be installed and maintained on one server. There is no need to maintain various number of map servers on each client anymore.

2. Use a *thin client*.
   By moving the application logic to the server-side, the application logic and the presentation layer are separated. On the one side the simplified clients have to be updated fewer times (only if the presentation layer is modified) and on the other side only one instance of the application logic has to be maintained on server side.

The aforementioned improvements can be realized with the help of a three-tier architecture. Figure 2.4 illustrates it graphically.

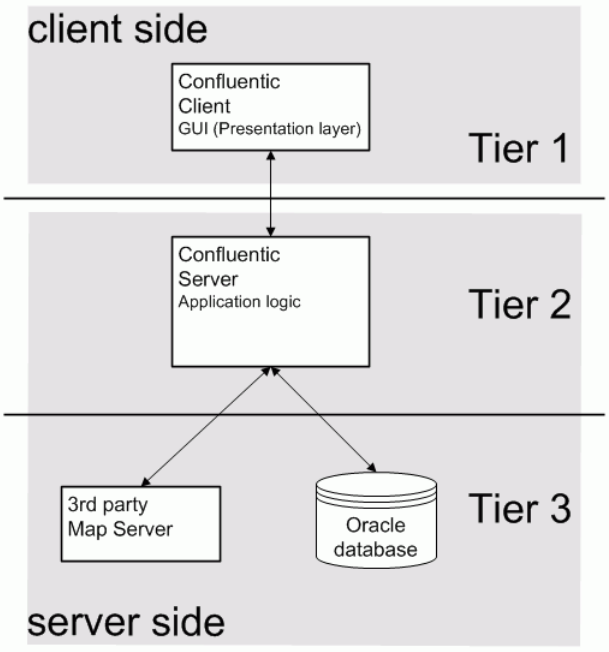



Figure 2.4: Three-tier architecture for a improved Confluentic Application

Now only on client side the presentation layer is located (tier 1). The whole application logic instead is centralized at one single server (tier 2). This Confluentic Server itself accesses a map server[21] as well as the Oracle database (tier 3).

The concrete chosen architecture of Confluentic WEB is described in subsection 3.2.2.

[21] Maybe the current used map server has to be removed and exchanged according to the new architectural needs.

# Chapter 3

# Requirements Specification

Whereas chapter 2 discusses the analysis phase, this chapter gives an overview of the resulting requirements specification.

The final version 1.8 of the requirements specification was signed by Tenneco's logisticians and IT department and was the result of several revised versions during the analysing process. The origin version 1.8 can be found in Appendix B. Additionally this and all former versions can be found in the Transport Wiki [Tra06b].

Following section 3.1 considers the business requirements of Confluentic WEB, whereas section 3.2 outlines the technical and IT requirements respectively.

## 3.1 Business requirements

According to the defined general goals (compare section 2.1) the requirements specification shall ensure to transfer all existing features of Confluentic 1 to the new version Confluentic WEB. In particular all features have been revealed and written down piece by piece (see chapter 3 of the requirements specification).

Figure 3.1 can be seen as a summary of all desired features of Confluentic WEB. The depicted first use case diagram of Confluentic WEB was developed based on the requirements specification. This and all its refinements will be topic within the Design and Programmer's Manual (chapter 4).

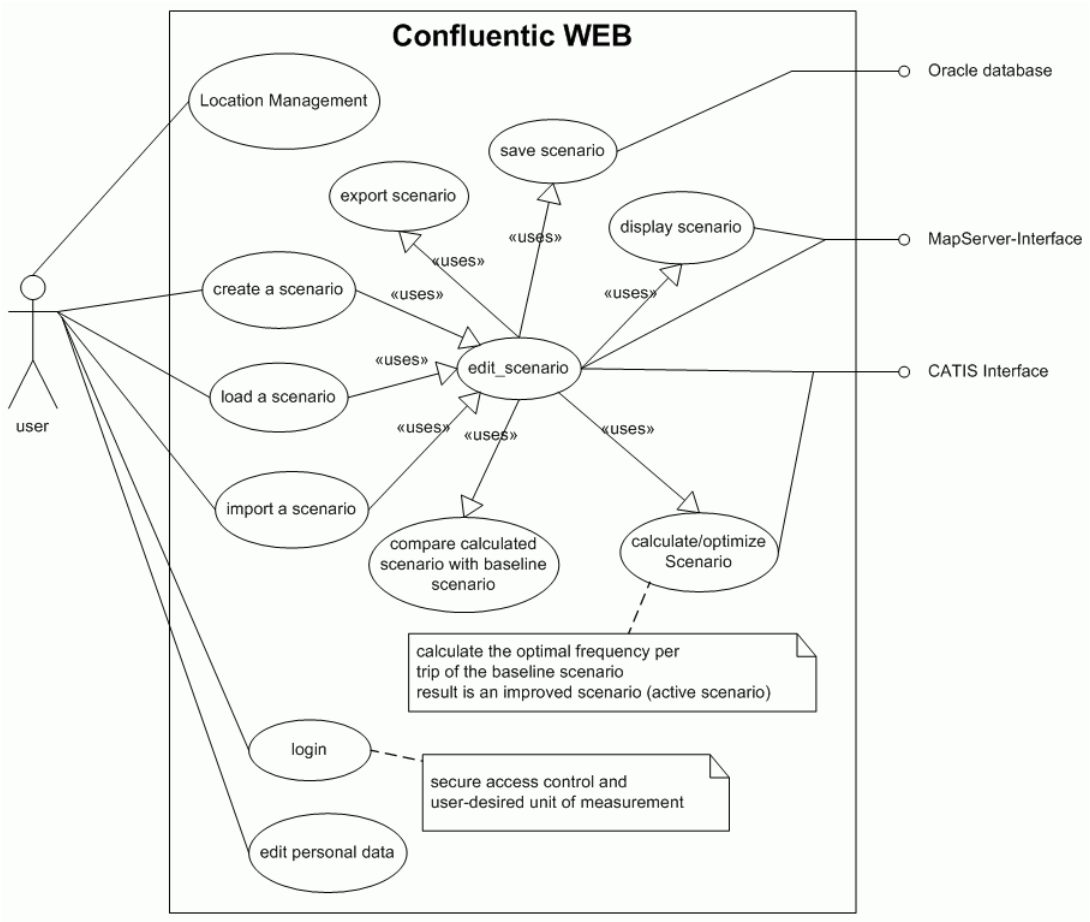



Figure 3.1: First global use case diagram of Confluentic WEB

### 3.1.1 Location master data

Beneath Confluentic WEB the two neighboured projects, CATIS and FIONA, have been developed by fellow students in parallel.
Both, the *Carrier and Tariff Information System* (see [Kop06]) as well as the *Freight & Invoice Operations Network Application* (see [DR06]), have been implemented for the Tenneco company.

In particular CATIS is used to standardize and centralize tariffs and carrier contracts information for all Tenneco plants[1], whereas FIONA is used for processing and monitoring of freight bookings in daily business.

Since all three projects have got very close relationships[2] and are dealing with the

[1] Each Tenneco plant only cared for its own needed tariffs and carrier contracts before.
[2] They all deal about Tenneco's logistic world.

same locations, the requirements were extended to join and unify all location data to master data. These master data have to be used and accessed by CATIS, FIONA and Confluentic WEB corporately.
Therefore all three applications have to store all their data[3] within a single big centralized database.

Along this requirement another big goal was reached concerning Confluentic WEB. The problem/disadvantage of having no location master data (compare section 4.3.1) had been eliminated.

### 3.1.2 LMT - Location Management Tool

Contributing to the aforementioned requirement of joining the location master data, developing a small *Location Management Tool (LMT)* was added to the requirements of Confluentic WEB. The LMT shall be used to maintain (create, import, edit) common `location` data[4], which CATIS, FIONA and Confluentic WEB are accessing corporately.

### 3.1.3 Virtual locations

Beneath the usage of all existing locations of the Tenneco world (location master data), Confluentic WEB shall be able to create and use locations of its own additionally. These *virtual locations* do not affect FIONA nor CATIS. *Virtual locations* are used within the Confluentic context only.

This feature was required to enable Confluentic WEB to simulate bigger changes within a scenario. In particular transport and inventory cost effect changes could be examined.
For example what will happen, if a whole Tenneco location is moved from A to B? Or what costs would be saved, if a new *virtual* crossdock was set up at location C?

### 3.1.4 Real tariffs

According to the availability of the new tariff information system CATIS another requirement of Confluentic WEB was to make use of CATIS and thereby to enable

[3] Also the data, which is only needed by one particular application.
[4] Additionally the LMT will be used to maintain default shipment data for Confluentic WEB.

Confluentic WEB to work on real tariffs. In doing so the disadvantage of Confluentic 1 described in subsection 2.3.2 could have been eliminated.

Therefore the Programmer's Manual will describe the interface needed from CATIS (see 4.5). More precisely it will be specified, what data shall be given as input for CATIS and what receiving data is expected.

In particular two types of tariffs are of interest for Confluentic WEB[5]:

#### FTL tariffs

*Full Truck Load* tariffs are route based tariffs. This means, a complete dedicated truck has to be paid for a specified trip regardless of its fill rate.

#### Groupage tariffs

In contrast to FTL tariffs, *groupage* tariffs are weight and distance dependent tariffs. This means, only the actual load of a truck is charged and additionally the distance between sender and receiver is taken into account. The bigger the batch and the bigger the distance, the more expensive the transportation costs are.

### 3.1.5 Fall back and generic tariffs

Current version of CATIS implements FTL tariffs only. Until now, groupage tariffs are just described conceptual within the Diploma Thesis of Jürgen Kopper [Kop06]. It is planned to implement groupage tariffs by Tenneco's IT department shortly. Therefore groupage tariffs should be available before implementation of Confluentic WEB will be finished.
Thus, Tenneco's logisticians were concerned about the availability of tariffs highly recommended by Confluentic WEB and desired a kind of fall back solution, in case CATIS is not working properly.

Nevertheless the requirement of an additionally tariff system as a fall back was turned down according to the following reasons[6]:

[5] CATIS also maintains premium freight tariffs. Since these tariffs are always expensive and only used for specific urgent deliveries, they are useless within the context of Confluentic WEB.

[6] Discussion of this topic was a very time consuming process.

1. A fall back tariff system would mean to build the whole tariff system twice. This would highly increase maintenance effort, because both data sources had to be kept up to date.

2. If the database of CATIS is down or not accessible, Confluentic WEB will be down too, because CATIS and Confluentic WEB are using the same database.

3. If the application server of CATIS is down, Confluentic WEB will also be down, because both applications will be run on the same server.
   Thus and because of point 2 a second tariff system would be useless. If CATIS is not working because of a technical reason, Confluentic will not work either.

4. If CATIS has got a logical bug, a fall back system will have got the same bug supposedly, because much more time is spent on developing CATIS than on a fallback system.

Instead a simplified *generic tariff* has to be implemented within Confluentic WEB, which can be chosen alternatively to real tariffs. This generic tariff consists of the maximum truck load and costs per kilometer only.
In first place this tariff shall be used, when no real tariffs are available or when the available tariffs for a specific trip are not correct.

The described generic tariff should only be used in particular cases. Otherwise the improvement of Confluentic WEB, to calculate on realistic tariffs (compare 2.3.2), would be abolished.

## 3.2 Technical (IT) requirements

To transfer Confluentic 1 into an appropriate three-tier architecture as described in subsection 2.4.3, which also is suited to fit into Tenneco's client-server environment, Tenneco's IT department provided their *"Java Design Guidelines"* [Ten05] and *"Tenneco Automotive Java Coding Standards"* [TA 05].

### 3.2.1 Global system requirements

According to these guidelines, Confluentic WEB has to be designed, implemented and maintained under following system environment:

- Operating system: Microsoft Windows 2003 [Mic06b]
- IBM WebSphere Application Server 5.1 [IBM06]
- Oracle 9i database [Ora06]
- Java 1.3 [Sun06]
- Jakarta Struts 1.1 [Apa06]

### 3.2.2 MVC and Struts Framework

In particular Confluentic WEB has to be implemented into a MVC-oriented three-tier architecture based on Jakarta Struts[7] and an Oracle database [Apa06].

*MVC* or *Model-View-Controller* means to separate a system into three units: Model, View and Controller.
This separation clearly isolates the presentation (view) from the business logic (model). The controller defines application behaviour and maps user actions to the model and vice versa. By this architecture flexibility is enhanced (e.g. substitution of different views). For an introduction of the Model-View-Controller pattern see [BMR+96].

In particular the Jakarta Struts framework uses *MVC Version 2* or *MVC 2*. This is a specialized type of the Model-View-Controller pattern for the usage in a web application[8].

[7] This implies the use of Java Server Pages (JSP).
[8] In contrast to the common MVC-model *MVC 2* separates the components more clearly.

Compared to the three-tier architecture described in subsection 2.4.3, the presentation layer (view) is moved to the server instance at tier 2. Additionally the thin Confluentic client is replaced by an Internet Explorer (IE). The IE is used for displaying the new Graphical User Interface (GUI): JSPs and HTML-pages respectively, which are delivered by the view component. Figure 3.2 depicts it graphically.

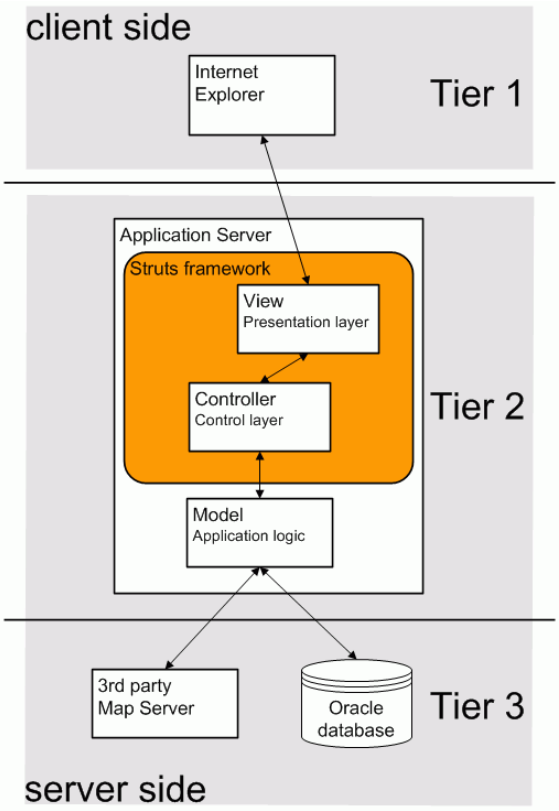



Figure 3.2: Web application with Struts

Within the Struts framework each HTTP-request is taken by a controller component (ActionServlet), which connects to the model. View components never call other view components directly. The whole workflow is controlled by the controller components.
Struts itself is a Java framework using Java Server Pages (JSPs), JavaServlets and Java Beans. By using this framework maintenance is highly relieved. A good introduction of Struts is delivered by [HDFW03].

By the described architecture the maintenance effort of Confluentic WEB is completely reduced to the sever side. All clients are only using Internet Explorer (IE), which are installed on each PC anyway. The IE is only responsible for visualization of the view.

### 3.2.3 Visualization

The graphical representation and visualization of all supply relationships of scenarios is one of the key features of Confluentic 1. Each scenario can be displayed on a map. Additionally truck utilization and capacity aspects are visualized by the appearance of the trips (arrows)[9].
This visualization allows the user to get an overview of a scenario and delivers indications on which shipments his attention should concentrate on for improvements (compare [KLS05] subsection 5.2.6 and 5.2.7).

Confluentic 1 uses map&guide mapserver4 as third party GIS. Because of the new architecture and consequently totally new design of Confluentic WEB, a gap analysis of possible alternatives to mapserver4 should take place and suggest a preferred GIS to Tenneco's IT department. The gap analysis is summarized in section 4.6.

## 3.3 Programmer's Manual

Because this Diploma Thesis shall be used as a Programmer's Manual by Tenneco's IT during implementation, several needed documents were specified:

- process diagrams
- UML-Diagrams
  class-diagrams, use cases, dataflow etc.
- signature descriptions for methods, classes etc.
  including input/output descriptions
- sample code, pseudo-code, flow charts, formulas etc. to sufficiently describe the processing within each method
- web page and menu layouts, behaviour and data validation descriptions
- user authentication and authorization rules
- Entity-Relationship diagram (UML notation)

[9] Scenario dependent worst 50% are colored red, next 25% are colored yellow and best 25% are colored green. Also the higher the value of a shipment is, the wider the arrow is painted.

In fact not all of these items are part of this thesis. In consideration of the limited range, capacity and time of a diploma thesis, focus was laid on those items, thought to be most useful for Tenneco's IT department. IT was constantly involved in the design process to take care that all important issues are touched by this thesis.

## 3.4 Transport Wiki

Another general requirement was to set up a Transport Wiki for CATIS, FIONA, Confluentic 1 and Confluentic WEB. It serves as a glossary and general information base for Tenneco's IT department. The Transport Wiki is accessible at:

http://www.uni-koblenz.de/~confluentic/wiki/

It has been enriched, maintained and expanded over the whole project time.

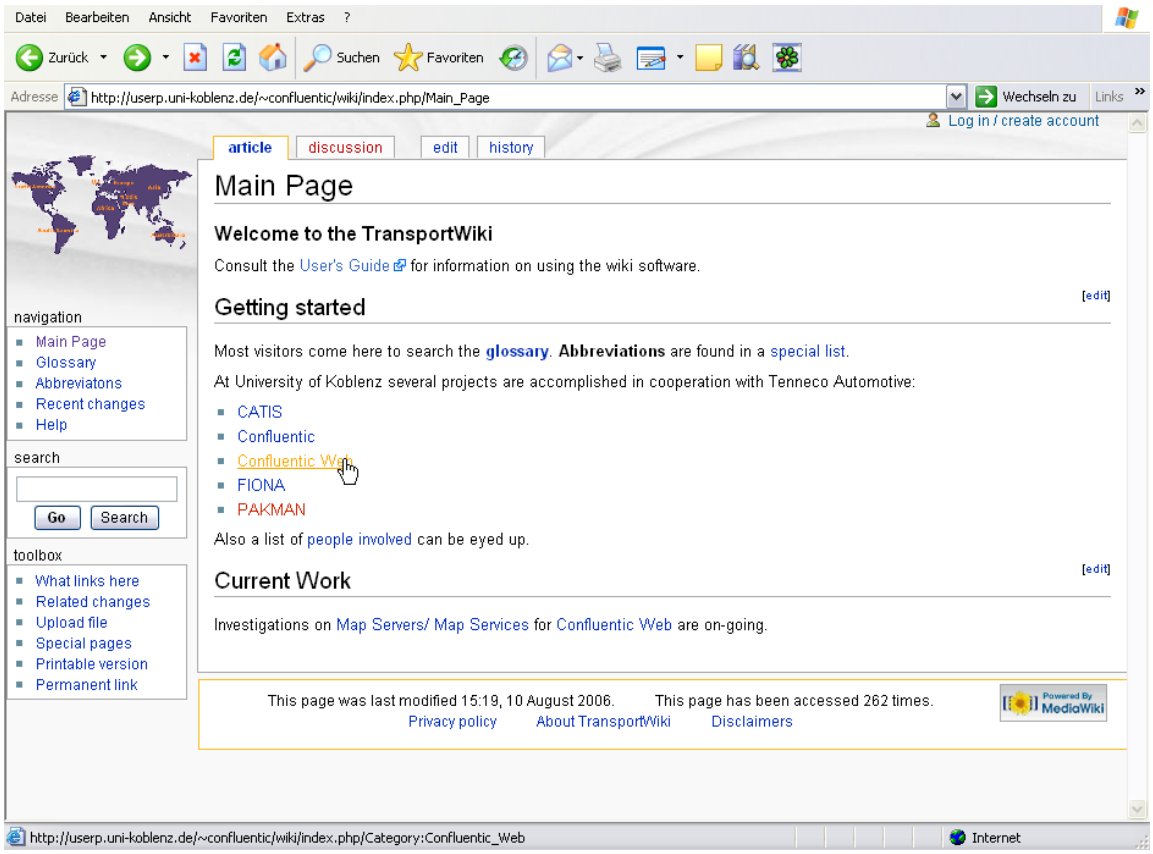



Figure 3.3: Transport Wiki – start page

# Chapter 4

# Design and Programmer's Manual

This chapter is seen as the desired *Programmer's Manual*. It provides all postulated documents, which shall help in implementing Confluentic WEB by Tenneco's IT department.

Since the changes to the new three-tier architecture of Confluentic WEB were already described in subsections 2.4.3 and 3.2.2, this chapter contains the formal model (section 4.1), use case diagrams (section 4.2), the database model (section 4.3) as well as the developed dummy pages for Confluentic WEB and for the Location Management Tool (section 4.4). All of this documents were developed within this Diploma Thesis.

Additionally the desired interface of CATIS is described in section 4.5 and a gap analysis of alternative map servers is presented in section 4.6.

## 4.1 Formal model

After the requirement analysis was finished by the signed requirements specification, the design phase started with examining and adjusting the former developed formal model of Confluentic 1 to Confluentic WEB needs. For example the representation of hauliers and tariffs had to be changed caused by the desired new interface to CATIS.
In particular the model was rebuild based on the definitions given in section 4.3 of the Confluentic 1 thesis (see [KLS05], pages 37ff.). Afterwards the resulting UML diagram was compared with the UML diagram of Confluentic 1 (see Appendix C).

This kind of *"double checking"* should ensure to find the optimal representation of the conceptual model of Confluentic WEB.

Figure 4.1 depicts the redesigned UML diagram and final formal model of Confluentic WEB. The origin visio-file can be found in the Transport Wiki [Tra06a].

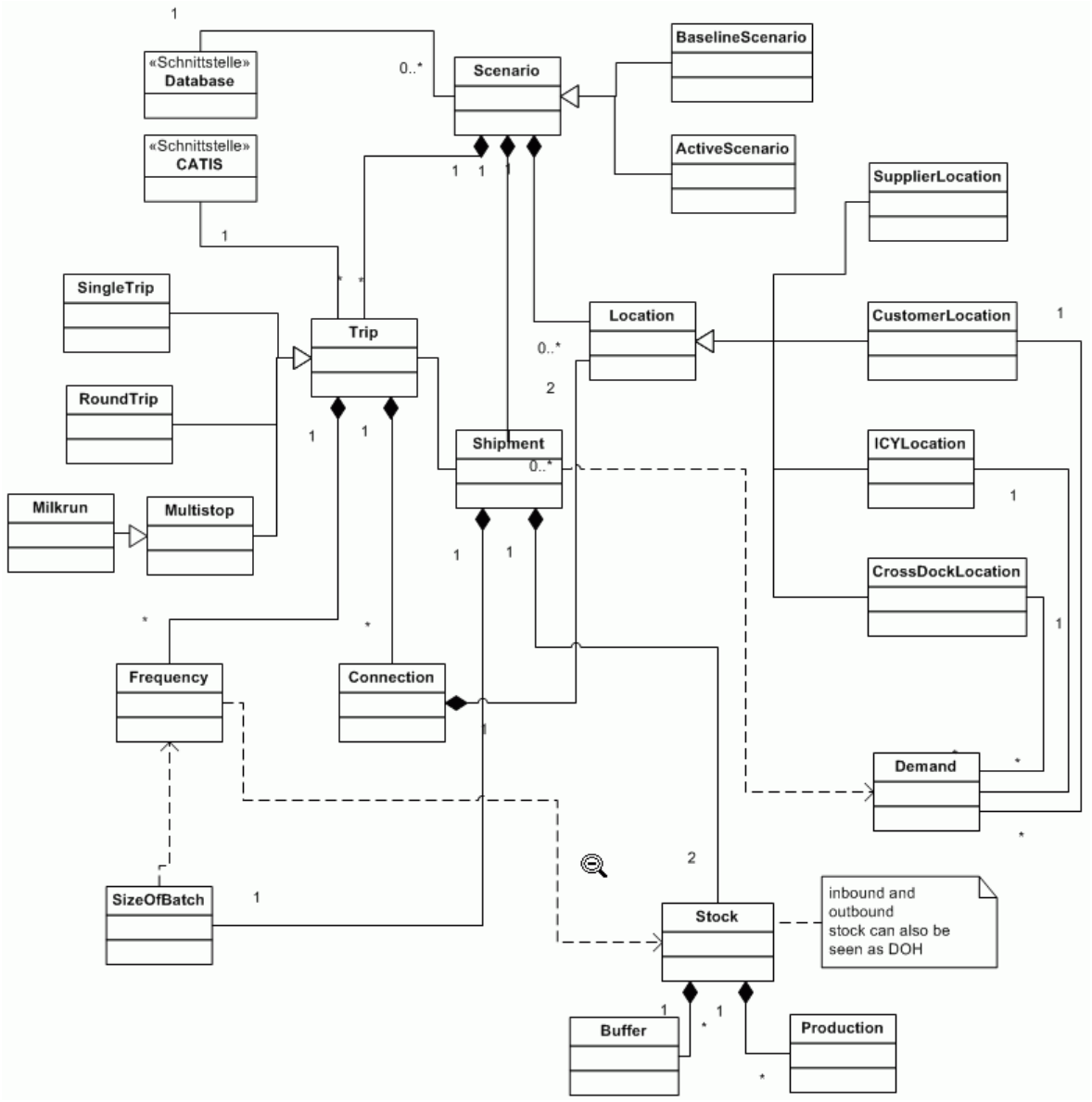



Figure 4.1: Formal model of Confluentic WEB

In general this UML diagram resembles the UML diagram of Confluentic 1. Except of the entity `configuration`. This entity has been omitted, because there is seen no reason to distinguish between `configuration` and `scenario` anymore[1].

[1]Of course entities like tariff, haulier etc. are omitted too. Instead the new interface to CATIS is used.

### 4.1.1 Scenario

A scenario represents a concrete model of the logistic world (see subsection 2.2.1). In particular it is composed of locations, shipments and trips.

Scenarios are divided into activeScenarios and baselineScenarios. BaselineScenarios are always *freezed* and are not allowed to be edited or modified. Instead a copy of this baselineScenario is created and which can be edited. This scenario is called activeScenario.
Within Confluentic WEB both kinds of scenarios can be compared concerning of costs improvements (compare subsection 2.2.4).

All scenarios are saved in a database.

### 4.1.2 Location

A location represents a plant, which receives shipments from other locations according to its demand. In other words: "A location is a place where shipments can be loaded, unloaded or transshipped." (see [KLS05], page 39). There are four sub entities of a location:

- SupplierLocation
  Generally speaking a plant/company, which delivers raw materials or individual parts to Tenneco plants (ICYLocations). According to model only the Tenneco relating logistic world supplierLocations do not have a demand.
- CustomerLocation
  A plant, which receives finished goods from a Tenneco plant (ICYLocation).
- ICYLocation
  A plant owned by Tenneco. It receives goods from supplierLocations, other ICYLocations and CrossDockLocations. Additionally it sends goods to Customers as well as to other ICYLocations.
- CrossDockLocation
  A hub, which receives and delivers shipments. At these hubs shipments are laid on stock and are reassigned to other trips in order to reach the destined location. CrossDockLocations do not produce or consume anything (except for empties). But however they also have a demand according to fulfill shipments, which have to be send to other locations.

### 4.1.3 Shipment

A shipment is defined as a specified amount of one kind of goods, which is needed or consumed by location B within a determined time period (demand).
Because the goods are originated at location A, this shipment has to be transported from A to B.

Shipments are assigned to trips. Meaning that a shipment is transported via a trip or a concatenation of trips respectively.
Depending on the frequency of a trip, the sizeOfBatch is directly affected. The higher the frequency is, the smaller the batches are, since the total size of the shipment has to remain unchanged.

Another component of a shipment is stock. It represents the inbound or outbound side of a shipment. The outbound stock refers to the sending location whereas the inbound stock refers to the receiving location.

A stock is composed of buffer and production. Buffer represents and borders the security stock, which is ought to be available at a location to ensure continuous production (compare subsection 2.2.3). Production instead specifies the minimum and maximum size (time span) of production stock, which should be located at a location[2].

In particular a stock restricts and affects the frequency of a trip by setting up boundary conditions for each shipment.

### 4.1.4 Trip

Trips are used to transport the aforementioned shipments and are composed of a connection or a concatenation of connections. A connection connects two locations and describes the route e.g. a truck has to drive.
Additionally a trip is run with a specified frequency. This amount specifies how often e.g. the tuck drives during the determined time period of the scenario.

Four different trip types are defined[3]:

[2] In terms of an outbound location a stock specifies the average stock size remaining in house just after a new batch has been sent out.

[3] Additionally CATIS defines a trip type "distribution", but this type of trip is not covered by Confluentic WEB (see [Kop06], section 2.2)

- `SingleTrip`
  is a on way `trip` between two `locations`
- `RoundTrip`
  is a two way `trip` between two `locations` (one forward and one backward `trip`)
- `Multistop`
  is `trip` between three or more `locations`.
- `Milkrun`
  is a `multistop`. Additionally the start `location` equals the end `location`.

Trip types do not have to be differentiated within Confluentic WEB. They arise out of their composition. Nevertheless Confluentic 1 already delivers algorithms (pseudo code) for the determination of a `trip` type if needed (refer to [KLS05], subsection 5.1.7.6).

The CATIS interface is used to get transportation costs delivered according to real tariffs maintained by CATIS.

## 4.2 Use cases

First use case diagrams were developed based on the requirements specification as well as on Confluentic 1 itself. Outgoing from the main use case diagram, which is already depicted in section 3.1, further use cases were developed to refine and specify Confluentic WEB in detail.
Since most use case diagrams are self-explanatory, this section only picks up those use cases, which need to be described additionally. The whole set of use case diagrams can be found in Appendix D. The corresponding visio-file can be found in the Transport Wiki [Tra06a].

### 4.2.1 Create a scenario

To `create a scenario` general data like `scenario_name`, `description`, `time_period` etc. have to be entered, before the new/created scenario can be edited.
The use case diagram is shown in figure 4.2.

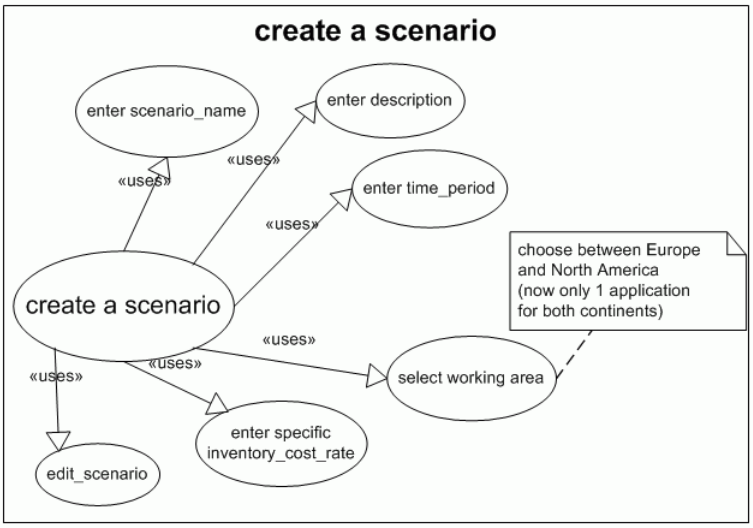



Figure 4.2: Use case "create a scenario"

In contrast to Confluentic 1 a `working area` have to be selected additionally.
At present two versions of Confluentic 1 exist: One version for Europe and one version for North America[4]. Now only one centralized version of Confluentic WEB will exist (compare subsection 3.2.2).

Since Confluentic WEB either covers pan-European or pan-American scenarios[5], a new scenario have to be restricted to Europe or North America respectively.
According to the selected `working area` only locations (master location data) of the respective continent shall be accessible within this scenario.

### 4.2.2 Load a scenario

Confluentic WEB is able to compare two scenarios with each other. In particular an active scenario is compared with its freezed baseline scenario (see subsections 2.2.5 and 4.1.1)[6].

To allow all possible ways in manipulating scenarios, four different use cases have to be supported to load an existing scenario from the database.
Figure 4.3 depicts the corresponding diagram.

[4] In particular different maps are used within the mapserver4.
[5] No global scenarios will be available.
[6] In general the active scenario was edited to achieve improvements before.

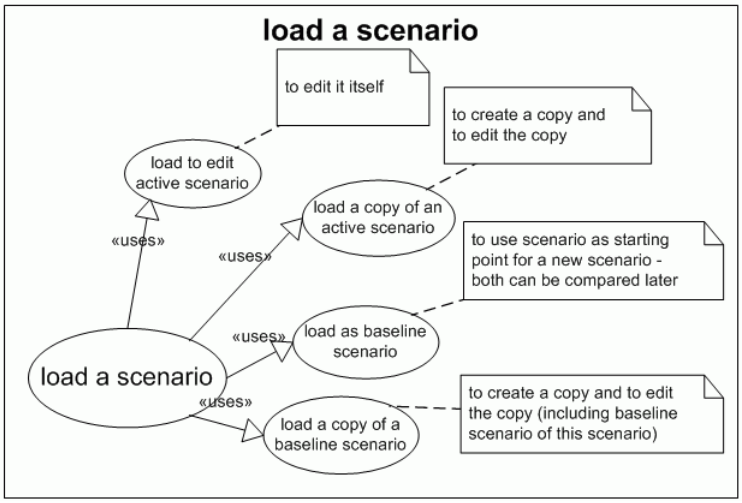



Figure 4.3: Use case "load a scenario"

Please remember, that only *freezed* scenarios can be used as a baseline scenario and therefore they must not be edited anymore. This restriction is necessary to ensure, that all active scenarios keep their unchanged baseline scenario.

The different use cases can be described as follows:

1. `load to edit an active scenario`
   Means to load an active scenario to edit it itself. The user edits the loaded scenario and changes are saved in the database.

2. `load a copy of an active scenario`
   Means that a clone or a copy of the active scenario will be created on which the user performs his changes and modifications. The original active scenario remains untouched and is still available in the database[7]. A complete new scenario is created within the database. The baseline scenario of the loaded scenario will be the baseline scenario of the new created scenario too.

3. `load as baseline scenario`
   Means that a new copy of the selected scenario will be created. The loaded scenario becomes to the baseline scenario, whereas the copy becomes to the active scenario. This active scenario can be edited and adjusted by the user. Later both scenarios can be compared as usual and it will be recognized, if modifications caused improvements and cost reductions respectively.

[7] It is not freezed and still can be modified.

4. `load a copy of a baseline scenario`
   Means that a copy of a freezed baseline scenario will be created. But in contrast to use case number 3, the baseline scenario of this new scenario will be the same baseline scenario as the loaded one. In other words, the scenario is copied and this copy is not freezed anymore and can be edited again.
   By this construct the user is able to even compare a changed baseline scenario with its own origin baseline scenario.

Table 4.1 tries to summarize the different loading mechanisms described above. It quickly shows, which scenario will be the active one and which will be the baseline scenario respectively.

| | **active scenario** | **baseline scenario** |
|---|---|---|
| **load to edit (1)** | origin scenario | origin baseline scenario |
| **load a copy (2)** | copy of origin scenario | origin baseline scenario |
| **load as baseline (3)** | copy of origin scenario | origin scenario |
| **load a copy (4)** | copy of a freezed scenario | origin baseline scenario |

Table 4.1: Loading mechanisms of Confluentic WEB

### 4.2.3 Calculate/optimize scenario

According to the Confluentic approach, Confluentic WEB shall be able to find the optimal frequencies of each shipment or trip respectively by calculation (compare subsection 2.2.4). As seen in figure 4.4, Confluentic WEB offers two possible types in saving the optimized scenario within the database.

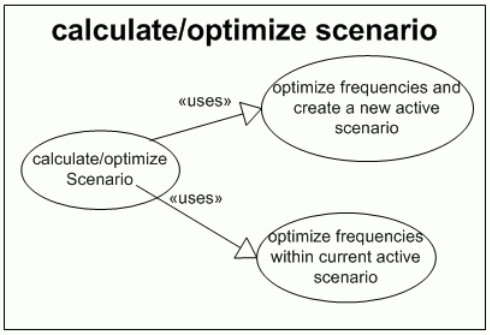



Figure 4.4: Use case "calculate/optimize scenario"

The first possibility is to save the optimized scenario as a `new active scenario`. The origin scenario, on which the calculation is based, remains unchanged. Instead it is marked as the baseline scenario of the new active scenario.

The second possible way in saving the optimized scenario is to overwrite the origin active scenario with the optimized one. In doing so the origin active scenario is lost on the one hand, but on the other hand the optimized scenario can be compared to the origin baseline scenario.
This allows an easy way to improve a scenario step by step, without the need of creation a new scenario for each optimization run. The user edits the scenario and subsequently "clicks" for the automatic optimization iteratively.

### 4.2.4 Location Management

According to the requirements specification a Location Management Tool (LMT) has to be set up within Confluentic WEB (compare subsection 4.4.4). It will be used to manage master location data corporately used by CATIS, FIONA and Confluentic WEB. Figure 4.5 depicts the corresponding use case diagram.

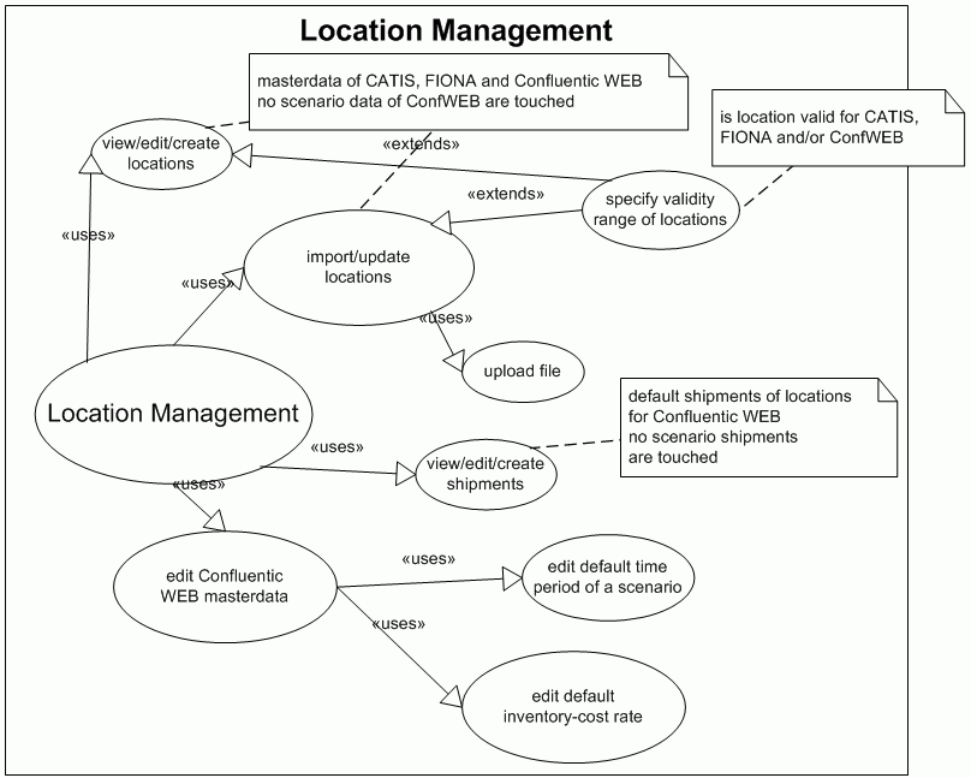



Figure 4.5: Use case "Location Management"

Location data can be `imported`, `viewed`, `created` and `updated` etc. Please consider, that the LMT is the only tool to access master data.[8]
Instead Confluentic WEB always works on a copy of these master data only. These copies are saved separately for each scenario (compare section 4.3).

Additionally the `validity range of location` have to be set for each master location. This means it has to be specified, which applications (CATIS, FIONA and/or Confluentic WEB) are allowed to access the respective location data.
E.g. validity for Confluentic WEB only means, that FIONA and CATIS do not "see" the corresponding location. Only Confluentic WEB can work with it[9].

Beside the new feature of location master data, `default shipments` of each location shall be maintained as master data by the LMT as well. In contrast to the location master data, default shipments are of interest of Confluentic WEB only.
In particular the user shall be enabled to transfer location master data as well as the corresponding default shipment data to each scenario[10]. Thus, the user does not need to input location and shipment data for each scenario again and again.

## 4.3 Database model

As mentioned in subsection 3.1.1 the database model was designed to be used corporately by CATIS, FIONA and Confluentic WEB.
The E/R diagram depicted in figure 4.6 shows all relations/tables, which directly affect Confluentic WEB or are accessed by the Location Management Tool. Additionally, all tables of CATIS are pictured, that are necessary to describe the relationship between Confluentic WEB and CATIS.

Colours indicate the intended affiliation of the tables. White tables belong to Confluentic WEB, orange tables are mainly used by CATIS. The yellow tables are dedicated for common use.
Tables of FIONA and CATIS, which are of minor interest for Confluentic WEB, have been removed to keep focus on most relevant issues. The complete E/R diagram of the developed database can be found in Appendix E. The corresponding visio-file is

[8] It is highly recommended, that only privileged users are allowed to use the LMT. Wrong changes (e.g. deleting a location) could cause crashes in all applications (FIONA, CATIS and Confluentic WEB).
[9] In particular such a location would be a virtual location (compare subsection 3.1.3).
[10] Again each scenario works on o copy of the default shipments only.

maintained at the Transport Wiki [Tra06a]. For a detailed description of the tables and relations of CATIS and FIONA, please refer to the writings of [Kop06] and [DR06].

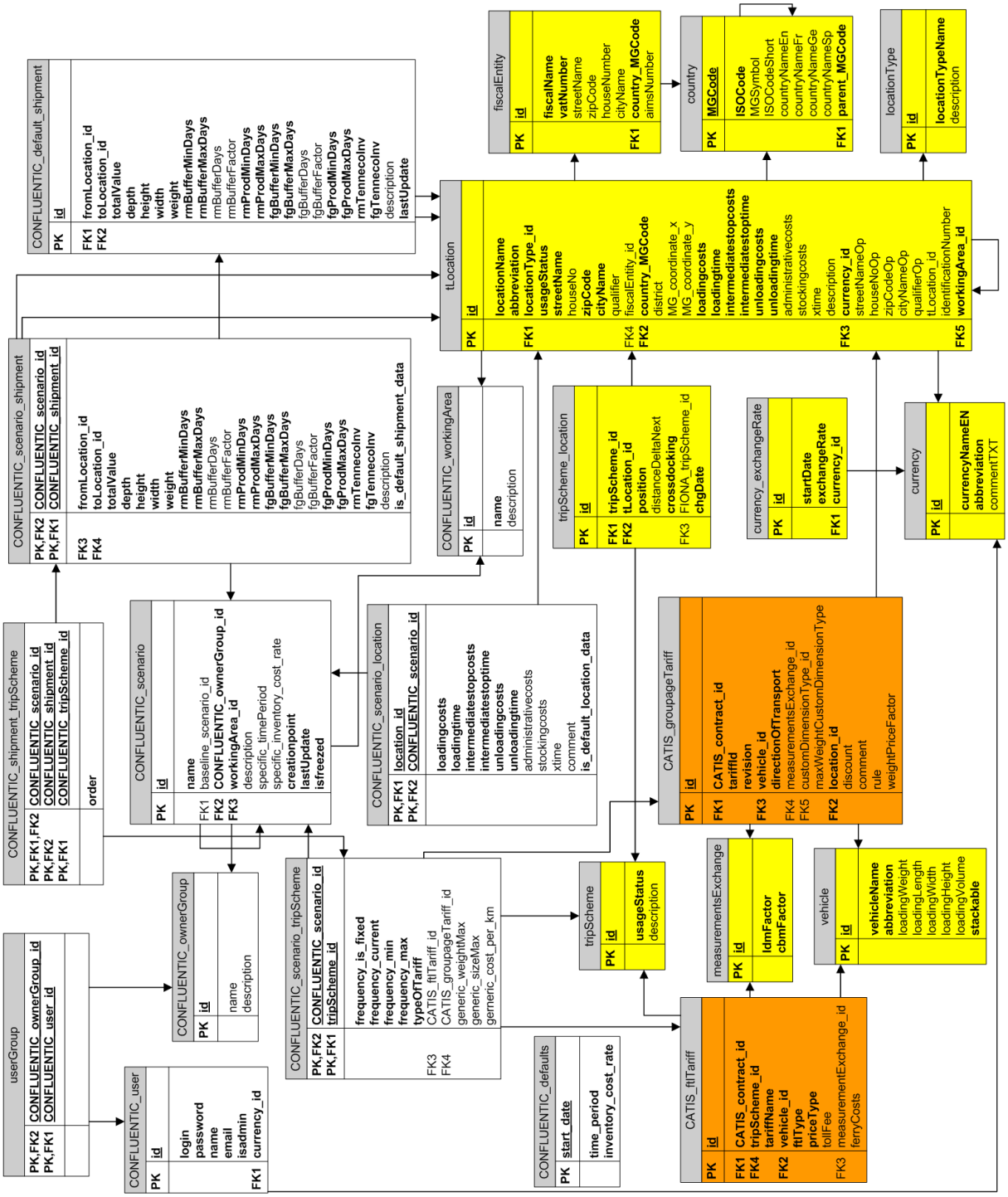



Figure 4.6: Database model - Confluentic WEB view

Subsections 4.3.1 to 4.3.4 describe the E/R diagram from the Confluentic WEB point of view. Since most attributes are self-explanatory and are explained in the visio-file respectively, following sections focus on the overall concept and relationships between each table.

### 4.3.1 Location master data and default shipments

Location master data is located at the **`tLocation`** table. In particular location attributes like `locationName`, `streetName`, `zipCode` etc. are saved there to describe each location.
`LocationType_id` references to table **`locationType`**, which specifies whether a location is a Supplier-, Customer-, ICY- or CrossDock-Location (compare subsection 4.1.2).

Attribute `usageStatus` specifies the validity range of a location, meaning whether a location is accessible by FIONA, CATIS and/or Confluentic WEB or not. Following table 4.2 summarizes all possible values.
Please keep in mind, that each location is a real existing location. Just locations with `usageStatus = CONF` are imaginary virtual locations.

| value | validity range |
|---|---|
| CATIS | CATIS |
| CATISFIONA | CATIS and FIONA |
| CATISCONF | CATIS and Confluentic WEB |
| CATISFIONACONF | CATIS, FIONA and Confluentic WEB |
| CONF | Confluentic WEB (a virtual location) |

Table 4.2: Possible values of `usageStatus`

Since the described attributes above are of interest of all applications, the attributes like `loadingcosts`, `loadingtime`, `administrativecosts` etc. are used by Confluentic WEB only[11]. In particular these attributes are used for calculation of transport costs.
All cash values are saved in the original currency (`currency_id`) used by each particular location. Current and past exchange rates are kept in the database too (table **`currency_exchangeRate`**).

[11] In particular `administrativecosts`, `stockingcosts` and `xtime` are only used by CrossDockLocations.

The attribute workingArea_id references to table **CONFLUENTIC_workingArea** and is only used by Confluentic WEB until now. It specifies to which working area a location belongs. In particular the two areas *Europe* and *NorthAmerica* are provided to distinguish between European and American locations (compare subsection 4.2.1). But a more granular classification would be possible.

Default shipments of each location (master data) are stored in table **CONFLUENTIC_default_shipment**. A shipment is described by its receiving and sending location (from_Location_id, to_Location_id)[12], by its dimensions (depth, height, width and weight) and by the totalValue.
Additionally several buffer and production attributes are defined (e.g. rmBufferMinDays, fgProdMaxDays etc.). These attributes[13] set boundary conditions of inbound[14] and outbound[15] stock respectively. According to this conditions possible frequencies for a trip, which delivers batches of the shipment are bordered. This correlation is already described in subsection 4.1.3.

Confluentic 1 also introduced a BufferFactor, which measures the buffer size according the number of missed batches. For example a factor of 1 means, that the buffer is that big, that the location is able to continue production, as long as only one batch is missing. After the second delivery is missed too, stock will run empty. A detailed definition of a *buffer factor* can be found in [KLS05], definitions 4.6 and 4.7.

TennecoInv states, whether the goods of a shipment are owned by Tenneco or not.

### 4.3.2 Scenarios, scenario locations and scenario shipments

Table **CONFLUENTIC_scenario** is seen as the central table of Confluentic WEB. Beneath general data like name and description, the working_area of a scenario is specified (compare subsection 4.3.1) too. According to the chosen area, locations with the same working area are accessible only. Also every scenario can be linked to its baseline_scenario.
The attribute isfreezed indicates, whether it is allowed to edit a scenario or not. Only freezed scenarios can be used as baseline scenarios.

[12] Note, that shipments are always associated to their receiving locations.
[13] Detailed definitions for calculation of buffer days etc. can be found in [KLS05], subsection 4.3.5.
[14] *rm* stands for *raw material*
[15] *fg* stands for *finished goods*

**CONFLUENTIC_scenario_location** connects locations (master data) to a scenario. Since the master data must not be edited on scenario level, a *copy* of each used location is stored for each scenario. Now attributes of these location copies can be edited within each scenario and the location master data remain unchanged. `Is_default_location_data` indicates, whether the copy has been edited yet or not.

The same approach is used for default shipments. The user has got the possibility to include the corresponding default shipments of each selected location. The copies of the default shipments are stored in table **CONFLUENTIC_scenario_shipment**. Also new shipments (not default shipments), which are created on scenario level, are stored there. Note, that these shipments are only accessible for the corresponding scenario.

### 4.3.3 TripSchemes

A trip is represented by a **tripScheme**. In particular a tripScheme consists of a concatenation or sequence of locations, which have to be visited one after the other (compare subsection 2.2.1). The sequence of locations is stored in table **tripScheme_location**, whereas `position` specifies the order.

Table **CONFLUENTIC_scenario_tripScheme** connects trips to a scenario. Adjacent to the `Confluentic_scenario_id` and `tripScheme_id` all needed frequency attributes are specified additionally. In particular `frequency_is_fixed` indicates, whether the frequency of a trip is excluded for optimization or not.

Each trip can be associated to a tariff. Possible tariffs are **CATIS_ftlTariff**, **CATIS_groupageTariff** or `genericTariff`. According to the chosen `typeOfTariff`, the corresponding reference is stored. In case of a generic tariff, maximum weight and size of a truck is saved as well as a `cost_per_km` price.

Last but not least table **CONFLUENTIC_shipment_tripScheme** connects **CONFLUENTIC_scenario_shipment** to **CONFLUENTIC_scenario_tripScheme**. In particular a scenario shipment is assigned to a trip or a concatenation of trips.

### 4.3.4 User rights

Each scenario is owned by one **CONFLUENTIC_ownerGroup**. Only members of the group are allowed to view and edit the corresponding scenario.
A **CONFLUENTIC_user** can become a member of several groups[16].

For convenience a user is able to set his preferred currency. Consequently all cash values will be converted and displayed in the desired currency.

## 4.4 Graphical User Interface

According the chosen MVC-oriented three-tier architecture based on Jakarta Struts (compare subsection 3.2.2), web pages represent the GUI of Confluentic WEB displayed by an Internet Explorer.

To specify how the GUI will look like and how a user will interact with Confluentic WEB, HTML dummy pages were developed. In particular a sequence of HTML-pages were set up to simulate all possible features and properties, that occur within a typical Confluentic workflow.[17]
On the one hand Tenneco's logisticians should get a clear idea of what Confluentic WEB will do. Thereby they were enabled to give suggestions to improve Confluentic WEB from the user point of view.
On the other hand the dummy pages deliver all important information and thereby enable Tenneco's IT department to implement Confluentic WEB in the desired manner.
The complete set of the dummy pages can be found in the Transport Wiki [Tra06a].

### 4.4.1 General layout

Since the struts framework is used for Confluentic WEB, the general layout of the webpages is defined according the *tiles* framework delivered by struts. *Tiles* is a template extension for inclusion and reuse of page fragments. In particular it allows to build component based webpages, whereas each component can composed of other components[18]. Figure 4.7 depicts the general layout for Confluentic WEB.

[16] Creating a public group for all users with public baseline scenarios may be a good idea.
[17] The dummy pages only fake interaction with Confluentic WEB, but nevertheless a complete run through the workflow is possible by clicking the right buttons.
[18] Tiles are described very well in [HDFW03].

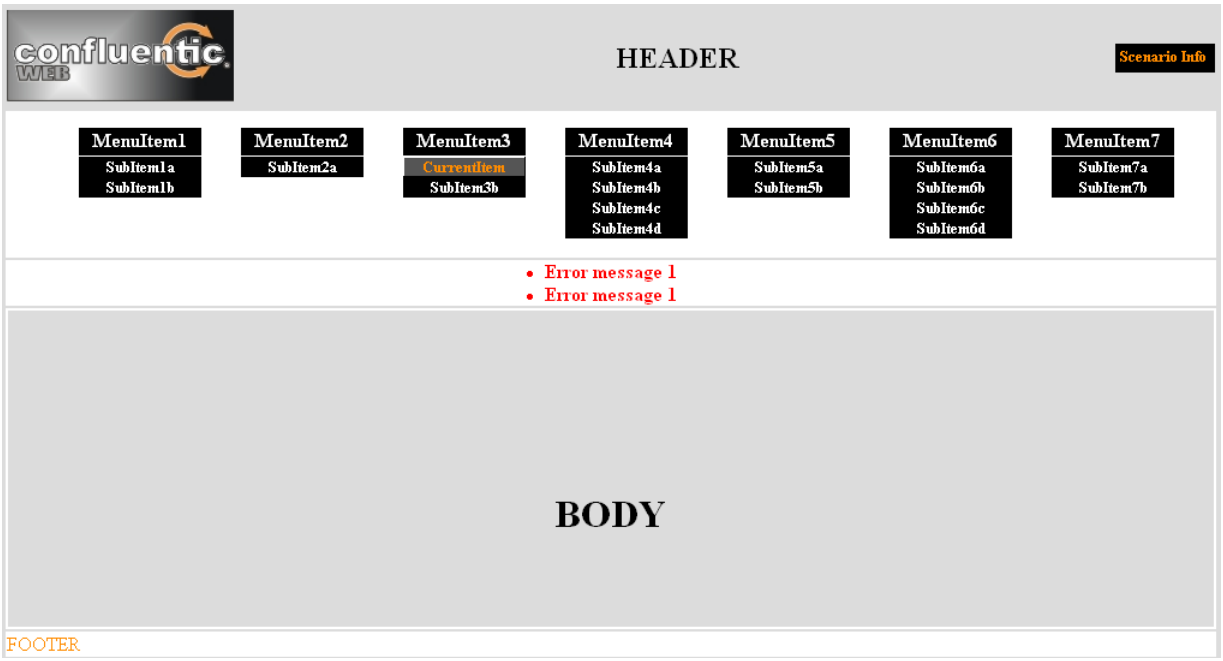



Figure 4.7: General layout

In particular a Confluentic WEB page consists of a *header*[19], a *menu*, a small *row* to display error messages, the *body* and a *footer*. This composition of tiles is adapted to the general layout of FIONA and CATIS, which shall foster uniformity of all applications.

The menu is used for navigation and calls all available features of Confluentic WEB. According Tenneco's design guidelines (refer to [Ten05]) use of javascript shall be avoided. Therefore the menu is created using Cascading Style Sheets (CSS) to avoid a static menu.
In particular only *MenuItems* are visible. *SubItems* of a MenuItem only become visible by hovering the mouse over the corresponding MenuItem.
If a feature is currently displayed within the body, the corresponding Item will become visible and will be highlighted additionally.

### 4.4.2 Menu based workflow

As already indicated with the general layout, the Confluentic WEB workflow will be menu based.

[19] Area *Scenario Info* will be used to display the name of the active and baseline scenario respectively.

This means, that there is no fixed sequence of visited webpages. Instead a menu is used to navigate within the application.
This kind of organization of the workflow was chosen to keep the work with the tool as flexible as possible. The user is enabled to access every single feature of Confluentic WEB at any point of time.
Figure 4.8. summarizes the menu based workflow graphically.

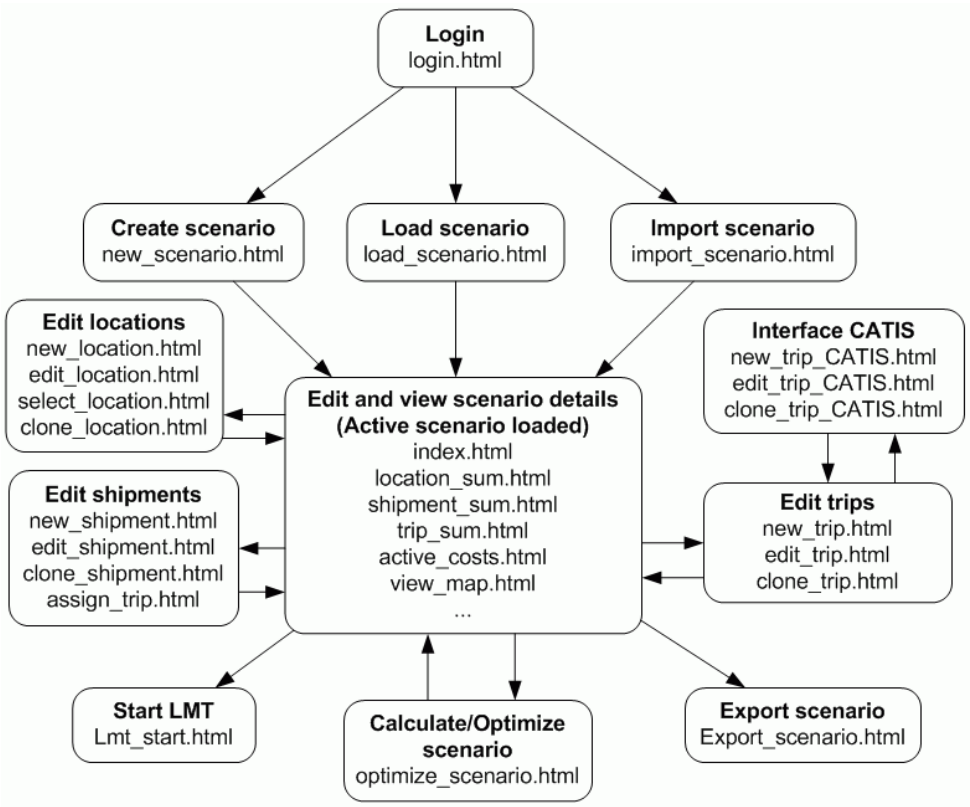



Figure 4.8: Menu based workflow of Confluentic WEB

After the user is logged in, he is able to either load, import or create a scenario. Through this the corresponding scenario becomes the active scenario and subsequently all scenario details are accessible to be viewed and edited respectively. It is up to the user to decide in which order he wants to for example create a scenario.

The concrete menu is depicted in below.

Figure 4.9: Menu of Confluentic WEB

Top MenuItems are always used to represent a kind of summary. All SubItems instead are used to create and to edit entities of the scenario.
Here is an example:
By clicking MenuItem *Location* all locations of the scenario are summarized (location_sum.html).
By clicking SubItem *Select* - below MenuItem Location - locations can be added to the scenario (select_location.html).

Features concerning the same kind of entity are located within one column. For example all features concerning locations are located at column 2.
The columns are arranged in a specific order. It is assumed, that a user usually will go through the menu from left to right. In particular first a scenario will be created, secondly locations are added, subsequently shipments are created and trips are developed etc.

Another quirk of the menu is, that it *grows* during the creation of a new scenario according accessible features.
For example right after a user has logged in, no scenario is loaded, imported or created. Therefore he has to do so. Since features of locations, shipment and trips etc. make no sense at this point of time, the corresponding columns are set invisible. Once the user creates a new scenario, column Location will appear.
Furthermore columns shipment and trip remain invisible, until the first location is created or selected. The reason is, that shipments and trips require locations. Without existing locations the creation of shipments and trips is not possible within a scenario.

Following subsection will describe the developed dummy pages in detail and thereby the workflow at the same time.

### 4.4.3 Dummy pages of Confluentic WEB

Since the dummy pages are not able to simulate the described flexible workflow, they represent only one typical example, how Confluentic WEB should be used. In

particular it is simulated, how to create and edit a new scenario.
First an empty scenario is created and subsequently locations, shipments and trips are added and modified. Afterwards results of Cash&Cost comparisons are listed and all supply relationships are visualized graphically. In particular this shall show, how the map server has to be used within Confluentic WEB.
Finally it is shown, how a scenario can be calculated and optimized by the application.
In the following all important dummy pages are described in detail.

After the user has logged in, he is able to either create a *new* scenario, *load* an existing scenario or alternatively he is able to *import* a scenario from an excel file.

**new_scenario.html**

To create a new scenario the user has to input a `Name` of the new scenario, a `Description` and the desired `Time Period`. By selection the `Working Area` is specified (compare subsection 4.2.1).
Additionally the user is able to set a specific `inventory-cost-rate`, which will be valid for this one scenario. If the input field remains empty, the default rate will be used. By clicking the `Save` button the scenario will be created and saved in the database.

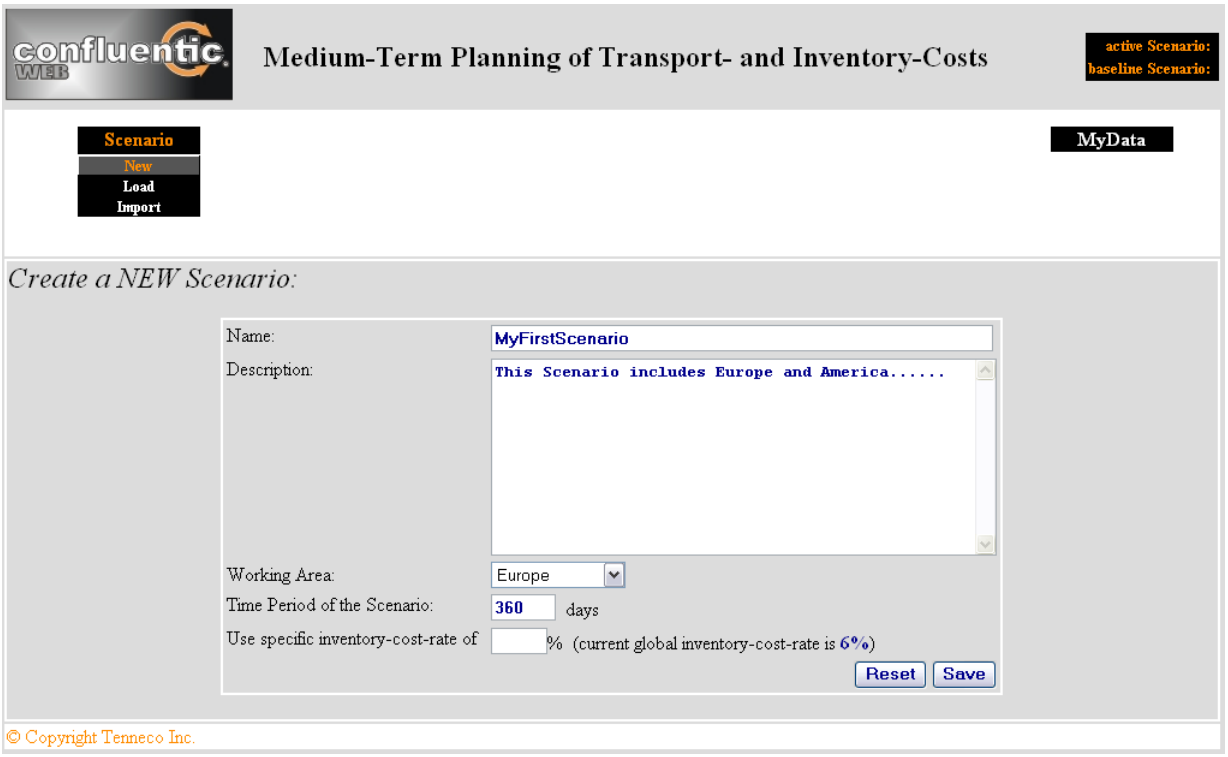



Figure 4.10: Dummy page *create_scenario.html*

**load_scenario.html**

Alternatively also an existing scenario can be loaded out of the database[20]. A detailed description of the different types of loading a scenario is omitted, since they are already described in subsection 4.2.2.

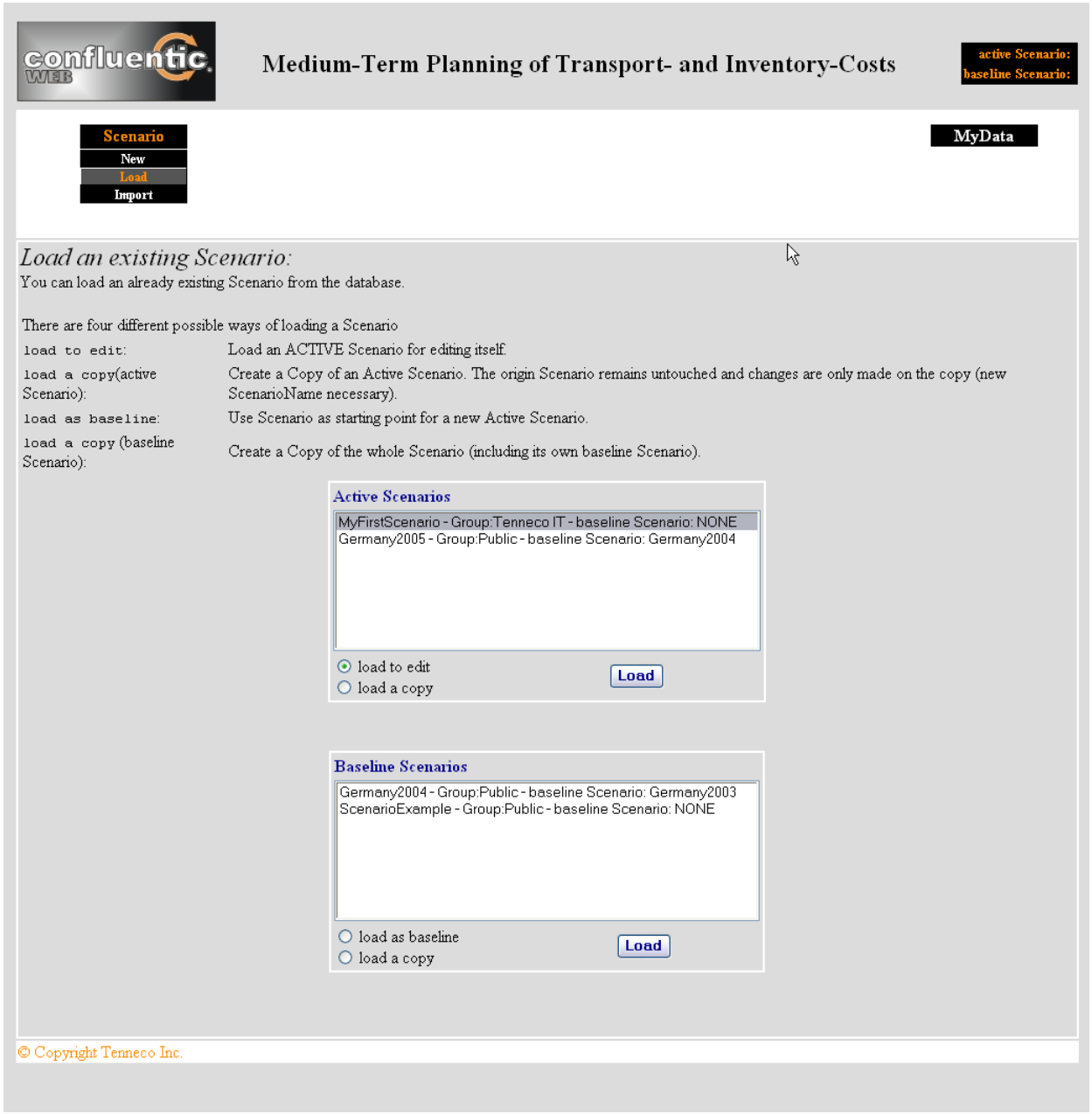



Figure 4.11: Dummy page *load_scenario.html*

[20]Only scenarios will be displayed, which are owned by those usergroups the user is a member of.

**index.html (scenario_sum)**

This page will appear, if the user clicks on MenuItem *Scenario*. General scenario data is shown and can be edited there. `Name`, `Working Area`, `CreationDate` and `Last Updated` are excluded from manipulation by the editor, since changes are not allowed there.
By checking a checkbox `Freeze` the active scenario becomes to a baseline scenario and no more modifications are allowed anymore.

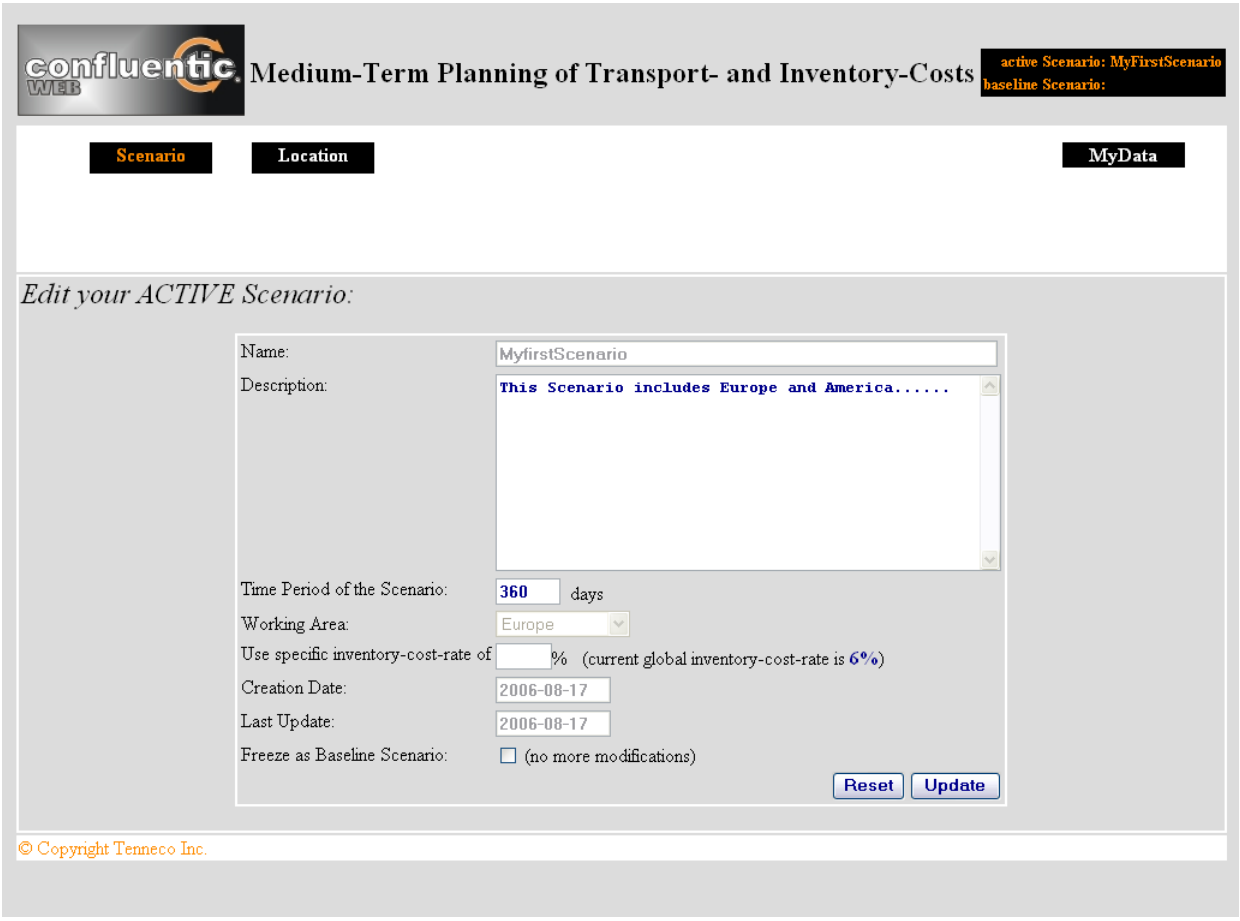



Figure 4.12: Dummy page *index.html*

**new_location.html**

A new location can be created by clicking on SubItem *New Virtual*. Subsequently all needed location data has to be input. Note, that only virtual locations (`usageStatus=CONF`)

can be created within Confluentic WEB. To create real existing locations the LMT (see subsection4.4.4) has to be used.

By clicking the *Save* button the virtual location is saved to the database. In particular it is saved to table **`tLocation`** (master location data). Thus, this new virtual location can also be used by all other scenarios. Of course a copy of the location for this scenario is created as well and saved in table **`CONFLUENTIC_scenario_location`** (compare subsection 4.3.2).

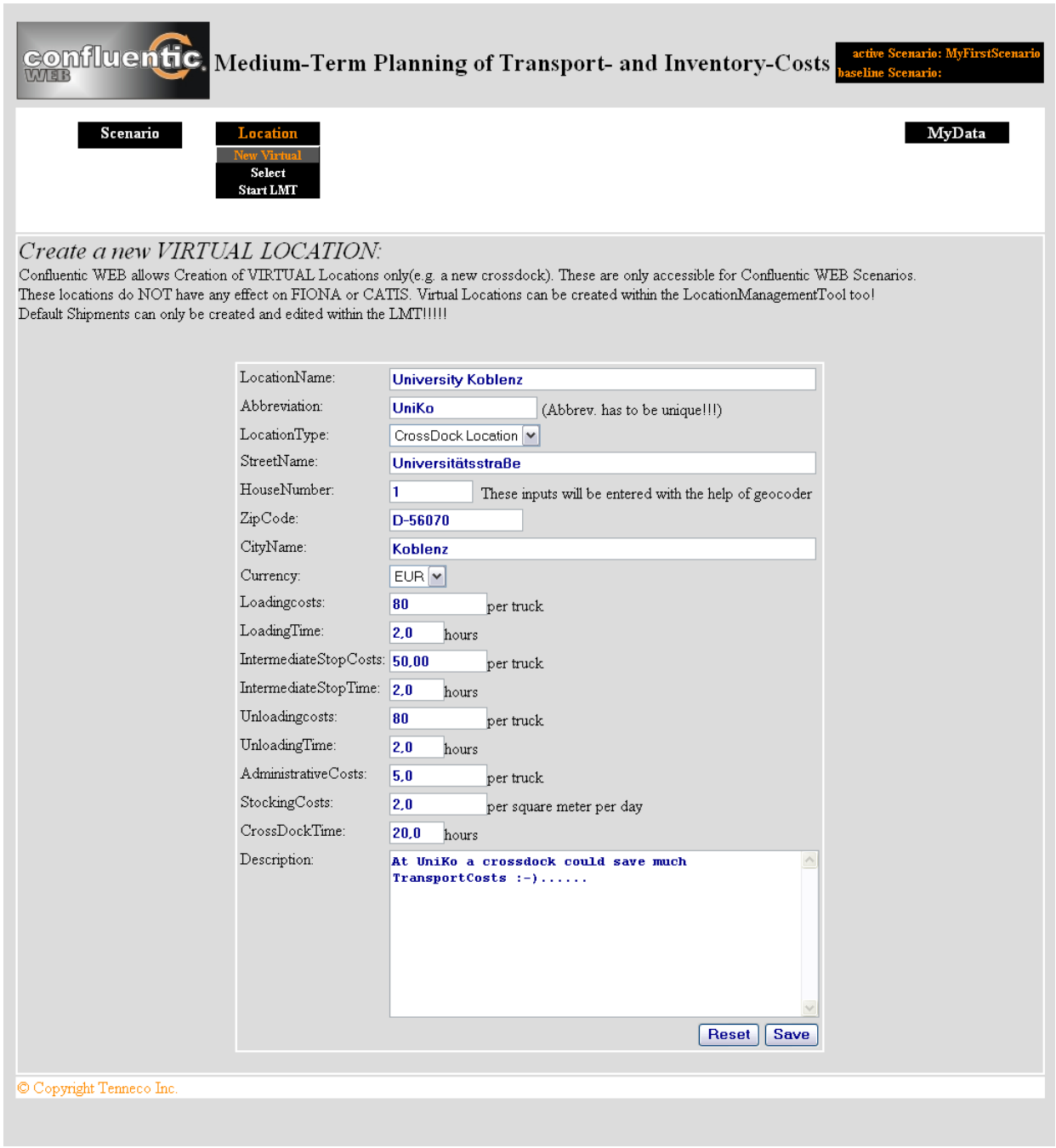



Figure 4.13: Dummy page *new_location.html*

**select_location.html**

By clicking on SubItem *Select* all existing locations (master location data)[21] of the database are listed. Most important attributes like `Abbreviation`, `Name` and `Loc_Type` etc. are displayed. Button *ViewDetails* has to be clicked to view all details of the corresponding location (location_details.html).

Each location can be selected to be part of the active scenario by checking the corresponding checkbox. Additionally default shipments of the corresponding location can be included to the scenario as well. If the corresponding checkbox is disabled, it indicates, that there will be no default shipments for this particular location.

After clicking the *Add* button all selected locations and shipments are associated to the active scenario. This means, that copies of the master data are saved in table **`CONFLUENTIC_scenario_location`** and **`CONFLUENTIC_scenario_shipment`** respectively (compare 4.3.2).

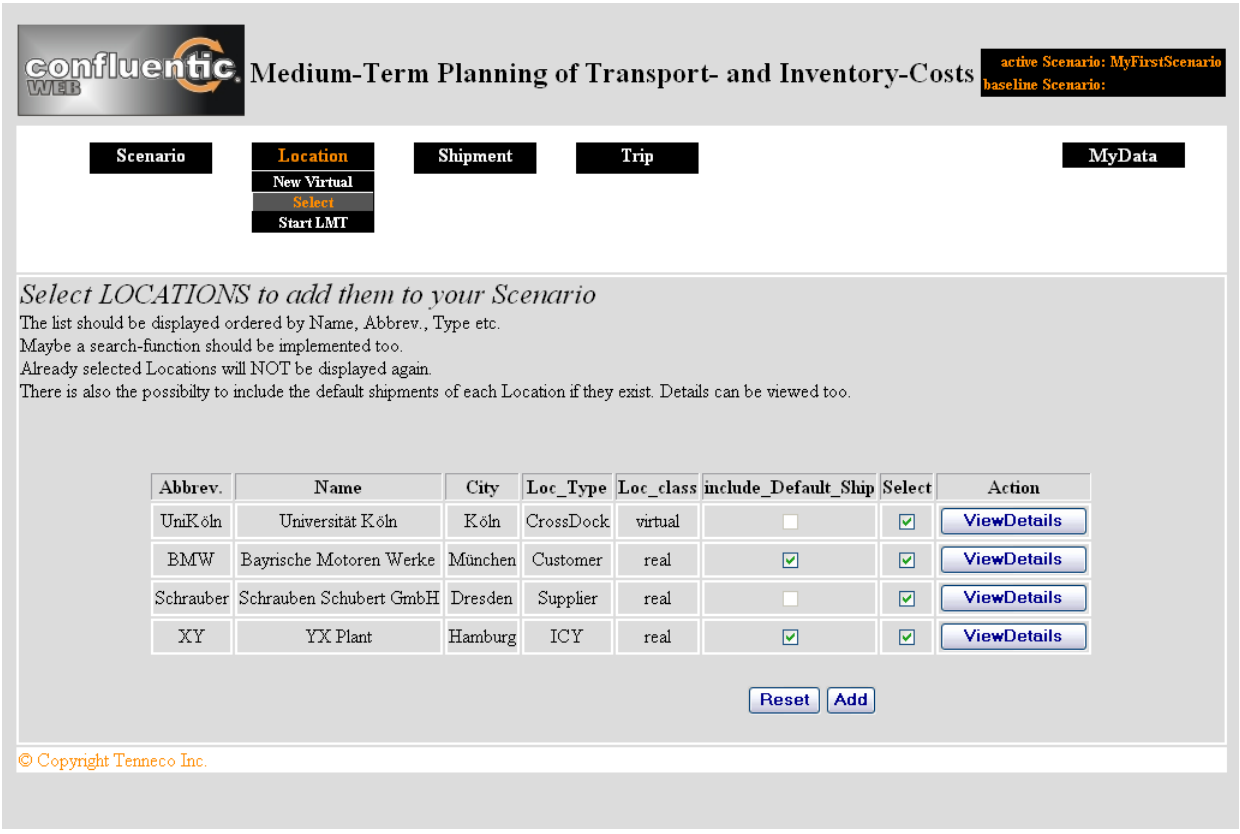



Figure 4.14: Dummy page *select_location.html*

[21] According the chosen Working Area.

**location_sum.html**

This page appears by clicking MenuItem *Location*. It lists all locations, which are associated to the scenario.
In particular `use_Loc_Data` indicates, whether current location data (table **`CONFLUENTIC_scenario_location`**) equals master location data (table **`tLocation`**) or whether the data has been modified for this scenario yet. This feature shall help the user to keep an overview about all locations, which have been modified already.

Additionally `has_Shipments` provides information about the shipments of each location. *No* indicates, that there are no shipments of the corresponding location yet. *Default* indicates, that there are only default shipments used, which have not been modified yet. And last but not least *Custom* indicates, that custom or modified default shipments are used.

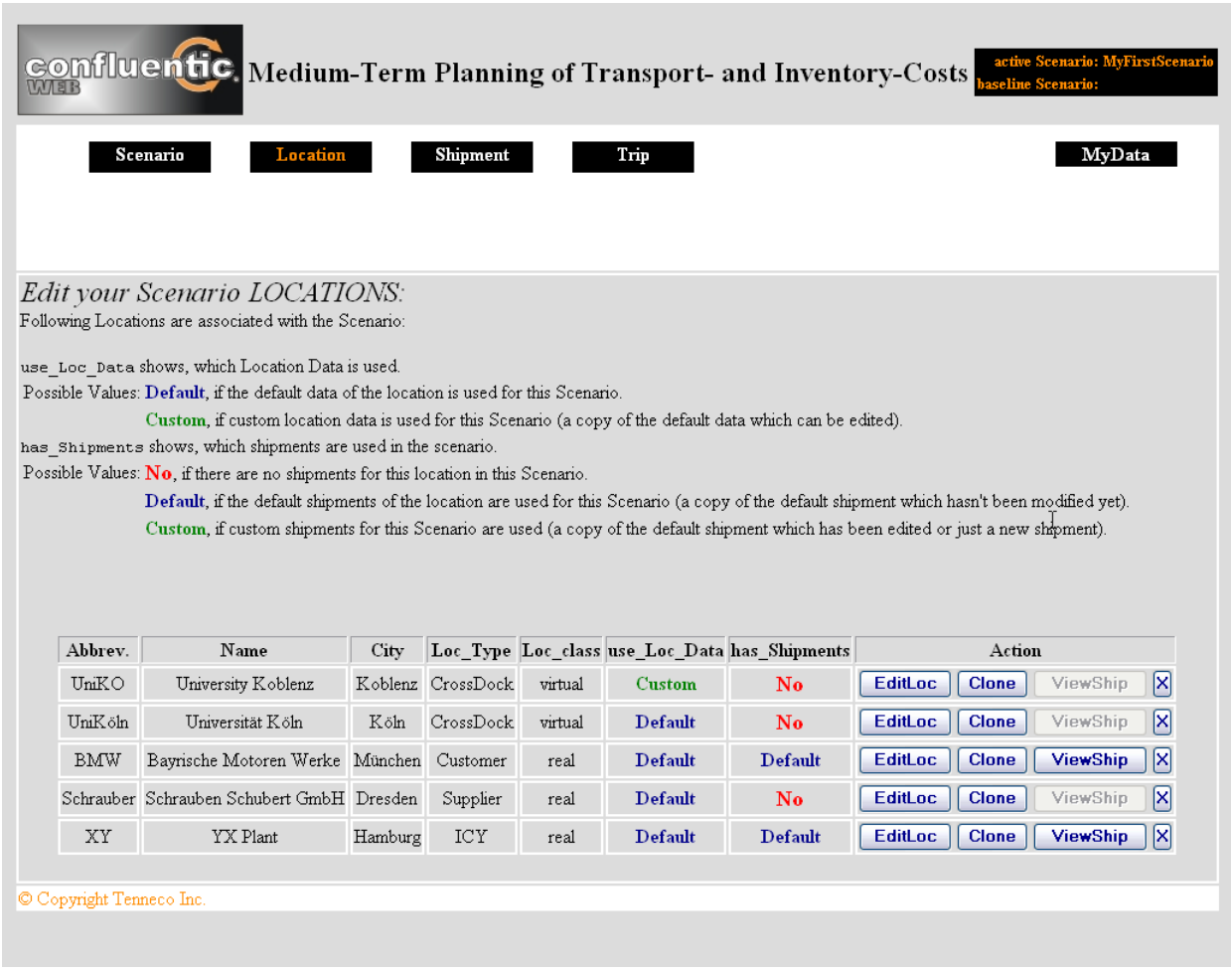



Figure 4.15: Dummy page *location_sum.html*

By clicking the corresponding button within the `Action` column each location can be edited, copied and deleted. Additionally all shipments of the corresponding location can be viewed up.

Editing a location (*EditLoc*[22]) implies, that only data concerning Confluentic WEB (loadingcosts etc.) can be edited. No master location data like `StreetName` etc. can be edited. In particular only the copy (table **`CONFLUENTIC_scenario_location`**) is edited. Changes only affect this one scenario and location master data (table **`tLocation`**) is not touched.

To `Clone`[23] a location equals to create a new virtual location described above. In particular a new location is created out of the copied data. Additionally the user has got the possibility to *"move the Origin Location"*. If the corresponding checkbox is checked, the origin location will be deleted and only the clone will exist. This feature enables Confluentic WEB to move locations around.

Note, that all changes only affect the current scenario, because changes are always made on scenario level only.

#### new_shipment.html

New shipments can be created by clicking SubItem *New* in column Shipment.
Subsequently all needed data have to be input (compare subsections 4.3.1 and 4.3.2).

Note, that those locations can be selected only, which have been associated to the current scenario already.

By clicking the *Save* button a new shipment is stored on scenario level. In particular the shipment is stored in table **`CONFLUENTIC_scenario_shipment`**. Note, that it is never stored in table **`CONFLUENTIC_default_shipment`**, because the created shipment is a custom shipment and not a default one.

[22] This will call up dummy page edit_location.html
[23] This button references to clone_location.html.

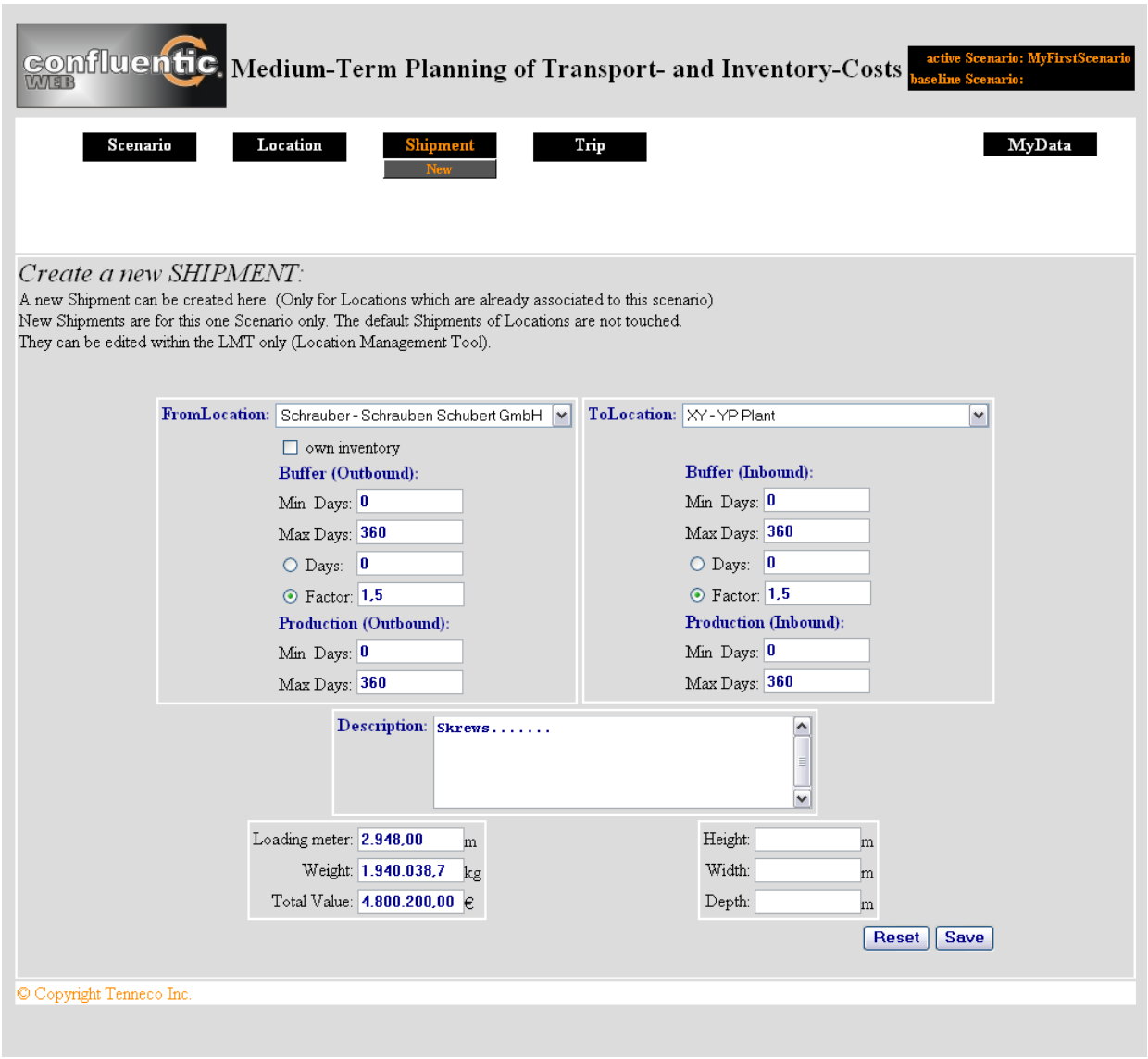



Figure 4.16: Dummy page *new_shipment.html*

### shipment_sum.html

This page appears by clicking MenuItem *Shipment*. Similar to `location_sum.html` all shipments of the scenario are listed. Each shipment can be edited, cloned and deleted like it is already described for locations.

Additionally each shipment can be assigned to a trip, meaning to specify which trip or concatenation of trips are used to deliver the shipment from A to B.
Column `is_shipped` indicates, whether a shipment has been assigned to a trip or not. Buttons *AssignTrip* are disabled at this point of time, because there have not been set up any trips so far.

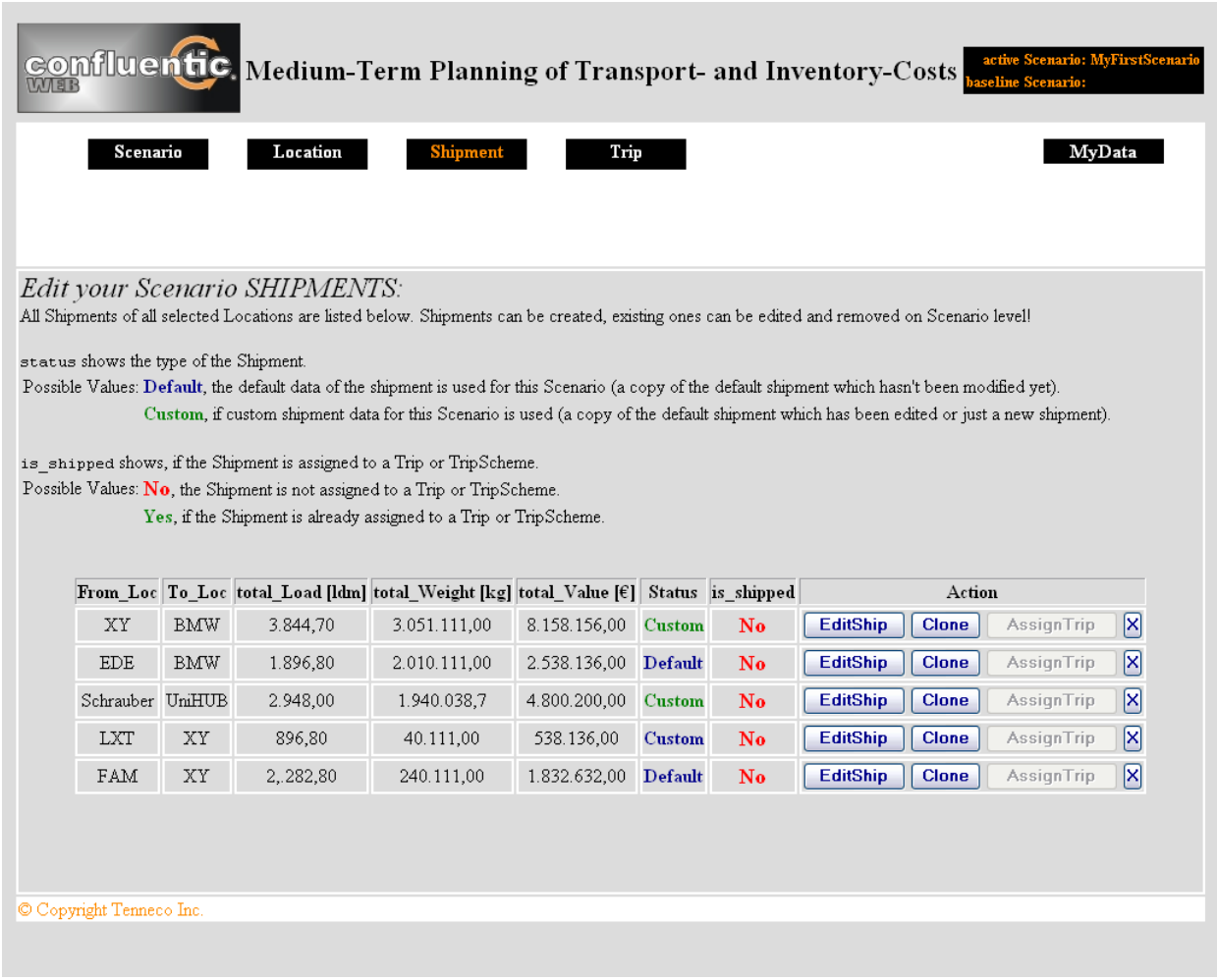



Figure 4.17: Dummy page *shipment_sum.html*

### new_trip.html and new_trip_catis.html

Setting up a trip is performed in two steps. It first starts with `new_trip.html`, which is called up by clicking SubItem *New* in column Trip.
In particular a tripScheme is set up, meaning the order of all visited locations between *Start* and *Destination* are specified (compare subsection 4.3.3). Note, that only locations can be part of the tripScheme, which have been associated to the scenario already.
Beneath setting up all frequency values, additionally the trip can be excluded from the later optimization performed by Confluentic WEB. This means, that the *Actual Frequency* of the trip is fixed and can not be changed by the application to optimize the sum of transport an inventory costs.

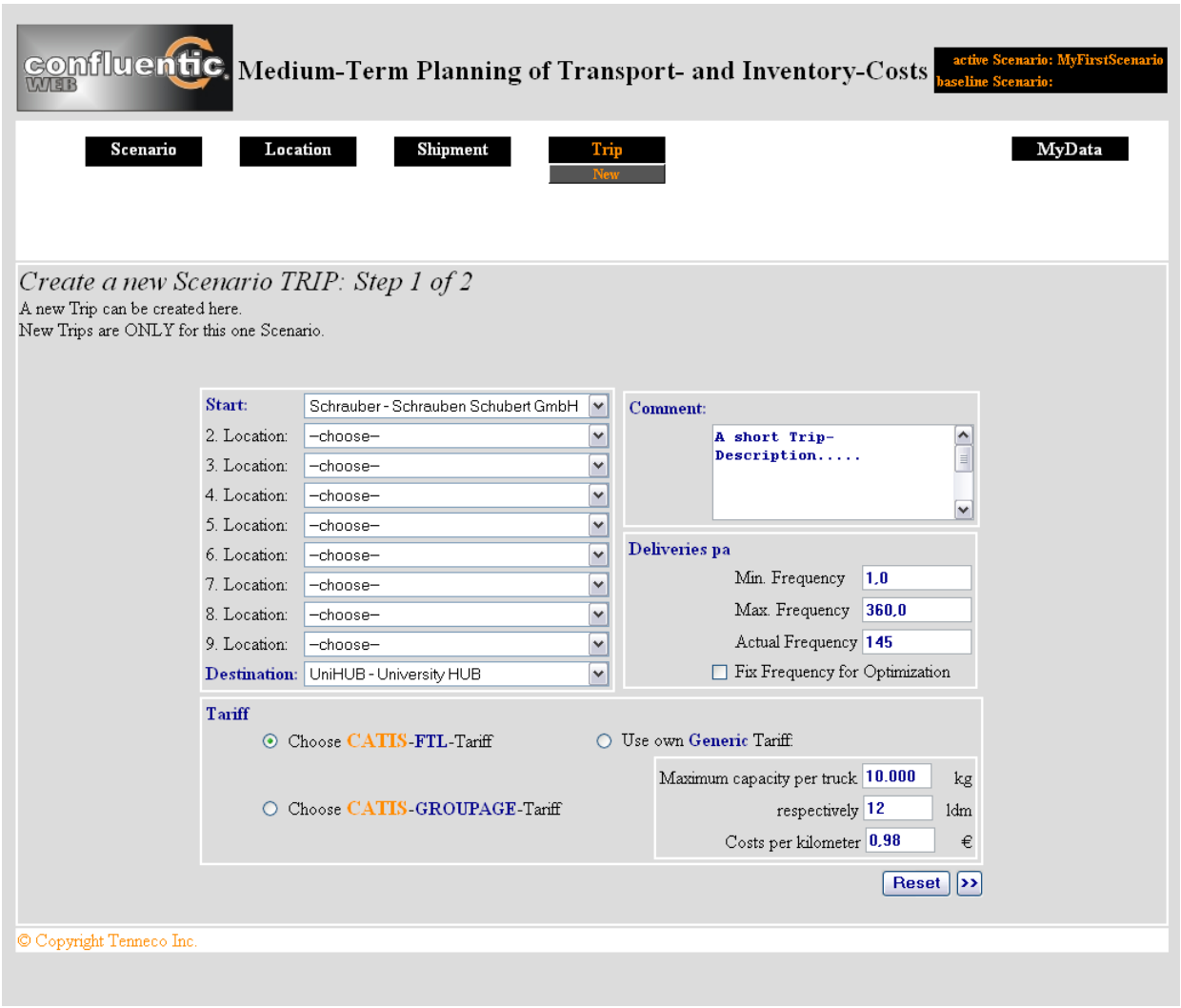



Figure 4.18: Dummy page *new_trip.html*

Additionally the user has to specify, whether a *CATIS-FTL-Tariff* or a *CATIS-GROUPAGE-Tariff* shall be used by the trip. According this decision and clicking the > > button the CATIS interface (described in section 4.5) is called to search for suitable tariffs. Alternatively a *Generic Tariff* can be chosen and specified. But it is highly recommended to make use of it in a few individual cases only. Otherwise the new benefit of using realistic tariffs will get lost (compare subsection 3.1.4).

The second step is to choose one tariff delivered by the CATIS interface. This is done on page `new_trip_CATIS.html`. By clicking *Save* the new trip is stored in the database.

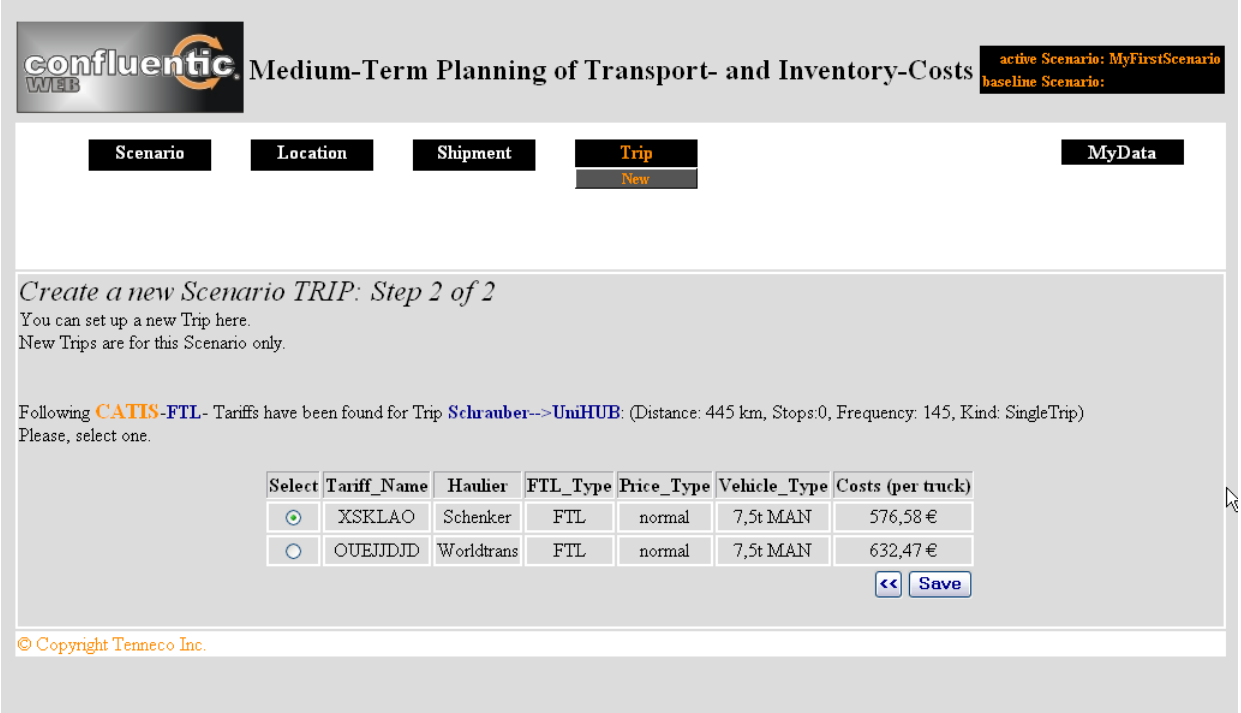



Figure 4.19: Dummy page *new_trip_catis.html*

Of course all created tariffs can be viewed up and edited as usual by clicking MenuItem *Trip* too. But since `trip_sum.html` almost looks like `shipment_sum.html` and `location_sum.html` respectively, the page is not described here.

### assign_trip.html

After trips and shipments have been set up, now it is possible to assign trips to shipments. After clicking on a *AssignTrip* button on `shipment_sum.html` (see above), the user is able to specify, which trip shall be used for the corresponding shipment.

In addition to assign one single trip, the user is also enabled to assign a concatenation of trips to the shipment.
Spoken on database level: By this feature it is possible to create a tripScheme of several tripSchemes. The assignment of trips and shipments is stored in table **`CONFLUENTIC_ shipment_tripScheme`**.

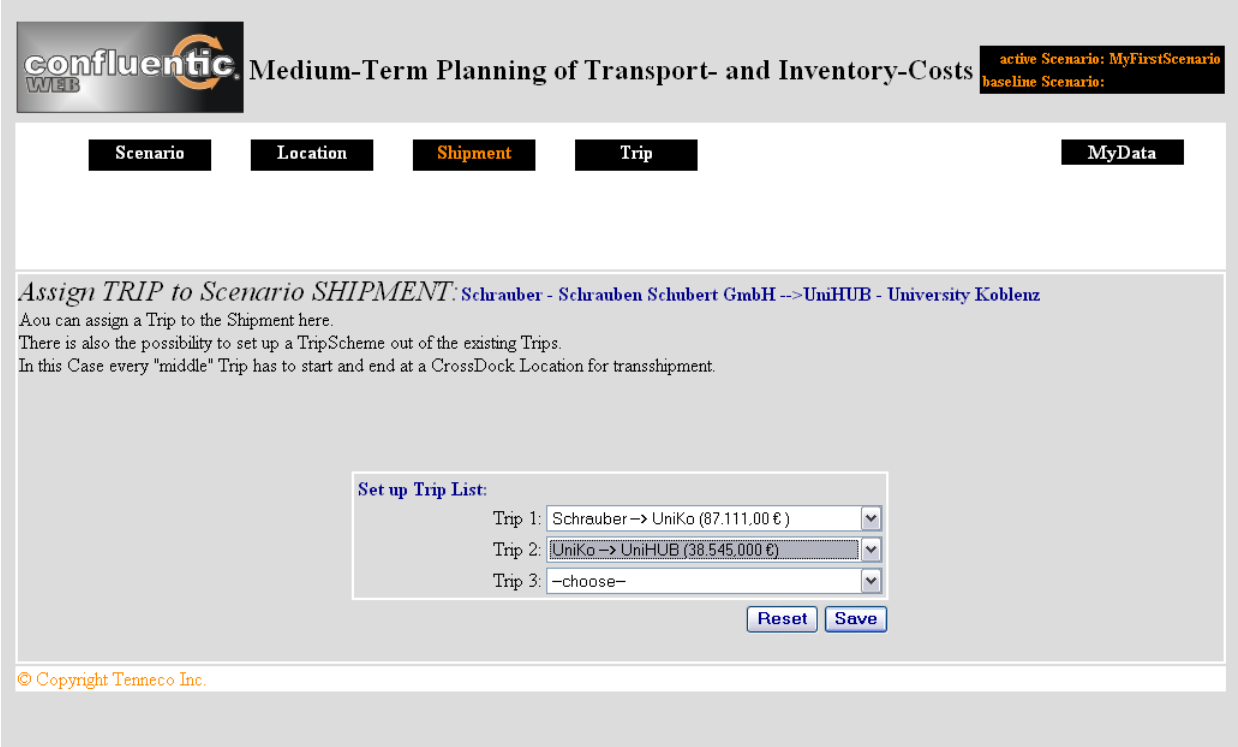



Figure 4.20: Dummy page *assign_trip.html*

### active_costs.html

Confluentic WEB lists all trips concerning frequency, truck utilization, sum of transported values, transport costs and inventory costs within a spreadsheet. This is possible for the baseline scenario as well as for the active scenario. Since both are build in the same way, only `active_costs.html` is described here[24].

This sheet can be used as indicator, at which position the user should think about modifying the scenario.
In particular the frequencies are marked red, where a trip is overloaded. Additionally the utilization values of each trip are differently coloured according their utilization degree.
Best degrees are coloured green (25%), next 25% are coloured orange and worst 50% are coloured red.

[24]Cash and Costs comparison sheets aren't described either, because they look similar except they are dealing about the locations instead and compare active and baseline scenario.

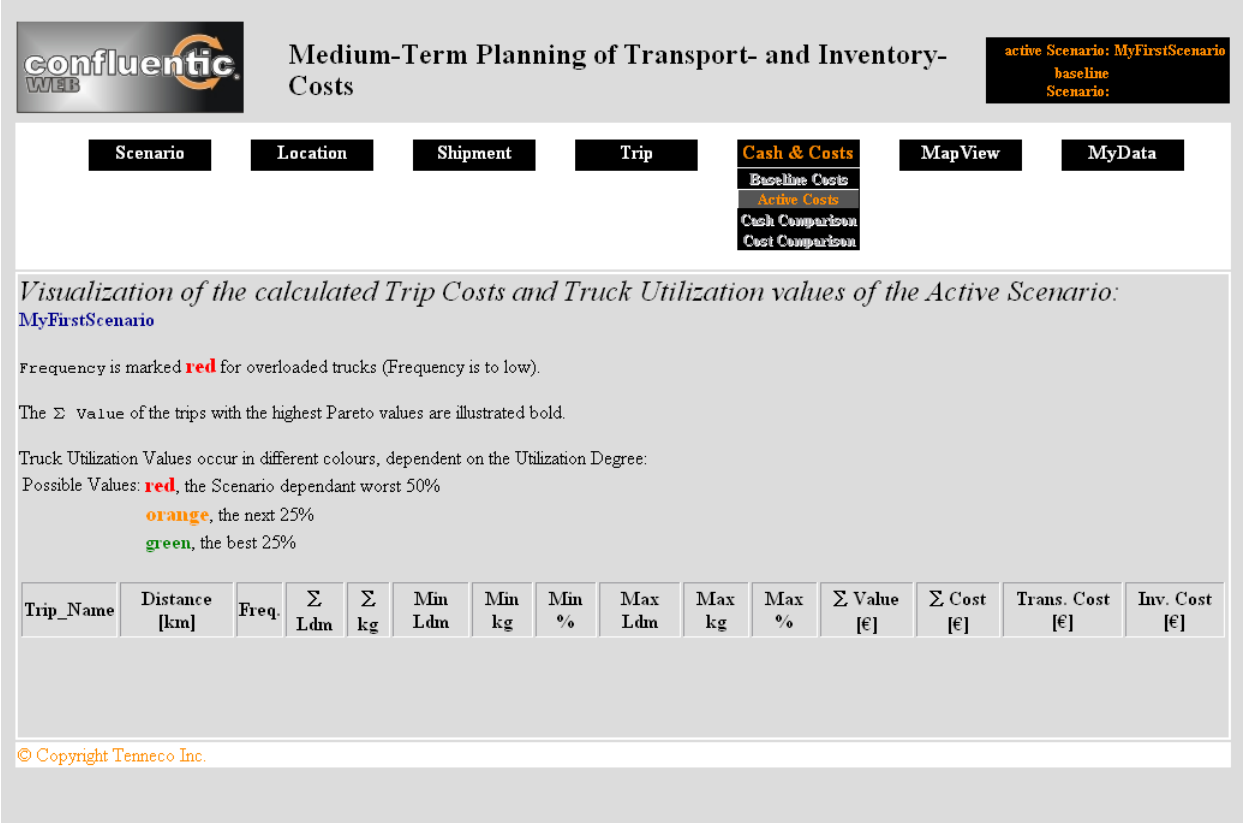



Figure 4.21: Dummy page *active_costs.html*

Best practice for the user is to focus on those trips, which are coloured red and having the highest Pareto values. Improving these costs will have the biggest overall effect.

Calculation algorithms and the detailed mathematical background is already described at [KLS05] section 4.3.

### view_map.html

Like Confluentic 1 Confluentic Web shall visualize all supply relationships within a map as well (compare subsection 3.2.3). The visualization with the help of a map server shall be triggered by clicking MenuItem *MapView*.

To get a detailed understanding of how the visualization should be realized, please refer to [KLS05] subsection 5.2.7.
In particular the map view should be used to hint at possible improvements in the same way, as `active_costs.html` does.

Figure 4.22: Dummy page *view_map.html*

**optimize_scenario.html**

The optimization feature of Confluentic WEB can be called by clicking SubItem *Optimize* at column Scenario. The user can choose, how optimization shall be performed (compare subsection 4.2.3).
In case the user wants to receive a new scenario, he has to input a new `ScenarioName` as well as a `Description`. Note, that the current active scenario has to be freezed first according the constraint, that baseline scenarios always have to be freezed. Otherwise inconsistencies could occur within the database, if a baseline scenario was modified afterwards.

By clicking *Optimize* calculation starts. Details how the optimized frequencies are calculated is already described in subsection 2.2.4.

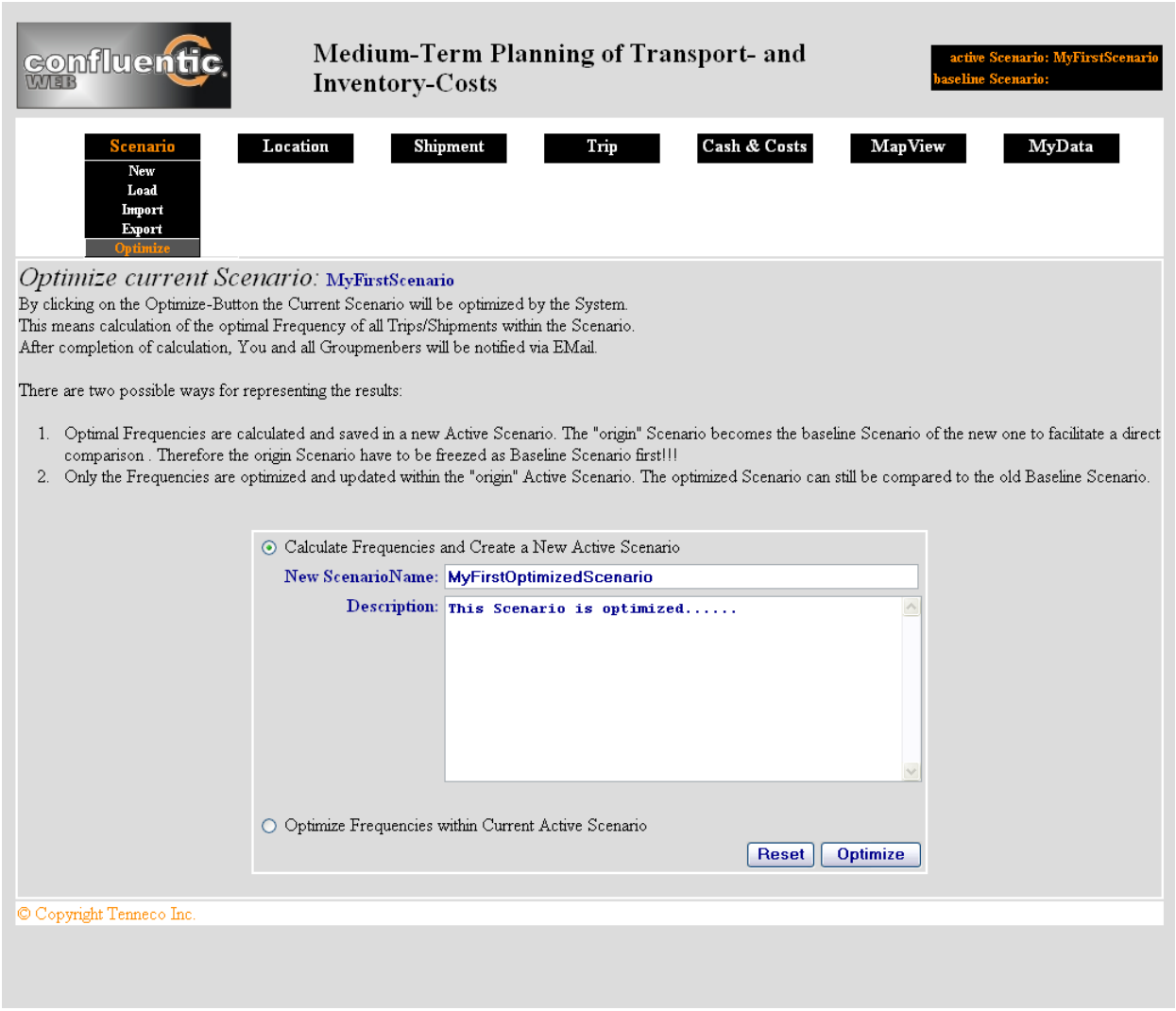



Figure 4.23: Dummy page *optimize_scenario.html*

### 4.4.4 LMT - Location Management Tool

As described in subsection 4.2.4 the Location Management Tool is used to maintain and manage location master data of CATIS, FIONA and Confluentic WEB.
In particular layout and usage is completely aligned according Confluentic WEB.

Starting from Confluentic WEB, the LMT is reached by clicking SubItem *Start LMT* at column Location. Concerning, that master data can be modified directly, access is granted to high privileged users only.

**locations_sum.html**

By clicking MenuItem *Location* all master locations are listed and each location can be edited. In contrast to Confluentic WEB column `usage_Status` is shown additionally, which states the validity range of each location (compare subsection 4.3.1).
Regard, that it is not allowed to delete a location.

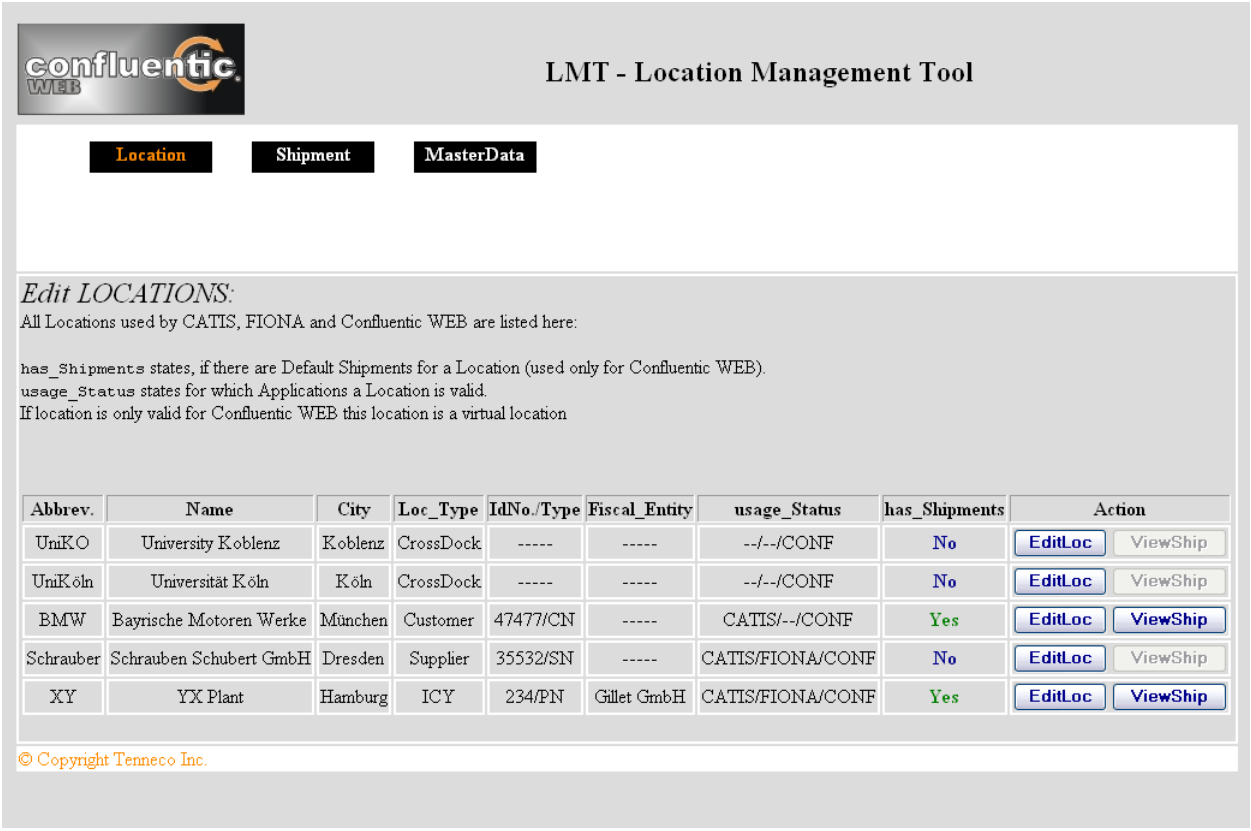



Figure 4.24: LMT dummy page *locations_sum.html*

**edit_location.html**

Additionally to Confluentic WEB the *Validity Range* of a location can be modified here too[25]. Please note, that it is highly recommended to increase this range only. If the range is decreased instead, one or more applications won't see the corresponding

[25]Dummy page create_location.html exactly looks like this page, therefore the description is omitted.

location anymore and the effect would be the same, as if the location was deleted. For example already created scenarios, which use the corresponding location will crash.

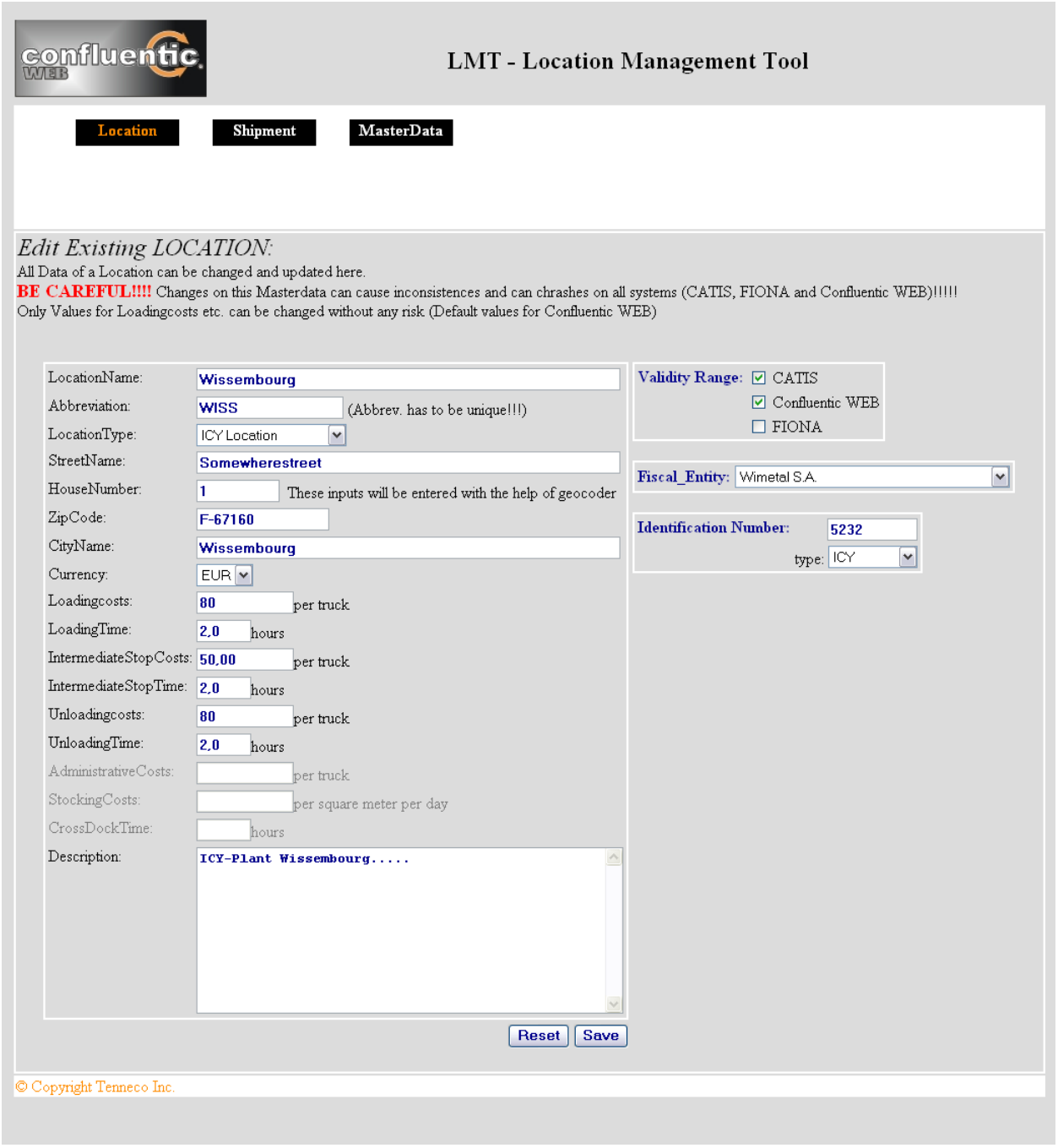



Figure 4.25: LMT dummy page *edit_location.html*

Another dangerous modification is to edit attributes concerning the address. This means to "move" a location and consequently existing scenarios of Confluentic

WEB would become corrupt[26]. Therefore only corrections of the spell should take place.
In case, that a location is really moved, a better way is to create a new location instead. Otherwise history states will get lost too.

Also a *Fiscal Entity* and a *Identification Number* can be specified. Until now, these attributes are used by FIONA and CATIS only.

All changes are directly saved in table **`tLocation`**.

#### shipment_sum.html

The Location Management Tool is also used to edit and maintain the default shipments. They are only used by Confluentic WEB.
A list of all existing default shipments is provided by clicking MenuItem *Shipment*. Editing and copying is completely organized in the same way, as it is done within Confluentic WEB[27]. The only difference is, that now all changes are stored in table **`CONFLUENTIC_default_shipment`**, where the master default shipments are located.

Please note, that in contrast to edit master locations, it is allowed to delete default shipments. Since for each scenario a copy of the default shipment is created in table **`CONFLUENTIC_scenario_shipment`**, no data will get lost, if a default shipment is deleted.
For example a good procedure would be to update all default shipments once a year. Thus, a scenario can be easily created with actual data. Additionally former created scenarios aren't touched and remain, as they were created.

[26] FIONA and CATIS will be affected too and this will cause a lot of corrupt data as well.

[27] Therefore a description of new_shipment.html is omitted, since it is similar to the description provided for Confluentic WEB.

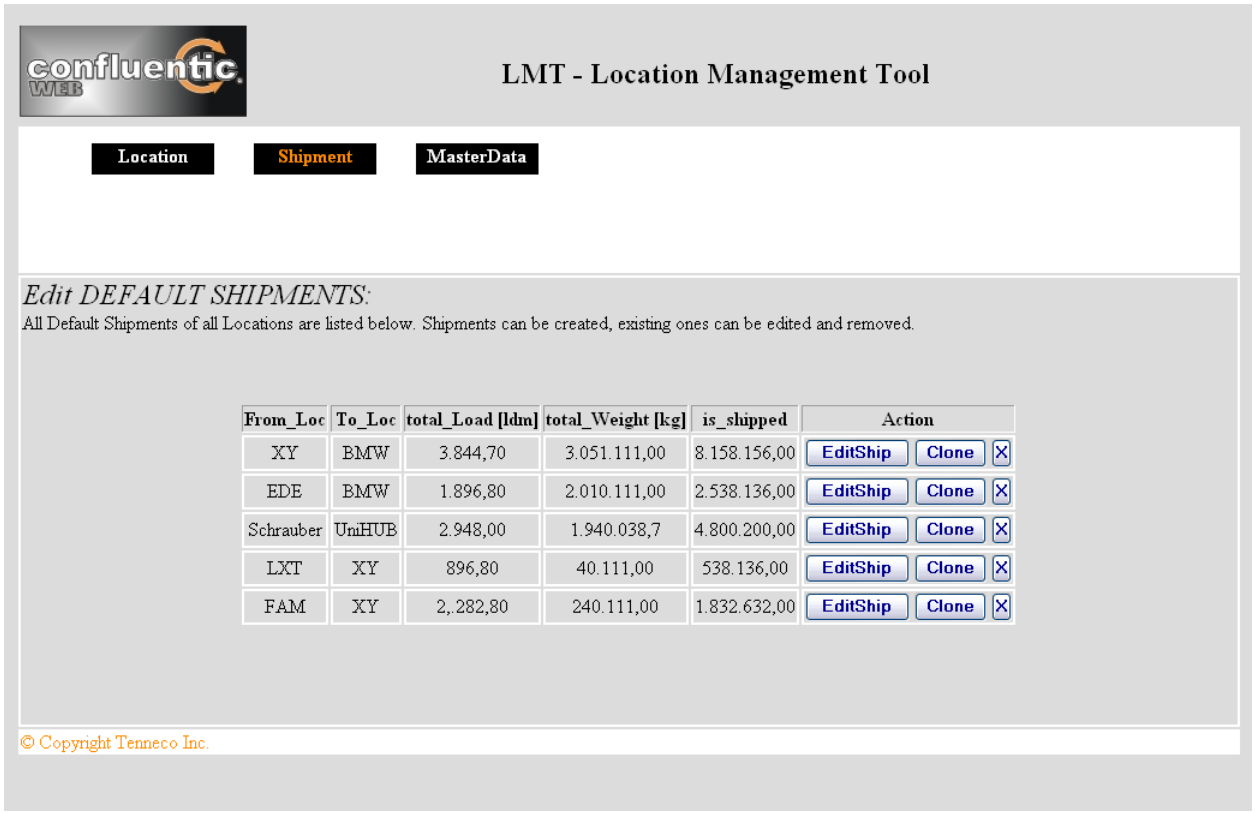



Figure 4.26: LMT dummy page *shipment_sum.html*

**conf_common.html**

This page shall enable to update and modify the common master data of Confluentic WEB. In particular common master data are defined as the default values for `TimePeriod of a scenario` and the default `current inventory-cost-rate`, on which all calculations are based on.

A complete history of the default values is stored in table **`CONFLUENTIC_defaults`**. In doing so, all former created scenarios are still based on the inventory cost rate, which was valid at this point of time.

Additionally it is possible to edit the history, but this will cause the just described side effects. On the other side this feature may be used to correct wrong input.

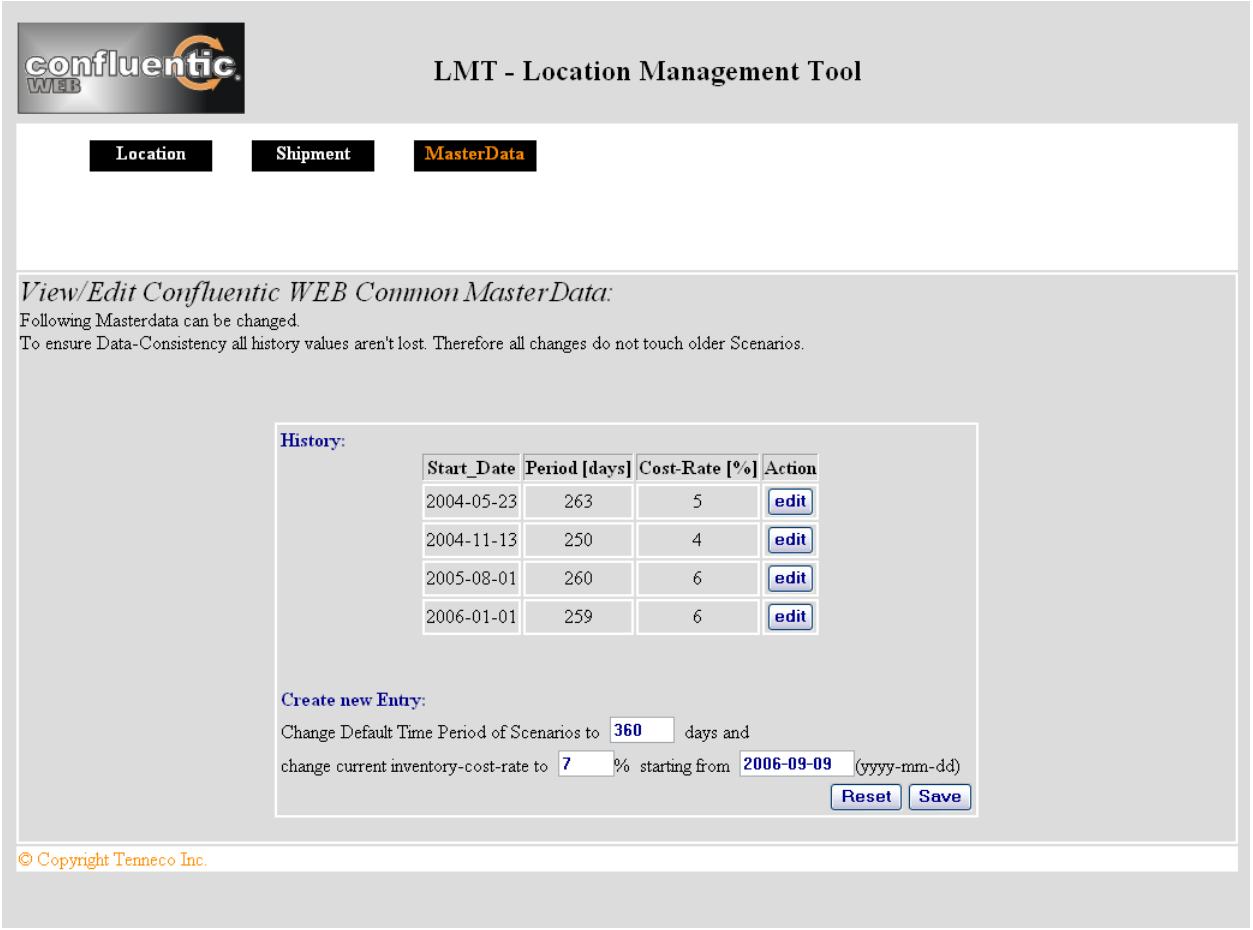



Figure 4.27: LMT dummy page *conf_common.html*

## 4.5 CATIS interface

As required in subsection 3.1.4 and described in subsection 4.2.3 Confluentic WEB needs access to an interface provided by CATIS to benefit of the feature of real tariffs.

Of course Confluentic WEB is accessing the same database and therefore could grab the needed information directly[28]. But this has to be avoided from the maintenance effort point of view.
First this would mean, that people, who are involved maintaining Confluentic WEB, also must have got a deep understanding of CATIS.
And secondly if something is changed within CATIS, Confluentic WEB needs to be

[28]Like first version of FIONA does.

adopted according to these changes too. Otherwise gained information may become wrong or in worst case, Confluentic WEB may not work anymore.

Therefore a interface should be provided by CATIS. Different applications are able to use it and retrieve information, without knowing how the data is collected internally. If changes occur, only CATIS is affected. Other applications do not need to know, since they still use the interface, which is called and used as usual.

Since the interface is not implemented yet, this section specifies, which information is needed by Confluentic WEB and what data is required by the CATIS interface to execute a corresponding search.

Whereas FTL tariffs are route based tariffs, groupage tariffs are weight and distance dependent tariffs instead (compare subsection 3.1.4). Consequently the CATIS interface requires different input to be able to provide both types of tariff information.

### FTL tariff

Concerning FTL tariffs Confluentic WEB always needs to know, which tariffs exist according a specific tripScheme. Therefore the CATIS interface needs input, for which particular tripScheme tariff information is requested. Additionally a date has to be provided, so the interface is able to deliver the correct price[29].

Output of the interface should be a list of all available tariffs, which suites to the tripScheme. In particular each tariff has to cover following attributes:

- tariffName
- haulier
- FTLType (this in fact arises out of the tripScheme already)
- vehicleType (to determine the maximum loading capacity)
- priceType (normal, express, backtrip)
- costs including the corresponding currency

[29] In fact CATIS holds different prices of the same tariff, concerning that prices are changing over time, because new contracts were made.

**Groupage tariff**

To get all suitable groupage tariffs the interface needs to know in particular:

- StartLocation_id and DestinationLocation_id
  Both locations are needed to provide both, outbound and inbound tariffs. Additionally CATIS now knows the corresponding zipCodes to provide zone priced tariffs.
- Distance between StartLocation and DestinationLocation
  This is needed to search for distance based tariffs.
- date
  This is needed to find the correct revision of a tariff.

Output of the interface should be several tariffs, consisting of

- the corresponding weight-based matrix,
- whether it is an inbound or an outbound tariff
- and what the maximum weight is.

For a detailed description of groupage tariffs, please refer to [Kop06].

## 4.6 Map server

Concerning the new architecture of Confluentic WEB (compare subsection 3.2.2) a gap analysis according a suitable map server or map service took place. This was done to offer Tenneco's IT department a few possible alternatives to Map&Guide mapserver4, which is used by Confluentic 1.

First of all mandatory and nice-to-have features of a map server were specified, which are necessary to be used within Confluentic WEB.

**Mandatory features**

- Usability within the Struts framework
  Which API will be used? Is it working with Struts and can maps be displayed within a web application?
- Routing
  It has to be possible to calculate distances, routes and driving times etc.
- Geocoding
  Map coordinates have to be able to be translated in addresses and vice versa.
- Visualization
  Drawing of routes, locations and arrows etc. have to be drawn within a map to visualize supply relationships.
- Global Maps
  Either a global map has to be provided or alternatively one European and one map of North America is required.

**Nice-to-have features**

- Ability of displaying several attributes of each object
  For example unloadingcosts of each location could be shown within the map.
- Calculation based on toll-free-only routes
- Interaction
  The user is able to edit objects within the map. Changes are passed through the application logic of Confluentic WEB.

During the analysis several map servers and map services have been investigated according the features described above. Finally three different alternatives to Map&Guide mapserver4 were suggested to Tenneco's IT department.

1. Mapsolute's MapTP server
   Provides an API particular for the Java Platform, using java and XML and seems to be very well documented.

2. Map&Guide web services
   Provides an XML/SOAP API. Since it is a web service, no server has to be maintained by Tenneco.

3. Map&Guide iNETServer
   is a server similar to mapserver4, but enhanced for usage in a intranet. In particular the API supports DCOM objects and a TCP/IP-Interface.

Other server and services were excluded concerning their features and licenses. For example Microsoft Mappoint, google maps etc.
A complete list of all investigated map server and services can be found in the Transport Wiki [Tra06a].

# Chapter 5

# Conclusion

By handing over this Diploma Thesis first two phases of the project *Confluentic WEB* have been completed and all basics are prepared for a followed implementation phase conducted by Tenneco's IT department.

## 5.1 Summary

Starting from the client application of Confluentic 1 a complete new design was developed to contribute to the desired transfer into Tenneco's client-server architecture.

Due to a close examination and analysis of Confluentic 1 all features were named and specified according to the new architecture and according to the desired enhancements concerning master location data and real tariffs.
In particular Tenneco's logisticians were highly involved in this process to ensure to design an applicable application covering all needs from the business point of view.

During design phase several documents were developed and were viewed up by Tenneco's IT department afterwards. In return missing things were pointed out, which subsequently have been added in the following delivered document version.

Thus, this thesis should contain all documents, which are thought to be useful to help implementing Confluentic WEB.
This thesis maybe do not pay enough attention on the mathematical background and needed algorithms. But it is thought, that this was already introduced and explained within the thesis of Confluentic 1 in detail. Nevertheless Tenneco's IT department should use this document as a very valuable information base in addition.

Recapitulating it can be said, that in addition of porting Confluentic 1 into a new architecture, the new design of Confluentic WEB enhances maintenance effort by the usage of a centralized databases. From the business point of view it is highly enriched by the feature of location master data as well as by the usage of CATIS tariffs.

## 5.2 Prospects

After Confluentic WEB is implemented further enhancements could be possible to improve the application more and more.

The working area of scenarios could be extended. On the one hand working areas could be narrowed down to country level . On the other hand a global scenario would be possible too.

Due to the corporately used database a foundation is laid for a closer interconnection and interaction between CATIS, FIONA and Confluentic WEB.

Beneath master location data tripSchemes of CATIS could be seen as master data too. For example a shipment could be assigned to a CATIS tripScheme directly. Thereby a trip would have got a tariff immediately, without the need of creating trips on scenario level before.

Additionally FIONA could be treated as data source for Confluentic WEB. In particular default shipments could be set up and could be updated regularly, based on authentic data provided by FIONA.

In return Confluentic WEB could suggest truck routes to FIONA. After a scenario, which uses the aforementioned authentic default shipments, was optimized by Confluentic WEB, FIONA could adjust future truck routes accordingly.

All this possibilities could lead to a very powerful information system, based on CATIS, FIONA and Confluentic WEB.

# Appendix A

# Used applications

This thesis was written in LyX [Pro06], a LaTeX based document processor whereas the requirements specification was created in Microsoft Office Word 2003 [Mic06a].

All diagrams were developed in Microsoft Office Visio 2003 [Mic06a]. The Dummy Pages (see Chapter 4) were written with UltraEdit [IDM06], a simple text editor.

The E/R-Diagram for the relational database was also developed with the help of Microsoft Office Visio 2003 [Mic06a].

Version control for the projects CATIS, FIONA and Confluentic WEB was done in Subversion. TortoiseSVN was used as client front end [Col06].

Communication between Tenneco's logisticians, IT department and university was mainly conducted via telephone and email. Additionally a Transport Wiki (see Chapter 4) was set up to deal as information base and glossary [Med06]. The Wiki contains all noteworthy documents of the project.

# Appendix B

# Requirements Specification 1.8

Following pages contain the original final Requirements Specification version 1.8 which has been developed during the Requirements Analysis. Version 1.8 has been freezed and signed by Tenneco Logistics experts and Tenneco IT department at the monthly Review Meeting on July the 28th, 2006.

UNIVERSITÄT KOBLENZ · LANDAU

# REQUIREMENT SPECIFICATION
# - VERSION 1.8 -
**(FINAL)**

Prof. Dr. Klaus G. Troitzsch
Daniel Schmidt

Jens Drogi

**Institute of Information Systems Research**

**Department of Computer Science**

**University of Koblenz-Landau**

**http://www.uni-koblenz.de/FB4/Institutes/IWVI**

2006-07-28

# 1. Statement of work

This document is part of the diploma thesis of Jens Drogi supervised by Prof. Dr. Klaus G. Troitzsch and Daniel Schmidt. Further on, these three people are called project group.

The project is based on the cooperation between the Institute of Information Systems Research, Faculty of Computer Science at the University of Koblenz-Landau, and Tenneco Automotive.

## 1.1. Project goal

The existing *Confluentic 1* Software has to be ported into Tenneco's IT Infrastructure.
Therefore the designated aim is to transfer all existing features of *Confluentic 1* into *Confluentic WEB*.
Delivering a reengineered design according to the new IT Infrastructure is the main target of this diploma thesis.
In addition a "*programmer's manual*" will be set up to ease later implementation for Tenneco's IT-staff (see 12).

# 2. Scope of Confluentic WEB application

The application supports a medium-term advancement of transport and inventory costs by calculating an improved scenario of a given configuration. This means the optimal frequencies per connections are computed.

## 2.1. Operative range / Application area

The application automatically detects an improved scenario of a configuration. In addition the user has the possibility to vary different attributes of the scenario. The budget planning and decision making in medium-term strategy of logistics is provided by the results of calculation. Scenarios are displayed graphically and in table form.

## 2.2. Target group

Users of the application are the members of Tenneco Automotive Europe cooperate logistics staff (GSCM).

A User-profile will be used and maintained by Confluentic WEB to ensure secure access control, user roles etc. Especially this User-profile will be used to ensure displaying data in the user-desired unit of measurement (see 10.1).

## 2.3. Operating conditions

The application is used in a client-server environment. On the client side, only a Web-Browser is required.

# 3. Transferred features of Confluentic 1

The following features of Confluentic 1 will be transferred to Confluentic WEB:

## 3.1. Import of locations, trips and shipments with their parameters from excel files

- The parameters are given as well-defined excel sheets.
- These well-defined files can be imported into the application.

## 3.2. Calculation of route distances between locations

- Route distances for trucks are calculated automatically by an interface to a GIS-Server like mapserver4 (map&guide) or Microsoft Mappoint.
- Which GIS-Server will be selected, has to be cleared with Tenneco's IT according to System Requirement boundaries, available features and cost aspects.(*see 10.2 Map-Server*).

## 3.3. Graphical development and editing of configurations and scenarios

- Configurations are input and displayed as a digraph (a directed graph).
- The edges (arrows) are attributed with frequencies and are connecting two nodes (locations).
- The parameters of a scenario (attributes of trips and shipments, frequencies, Min-Max-rates of frequencies, timespans, cost rates etc.) can be edited manually.
- The scenario can be displayed on a map.
- With the zoom functionality it is possible to enlarge sections of the graph and the map.
- Connections between locations can be input and edited by keyboard entry.

## 3.4. Load and save configurations and scenarios

- Configurations and scenarios (e.g. baseline scenario) can be loaded and saved at any time.

## *3.5. Improvement of transportation and inventory costs*

- The lowest sum of transportation and inventory costs is computed by varying the parameters of a scenario, especially by varying the frequencies of trucks. In consequence, the other parameters are modified, too.
- The calculation of inventory costs depends on the underlying inventory cost rate. Transportation costs, inventory costs and savings are given as time period amounts. Calculation of transportation costs depends on the tariffs which are maintained by CATIS. (see 6 Tariff system)

## *3.6. Automatically attributed configurations (scenarios) can be edited manually*

- The parameters of connections (frequencies, Min-Max-frequencies) and locations (Security Stock) can be edited manually.
- The user can set the frequency constant to exclude it from calculation.

## *3.7. Recalculation of manually edited scenarios*

- After manually editing a calculated scenario the user can start a recalculation (see 3.6).

## *3.8. Comparison of the alternative scenario to the baseline scenario*

- After calculating an alternative scenario the user has the possibility to compare the results with the baseline scenario.

## *3.9. Master data*

- The parameters of locations and tariffs are defined as master data (see 8 Application data).
- Tariffs are defined and maintained by CATIS. They are not maintained by the Confluentic WEB application (see 6 Tariff system). Tariff-information will be given (read-only) through an interface delivered by CATIS.
- The master data are not subject to automatic improvement, but they can be manually edited at any time.
- Route distances between locations are calculated automatically.

### 3.10. Input and Output (I/O)

- The output of the application can be visualized graphically (in a map) or in table form (spread sheet). This output can be printed (hard copy) or copied to other applications (especially Microsoft Excel) via copy-paste-functionality (soft copy). Savings and extra-costs are displayed for each location and connection.
- In addition, the application provides the opportunity to save and load configurations and scenarios at any time.
- Further on, the master data can be imported from excel sheets and exported by simple copy-paste.

## 4. Additional features

Additional features will only be considered and adopted in the new design if they have been approved and accepted by both, Tenneco and the project group **until 25th of July, 2006**. Also this requirement specification has to be finalized at this date.

### 4.1. Suggestions for additional features

Following features suggested by the project group are clearly marked as “Nice-to-have” by Tenneco. Thus they are not mandatory to reach the project goal.

- For calculation of route distances between locations, routes can be restricted to ordinary highways or to toll-free motorways (if the map supports this feature).
- Import und maintenance of virtual locations (e.g. a new cross dock). The new location then can be included for calculation of better scenarios. Virtual locations do not affect CATIS or FIONA. They are only used by Confluentic WEB.
- In a later step Confluentic WEB may be linked with FIONA to transfer routes to it.
- Routes implemented in the FIONA tool could also serve as data supplier for Confluentic WEB as FIONA deals with up-to-date data.

## 5. Limitations

- The application does not automatically optimize the attributes of locations (e. g. supply, demand). They have to be input and edited by the user.
- The application does not communicate online with other applications (e.g. ERP system, office application). It only gets tariffs from CATIS (see 6 Tariff system).
- The application calculates with the data provided in the well-defined excel sheets, given that these are error-free.
- Imported locations can not be edited by the application. They are set as "read-only". Locations can only be edited by updating the well-defined excel sheets and importing (uploading) them to the application again.

## 6. Tariff system (CATIS)

- Tariffs are defined and maintained by CATIS. They are not maintained by the Confluentic WEB application
- Tariff information will be given (read-only) through an interface delivered by CATIS.
- Within the scope of the diploma thesis "CATIS" of Jürgen Kopper only FTL (Full Truck Load) tariffs are implemented yet. Groupage tariffs will only be described and designed in his diploma thesis to ensure an easy and quick implementation by Tenneco's IT. Thus groupage tariffs will be available, when Confluentic WEB is completely implemented.
- The Programmer's manual of Confluentic WEB will also describe the interface to CATIS. In especially the interface will define what data are given to CATIS and what data Confluentic WEB are expected from CATIS.

## 7. Level of abstraction

- The calculation considers a year by default with 250 working days. The working days can be modified by the user.
- Inventory and transportation costs calculation is based on calendar days.
- The smallest time unit is a day.
- The flow of goods in a user specified period is considered as a constant and is used to calculate the volume of the individual delivery.

# 8. Application data

Relevant data for locations, tariffs (master data), connections and others are handled by the application.

## 8.1. Locations

For locations the following data are stored:
name and address (street, number, ZIP code, city, district, country, coordinates).
Locations are subdivided into Supplier, Cross Dock, Plant and Customer Locations.

## 8.2. Supplier

In addition a supplier location has a supplier_number.

## 8.3. Cross Dock

A cross dock location does not need further information except of cross dock costs and transit inventory costs.

## 8.4. Plant

The demand (supplier, weight, loading meter, value), DOH and OH€ of a plant location is stored.

## 8.5. Customer

For costumer locations the costumer_number, their demand (supplier, weight, loading meter, value), DOH and OH€ are stored.

## 8.6. Tariffs

The tariffs are given by CAT-IS. Confluentic WEB only reads this data.

## 8.7. Connections

Beside start_point and end_point the following data are stored for connections:
frequency, routing [preferred route (fastest; shortest; toll-free_restricted; ordinary highway_restricted) and type_of_routing (single_trip; milk_run; round_trip)].

## 8.8. Inventory cost rate

The inventory cost rate is input as a percentage rate.

# 9. System Requirements

- Operating System: Microsoft Windows 2003
- IBM WebSphere Application Server V5.1
- Oracle 9i database
- Java 1.3
- Jakarta Struts 1.1

# 10. Guidelines and Code Conventions

The New Design and the Programmer's manual will be developed with respect to **Tenneco IT Java Design Guidelines** and **Tenneco Automotive Java Coding Standards**.

# 11. New Design

## 11.1. Client Server Architecture

The new design will be client-server based. This will ease usability and maintenance. On the client side, only a Web-Browser is required. On the server side, java server pages will be used (Struts-Framwork).

Data will be stored in the existing database of the CATIS and FIONA projects (Oracle-Database). During design the database may be modified according to Confluentic WEB needs. Data will be stored in its original unit of measurement (value and unit of measurement). The necessary transformation tables will be kept in the database, too.

## 11.2. Mapserver

Confluentic 1 uses map&guide mapserver as GIS (Geographical Information System). During the design phase alternative possibilities, such as Microsoft MapPoint, will be examined and the advantages, disadvantages, costs and boundary conditions of competitive products will be documented. Maybe a competitive product will be chosen.

## 11.3. Graphical-User-Interface (GUI)

Server-based web pages will be used (java server pages) to interact with the system. No logics or calculations are performed on the client side. Therefore only a Internet Browser is used.

## 12. Programmer's manual

The programmer's manual will lead through the implementation. It will consist of the new Design, especially:

- Process diagramms
- UML-Diagramms
  class-diagramms, use-case-diagramms, dataflow etc.
- Signature descriptions for methods, classes etc.
  including input/output descriptions
- Sample-code, pseudo-code, flow charts, formulas, etc. to sufficiently describe the processing within each method
- Web page and menu layouts, behaviour and data validation rules
- User authentification and authorization rules
- Entity-Realtionship Diagramms (UML-notation)
- Implementation suggestions, especially for items 3.1, 3.2, 3.3 and 3.10

## 13. Roughly Estimated Project-Timeline

- *2006-05-01* Project-Start
- *2006-07-25* Deadline for additional features and requirement specification
- *2006-07-20* First draft description of the new design
- *2006-07-31* First draft of programmer's manual
- *2006-08-08* Confluentic 1 demo for Tenneco IT programmers
- *2006-08-31* Second draft of both deliverables
- *2006-09-30* Final versions of both documents and **End of Project**

After finalizing this requirement specification biweekly conference calls will be arranged to keep track on the design progress. First conference call is dated on July 06th, 2006.

## 14. Transport-Wiki

A Transport-Wiki for FIONA, CAT-IS, Confluentic 1 and Confluentic WEB will be set up. It will serve as **glossary** and general information base for Tenneco's IT staff.The Transport-Wiki is available at:

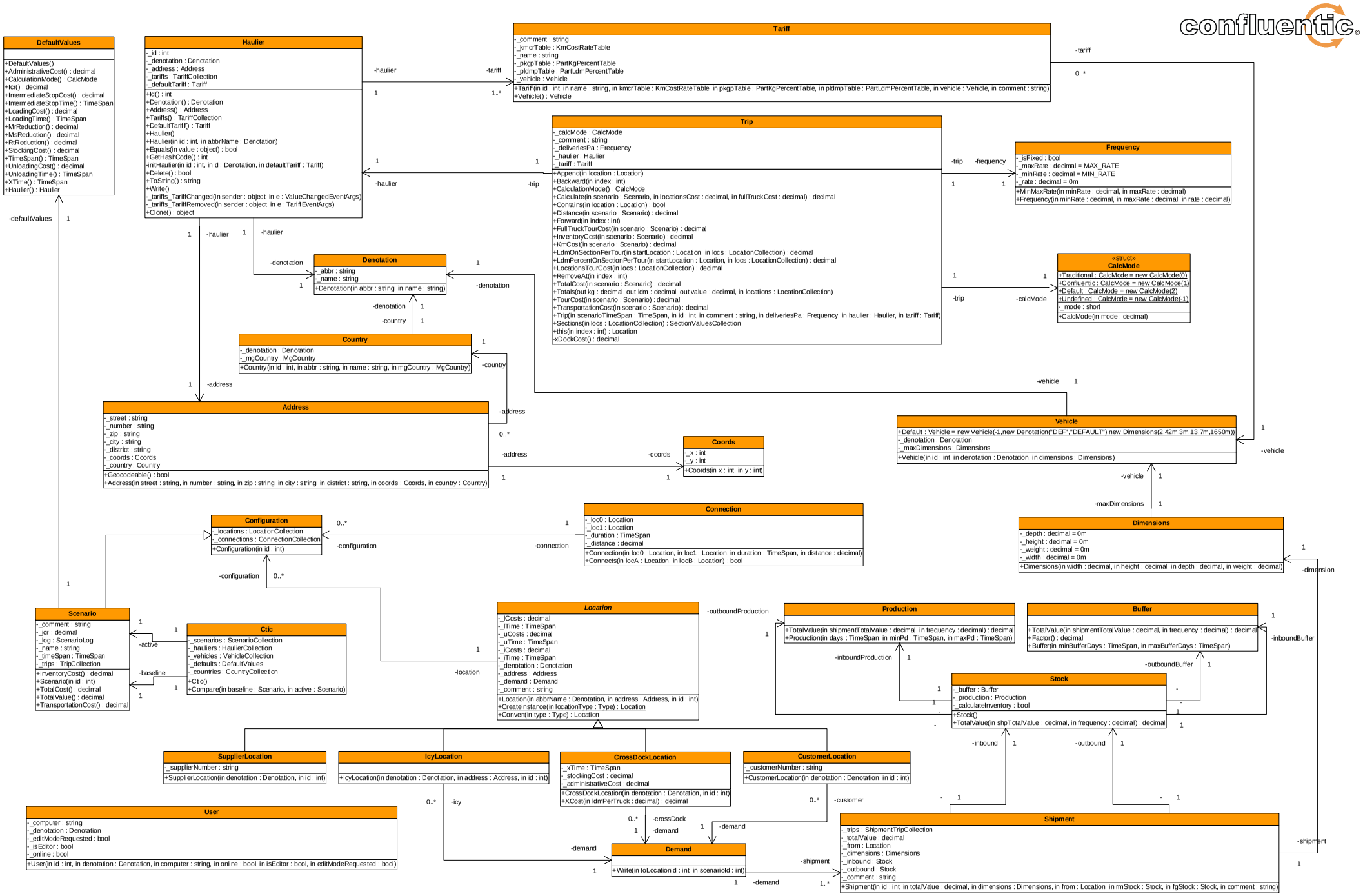
http://www.uni-koblenz.de/~confluentic/wiki/

It will be enriched and maintained over the whole project time.

# Appendix C

# UML diagram of Confluentic 1

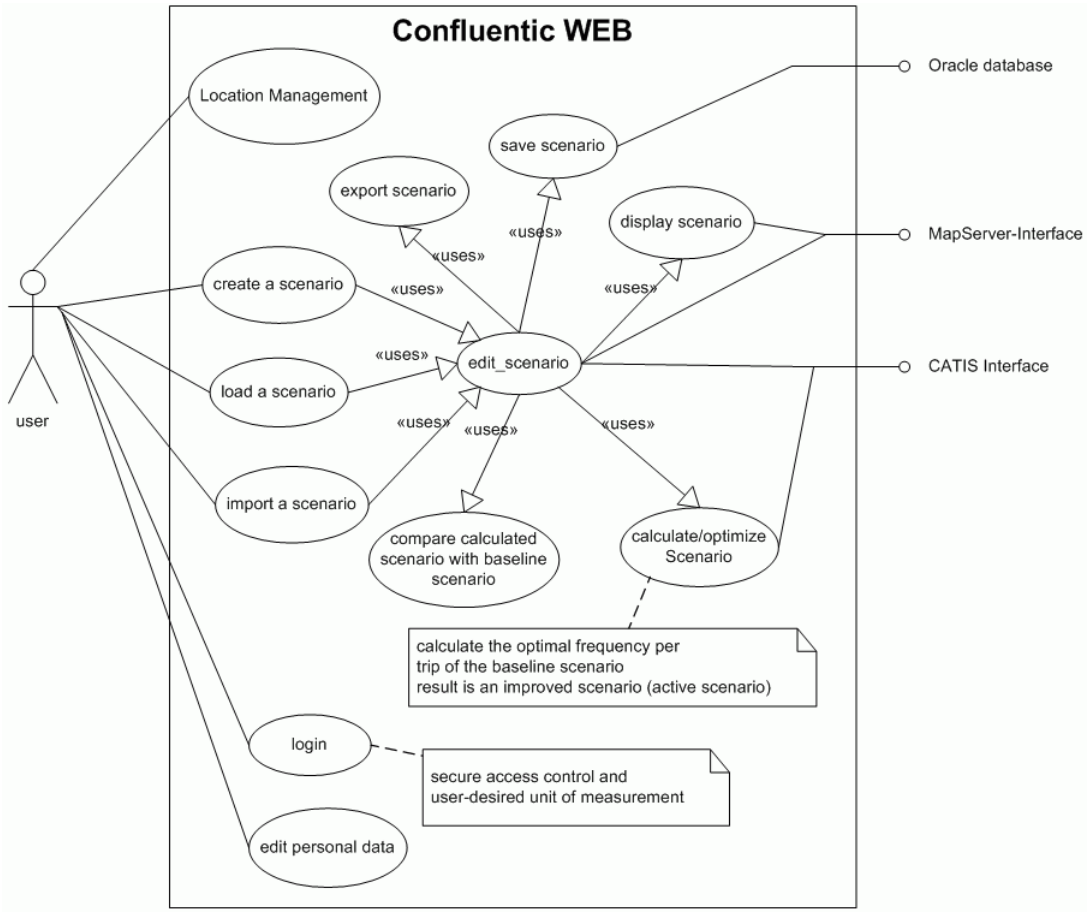
The formal model of Confluentic 1 was used for developing, comparing and proofing the formal model of Confluentic WEB (see section 4.1). This UML diagram can also be a valuable information base during implementation of Confluentic WEB.

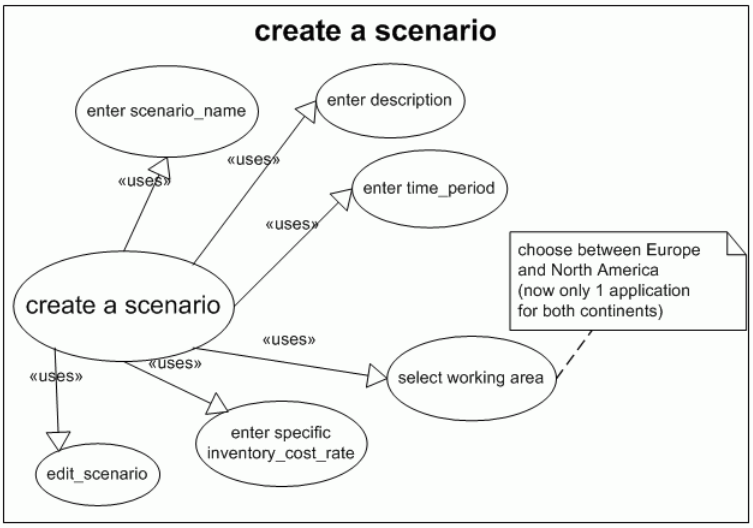

DefaultValues
+DefaultValues()
+AdministrativeCost() : decimal
+CalculationMode() : CalcMode
+Icr() : decimal
+IntermediateStopCost() : decimal
+IntermediateStopTime() : TimeSpan
+LoadingCost() : decimal
+LoadingTime() : TimeSpan
+MrReduction() : decimal
+MsReduction() : decimal
+RtReduction() : decimal
+StockingCost() : decimal
+TimeSpan() : TimeSpan
+UnloadingCost() : decimal
+UnloadingTime() : TimeSpan
+XTime() : TimeSpan
+Haulier() : Haulier
Haulier
-_id : int
-_denotation : Denotation
-_address : Address
-_tariffs : TariffCollection
-_defaultTariff : Tariff
+Id() : int
+Denotation() : Denotation
+Address() : Address
+Tariffs() : TariffCollection
+DefaultTariff() : Tariff
+Haulier()
+Haulier(in id : int, in abbrName : Denotation)
+Equals(in value : object) : bool
+GetHashCode() : int
-initHaulier(in id : int, in d : Denotation, in defaultTariff : Tariff)
+Delete() : bool
+ToString() : string
+Write()
-_tariffs_TariffChanged(in sender : object, in e : ValueChangedEventArgs)
-_tariffs_TariffRemoved(in sender : object, in e : TariffEventArgs)
+Clone() : object
Tariff
-_comment : string
-_kmcrTable : KmCostRateTable
-_name : string
-_pkgpTable : PartKgPercentTable
-_pldmpTable : PartLdmPercentTable
-_vehicle : Vehicle
+Tariff(in id : int, in name : string, in kmcrTable : KmCostRateTable, in pkgpTable : PartKgPercentTable, in pldmpTable : PartLdmPercentTable, in vehicle : Vehicle, in comment : string)
+Vehicle() : Vehicle
Trip
-_calcMode : CalcMode
-_comment : string
-_deliveriesPa : Frequency
-_haulier : Haulier
-_tariff : Tariff
+Append(in location : Location)
+Backward(in index : int)
+CalculationMode() : CalcMode
+Calculate(in scenario : Scenario, in locationsCost : decimal, in fullTruckCost : decimal) : decimal
+Contains(in location : Location) : bool
+Distance(in scenario : Scenario) : decimal
+Forward(in index : int)
+FullTruckTourCost(in scenario : Scenario) : decimal
+InventoryCost(in scenario : Scenario) : decimal
+KmCost(in scenario : Scenario) : decimal
+LdmOnSectionPerTour(in startLocation : Location, in locs : LocationCollection) : decimal
+LdmPercentOnSectionPerTour(in startLocation : Location, in locs : LocationCollection) : decimal
+LocationsTourCost(in locs : LocationCollection) : decimal
+RemoveAt(in index : int)
+TotalCost(in scenario : Scenario) : decimal
+Totals(out kg : decimal, out ldm : decimal, out value : decimal, in locations : LocationCollection)
+TourCost(in scenario : Scenario) : decimal
+TransportationCost(in scenario : Scenario) : decimal
+Trip(in scenarioTimeSpan : TimeSpan, in id : int, in comment : string, in deliveriesPa : Frequency, in haulier : Haulier, in tariff : Tariff)
+Sections(in locs : LocationCollection) : SectionValuesCollection
+this(in index : int) : Location
-xDockCost() : decimal
Frequency
-_isFixed : bool
-_maxRate : decimal = MAX_RATE
-_minRate : decimal = MIN_RATE
-_rate : decimal = 0m
+MinMaxRate(in minRate : decimal, in maxRate : decimal)
+Frequency(in minRate : decimal, in maxRate : decimal, in rate : decimal)
«struct»
CalcMode
+Traditional : CalcMode = new CalcMode(0)
+Confluentic : CalcMode = new CalcMode(1)
+Default : CalcMode = new CalcMode(2)
+Undefined : CalcMode = new CalcMode(-1)
-_mode : short
+CalcMode(in mode : decimal)
Denotation
-_abbr : string
-_name : string
+Denotation(in abbr : string, in name : string)
Country
-_denotation : Denotation
-_mgCountry : MgCountry
+Country(in id : int, in abbr : string, in name : string, in mgCountry : MgCountry)
Address
-_street : string
-_number : string
-_zip : string
-_city : string
-_district : string
-_coords : Coords
-_country : Country
+Geocodeable() : bool
+Address(in street : string, in number : string, in zip : string, in city : string, in district : string, in coords : Coords, in country : Country)
Coords
-_x : int
-_y : int
+Coords(in x : int, in y : int)
Vehicle
+Default : Vehicle = new Vehicle(-1,new Denotation("DEF","DEFAULT"),new Dimensions(2.42m,3m,13.7m,1650m))
-_denotation : Denotation
-_maxDimensions : Dimensions
+Vehicle(in id : int, in denotation : Denotation, in dimensions : Dimensions)
Configuration
-_locations : LocationCollection
-_connections : ConnectionCollection
+Configuration(in id : int)
Connection
-_loc0 : Location
-_loc1 : Location
-_duration : TimeSpan
-_distance : decimal
+Connection(in loc0 : Location, in loc1 : Location, in duration : TimeSpan, in distance : decimal)
+Connects(in locA : Location, in locB : Location) : bool
Dimensions
-_depth : decimal = 0m
-_height : decimal = 0m
-_weight : decimal = 0m
-_width : decimal = 0m
+Dimensions(in width : decimal, in height : decimal, in depth : decimal, in weight : decimal)
Scenario
-_comment : string
-_icr : decimal
-_log : ScenarioLog
-_name : string
-_timeSpan : TimeSpan
-_trips : TripCollection
+InventoryCost() : decimal
+Scenario(in id : int)
+TotalCost() : decimal
+TotalValue() : decimal
+TransportationCost() : decimal
Ctic
-_scenarios : ScenarioCollection
-_hauliers : HaulierCollection
-_vehicles : VehicleCollection
-_defaults : DefaultValues
-_countries : CountryCollection
+Ctic()
+Compare(in baseline : Scenario, in active : Scenario)
Location
-_lCosts : decimal
-_lTime : TimeSpan
-_uCosts : decimal
-_uTime : TimeSpan
-_iCosts : decimal
-_iTime : TimeSpan
-_denotation : Denotation
-_address : Address
-_demand : Demand
-_comment : string
+Location(in abbrName : Denotation, in address : Address, in id : int)
+CreateInstance(in locationType : Type) : Location
+Convert(in type : Type) : Location
Production
+TotalValue(in shipmentTotalValue : decimal, in frequency : decimal) : decimal
+Production(in days : TimeSpan, in minPd : TimeSpan, in maxPd : TimeSpan)
Buffer
+TotalValue(in shipmentTotalValue : decimal, in frequency : decimal) : decimal
+Factor() : decimal
+Buffer(in minBufferDays : TimeSpan, in maxBufferDays : TimeSpan)
Stock
-_buffer : Buffer
-_production : Production
-_calculateInventory : bool
+Stock()
+TotalValue(in shpTotalValue : decimal, in frequency : decimal) : decimal
SupplierLocation
-_supplierNumber : string
+SupplierLocation(in denotation : Denotation, in id : int)
IcyLocation
+IcyLocation(in denotation : Denotation, in address : Address, in id : int)
CrossDockLocation
-_xTime : TimeSpan
-_stockingCost : decimal
-_administrativeCost : decimal
+CrossDockLocation(in denotation : Denotation, in id : int)
+XCost(in ldmPerTruck : decimal) : decimal
CustomerLocation
-_customerNumber : string
+CustomerLocation(in denotation : Denotation, in id : int)
User
-_computer : string
-_denotation : Denotation
-_editModeRequested : bool
-_isEditor : bool
-_online : bool
+User(in id : int, in denotation : Denotation, in computer : string, in online : bool, in isEditor : bool, in editModeRequested : bool)
Demand
+Write(in toLocationId : int, in scenarioId : int)
Shipment
-_trips : ShipmentTripCollection
-_totalValue : decimal
-_from : Location
-_dimensions : Dimensions
-_inbound : Stock
-_outbound : Stock
-_comment : string
+Shipment(in id : int, in totalValue : decimal, in dimensions : Dimensions, in from : Location, in rmStock : Stock, in fgStock : Stock, in comment : string)
-tariff
-haulier
-trip
-frequency
-calcMode
-defaultValues
-denotation
-country
-address
-coords
-vehicle
-maxDimensions
-configuration
-connection
-dimension
-active
-baseline
-location
-outboundProduction
-inboundProduction
-inboundBuffer
-outboundBuffer
-inbound
-outbound
-icy
-customer
-crossDock
-demand
-shipment

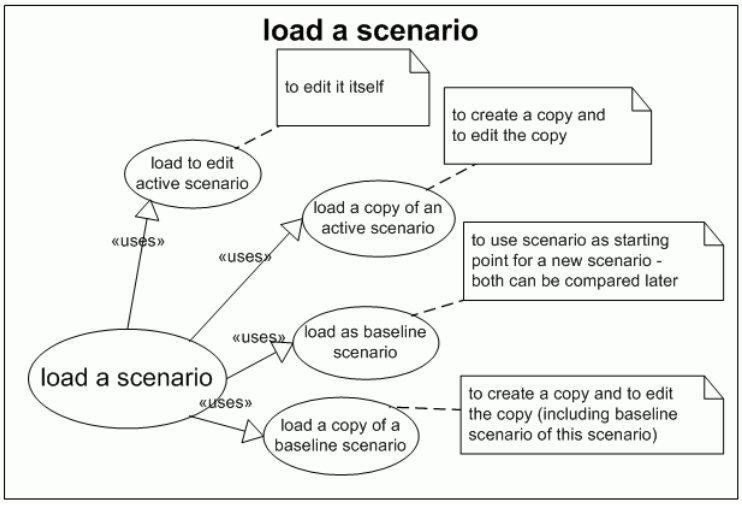
# Appendix D

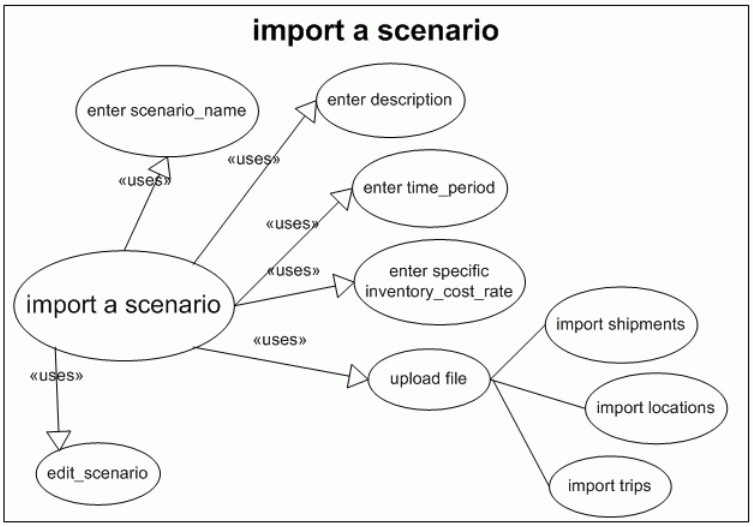
# Use Case diagrams

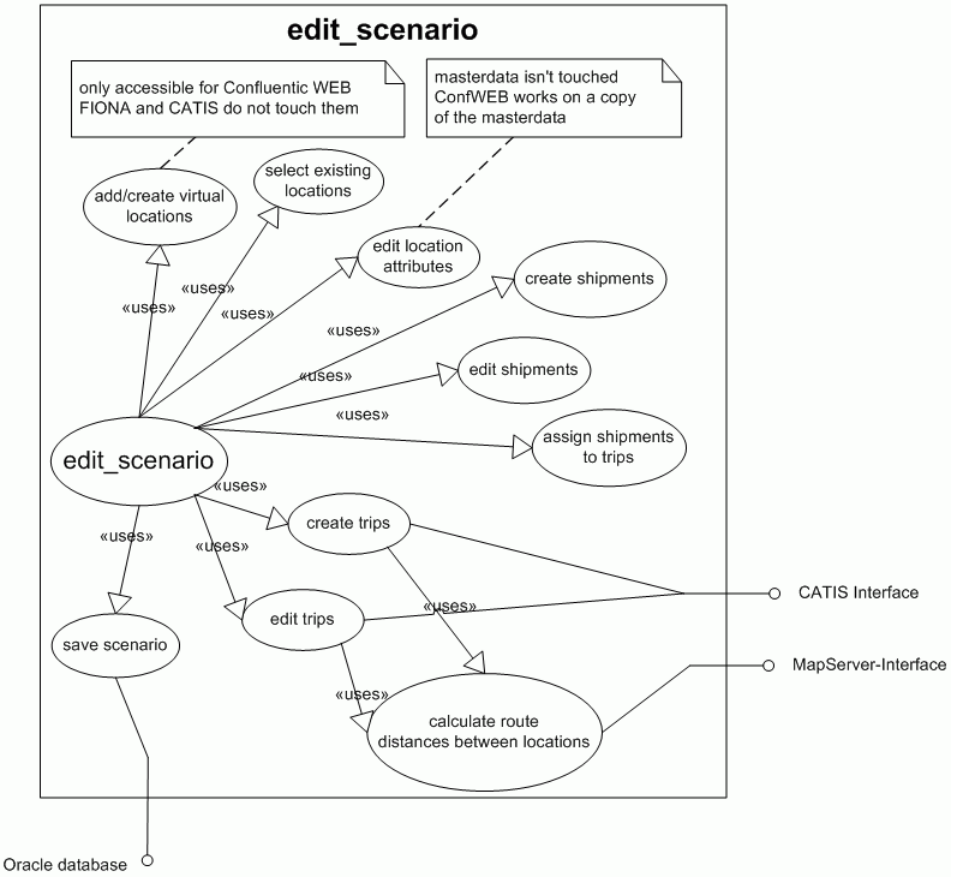
All developed use case diagrams are depicted below. The corresponding visio-file can be found at [Tra06a].

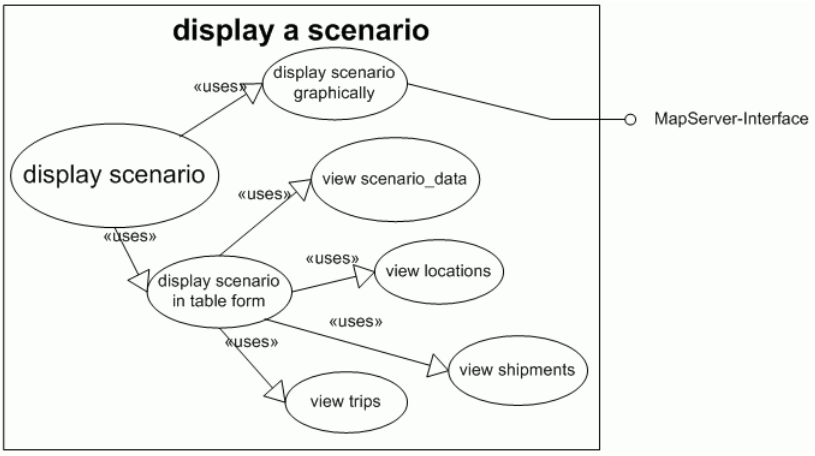


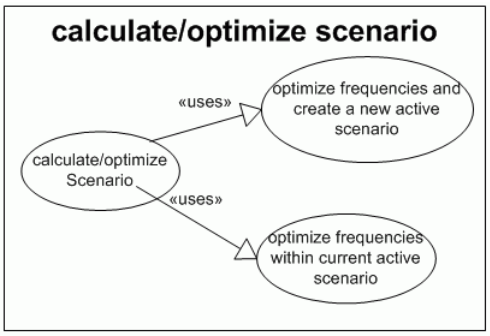

create a scenario
enter scenario_name
enter description
enter time_period
create a scenario
choose between Europe and North America (now only 1 application for both continents)
select working area
enter specific inventory_cost_rate
edit_scenario
«uses»

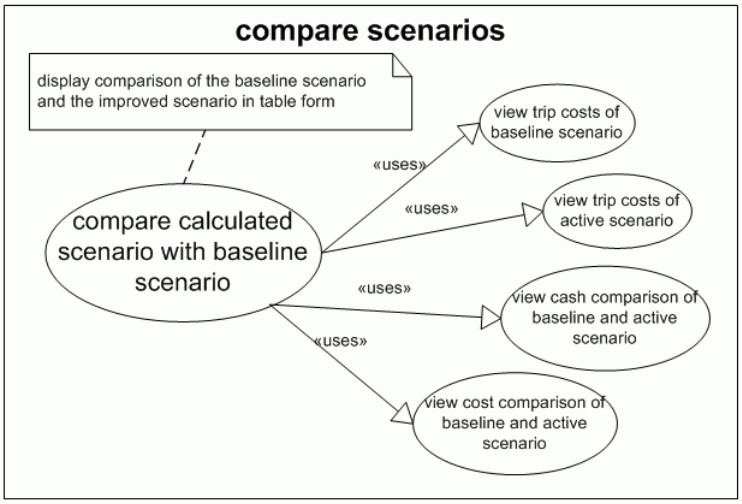

load a scenario
to edit it itself
to create a copy and to edit the copy
load to edit active scenario
load a copy of an active scenario
to use scenario as starting point for a new scenario - both can be compared later
load as baseline scenario
load a scenario
to create a copy and to edit the copy (including baseline scenario of this scenario)
load a copy of a baseline scenario
«uses»

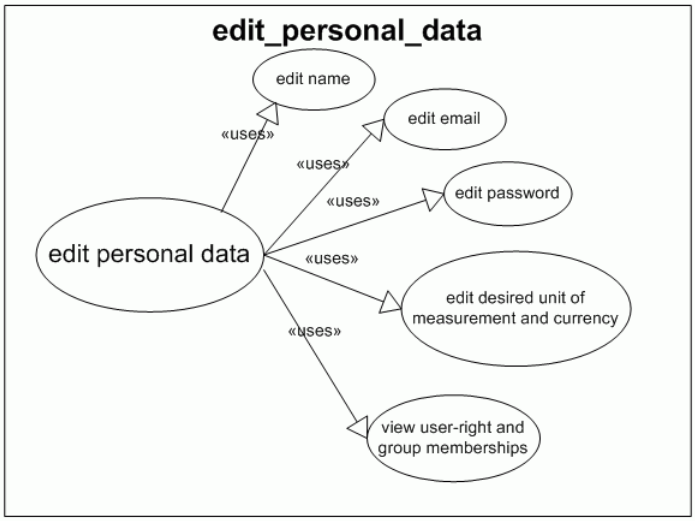

import a scenario
enter scenario_name
enter description
enter time_period
enter specific inventory_cost_rate
import a scenario
import shipments
upload file
import locations
import trips
edit_scenario
«uses»

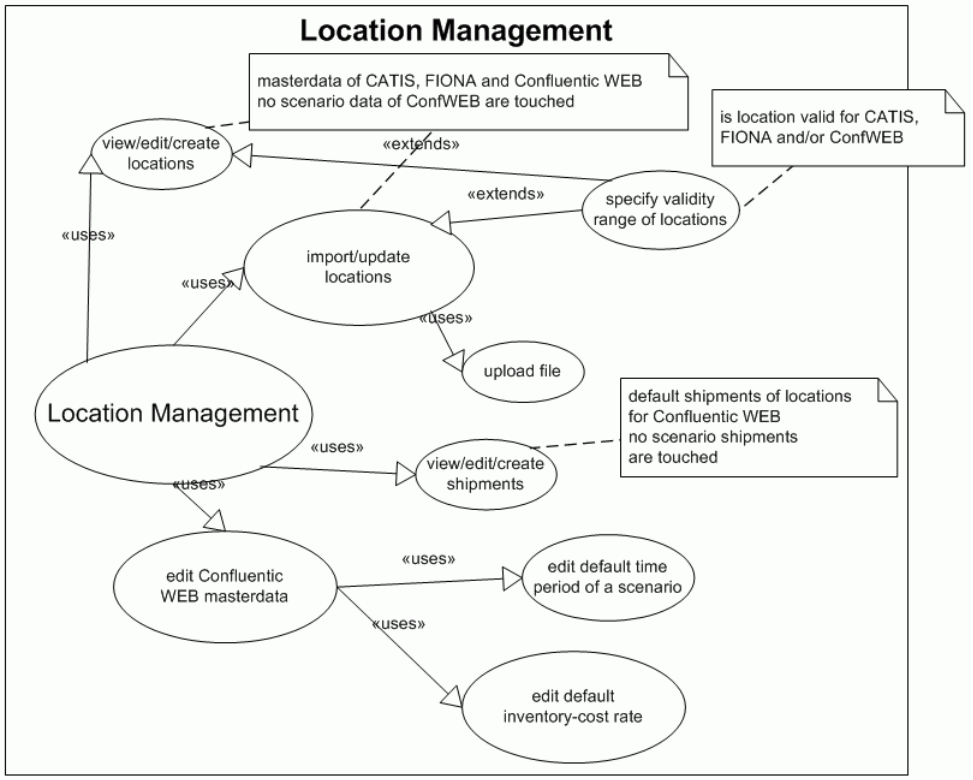

edit_scenario
only accessible for Confluentic WEB FIONA and CATIS do not touch them
masterdata isn't touched ConfWEB works on a copy of the masterdata
add/create virtual locations
select existing locations
edit location attributes
create shipments
edit shipments
assign shipments to trips
edit_scenario
create trips
edit trips
save scenario
calculate route distances between locations
CATIS Interface
MapServer-Interface
Oracle database
«uses»


display a scenario
display scenario graphically
«uses»
MapServer-Interface
display scenario
view scenario_data
«uses»
«uses»
«uses»
view locations
display scenario in table form
«uses»
«uses»
view shipments
view trips


calculate/optimize scenario
«uses»
optimize frequencies and create a new active scenario
calculate/optimize Scenario
«uses»
optimize frequencies within current active scenario


compare scenarios
display comparison of the baseline scenario and the improved scenario in table form
view trip costs of baseline scenario
«uses»
«uses»
view trip costs of active scenario
compare calculated scenario with baseline scenario
«uses»
view cash comparison of baseline and active scenario
«uses»
view cost comparison of baseline and active scenario


edit_personal_data
edit name
edit email
edit password
edit personal data
edit desired unit of measurement and currency
view user-right and group memberships
«uses»
«uses»
«uses»
«uses»
«uses»


Location Management
masterdata of CATIS, FIONA and Confluentic WEB
no scenario data of ConfWEB are touched
is location valid for CATIS, FIONA and/or ConfWEB
view/edit/create locations
specify validity range of locations
import/update locations
upload file
Location Management
default shipments of locations for Confluentic WEB
no scenario shipments are touched
view/edit/create shipments
edit Confluentic WEB masterdata
edit default time period of a scenario
edit default inventory-cost rate
«extends»
«extends»
«uses»
«uses»
«uses»
«uses»
«uses»
«uses»
«uses»

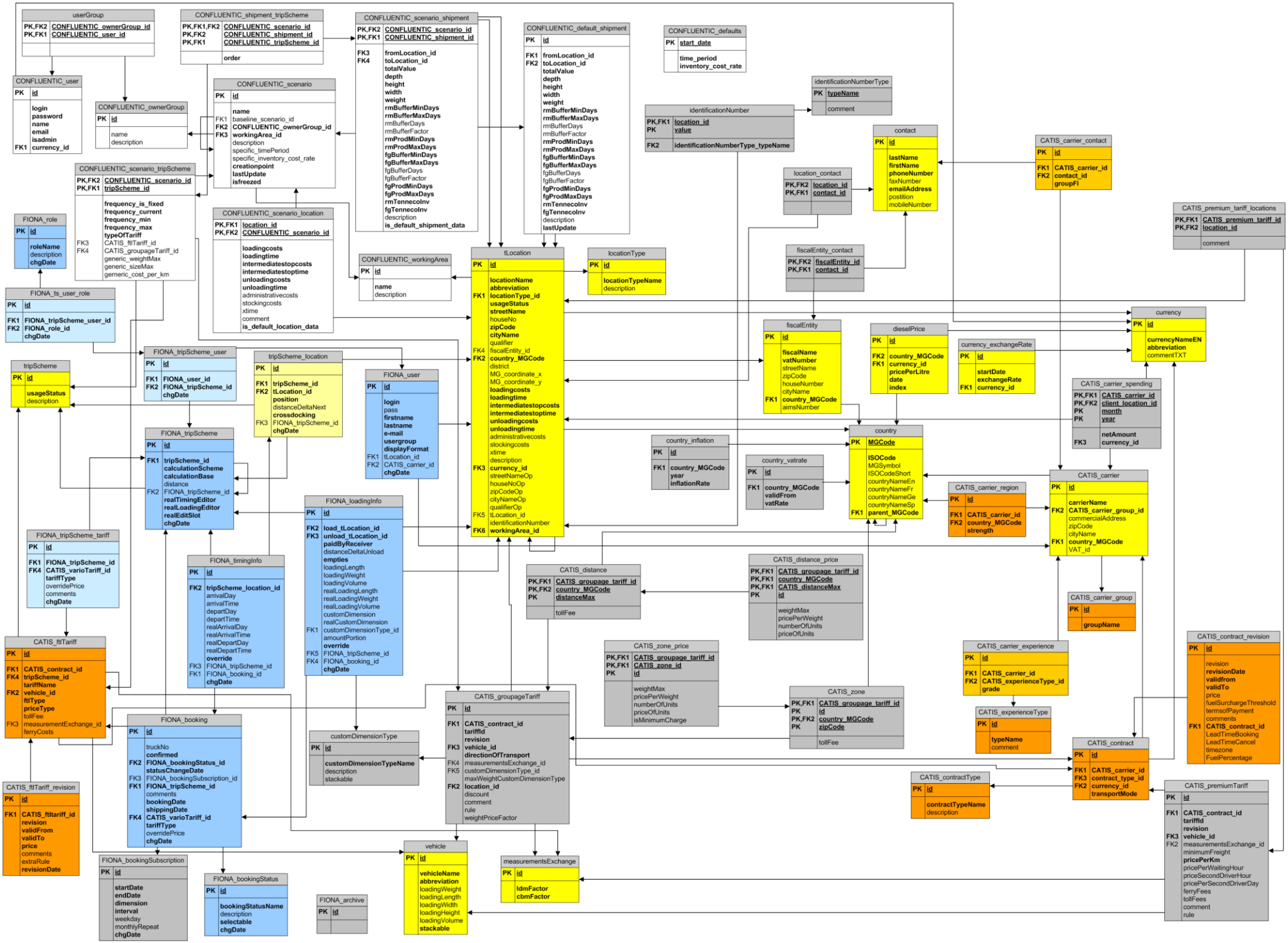
# Appendix E

# Database model CATIS, FIONA and Confluentic WEB

Following E/R Diagram depicts the complete database model of the corporately used database. The corresponding visio-file can be found at [Tra06a].

The colours indicate the affiliation of the tables. White tables belong to Confluentic WEB and orange tables are mainly used by CATIS. FIONA tables are coloured blue. The yellow tables are dedicated for common use and represent the master data corporately used by CATIS, FIONA and Confluentic WEB.

Additionally grey indicates that these tables are destined for future use and that they are only conceptional so far.


userGroup
PK,FK2 CONFLUENTIC_ownerGroup_id
PK,FK1 CONFLUENTIC_user_id
CONFLUENTIC_shipment_tripScheme
PK,FK1,FK2 CONFLUENTIC_scenario_id
PK,FK2 CONFLUENTIC_shipment_id
PK,FK1 CONFLUENTIC_tripScheme_id
order
CONFLUENTIC_scenario_shipment
PK,FK2 CONFLUENTIC_scenario_id
PK,FK1 CONFLUENTIC_shipment_id
FK3 fromLocation_id
FK4 toLocation_id
totalValue
depth
height
width
weight
rmBufferMinDays
rmBufferMaxDays
rmBufferDays
rmBufferFactor
rmProdMinDays
rmProdMaxDays
fgBufferMinDays
fgBufferMaxDays
fgBufferDays
fgBufferFactor
fgProdMinDays
fgProdMaxDays
rmTennecoInv
fgTennecoInv
description
is_default_shipment_data
CONFLUENTIC_default_shipment
PK id
FK1 fromLocation_id
FK2 toLocation_id
totalValue
depth
height
width
weight
rmBufferMinDays
rmBufferMaxDays
rmBufferDays
rmBufferFactor
rmProdMinDays
rmProdMaxDays
fgBufferMinDays
fgBufferMaxDays
fgBufferDays
fgBufferFactor
fgProdMinDays
fgProdMaxDays
rmTennecoInv
fgTennecoInv
description
lastUpdate
CONFLUENTIC_defaults
PK start_date
time_period
inventory_cost_rate
CONFLUENTIC_user
PK id
login
password
name
email
isadmin
FK1 currency_id
CONFLUENTIC_ownerGroup
PK id
name
description
CONFLUENTIC_scenario
PK id
name
FK1 baseline_scenario_id
FK2 CONFLUENTIC_ownerGroup_id
FK3 workingArea_id
description
specific_timePeriod
specific_inventory_cost_rate
creationpoint
lastUpdate
isfreezed
CONFLUENTIC_scenario_tripScheme
PK,FK2 CONFLUENTIC_scenario_id
PK,FK1 tripScheme_id
frequency_is_fixed
frequency_current
frequency_min
frequency_max
typeOfTariff
FK3 CATIS_ftlTariff_id
FK4 CATIS_groupageTariff_id
generic_weightMax
generic_sizeMax
gerneric_cost_per_km
CONFLUENTIC_scenario_location
PK,FK1 location_id
PK,FK2 CONFLUENTIC_scenario_id
loadingcosts
loadingtime
intermediatestopcosts
intermediatestoptime
unloadingcosts
unloadingtime
administrativecosts
stockingcosts
xtime
comment
is_default_location_data
CONFLUENTIC_workingArea
PK id
name
description
identificationNumberType
PK typeName
comment
identificationNumber
PK,FK1 location_id
PK value
FK2 identificationNumberType_typeName
contact
PK id
lastName
firstName
phoneNumber
faxNumber
emailAddress
postition
mobileNumber
location_contact
PK,FK2 location_id
PK,FK1 contact_id
CATIS_carrier_contact
PK id
FK1 CATIS_carrier_id
FK2 contact_id
groupFl
CATIS_premium_tariff_locations
PK,FK1 CATIS_premium_tariff_id
PK,FK2 location_id
comment
FIONA_role
PK id
roleName
description
chgDate
FIONA_ts_user_role
PK id
FK1 FIONA_tripScheme_user_id
FK2 FIONA_role_id
chgDate
tripScheme
PK id
usageStatus
description
FIONA_tripScheme_user
PK id
FK1 FIONA_user_id
FK2 FIONA_tripScheme_id
chgDate
tripScheme_location
PK id
FK1 tripScheme_id
FK2 tLocation_id
position
distanceDeltaNext
crossdocking
FK3 FIONA_tripScheme_id
chgDate
FIONA_user
PK id
login
pass
firstname
lastname
e-mail
usergroup
displayFormat
FK1 tLocation_id
FK2 CATIS_carrier_id
chgDate
tLocation
PK id
locationName
abbreviation
FK1 locationType_id
usageStatus
streetName
houseNo
zipCode
cityName
qualifier
FK4 fiscalEntity_id
FK2 country_MGCode
district
MG_coordinate_x
MG_coordinate_y
loadingcosts
loadingtime
intermediatestopcosts
intermediatestoptime
unloadingcosts
unloadingtime
administrativecosts
stockingcosts
xtime
description
FK3 currency_id
streetNameOp
houseNoOp
zipCodeOp
cityNameOp
qualifierOp
FK5 tLocation_id
identificationNumber
FK6 workingArea_id
locationType
PK id
locationTypeName
description
fiscalEntity_contact
PK,FK2 fiscalEntity_id
PK,FK1 contact_id
fiscalEntity
PK id
fiscalName
vatNumber
streetName
zipCode
houseNumber
cityName
FK1 country_MGCode
aimsNumber
dieselPrice
PK id
FK2 country_MGCode
FK1 currency_id
pricePerLitre
date
index
currency_exchangeRate
PK id
startDate
exchangeRate
FK1 currency_id
currency
PK id
currencyNameEN
abbreviation
commentTXT
CATIS_carrier_spending
PK,FK1 CATIS_carrier_id
PK,FK2 client_location_id
PK month
PK year
netAmount
FK3 currency_id
country_inflation
PK id
FK1 country_MGCode
year
inflationRate
country_vatrate
PK id
FK1 country_MGCode
validFrom
vatRate
country
PK MGCode
ISOCode
MGSymbol
ISOCodeShort
countryNameEn
countryNameFr
countryNameGe
countryNameSp
FK1 parent_MGCode
CATIS_carrier_region
PK id
FK1 CATIS_carrier_id
FK2 country_MGCode
strength
CATIS_carrier
PK id
carrierName
FK2 CATIS_carrier_group_id
commercialAddress
zipCode
cityName
FK1 country_MGCode
VAT_id
CATIS_carrier_group
PK id
groupName
FIONA_tripScheme
PK id
FK1 tripScheme_id
calculationScheme
calculationBase
distance
FK2 FIONA_tripScheme_id
realTimingEditor
realLoadingEditor
realEditSlot
chgDate
FIONA_loadingInfo
PK id
FK2 load_tLocation_id
FK3 unload_tLocation_id
paidByReceiver
distanceDeltaUnload
empties
loadingLength
loadingWeight
loadingVolume
realLoadingLength
realLoadingWeight
realLoadingVolume
customDimension
realCustomDimension
FK1 customDimensionType_id
amountPortion
override
FK5 FIONA_tripScheme_id
FK4 FIONA_booking_id
chgDate
FIONA_tripScheme_tariff
PK id
FK1 FIONA_tripScheme_id
FK4 CATIS_varioTariff_id
tariffType
overridePrice
comments
chgDate
FIONA_timingInfo
PK id
FK2 tripScheme_location_id
arrivalDay
arrivalTime
departDay
departTime
realArrivalDay
realArrivalTime
realDepartDay
realDepartTime
override
FK3 FIONA_tripScheme_id
FK1 FIONA_booking_id
chgDate
CATIS_distance
PK,FK1 CATIS_groupage_tariff_id
PK,FK2 country_MGCode
PK distanceMax
tollFee
CATIS_distance_price
PK,FK1 CATIS_groupage_tariff_id
PK,FK1 country_MGCode
PK,FK1 CATIS_distanceMax
PK id
weightMax
pricePerWeight
numberOfUnits
priceOfUnits
CATIS_zone_price
PK,FK1 CATIS_groupage_tariff_id
PK,FK1 CATIS_zone_id
PK id
weightMax
pricePerWeight
numberOfUnits
priceOfUnits
isMinimumCharge
CATIS_zone
PK,FK1 CATIS_groupage_tariff_id
PK id
PK,FK2 country_MGCode
PK zipCode
tollFee
CATIS_carrier_experience
PK id
FK1 CATIS_carrier_id
FK2 CATIS_experienceType_id
grade
CATIS_experienceType
PK id
typeName
comment
CATIS_contract_revision
PK id
revision
revisionDate
validfrom
validTo
price
fuelSurchargeThreshold
termsofPayment
comments
FK1 CATIS_contract_id
LeadTimeBooking
LeadTimeCancel
timezone
FuelPercentage
CATIS_contract
PK id
FK1 CATIS_carrier_id
FK3 contract_type_id
FK2 currency_id
transportMode
CATIS_contractType
PK id
contractTypeName
description
CATIS_ftlTariff
PK id
FK1 CATIS_contract_id
FK4 tripScheme_id
tariffName
FK2 vehicle_id
ftlType
priceType
tollFee
FK3 measurementExchange_id
ferryCosts
CATIS_ftlTariff_revision
PK id
FK1 CATIS_ftltariff_id
revision
validFrom
validTo
price
comments
extraRule
revisionDate
FIONA_booking
PK id
truckNo
confirmed
FK2 FIONA_bookingStatus_id
statusChangeDate
FK3 FIONA_bookingSubscription_id
FK1 FIONA_tripScheme_id
comments
bookingDate
shippingDate
FK4 CATIS_varioTariff_id
tariffType
overridePrice
chgDate
customDimensionType
PK id
customDimensionTypeName
description
stackable
CATIS_groupageTariff
PK id
FK1 CATIS_contract_id
tariffId
revision
FK3 vehicle_id
directionOfTransport
FK4 measurementsExchange_id
FK5 customDimensionType_id
maxWeightCustomDimensionType
FK2 location_id
discount
comment
rule
weightPriceFactor
CATIS_premiumTariff
PK id
FK1 CATIS_contract_id
tariffId
revision
FK3 vehicle_id
FK2 measurementsExchange_id
minimumFreight
pricePerKm
pricePerWaitingHour
priceSecondDriverHour
pricePerSecondDriverDay
ferryFees
tollFees
comment
rule
FIONA_bookingSubscription
PK id
startDate
endDate
dimension
interval
weekday
monthlyRepeat
chgDate
FIONA_bookingStatus
PK id
bookingStatusName
description
selectable
chgDate
FIONA_archive
PK id
vehicle
PK id
vehicleName
abbreviation
loadingWeight
loadingLength
loadingWidth
loadingHeight
loadingVolume
stackable
measurementsExchange
PK id
ldmFactor
cbmFactor

# Appendix F

# Glossary

**AM**

After Market – The Tenneco customer division comprising spare parts intended for non-original manufacturers/dealers. *(1)*

**batch**

A batch is a partial delivery of a `shipment`. *(7)*

**Buffer**

Buffer is the time span manufacturing keeps on going after the `Production` is used up and no further batch arrives. *(8)*

**CATIS**

Carrier And Tariff Information System – Web-Application maintaining actual Tariffs. This application is used as datasource by FIONA and Confluentic WEB. *(2)*

**COM**

Component Object Model – is a client-server based principle. COM-objects define COM-interfaces, which are accessed by clients to use functions provided by these COM-objects. *(12)*

**Confluentic (Confluentic 1)**

Software Application for midterm logistics planning which examines the relationship between inventory and transport costs with the goal in finding the cost-optimal balance between both of them. Confluentic 1 is the pre-version of Confluentic WEB. *(2)*

**CrossDock**

A Crossdock is a hub, which receives and delivers batches/shipments from and to another location. Shipments are transshipped there to set them on other trips. *(7)*

**DOH**

Days On Hand – is the maximum time for continuous production without receiving another batch. It is the sum of `Production` and `Buffer`. *(8)*

**EC**

Emission Control – The Tenneco product division comprising exhaust systems area. *(1)*

**E/R Diagram**

Entity/Relationship Diagram – is diagram type used to describe relational database models. *(4)*

**Fat client**

In contrast to a thin client a fat client consists of both, the GUI and some application logic. This type of a client-server architecture causes a decentralized and higher maintenance effort compared to a thin client. *(12)*

**FIONA**

Freight & Invoice Operations Network Application – Web-Application for processing and monitoring freight bookings in daily business. *(2)*

**FTL**

Full Truck Load – is a transport type with a fixed price, regardless to the fill rate. *(18)*

**GIS**

Geographical Information System – e.g. a map server which is providing geographical information.. *(12)*

**Groupage**

Groupage – is a transport type with a weight and distance dependent price. *(18)*

**GSCM**

Global Supply Chain Management – is a department responsible for supply of raw materials etc. *(**??**)*

**GUI**

Graphical User Interface – is an interface for the graphical interaction between software and user. *(11)*

**HTML**

Hypertext Markup Language – is a language for representation of text, images and hyperlinks in the world wide web (www). *(21)*

**HTTP**

Hypertext Transfer Protocol – is a protocol mainly used for transportation of web pages within the world wide web (www). *(21)*

**IC**

Inventory Costs – Storage costs for keeping goods in stock. Inventory costs are calculated by charging the value of goods against the `inventory cost rate (ICR)`. *(8)*

**ICR**

Inventory Cost Rate – is a percentage rate for calculation of `inventory costs`. *(8)*

**ICY**

InterCompanY – refers to shipments and locations within the company Tenneco. *(1)*

**ICYLocation**

InterCompanY Location – a plant which is owned by Tenneco. *(26)*

**IE**

Internet Explorer – is a browser developed by Microsoft Inc. *(21)*

**JSP**

Java Server Pages – a technology used for creation of dynamic HTML- and XML-pages. *(21)*

**ldm**

loading meter – is a unit of measurement for truckload. In particular, space of goods on a truck. 1 ldm stands for 1 m x 2.42 m x 3 m (*width x depth x height*) with a maximum load of 1650 kg. *(7)*

**LMT**

Location Management Tool – a small Web-Application for maintaining master data (location data) for CATIS, FIONA and Confluentic WEB. *(17)*

**MVC**

Model-View-Controller – is a pattern for separation a software system into three units - model, view and controller. *(20)*

**MVC2**

MVC model 2 – is a modified Model-View-Controller pattern specialized for web applications. *(20)*

**OE**

Original Equipment – The Tenneco customer division comprising spare parts for automotive production by original manufacturers. *(1)*

**OH€**

On Hand Euro – This is the cash value of all goods in stock (`Buffer` and `Production`). *(8)*

**Production**

Production is the time span between two batch arrivals. The plant consumes all delivered goods in this period of time. *(8)*

**PakMan**

Packaging Management System – Conceptual master thesis concerning tracing and monitoring of packages and empties. *(2)*

**RC**

Ride Control – The Tenneco product division comprising shock absorber area. *(1)*

**TC**

Transport Costs – Costs that arise out of haulier costs and location costs. *(7)*

**Thin client**

A thin client within a client-server architecture means, that the clients are limited to input and output. The whole application logic is centralized on a server. *(13)*

**UML**

Unified Modeling Language – is a standardized language for modeling software. *(4)*

**Wiki**

WikiWeb is a kind of Content Management System. A type of Web site that allows the visitors themselves to easily add, remove and change some available content. *(68)*

# Bibliography


[Apa06] Apache Software Foundation. Website: Struts. http://struts.apache.org, 2006. Last visited: 2006-09-11. 20

[Bal01] Helmut Balzert. *Lehrbuch der Software-Technik*. Spektrum Akademischer Verlag, 2nd edition, 2001. 3

[BMR+96] Frank Buschmann, Regine Meunier, Hans Rohner, Peter Sommerlad, and Michael Stal. *Pattern-Oriented Software Architecture: A System of Patterns*. John Wiley and Sons Ltd., Chichester, 1996. 20

[Col06] CollabNet. Website: Tigris.org – Category home: Software configuration management tools. http://scm.tigris.org, 2006. Last visited: 2006-09-30. 68

[Dep06] Department of Computer Science. Website: FB4. http://www-uni-koblenz.de/FB4/, 2006. Last visited: 2006-10-23. 1

[DR06] Stefan Dederichs and Andreas Röhncke. FIONA — Freight & Invoice Operations Network Application. Diploma Thesis, Institute for Information Systems Research, Department of Computer Science, University of Koblenz-Landau, Sep 2006. 2, 16, 34

[HDFW03] Ted Husted, Cedric Dumoulin, George Franciscus, and David Winterfeldt. *Struts in Action - Building web applications with the leading Java framework*. Manning Publications Co., Greenwich, 2003. 21, 38

[Her05] Timo A. Herborn. PakMan – Packaging Management System – Conceptual Development of a web based Packaging Management System. Master Thesis, Institute for Information Systems Research, Department of Computer Science, University of Koblenz-Landau, Sep 2005. 2

[IBM06] IBM Corporation. Website: IBM WebSphere Software. http://www.ibm.com/software/websphere/, 2006. Last visited: 2006-09-11. 20

[IDM06] IDM Computer Solutions Inc. Website: IDM Inc. - UltraEdit text editor. http://www.ultraedit.com, 2006. Last visited: 2006-11-15. 68

[Ins06] Institute for Information Systems Research. Website: Institute for IS Research. http://www-uni-koblenz.de/FB4/Institutes/IWVI, 2006. Last visited: 2006-10-15. 1

[KLS05] Ralf Krechel, Lars List, and Daniel Schmidt. Confluentic. Diploma Thesis, Institute for Information Systems Research, Department of Computer Science, University of Koblenz-Landau, Mar 2005. 2, 5, 7, 8, 9, 10, 11, 12, 22, 24, 26, 28, 36, 54

[Kop06] Jürgen Kopper. CaTIS —Carrier and Tariff Information System. Diploma Thesis, Institute for Information Systems Research, Department of Computer Science, University of Koblenz-Landau, Okt 2006. 2, 16, 18, 27, 34, 63

[map06] map&guide. Website: map&guide - The Mapware Company. http://www.mapandguide.de/, 2006. Last visited: 2006-11-15. 12

[Med06] MediaWiki. Website: MediaWiki.org - free software wiki. http://www.mediawiki.org, 2006. Last visited: 2006-11-15. 68

[Mic06a] Microsoft Corporation. Website: Microsoft Product Information Center - Office. http://www.microsoft.com/products/office, 2006. Last visited: 2006-09-30. 68

[Mic06b] Microsoft Corporation. Website: Microsoft Windows Server 2003. http://www.microsoft.com/windowsserver2003/default.mspx, 2006. Last visited: 2006-11-16. 20

[Mic06c] Microsoft Corporation. Website: MSDN Developer Center - .NET Framework. http://msdn2.microsoft.com/en-us/netframework/default.aspx, 2006. Last visited: 2006-11-15. 11

[Mün05] Thomas Münch. Implementation of a web-based Packaging Management System for Tenneco Automotive Europe. Master Thesis, Institute for Information Systems Research, Department of Computer Science, University of Koblenz-Landau, Aug 2005. 2

[Ora06] Oracle. Website: Oracle, The World's Largest Enterprise Software Company. http://www.oracle.com, 2006. Last visited: 2006-11-15. 12, 20

[Pro06] Project LyX. Website: LyX.org - WYSIWYM document processor. http://www.lyx.org, 2006. Last visited: 2006-11-15. 68

[Sun06] Sun Microsystems Inc. Website: Sun Developer Network (SDN). http://java.sun.com/j2se/1.3/, 2006. Last visited: 2006-09-11. 20

[TA 05] TA Corporate Technology. *Tenneco Automotive Java Coding Standards*. Tenneco Inc., 2005. 20

[Ten05] Tenneco Information Technology. *Java Design Guidelines*. Tenneco Inc., Dec 2005. 20, 39

[Ten06a] Tenneco Automotive. Website: Tenneco Inc. http://www.tenneco.com/, 2006. Last visited: 2006-10-12. 1

[Ten06b] Tenneco Automotive. Website: Tenneco Profile. http://www.tenneco.com/overview/financial.html, 2006. Last visited: 2006-10-22. 1

[Tra06a] Transport Wiki. Website: Confluentic WEB - Design. http://userp.uni-koblenz.de/~confluentic/wiki/index.php/ConfluenticWEB-Design, 2006. Last visited: 2006-11-15. 25, 28, 34, 38, 65, 81, 86

[Tra06b] Transport Wiki. Website: Confluentic WEB - Project-Timeline. http://userp.uni-koblenz.de/~confluentic/wiki/index.php/ConfluenticWEB-Project-Timeline, 2006. Last visited: 2006-11-15. 4, 15

[Uni06a] University Koblenz-Landau. Website: Uni Koblenz-Landau. http://www.uni-koblenz-landau.de/, 2006. Last visited: 2006-10-22. 1

[Uni06b] University Koblenz-Landau, Campus Koblenz. Website: Campus Koblenz. http://www-uni-koblenz.de/index.extern.html, 2006. Last visited: 2006-10-22. 1