

# VeRoLog Solver Challenge 2014

The first international Vehicle Routing solver challenge

EURO Working Group on Vehicle Routing and Logistics Optimization - VeRoLog

[www.verolog.eu](http://www.verolog.eu)

## Overview

VeRoLog, the EURO Working Group on Vehicle Routing and Logistics Optimization, in collaboration with PTV group, is proud to announce the first edition of the VeRoLog Solver Challenge (VSC2014). This challenge is aimed at comparing on a specific variant of Vehicle Routing Problem (VRP), this year proposed by PTV, the computer codes implemented by the participants and submitted in executable form to the jury. The codes will be compared by considering the quality of the solutions obtained within a specific time limit on a set of test instances that will be defined by the jury. The declaration of the winners will take place at VeRoLog 2014 in Oslo, June 22-25, 2014.

The problem that is the subject of VSC2014 is called the Swap-Body VRP (SB-VRP) and will be described in detail in the following. The participant teams have to pre-register by sending an email to the jury at [ewg.verolog@gmail.com](mailto:ewg.verolog@gmail.com) indicating the name and affiliation of all team members and the name of the team leader.

There is no limit to the number of participants and we encourage teams formed by junior researchers. After the registration and before a prescribed date (see below) each team, through its team leader can submit queries to the jury including clarification requests about the problem definition and completion rules. Answer to the queries will be made available to all participants.

At the end of the pre-registration, an information package will be distributed, including the final description of the problem and the rules, the requisites of the executable code to be submitted, a first set of test instances, and an executable code that performs a feasibility check and computes the value of a solution.

In case the number of pre-registered teams is large, a selection will take place in spring. Only the selected teams will be entitled to participate to the final round that will be performed in June before the VeRoLog conference. Each team is free to choose the specific algorithmic approach to be coded and submitted in executable form to the challenge. However, originality and scientific or practical interest may be taken into account in the final evaluation. The actual evaluation rules will be part of the final package.

The jury of VSC2014 is formed by Geir Hasle, Werner Heid and Daniele Vigo.

Both the possible pre-selection and the final stage will be performed by the jury by using the executable codes submitted by the participating teams. The winner is awarded a certificate and a monetary prize. The teams presenting particularly effective, innovative, and original

approaches will be encouraged to submit their work to Computers and Operations Research. The jury will select the finalists and the winner at its sole discretion. All decisions will be final.

### **Important Dates**

Pre-registration deadline:	December 31, 2013
Query deadline:	January 15, 2014
Challenge package distribution:	January 31, 2014
Query deadline:	February 15, 2014
Pre-selection submission (possible):	April, 15, 2014
Final code submission:	May 31, 2014
Winner proclamation:	June 22-25, 2014 in Oslo

## Problem description

### Swap-Body Vehicle Routing Problem (SB-VRP)

A set of *customers* is given. Each customer  $i$  has to be delivered with a given *quantity*  $q_i$  (i.e. either weight, volume, or shipping units). The unloading at each customer takes a given amount of time  $s_i$  (often the duration of the service is related to the quantity that has to be dealt with at the customer). A homogeneous fleet that consists of *trucks*, *semi-trailers* and *swap-bodies* is located at a single *depot*,  $D$ . All routes start and end at this depot. The different components and characteristics of the problem are defined with more detail in the following:

#### ► Depot

- the place where the vehicle fleet is located
- all routes start and end at this depot

#### ► Fleet

- A homogeneous fleet is located at one single depot
- the fleet consists of
  - trucks
  - semi-trailers
  - swap-bodies
- side loading (or unloading) of the swap-bodies is possible.  
This ensures that if you visit a customer with a *train* (i.e. when the truck tows two swap-bodies) the sequence of the swap-bodies is not relevant
- the maximum load for a swap-body is  $Q$ . Only swap-bodies can be loaded, i.e. the maximum load for all trucks and semi-trailers is 0
- an unlimited number of each of the above fleet elements is available

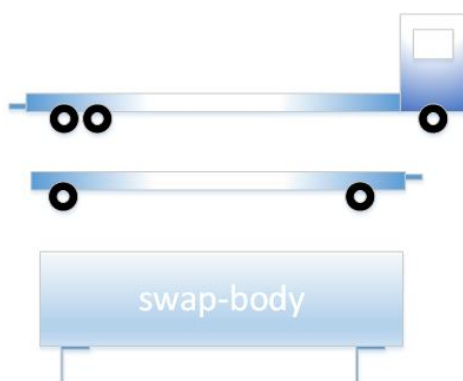


Figure 1: Truck, semi-trailer, and swap-body

- ▶ valid vehicle combinations are
  - ▶ a truck carrying one swap-body
  - ▶ a train (truck and semi-trailer) carrying two swap-bodies

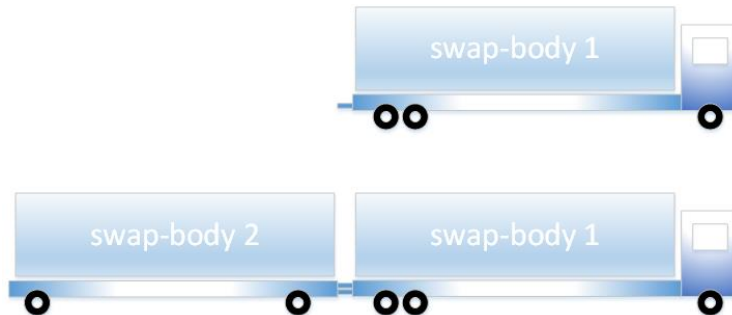


Figure 2: valid vehicle combinations (truck and train)

- ▶ en route a swap-body can be detached, left parked in specified locations, and later reattached to the truck. This allows the truck to visit customers that can be visited only by trucks with just one swap-body even if the truck departed from the depot as a train of two swap-bodies.
- ▶ en route no exchange of swap-bodies between trucks is allowed
- ▶ a truck/train has to return to the depot with exactly the same swap-bodies (one or two) it departed with
- ▶ **Customers**
  - ▶ each customer is delivered with an individual quantity  $q_i$ . Deliveries must not be split, hence each customer is visited exactly once. It is valid to load the quantity for one customer on two swap-bodies if this seems beneficial. In case, the two swap-bodies must clearly be assigned to the same truck. In order to guarantee solution feasibility the quantity of each customer does not exceed  $2*Q$  if this customer can be visited by a train or  $Q$  otherwise
  - ▶ each customer has a flag that indicates whether it can be visited by a train or only with a truck carrying just one swap-body
- ▶ **Swap locations**

there is a set of swap locations where different actions are allowed, swap locations can be used if the route is executed by a train. Operations allowed at a swap location are:

  - ▶ park
 

a truck parks the semi-trailer and continues the route with just one swap-body. The red traffic sign in figures 3-6 indicates that this swap-body is parked at the swap location.

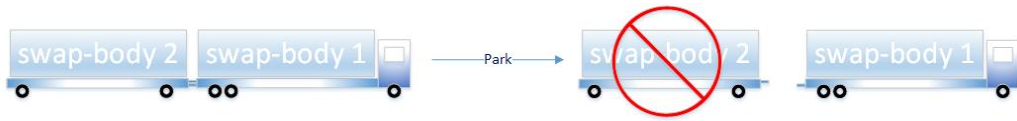


Figure 3: park

► pick up

the truck picks up the semi-trailer with the swap-body it has parked there at an earlier stage of the route

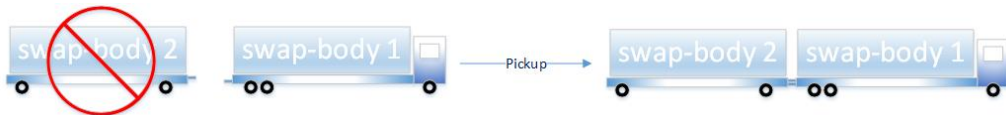


Figure 4: pickup

► swap

a truck parks the swap-body it is currently carrying and picks up the other swap-body from the semi-trailer it has parked there at an earlier stage of the route

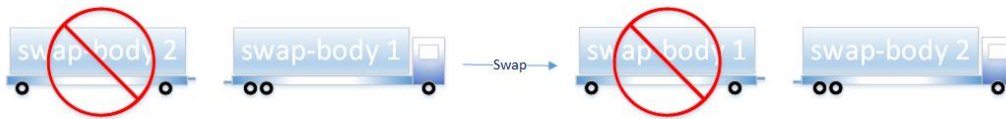


Figure 5: swap

► exchange

a truck parks the semi-trailer, exchanges the swap-bodies between truck and semi-trailer and continues the route with this swap-body



Figure 6: exchange

► the state diagram describes valid transitions

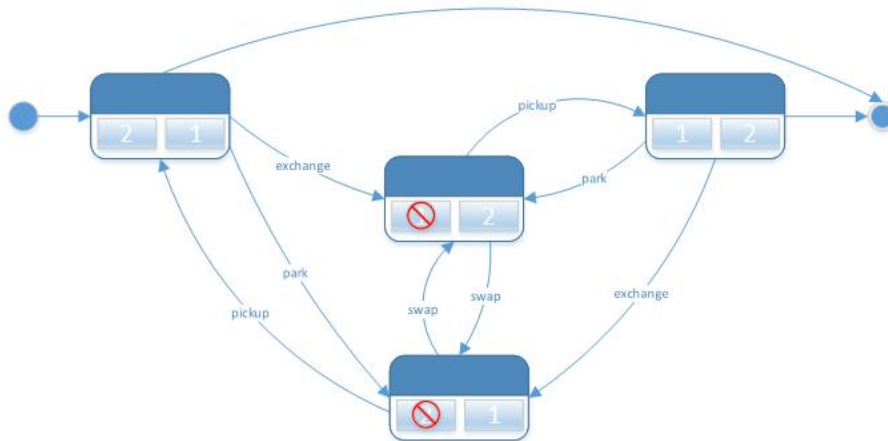


Figure 7: valid action transitions at swap locations

- the number of swap location visits per route is not limited
- we define a specific handling time per action (parking takes probably less time than swapping)
- the state diagram implies that a truck cannot drive without at least one swap body. We deliberately did without this option in order not to incorporate too many aspects of richness into the problem.
- **Distances and Driving times**
  - distances and driving times between all relevant locations are given in a matrix. The values are based on shortest path calculations in digital road networks.
  - distance and driving time matrices are asymmetric (i.e. distance and time between two locations may be different in the two possible directions).
- **Constraints**
  - we only allow round trips (routes start and end at the depot D)
  - we restrict the maximum duration of all routes
  - the loading capacity of all swap-bodies must not be exceeded
- **Cost structure and Objective Function**
  - Truck
    - fixed cost if this truck is used in the solution and
    - variable costs (cost / km and cost / h)
  - semi-trailer
    - fixed cost if this semi-trailer is used in the solution and
    - variable costs (cost / km)
  - swap-bodies
    - no costs are related to swap-bodies

- ▶ with this definition the driver costs are approximated quite satisfactorily for practical purposes
- ▶ Objective function  
we are rather sure that the cost structure allows us to define the objective function completely by costs. The goal is to minimize the total costs of the plan  
(remark: of course it could be smart to work with hierarchical structures for the optimization goal in the algorithms but of course we leave this up to the participants of the challenge)

## Test instances

We are planning to provide three different test instances for the participants. Instances will be provided as plain text files including all instance data according to a specified format.

- ▶ small instance  
approx. 50 customers  
approx. 15 to 20 swap locations  
approx. 15 customers where no train is allowed for service
- ▶ medium size  
approx. 200 customers  
approx. 50 swap locations  
approx. 20 customers where no train is allowed for service
- ▶ large  
approx. 500 customers  
approx. 100 swap locations  
approx. 50 customers where no train is allowed for service

For each instance, two additional variants can be considered:

- ▶ variant1: all customers can be visited by a train
- ▶ variant 2: no customer can be visited by a train

Furthermore we will define an additional set of “private” instances which shall be used by the jury to determine the winner of the competition.

## Data files

All data are given in text files, where the first line gives the description and the following lines give data separated by a semicolon;

### ***Locations.txtw***

- ▶ Depots, Swap Locations and Customers data are available through a separate text file called **Locations** where for each customer is reported:
  - ▶ location descriptive name, the identifier , the post code and the city (for descriptive purposes only), the Longitude and Latitude
  - ▶ quantity to be delivered in load units, for customers only
  - ▶ impossibility of being visited by a train (1=impossible), for customers only

- ▶ possibility of performing a swap (1=yes), for swap locations only
- ▶ service time in minutes, for customers only

### ***Vehicles.txt***

- ▶ For each equipment type (Truck, Semi Trailer and Swap Body) is reported
  - ▶ type name
  - ▶ capacity in load units
  - ▶ distance cost in monetary units per Km
  - ▶ time cost in monetary units per hour
  - ▶ fixed cost in monetary units per use

### ***SwapActions.txt***

- ▶ For swap action type (Park, Swap, Exchange and Pickup) is reported
  - ▶ type name
  - ▶ fixed duration in minutes

### ***DistanceCoordinates.txt***

- ▶ For each location (depot-, customer- and swap-locations) we give
  - ▶ Location ID
  - ▶ The X co-ordinate  $X_i$  and Y co-ordinate  $Y_i$  of each location

### ***DistanceTimes.txt***

- ▶ For each location (depot-, customer- and swap-locations) IN THE SAME ORDER AS THAT REPORTED in DistanceCoordinates.txt file we give
  - ▶ The distance  $d_{ij}$  and driving period  $p_{ij}$  between the start-location  $L_i$  and each destination-location  $L_j$  for  $j = 1, \dots, n$  are stored in separate rows separated by a semicolon (;).
  - ▶ For example: A distance table that consists of the distances and driving periods between 3 locations is stored as follows:
 

```
d11; p11; d12; p12; d13; p13
d21; p21; d22; p22; d23; p23
d31; p31; d32; p32; d33; p33
```
  - ▶ all distances in this matrix are in meters and times are in seconds

### **Feasibility tool**

We will provide a simple tool for the participants of the contest (and for us of course) to check the feasibility and the objective value of the obtained solutions. Probably this will be a simple console application for Windows.