

PTV ROUTE OPTIMISER

the mind of movement

PTV Route Optimiser ST 2021.1

Performance Description

Hosting variant

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1 Profile

The automatic trip planning software PTV Route Optimiser schedules your orders for trips using powerful optimisation algorithms. The planning requirements and restrictions that are relevant for you and your customers as well as vehicle capacities and equipment are accounted for in this process. This makes the software as individual as you are and it can be customised to your workflow requirements, system environment and complex planning tasks. Many important functions in PTV Route Optimiser support you in your day-to-day planning tasks.

- ▶ Automatic planning and optimisation of distribution and multi-drop services as well as direct transports, also as mixed planning
- ▶ Optimisation based on precombined trips or free planning
- ▶ Manual scheduling and semi-automatic suggestion functions
- ▶ Optimised trip plans even with quantities and journey points that vary daily
- ▶ Resource assignment planning with reassignments
- ▶ Multiple depots and alternative depot scheduling
- ▶ Planning in a continuous time horizon (rolling wave planning) or in a completed day planning
- ▶ Optional inclusion of different vehicle profiles
- ▶ Calculation of transport costs, toll charges and CO2 emissions
- ▶ Central administration and structuring of roles and rights, orders, vehicles and drivers
- ▶ Integrated data supply with master data as well as requirements and restrictions that are relevant for scheduling
- ▶ Scalable system that makes cooperative trip planning of several subsidiaries or employees possible
- ▶ Configuration that is flexible and user-oriented

2 Available program languages

The user can select the preferred language for the program interface when logging in.

PTV Route Optimiser ST is currently available in 9 languages:

- ▶ German
- ▶ English (en-GB)
- ▶ English (en-US)
- ▶ French
- ▶ Italian
- ▶ Dutch
- ▶ Polish
- ▶ Spanish
- ▶ Portuguese

3 Map and Map Material

The digital map displays orders, i.e. their pickup and delivery points, sites, depots, planned trips, routes and vehicle positions.

Geocoding, distance matrix calculation and routing are based on the acquired map material and country combinations, normally on TomTom standard maps (Europe City map or country map). Map data is available for the whole world. These depend on the licence.

Searchgraphs are available for fast calculation of distance matrices with the speed profiles "Car" and "Truck".

The following can also be installed to the map:

- ▶ The map setup (PTV maps from version 2019) installs the feature layer truck attributes without additional license key. The availability and also the quantity of data is very dependent on the map and the map data suppliers.
- ▶ CO2 emission calculation according to different standards (HBEFA 3.x only for Europa City map)

4 Importing and exporting data

Data can be exchanged with the customer system using the import and export functions.

Order data can be imported in Microsoft® Excel format as well as via the PTV TransferDB. Vehicle data are imported in Microsoft® Excel format and via the PTV TransferDB.

The following variations are available for import and export:

- Import of order data
- Importing vehicle data
- Importing driver data
- Importing vehicle calendars
- Importing sites with associated contact data
- Importing depots
- Export of planning results (trips) with detailed information about planned orders and used resources such as drivers and vehicles as well as emissions.

All functions are set up as a Microsoft® Windows service that automatically imports data based on rules.

4.1 Interfaces

PTV Route Optimiser provides import and export interfaces that allow you to exchange order data and planning results with the main system.

4.2 Data Exchange via the PTV Transfer Database

Data on orders, depots, vehicles, driver and loading points can be transferred in full from an external system to PTV Route Optimiser using the PTV Transfer DB.

In return, PTV Route Optimiser ST writes planning results to the Transfer DB in a structured format.

The PTV Transfer DB is delivered in a schema specified by PTV.

Note: Even if, for example, only vehicles are to be updated via the Transfer Database, the Transfer DB schema still contains all tables for orders, consignment items, trips, etc...

For each planned trip, information is written at trip header level (length, duration, start time, capacity, etc.), for the individual trip stops and the action points contained (= loading and unloading processes during the trip). This planning information can then be read by an external system and processed further.

5 Overview of the program areas

In PTV Route Optimiser the following program areas are available:

- ▶ User management
- ▶ Master data
- ▶ Fleet management
- ▶ Driver management
- ▶ Geocoding
- ▶ Order management
- ▶ Pre-planning
- ▶ Planning management
- ▶ Trip planning
- ▶ Data transfer (import/export)
- ▶ Reports and analyses
- ▶ System
- ▶ Further program areas via chargeable add-on modules (see chapter 19)
 - ▶ Route planning
 - ▶ Contract partner
- ▶ Further optional add-on modules available (see chapter 22)

Note: You can also set up a Microsoft® Windows service as a background service that automates essential process steps according to a configurable schedule and performs them in the background. These include, for example, import and export, planning, telematics and notification processes.

6 User Management Program Area

The User Management program area enables managing, assigning and structuring of users and planning objects such as orders, vehicles, drivers, sites, depots and the resulting trips.

You can create rights for using individual functions and assign these rights to users. This is especially necessary when PTV Route Optimiser is used in a multi-user system. User Management is available for users with admin rights.

6.1 Task fields program item

In the Task fields program item, if PTV Route Optimiser is used in a multi-user system then all data and objects to be planned are structured to one or several task fields through assignment. Task fields can be enabled for one or more users.

6.2 Roles and rights program item

In the Roles and Rights program items, rights are defined and created rights are grouped to roles. Afterwards, roles can be assigned to users.

Note: These functions are only available to your PTV Route Optimiser consultant.

6.3 User program item

In the User program item the users who are authorised in a multi-user system are created and managed. Task fields and roles can be assigned to the users.

7 Master Data Program Area

In the **Master data** program area you manage and maintain basic data such as pickup points, depots and fleet locations that are necessary for trip planning.

The sites are assigned to the order data imported from the external system.

For pickup points, depots and fleet locations the associated geocoordinates can be determined through integrated geocoding functions. This allows the display of these planning elements in the map.

Information that corresponds to orders can be saved at sites, depots and fleet locations. This allows the visualisation of logistical requirements that cannot usually be made available via the order data from the external order-management system, such as special opening hours, regional public holidays, or unique customer restrictions. Hereby, imported orders from the external system can be expanded by all necessary information relevant to scheduling and made available to automatic trip planning.

7.1 Sites program item

In the **Sites** program item, pickup and delivery points for trip planning are managed. You can also specify special opening hours and regional public holidays for receiving goods, or planning-relevant information relating to specific customers (e.g. individual restrictions such as aerial work platform required, only approach with motor vehicle, etc.).

For opening hours, vehicle restrictions and planning requirements, assortment-specific parameters can be created and managed so that assortment specifications can be included in planning.

A calendar can be used to display and maintain downtimes at the pickup and delivery points.

Linked contact data (names, telephone and mobile numbers, email addresses) can be used for the notification functions.

7.2 Depots program item

In the **Depots** program item, production or warehouse locations for trip planning are managed. Depots can also serve as vehicle locations. Pickup and delivery times can also be specified.

7.3 Fleet locations program item

In the **Fleet locations** program item the vehicle locations are managed.

8 Fleet Management Program Area

In the **Fleet management** program area vehicles of different categories are created and managed. In this process, motor vehicle types and trailer types as well as actual motor vehicles and trailers are differentiated.

Motor vehicle types and trailer types as well as motor vehicles and trailers can be grouped to combinations.

In equipment, logistical requirements can be visualised that often cannot be made available through the order data out of the external system that conducts the order (e.g. vehicle restrictions). Downtimes can be updated via a calendar, which can also be imported. The vehicles or their settings can be assigned to a version. Thereby, such a factor as equipment changes at a specific date can be included.

New vehicles or vehicle changes can be introduced via an import.

8.1 Motor vehicles types and trailer types program items

In the **Motor vehicle types** and **Trailer types** program items, vehicle templates are created and managed. Motor vehicle types and trailer types can be used as a master copy for actual vehicles. They do not depict concrete vehicles.

8.2 Motor vehicles and trailers program items

In the **Motor vehicles** and **Trailers** program items, actual vehicles that carry a license plate number are managed.

8.3 Combinations program item

In the **Combinations** program item, combinations from motor vehicles or motor vehicle types with trailers or trailer types can be formed.

8.4 Routing profiles program item

Routing profiles are used to define various parameters relevant to planning for calculating driving time and distance (route selection). These include speeds on different road types and other special features such as the consideration of truck attributes or a ban on ferries.

The vehicle attributes, such as engine capacity, emission class, number of axles and vehicle dimensions, are also relevant for the emissions calculation.

9 Driver Administration Program Area

In the **Driver management** program area you can manage the personal data and contact data of the fleet drivers. The drivers created in PTV Route Optimiser can be assigned to trips afterwards.

10 Geocoding Program Area

In the **Geocoding** program area you can see and edit the addresses used in PTV Route Optimiser regarding their geocoding quality.

Using comprehensive automatic and manual functions exact positions and coordinates can be determined for the imported and acquired addresses. Manual positioning by means of a click-point in the map is also possible. PTV Route Optimiser manages three different versions for each address:

- ▶ **Original address:** Corresponds to the address that was originally imported or acquired (for example, the address of the import record from the external system).
- ▶ **Geocoded address:** The address geocoded in PTV Route Optimiser, the coordinates of which are used in trip planning.
- ▶ **Address shown:** The address that is displayed in PTV Route Optimiser lists and overviews.

Thereby, on a practical level that means that colloquial expressions that are often used (such as "Fruit market south, gate 2") can still be used in the user interface of PTV Route Optimiser as the address, but PTV Route Optimiser works with the exact postal address and the corresponding coordinates.

11 Order management program area

In the **Order management** program area all orders imported into PTV Route Optimiser are displayed and managed. In addition, new orders can be manually created or existing ones can be duplicated and modified.

The **Postpone order** and **Global change** functions are used to change deadlines or parameters of existing orders. It is also possible to edit several orders at a time.

Using the filter functions, the number of displayed orders can be limited.

If PTV Route Optimiser is used as a multi-user system then assigned task fields are included. In this case only the orders that are located in task fields visible to the user are displayed.

12 Preplanning program area

You will not always be able to import plannable transport orders directly from the external system into PTV Route Optimiser. In some cases you have to edit the order data. The **Preplanning** program area provides you with functions for changing and adapting the orders to be planned.

Preplanning is done according to preplanning rules that can be specified separately for each function. If required, the preplanning rules can be called up manually or automatically according to a configurable schedule using a background service.

12.1 Preplanning function Depots

Using the **Depots** function, you can assign orders a start or an end depot.

You can change an existing assignment or make an initial assignment. If an order can be carried out from several depots, you can also assign alternative depots.

12.2 Preplanning function Quantity split

Using the **Quantity split** function, you can split orders into partial orders in PTV Route Optimiser. This allows you to schedule partial quantities of a order for transport.

12.3 Preplanning function Route split

Using the **Route split** function, you can split transport orders according to partial route sections in PTV Route Optimiser. This creates partial orders that can then be scheduled separately. The depots serve as the splitting points. A customer's transport order from A to B can e.g. be split via depots into a pre-, main and post transport run. The route split function works self-sufficiently from the external system. Order updates from the external system can only be processed for the original main order and handed down to the sub-orders. Data relevant to the split, such as deadlines at the split points cannot be changed by the external system.

12.4 Preplanning functions Task fields

In preplanning, you can define the rules governing how orders and groupage orders are assigned to the task fields. Using the assignment to the task fields one can determine at which subsidiary or through which dispatcher which orders can be scheduled with vehicles and depots to trips.

12.5 Preplanning functions Groupage orders

Groupage order formation allows orders with the same and overlapping time slots to be collected as groupage orders. Thereby you can, for example, combine several deliveries to or several pickups from a customer to one planning object. This results in a clearer overview and makes manual pre-planning easier. In this way, it can be ensured that deliveries or pickups are bundled.

In preplanning, you can define the rules governing how orders are grouped into groupage orders. You also have the option to add to existing planned and unplanned groupage orders. Existing planned orders can also be made into groupage orders.

You can configure whether an order should be removed from the groupage order or trip when changes are made to its planning-relevant fields (date, address data, precombined trip number).

13 Planning management program area

Planning areas are created and configured in **planning management** programm area.

13.1 Structure of trip planning in planning areas

In planning areas, trip planning with PTV Route Optimiser can be structured logically, chronologically and visually at each workplace. This clearly separates the different planning tasks from one another.

- ▶ Creating and managing several planning areas per user
- ▶ Selection of the task fields to be planned per planning area
- ▶ Specification of the planning time period (see chapter 14.4)
- ▶ Selection of the parameter set used by default according to the planning task
- ▶ Selection of the used view for the task-specific configuration of the planning user interface

The configuration and management of the planning areas and planning parameter sets takes place in the Planning management program item.

14 Trip planning program area

The **Trip planning** program area is the functional central component of PTV Route Optimiser. All planning objects are displayed in the trip planning area and can be automatically or manually planned into trips and optimised. Different planning tasks can be resolved thanks to a number of functions and processes plus settings and parameterization.

14.1 Available planning objects

For trip planning with PTV Route Optimiser, the following planning objects can be used:

- ▶ Orders
 - ▶ Vehicles (actual vehicles and vehicles types)
 - ▶ Trailers (actual trailers and trailer types)
 - ▶ Vehicle combinations (vehicles with trailers)
 - ▶ Depots
 - ▶ Driver
 - ▶ Trips
 - ▶ Forwarders (via the add-on module **Cargo**)
-

Note: Trips that are already scheduled can be newly established and added to further either manually or using automatic optimisation.

14.2 Order and trip structures

Order structures

With PTV Route Optimiser, depot-related orders and deliveries can be planned as of a depot or pickups from a site as well as direct delivery orders from A to B. An order in PTV Route Optimiser always consists of a pickup point and a delivery point.

- ▶ Pickup (Pickup point at customer site, delivery point at depot)
- ▶ Delivery (Pickup point at depot, delivery point at customer site)
- ▶ Transport (Pickup point at depot, delivery point at depot oder pickup point at customer site, delivery point at customer site)

All planning-relevant order information such as address, opening hours, restrictions, handling times, etc. can either be directly imported using the order interface or be permanently stored using the master data at the respective site. In this way, orders can be fully expanded and scheduled with logistical planning information if these order details are not available in the main system.

Orders in PTV Route Optimiser can include the following information:

- ▶ Order header information
 - ▶ Order ID
 - ▶ Type information (pickup, delivery, transport)
 - ▶ General order information
 - ▶ Priority

- ▶ Precombined trip requirements
- ▶ Maximum transport duration (dwell time on the vehicle)
- ▶ Information per action point (pickup or delivery)
 - ▶ Customer ID
 - ▶ Addresses for deliveries and pickups and/or coordinates
 - ▶ Deadlines or time slots
 - ▶ Restrictions (e.g. equipment requirements that the vehicle has to fulfil)
 - ▶ Handling times (consisting of a fixed share or a quantity-dependent pickup and delivery duration)
 - ▶ Vehicle requirements or restrictions

In addition to the order information, you can show several order or consignment items per order. To be able to do so, you need to import orders via the PTV TransferDB.

Trip structures

PTV Route Optimiser lets you create different trip structures through automatic or manual planning functions. For trip planning, the vehicle depot requirements are included. The following basic structures are possible:

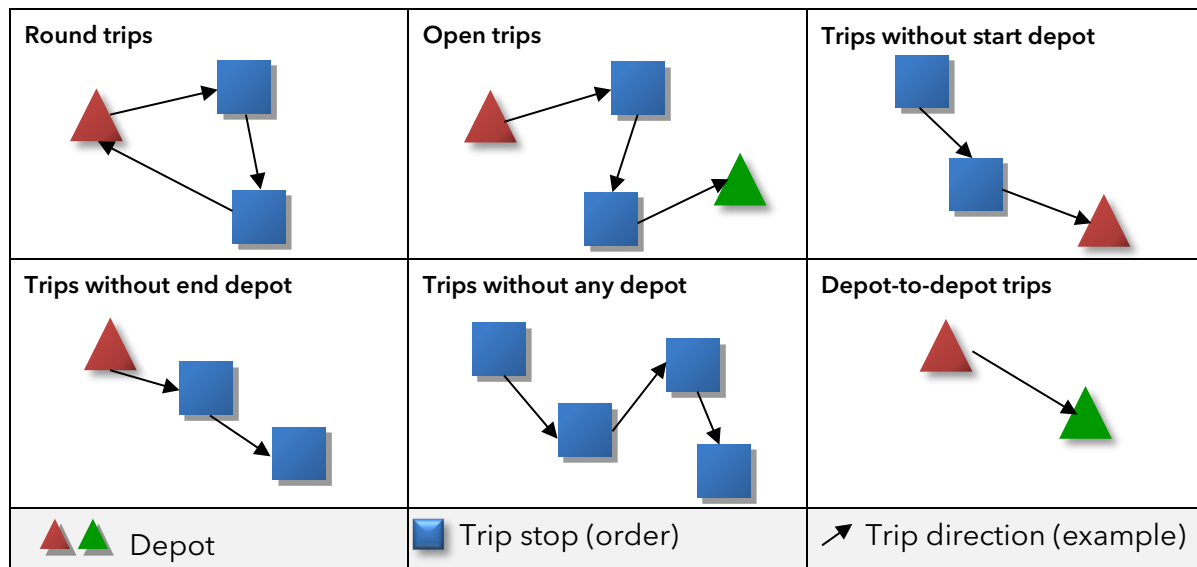


Figure 1: Trip structures in PTV Route Optimiser

Other than the vehicle depot assignment, a different fleet location can also be included during planning (e.g. if the driver takes the vehicle to his residence overnight). The arrival/departure to the vehicle location is listed at the trip start or stop during trip calculation as journey or continuation of the journey and included in the time calculation, but it is not graphically displayed.

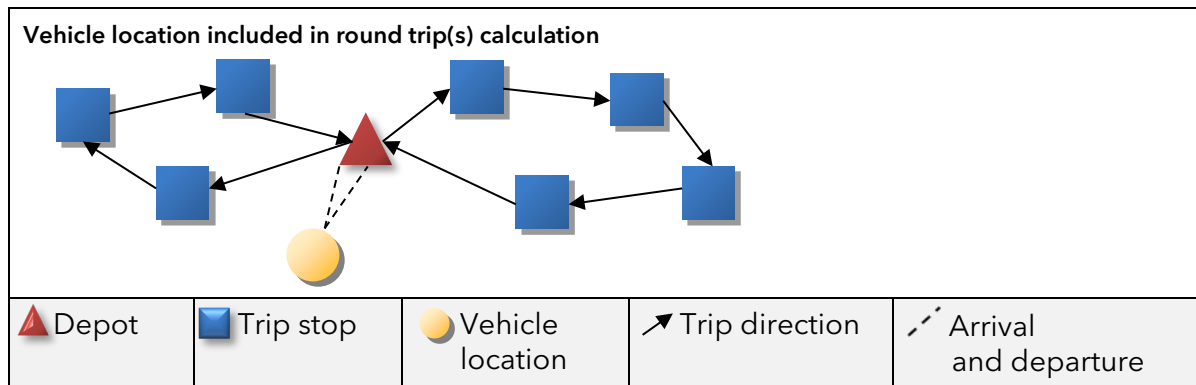


Figure 2: Example: PTV Route Optimiser includes the vehicle location in the trip structure

The trips formed according to trip planning include comprehensive planning-relevant information such as:

- Change information (when, who)
- Information of plan cost
- Specifications to the manual override for restriction violations
- Number of orders and trip stops
- User-defined trip information (numeric and alphanumeric)
- Gross quantities of the trip
- Max. load quantity of the trip
- Pickup/delivery quantities
- Emission values and imputed fuel consumption (add-on module)
- Driver data (name, ID), if necessary co-driver data
- Travelling time
- Vehicle information
- If necessary trailer information
- Break times and rest periods
- Planning status, execution status
- Vehicle load quantity utilisation in per cent
- Precombined trip number
- Restrictions
- Start time and end time, start location and destination
- Trip duration/Trip length
- Trip duration without depot return journey
- Trip ID
- Possibility of rescheduling
- Waiting time, handling time (pickup and delivery), turning time
- Distance and duration of journey/continuation of journey
- Date trip was created

Also, additional information is available at the stop level of the trip.

Note: Further information on import and export formats (orders and trips) can be found in the relevant interface description.

14.3 Trip planning program interface

For the display of the planning objects data, different elements are used by PTV Route Optimiser (e.g. tables, bar charts or the digital map).

14.3.1 Tables and lists in trip planning

Values and properties for the planning objects are clearly displayed in tables. For the majority of the tables, the following functions are available:

- ▶ Selection, configuration and positioning of the displayed information and columns
- ▶ General or conditional formatting of the display
- ▶ Filter and sort

Planning objects for orders, trips and vehicles additional tabs can be added. Filter settings are used for this.

14.3.2 Display of vehicle assignments

The time period of vehicle use in trips and the utilisation of the vehicles takes place in the **Trip planning** via the **Assignments** tab in the detailed view in the form of a bar chart. In the bar chart the following information and functions are available:

- ▶ Visual display of the trips and trip stops
- ▶ Display of the waiting times and handling times, the driving times as well as breaks and rest periods
- ▶ Display of the utilisation in the trip process
- ▶ Configuration and formatting of the display

14.3.3 Display of driver assignments

The driver assignments used in trips are displayed in the **Trip planning** via the **Driver assignments** tab in the detailed view in the form of a bar chart. The following information and functions are available in the bar chart:

- ▶ Visual display of the trips and trip stops
- ▶ Display of the waiting times and handling times, the driving times as well as breaks and rest periods
- ▶ Display of the utilisation in the trip process
- ▶ Configuration and formatting of the display

No checks are currently made for overlapping driver assignments. The diagram also shows the co-driver's or third driver's assignments.

14.3.4 Map display of planning objects

The map in trip planning provides visual information about the planning objects, orders, trips with stops and depots. This enables a quick and simple perception of geographic references and thereby supports planning.

In addition, the size, form and colours of the objects can be formatted subject to object properties. For example, the object size of orders can be selected subject to the load quantity or the colour according to the priority.

Object information can be shown as text in the form of labels or notifications in the quick information window when using "mouse over".

In the map and the interaction with the other trip planning elements, extensive manual planning functions are available.

14.4 Planning period

Two types of planning period are available in trip planning.

14.4.1 Continuous planning

This mode is appropriate for continuous planning where compliance with driving times and rest period regulations is important. For the most part, planning takes into account the assignment chains of vehicles from the past and the future.

14.4.2 Complete planning

This mode is suitable for a completed planning over a specific period of time (day or week), without taking into account the assignment chain for vehicles in the past and future.

14.5 Preplanning functions in trip planning

Within trip planning, the preplanning functions are also available or can be undone.

The following pre-planning functions are also available in trip planning:

- Pre-planning function **depots** (see also chapter 12.1)
 - Pre-planning function **quantity split** (see also chapter 12.2)
 - Pre-planning function **route split** (see also chapter 12.3)
 - Pre-planning function **groupage orders**
Groupage orders can be added to or resolved again if required (see chapter 12.5).
 - Pre-planning function **task fields**
The task field assignment in scheduling allows orders to be assigned to other task fields and can be transferred to other dispatchers in this way (see chapter 12.4).
-

14.6 Automatic trip planning

The core function of PTV Route Optimiser is automatic planning by means of high-performance algorithms. PTV Route Optimiser automatically schedules orders and vehicles to trips, taking into account up to several hundred planning-relevant requirements, properties and parameters.

During the automatic planning of PTV Route Optimiser, only valid trips are formed in accordance with the planning requirements and planning parameters.

Some of the requirements and parameters that PTV Route Optimiser includes for automatic planning are:

- Fixed deadlines or up to five time slots per day for the delivery or pickup of orders at the customer's location or at the depot
- Public holiday calendar at the sites and depot
- Quantities of orders or vehicle capacities

- ▶ Capacity sample groups of vehicles so that different loading patterns of the orders can be checked accordingly (for example, transports of containers of different sizes which cannot be combined as desired)
- ▶ Vehicle availability and fleet locations different from depot
- ▶ Order priorities
- ▶ Consideration of vehicles which have been previously assigned to orders
- ▶ Precombined trip requirements and precombined trip position (absolute and relative)
- ▶ Freely-configurable equipment requirements from the order to the vehicle (e.g. tail lift required) or corresponding vehicle equipment
- ▶ Limitations for different vehicle groups at the customer's location
- ▶ Trailer ban during delivery/pickup at the customer's location, necessity of a co-driver
- ▶ Variable and fixed handling times for pickup and delivery at depots and at the customer's location
- ▶ Setup time and turning time between two trips
- ▶ Trip driving times and rest periods for 1 or 2 driver(s)
- ▶ Regulations for breaks, night work and working hours for pickup and delivery activities at stops
- ▶ Requirements of combination possibilities regarding motor vehicles and trailers
- ▶ Parameter requirements for trip modelling
- ▶ Max. trip duration, trip driving time, trip length
- ▶ Max. number of vehicle assignments in the planning time period and the orders per trip

In PTV Route Optimiser, different methods for automatic trip planning are available. These can be used in accordance with the planning task.

14.6.1 Free planning

During free planning of PTV Route Optimiser the pre-selected orders and resources are scheduled to trips according to deadlines, restrictions, and planning parameters. During the process, existing trips can be included or excluded from planning.

Requirements for the precombined trip, order priorities or resources are not included in free planning.

14.6.2 Precombined trip planning

In PTV Route Optimiser precombined trip requirements for orders, trips and vehicles for automatic trip planning can be included using the specification of precombined trip numbers or names.

In addition, by assigning parameters for the planning procedure, one can also specify whether the order sequence within the trips is specified through the planning procedure or if a pre-configured sequence should be included. For the positioning of orders within the precombined trip, the following criteria are available:

- ▶ Firmly defined sequence number within the precombined trip
- ▶ Optimum sequence in the trip
- ▶ First stop in the trip
- ▶ First section in the trip
- ▶ Last section in the trip
- ▶ Last stop in the trip

Note: Using precombined trip planning, orders without precombined trip requirements can also be included in the planning.

14.6.3 Planning with priorities

In automatic trip planning with PTV Route Optimiser, order priorities can be included. In the process, the algorithm will cause orders with higher priority to get preferential treatment. The value range of priorities is indicated as an integer. The priority rises with the value.

14.6.4 Balanced planning

In automatic trip planning, widely-differing utilisations for the respectively-used vehicles and drivers regarding trip duration can arise, depending on the planning task and the parameter settings. In practice that can lead to dissatisfaction with the driving staff.

The Balanced planning function prevents this occurrence. In the process, the planning algorithm balances the trips in such a way that trip durations are balanced as much as possible. The result is that trip times are balanced.

In the process, the compromise is made to attain an expensive planning result because balanced trips cannot correspond to the standard cost-optimised planning results at the same time. This results in different utilisations.

The additional costs can be determined using a scenario comparison, for example, and can be weighed against the advantage of socially-balanced assignment times.

The balance can occur for trip duration or trip weight.

14.6.5 Round trips with temporary depot assignment

Using the Plan round trips function, PTV Route Optimiser can also plan vehicles in depot-related round trips that usually do not have a depot assignment.

14.6.6 Assignment optimisation

With PTV Route Optimiser, an assignment optimisation for the vehicles can be made afterwards for an existing trip plan. This often allows a further improvement to be achieved, in particular following a manual change to a planning result that was originally automatically generated, or following a precombined trip planning.

14.6.7 Post-optimisation

For the automatic planning procedure, Post-optimisation provides a tool for the improvement of planning results.

The planning procedure of PTV Route Optimiser is organised in such a way that a valid planning result will be achieved in the shortest amount of time possible. Because in many cases even complex planning tasks are calculated so fast that more time is available for automatic optimisation in the operative workflow, automatic optimisation can be used in post-optimisation for further planning improvements. Special algorithms try to further improve the existing trip plan in the process.

Post-optimisation can be automatically implemented directly after the planning procedure or can be started manually. In the process, PTV Route Optimiser shows the progress and the degree of the improvement. The post-optimisation procedure can be interrupted by the user at any time. In this case, the best planning result available at this time would then be used.

Aside from the maximum computation time, the priority of the planning objectives can be configured. The following parameters are available:

- ▶ Optimise trip driving time
- ▶ Optimise trip kilometres
- ▶ Optimise number of trips
- ▶ Optimise assignment time
- ▶ Optimise number of vehicles
- ▶ Plan unplanned stops

14.6.8 Multi-compartment planning

Vehicles with several separate compartments or temperature zones can be mapped in the trip planning. Compartments can be separated using flexible partition walls. Should the front compartment only be accessible via the rear compartment in the direction of travel, the extent to which the rear compartment can be loaded and still allow access to the front compartment can be determined and checked per vehicle.

14.7 Manual trip planning

In PTV Route Optimiser a variety of manual trip planning functions is available in addition to the automatic functions. The manual planning functions enable automatically-generated plans to be modified or trips and assignments to be entirely manually created.

For manual trip planning, PTV Route Optimiser includes time slots, deadlines, planning restrictions and settings to attain valid results. When necessary, the user can override these.

Various functions are available for manual planning. Other than direct drag-and-drop operations, function calls can be performed using the quick-access bar or the context menu. The drag-and-drop operations in the trip planning in particular allow for interaction between the objects in the tables and views and those in the map. Restrictions can also be overridden very easily by pressing the ALT key.

14.7.1 Manual editing functions

Orders or planned trips can be manually edited. For this purpose, PTV Route Optimiser offers, for example, the following functions:

- ▶ Delay time of orders (order date)
- ▶ Change orders globally. The **Change globally** function allows you to manually change one or several orders.
- ▶ Change pickup orders or delivery orders in transports (A-B structure)
- ▶ Assign or resolve start depot/destination depot and vehicle, trailer or driver
- ▶ Add trips with orders or remove orders
- ▶ Trip fixation for trip start time and switch precombined trip number on or off
- ▶ Vehicle fixation for the trip on or off
- ▶ Edit trip status and delete trips

14.8 Semi-automatic planning functions

PTV Route Optimiser also offers semi-automatic planning functions:

- ▶ Vehicle suggestion for a trip
- ▶ Order suggestion for a trip
- ▶ Trip suggestion for a vehicle

- ▶ Trip suggestion for an order

In the process, the user receives one or more suggestions to different planning alternatives. The expected costs such as extra expenses or additional kilometres are listed and the variation is displayed in the map. On this basis, the dispatcher can make the suitable selection after having considered the individual requirements.

14.9 Fill in trip candidates

Often the order does not arrive in the trip planning once per day but spread across the day. This also applies to orders by the same customer. It is problematic when a part of a customer's orders has already been planned and successive orders for the same customer no longer fit in the trip.

The **Fill in trip candidates** function inserts a customer's newly imported orders to existing trips in which other orders are already available and planned for the same customer/location. This allows you to process as many of a customer's orders in a planning period as possible in a single trip stop.

The possible trip candidates, i.e. all trips in which at least one order is planned at the same location, are shown in the order list. For all orders with at least one trip candidate, it is attempted to add them to one of these trips. As a result, all trip candidates are included, regardless of which trips have just been selected or filtered.

Tip: You have the option to specify whether or not restriction violations are allowed.

If several trip candidates are found, the order will be inserted in the trip which has the start of the handling time of the destination stops within an opening interval of the action points to be added. If it is not possible to insert it, the trips are sorted according to the distance between the start of the handling time and the nearest opening interval and inserted in this order.

- ▶ If restriction violations are not permitted, orders will be inserted provided that the trip is still valid and, for the available successive records, no additional restrictions are violated.
- ▶ If restriction violations are permitted, a trip will firstly be sought into which the order can be inserted validly. If it is not possible to insert it there, it will be inserted into the first trip according to the sorting described above.

14.10 Macros

In PTV Route Optimiser it is possible to record sequences of commands as a macro and execute them at a later time. This could be, for example, sequences of commands that are executed by the scheduler again and again in the same sequence in order to plan orders in accordance with a certain strategy.

In principle, the macro functionality is only available in trip planning. However, not all PTV Route Optimiser functions can be used in macros. Any functions that are not available are disabled both in the ribbon and in the context menus when recording a macro.

Recorded macros are not dependent on the language and are saved independently from the planning area. In other words, all macros can be seen in all planning areas and can also be played back in all planning areas.

15 Data transfer program area

In the **Data transfer** program area, the import from the external system occurs as well as the export.

Import data can be imported using interfaces from different data formats and they are then available in the different program areas of PTV Route Optimiser. Trips and stops can be exported (see chapter 3).

Note: Depending on the planning object for which data should be imported or exported, different file formats can be processed. More information on this topic can be found in the interface description.

16 Reports and Analyses program area

In the **Reports and analyses** program area, the program item **Reports** provides a wide range of configurable information and reports. Its display and output possibilities enable additional transparency of planning and trips. These can be loaded, displayed and output using report templates. Access to pre-generated reports is also possible directly via the scheduling interface. This allows you to create more comprehensive transport documents.

16.1 SQL server reports

In PTV Route Optimiser, reports can now be displayed which are created directly via the reporting services of the Microsoft © SQL server.

The following possibilities are available:

- Create some reports on the basis of a known report design tool
- Access these reports independently of the planning area.

As a result, IDs for planning can be displayed throughout an adjustable time period. The IDs can refer to trips, vehicles or sites, for example.

Note: Special reports for selected trips can be displayed in the quick-access of the trip planning.

17 Further program areas via add-on modules

17.1 Route planning program area

With the chargeable add-on module **route planner** you activate the program area **route planning**. It can be used to calculate routes between selected stop-off points for different vehicles. Here, individual settings help bring a quick overview of distances, duration, costs and emission values as well as toll for your routes.

In addition, routes can be extensively edited. For example, points en route can be entered, alternative routes can be calculated or the route can be reversed. Route planning can be adapted to individual requirements by selecting a routing profile or activating truck attributes.

17.2 Contract partners program area

With the chargeable add-on module **Cargo** you activate the program area **contract partner**. This module allows hauliers to be created and assigned to trips. An individual freight tariff can be administered for each forwarder and subsequently used to calculate the exact freight costs. This allows both simple distance- and quantity-based structures and complex variations with different surcharges to be modelled. The following functions are available:

- ▶ Create and manage forwarders
- ▶ Edit freight tariffs per forwarder
- ▶ Freight cost calculation for trips using assigned forwarder and freight tariff
- ▶ Freight cost comparison of forwarders to select the "most favourable" forwarder

PTV Route Optimiser uses an integrated component of our partner **LOCOM Software GmbH** to produce freight tariffs and to calculate freight costs.

18 Options in PTV Route Optimiser

PTV Route Optimiser basic settings and their program areas are selected in **Options**. Here, PTV Route Optimiser can be configured according to the requirements and thereby optimally adjusted to the operative processes in the company.

18.1 User interface options

In the **User interface** options, shortcut keys are set up and basic settings for dealing with profiles and views are managed. In addition, the exchange rates for different currencies are stored there, which can be adjusted manually. Furthermore, the display can be switched between kilometers and miles and between different quantity units and units of length (e.g. kg/pound and meter/foot). An additional trip overview window in the trip planning can be activated.

18.2 Geocoding options

In the **Geocoding** options, different display functions for geocoding are specified. The parameter set with the geocoding criteria can be edited in **Options**.

18.3 Options for the background service

In the **Background service** options, the user who uses the service and who configures the monitoring of the configuration is specified.

18.4 Password options

Under **Options**, you can enter minimum requirements for the **Password**.

18.5 Configuration of planning objects

In the **Configuration of planning objects** entry, the IDs to be used by default for the fleet are set up and the equipment is also specified. For manually created orders, criteria for a unique ID can be specified.

Assortments can be assigned to assortment groups. For assortment groups default opening hours, vehicle restrictions, and planning requirements can be entered (e.g. depot assignments, pickup and delivery times or surcharges, precombined trip numbers, etc.).

18.6 Master data options

In the **Master data** options, the different master data types are entered for the default opening hours, vehicle restrictions and planning requirements (e.g. depot assignments, pickup and delivery times or surcharges as well as precombined trip numbers, etc.).

18.7 Preplanning options

Preplanning can be activated as a planning prerequisite with different requirements. Settings and rules for the task field allocation and groupage order formation can be made here.

18.8 Change management options

In the options for change management, you can define what should happen during an order update with orders if these are already planned in advance or in trips or already in trips in execution.

18.9 Planning requirements options

In the **Planning requirements** options you can configure limit values, restrictions, times, service classes and opening hours tolerance. For example, the max. trip duration or max. number of orders per trip can be specified. Restrictions can be activated or deactivated.

18.10 Planning procedure options

In the **Planning procedure** options, the calculation procedure for trip planning is selected. Different basic settings about the planning procedure can be configured (e.g. for precombined trip planning, vehicle assignment and sequence optimisation).

Using prioritisation for required planning objectives, criteria for post-optimisation can be selected.

18.11 Route planning options

In the **Route planning** options, fuel prices are stored and start settings for route planning are carried out. Parameters are also available for the toll cost calculation.

18.12 Options for data reduction

In the data reduction Options, features are available for data reduction and database maintenance. In addition to the deletion of old trip data, order data, telematics messages, vehicle versions and log entries in the PTV Route Optimiser database, older import/export data from the transfer database can also be cleaned up. A database maintenance script can also be run following data reduction. Data reduction can be executed manually or carried out automatically according to a schedule.

18.13 Options for the SQL Server Reports

In the **Options for the SQL Server Reports** you can set the URL for the Report Server and the directories for the reports on the Report Server.

19 Additional Functions of PTV Route Optimiser

Other than the functions in the program areas, PTV Route Optimiser can perform the following functions.

Address functions

Addresses can be directly entered or processed in the different program areas (e.g. in the master data or during manual post-geocoding). You can use quick search to geocode addresses. You can also move addresses in the map.

You can use the address search to apply addresses directly to route planning.

Adjust opening hours and availability times in the calendar

In a calendar, opening hours and availability times can be specified and edited.

Moving Objects

You can easily move planning objects using drag and drop. Here are a few examples:

- ▶ You can select orders in the order list and move them into an existing trip in the trip list to extend an existing trip.
- ▶ You can drag orders out of the order list and thereby remove them from a trip.
- ▶ You can change the sequence of the stop-off points in the stop-off point list using drag and drop.
- ▶ You can change the sequence of a trip within a vehicle's assignment chain.

Keystroke combinations

To enable efficient controls, many functions can be implemented using keyboard shortcuts. The keyboard shortcuts are set up in Options.

Calculation of distance matrix

The planning algorithms of PTV Route Optimiser are being supplied with information from the distance matrix (dima) during optimisation. When using dynamic distance matrices, driving times and distances between all stops and the depot during the start of each planning session are calculated and saved. If addresses are repeated in the plan, this data is only newly calculated if the details on speed or route-time ratio have changed.

The calculation of distance matrices is based on search graphs (Car and Truck) that are pre-calculated according to the used map and the routing profile and that must be available in PTV Route Optimiser.

Order and trip quick search

With the order and trip quick search, you can use the unique identifiers of orders and trips to search for them in the PTV Route Optimiser ST database or the PTV Transfer database and show them in PTV Route Optimiser ST. The order and trip quick search displays information, so you can quickly identify in which trip and on which day a particular order was planned without leaving your current planning period. The objects found cannot be changed, planned or deleted.

20 Add-on modules

You can use the following add-on modules together with PTV Route Optimiser ST:

- ▶ **Multi-User**
Allows multiple users to access one database.
- ▶ **Route planner**
Allows free, non-order-dependent routing between the chosen stop-off points (see chapter 18.1).
- ▶ **Cargo (Freight cost calculation)**
Allows calculation of freight and transport costs (see chapter 18.2).

21 System requirements

The hardware and system software requirements for using PTV Route Optimiser ST are reduced to a minimum due to the usage of the hosting variant.

To establish a connection to the hosting platform, computers with standard equipment (incl. mouse) and installed Citrix workspace app must be available.

An internet connection with an available bandwidth of minimum 2 Mbit/s per user is required to achieve a stable and performant use of the hosting service.

The usage of two or more screens is supported.

Access to PTV TransferDB is permitted via SSL.

22 System Limits

Note: System limits for PTV Route Optimiser are not static for many parameters. Instead they are substantially the result of the type and size of the planning problem or the image and configuration of the planning processes.

Element / property	Max. values / recommendations
Planning horizon duration	Average 14 days. Longer planning horizons are possible. The planning horizon depends on the data availability from the planning objects and of the type and size of the planning problem.
Number of plannable single orders in an optimisation request	Recommended are up to 5,000 orders per planning.
Number of opening intervals for orders per day	5
Number of order quantities	10 Three quantity amounts are provided by the system (weight, volume, loading metre). Seven additional quantities are available for selection.
Number of handling time classes	99
Number of assignments per vehicle	20
Number of trips	We recommend up to 2000 trips per planning.
Orders per groupage order	500
Number of sites (stops and depots) in the distance matrix	32.700
Search graphs	Two search graphs are available, one with speed profile "Car" and one with speed profile "Truck".



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