# PTV GROUP

# Performance description

# PTV Route Optimiser ST 2022.1

# Document information

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# Contents

# 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
- Comparison of planned trips and trips actually carried out
- 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 $CO_2$ 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
- Standalone solution or multi-user system that makes cooperative trip planning of several subsidiaries or employees possible
- Configuration that is flexible and user-oriented
- Optional additional web-based tool for viewing and monitoring trips
- Notification of planned arrival times to the customers (chargeable add-on module Notification, see chapter 22).
- Monitoring the trips during implementation by connection of the telematics service provider (chargeable add-on module Telematic, see chapter 22).

# 2    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.

The following can also be installed to the map:

- Search graphs for quick calculation of distance matrices.
- 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.
- The separate Road Editor add-on module allows you to close selected sections of road on the map grid.
- $CO_2$ emission calculation according to different standards (HBEFA 3.x only for Europa City map)
- It is possible to limit the distance calculation to certain countries and exclude the remaining countries from the transit.

# 3      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)
- Dutch
- French
- Italian
- Polish
- Portuguese
- Spanish

# 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, in PTV DSC format as well as via the PTV TransferDB. Vehicle data are imported in Microsoft® Excel format and via the PTV TransferDB.

Order data can be imported and exported using the SAP IDoc interface using the additional module SAP Interface. This generally requires individual adjustments.

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 can be set up as a Microsoft® Windows service that will then automatically import 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.

Note: There are separate import and export interfaces available for exchanging telematics data between PTV Route Optimiser and the respective telematics system. More information can be found in the "Telematics" interface description.

# 5      Overview of the program areas

In PTV Route Optimiser the following program areas are available:

- User management
- Master data
- Additional data
- Address management
- 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
  - Plan/Actual comparison
- 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. You can alternatively use users from the Active Directory or the Windows domain.

# 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    Additional data program area

## 8.1    Traffic conditions program item

In the program area **Additional data** > program item **Traffic situations**, areas can be defined on the map in which areas are to be planned at certain times of the day with changed travel times.

The modified travel times are used for deliveries and pickups in the defined areas in accordance with their time window, but not for a mere drive through the area. The function is especially suited for small-case plannings in urban regions.

# 9       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.

## 9.1      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.

## 9.2      Motor vehicles and trailers program items

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

## 9.3      Combinations program item

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

## 9.4      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 relevant for the emissions calculation, such as engine capacity, emission class, number of axles and vehicle dimensions, are also defined here.

## 9.5     End devices program item

The **Telematics** add-on module includes the **End devices** program item. This is where the vehicle devices (OBUs) of the telematics service provider are created and managed. These end devices are assigned to vehicles in the **Motor vehicles** program item, in the **End device** tab.

End devices can also be assigned to drivers in the **Driver management** program area.

# 10    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. End devices are assigned to drivers using the **End device** tab.

# 11 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.

# 12    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.

# 13    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.

## 13.1    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.

## 13.2    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.

## 13.3    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.

## 13.4    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.

## 13.5    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).

# 14 Planning management program area

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

## 14.1 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 15.4)
- 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.

# 15      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.

## 15.1      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.

## 15.2      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:
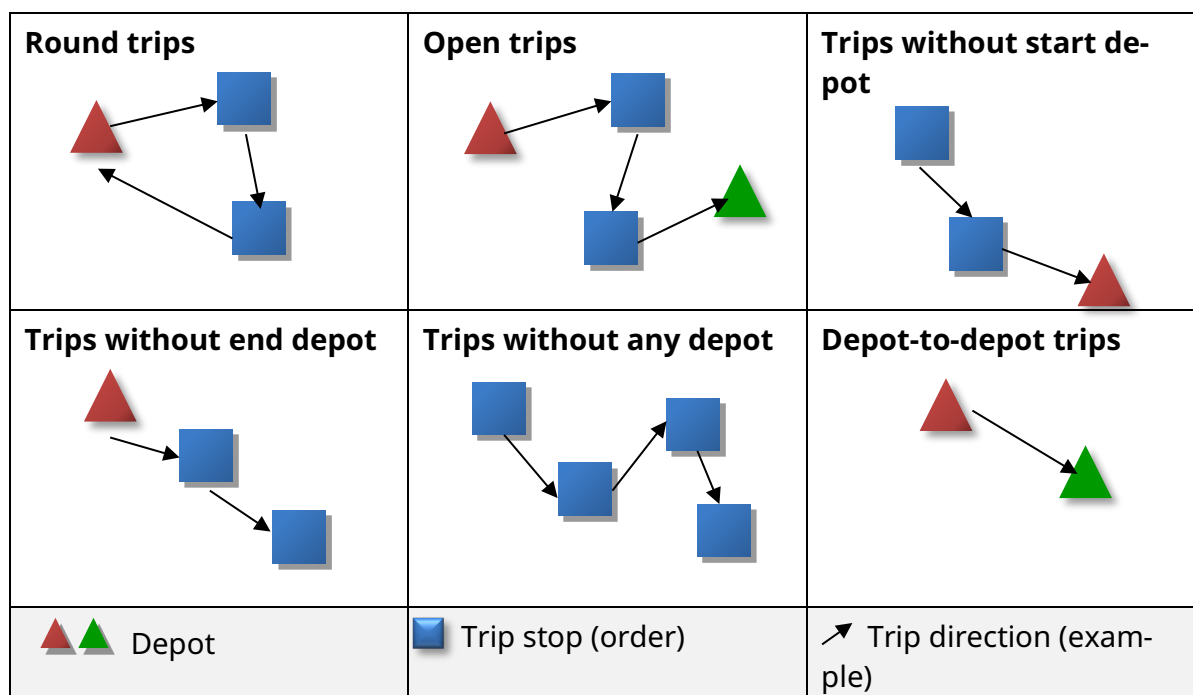


Figure 1:       Trip structures in PTV Route Optimiser

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.



**Vehicle location included in round trip(s) calculation**

| ▲ Depot | 🟦 Trip stop | 🟡 Vehicle location | ↗ Trip direction | ⬈ Arrival and departure |
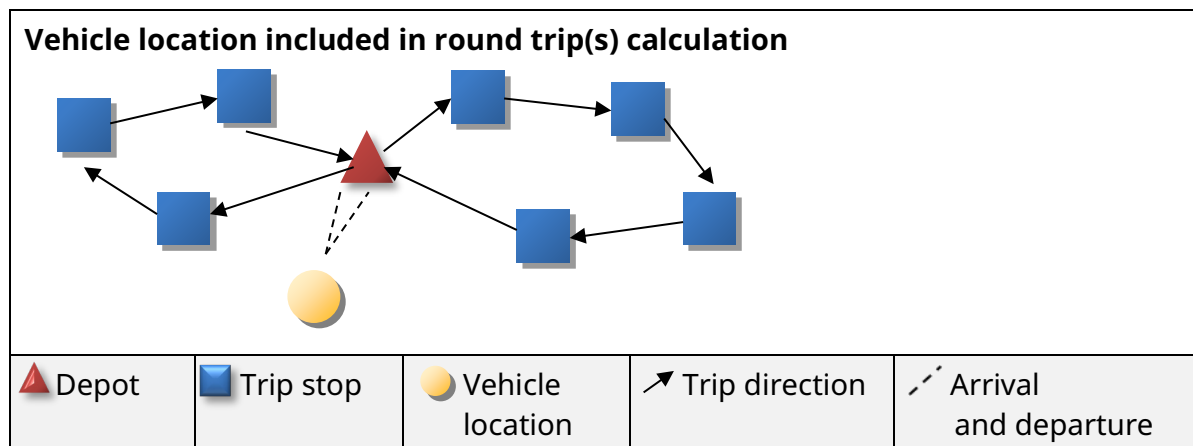
Figure 2:        Example: PTV Route Optimiser includes the vehicle location in the trip structure

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

- Change information (when, who)
- Plan cost specification
- 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.

## 15.3    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).

### 15.3.1    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.

### 15.3.2    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

### 15.3.3　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.

### 15.3.4　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.

## 15.4　Planning period

Two types of planning period are available in trip planning.

### 15.4.1　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.

### 15.4.2　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.

## 15.5    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).

## 15.6    Planning scenarios

PTV Route Optimiser allows you to work with different scenarios per planning area. For this, scenarios can be created and saved out of operative planning situations. This, for example, enables the user to develop alternative solutions with other general conditions or changed parameters.

Scenarios can be compared with each other or with the operative planning situation using key figures. Changes made to order data or planning objects (e.g. vehicles or depots) have an impact on the operational planning situation. These changes are not managed in scenarios. It is not possible to reuse a scenario in operational planning.

## 15.7    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.

### 15.7.1    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.

### 15.7.2    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 preconfigured 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.

### 15.7.3    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.

### 15.7.4    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.

### 15.7.5    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.

### 15.7.6    Assignment optimisation

With PTV Route Optimiser, an assignment optimisation for the vehicles can be made after-wards 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.

### 15.7.7    Post-optimisation

For the automatic planning procedure, Post-optimisation provides a tool for the improve-ment 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 im-prove 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

### 15.7.8   Sequence optimisation with soft time slots

For use cases in which a high order backlog coincides with narrow time slots and potentially insufficient vehicle resources, the sequence optimisation with soft time slots function is available. Customers and their opening hours are the priority in this process. If a trip already has various time violations through manual planning, this function can be used to reduce the number of time slot violations or make sure the trip is valid again.

The function focuses on maintaining time slots. Other restrictions are not checked, but any other violations will be shown subsequently.

### 15.7.9   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.

## 15.8   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.

### 15.8.1   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
- Reverse sequence of customer stops in the trip

## 15.9    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.

## 15.10    Territory planning functions in trip planning

There are three use cases which can be resolved using PTV Route Optimiser.

### 15.10.1  Plan trip territories from scratch

Based on the current orders the trip territory planning can provide a basis for spatially compact trips with an evenly-spread workload regarding one chosen quantity. It is then possible to plan trips in consideration of the previously planned trip territories. The assignment of the orders to their trip territories can be visualized on the map and in the order table.

### 15.10.2  Optimise depot assignment

The function **Optimise depot assignment** assigns current orders to the best fitting depot. It can be used for delivery transports and service orders where the availability of goods and services is provided for all depots. The assignment is based on spatial compactness and a relative depot capacity for a chosen quantity type (e.g service time) which can be defined for each depot.

### 15.10.3  Optimise precombined trips

You can balance precombined trips in reference to a chosen quantity type.

## 15.11    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.

## 15.12   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.

## 15.13   Integrating telematics into the planning interface

About the chargeable add-on module extensively supports PTV Route Optimiser telematics applications and integrates them directly into the planning interface. So switching between programs is no longer required. Using the telematics export interface, you can transfer scheduled trips to the telematics system and directly to the vehicle. Planned trips can be transferred to the telematics system via the telematics export interface and directly into the vehicle, enabling direct communication between driver and schedulers.The automatic telematics import function allows you to use the trip execution data of the telematics application in trip planning. This gives schedulers using PTV Route Optimiser an overview of everything: trip planning, vehicle location, order delivery status or any delays and effects on current trip planning.

Note: Depending on the telematics system used, interface compatibility between the PTV Route Optimiser telematics interface and the relevant provider must be enabled.

## 15.14   Send trips from PTV Route Optimiser to PTV Navigator

PTV Navigator can be operated as a telematics provider in PTV Route Optimiser. PTV Navigator carries out the navigation to the trip stops on the trip. There is currently no way to provide information on the current position of the vehicle or on the status of the trip stops.

The telematics provider must be configured and an end device which uses PTV Navigator as a provider must be assigned to the vehicle.

A trip is sent like for the other providers. A trip must be approved and then sent by clicking on the context menu or the ribbon.

Note: PTV Navigator must be active when sending the trip in order for the trip stop-off point list to be displayed on the end device.

## 15.15   ETA monitoring with PTV Drive&Arrive

About the chargeable connection to **PTV Drive&Arrive**, PTV Route Optimiser supports ETA (**E**stimated **T**ime of **A**rrival) monitoring for stop-off points. In addition, dispatchers can register trips in **PTV Drive&Arrive** and send web links for monitoring stop-off point ETAs to customers and drivers by e-mail.

Note: An access key (token) is required to use **PTV Drive&Arrive**, which can be purchased separately.

A pre-configured **PTV Arrival board** is also supported.

## 15.16   Notification of arrival times

PTV Route Optimiser supports the notification of planned arrival times via the **Notification** module, which is subject to license.

The shown information, the language, the accuracy, the type of communication (SMS or email) and the layout can be configured individually. The notification can be activated manually for selected trips by the planner. Late arrivals can also be notified.

Together with PTV Drive&Arrive an additional automatic notification shortly before the arrival at the customer can be initiated. Different templates can be used for manual notification using configurable rules per language.

## 15.17   Using PTV Driver App as a telematics end device

The PTV Driver App can be used as a PTV Route Optimiser end device. The PTV Driver App is connected as an end device as a standard telematics provider would be. When using the provider, there are no differences to the existing providers, except that the end device must be assigned to a driver and not a vehicle.

The telematics provider must be configured and an end device which uses the PTV Driver App as a provider must be assigned to the driver.

A trip is sent as it would be for any other provider. A trip must be released and can then be sent by clicking on the context menu or the ribbon. It will be sent to the email address on file for the driver.

# 16    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 4).

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.

# 17    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.

Note: With the program item **Analysis** (beta version), different planning and trip data can be selected, compiled in a pivot table and clearly displayed in a diagram. This function does not have product status yet and is not part of the delivery licence.

## 17.1    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.

# 18 System program area

In the **System** program area you can access information on the version of the database model and on the database update.

# 19 Further program areas via add-on modules

## 19.1 **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.

## 19.2 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 Siemens Digital Logistics GmbH to produce freight tariffs and to calculate freight costs.

## 19.3 Plan/Actual comparison program area

The chargeable add-on module Plan/Actual comparison allows a direct comparison of planned trips with trips that are actually carried out. Telematics messages from an OBU are required to generate actual trips so that the comparison can be made.

## 19.4     Area Management program area

With the additional module area management you can create or import geographical areas on the map and assign planning relevant restrictions and specifications to these areas. These apply in trip planning for all delivery and pickup points located in the area.

- For this purpose, own geographical areas can be defined in the map. Alternatively, areas can be imported from a "shapefile" with WGS 84 coordinates.
- If required, attributes for an area can only be defined for certain weekdays and weeks.

# 20 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.

## 20.1 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.

## 20.2 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.

## 20.3 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.

## 20.4 Password options

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

## 20.5 Options for SAP Remote Function Call (RFC)

In the options you can configure the server and the SAP Target System.

## 20.6 Configuration of planning objects

In the C**onfiguration 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.).

## 20.7 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.).

## 20.8 Address management options

If the **Address management** add-on module is licensed then parameters can be set relating to the radius search, the search by address spelling and the handling of unassigned addresses.

## 20.9 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.

## 20.10 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.

## 20.11 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.

## 20.12 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.

## 20.13 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 and the toll update.

## 20.14   Telematics options

Under **Telematics** options, you specify settings for communication with the telematics service. The telematics connection is an optional add-on module.

PTV Route Optimiser currently supports the telematics providers TomTom® and Trimble in addition to the PTV XML interface and the connection to the PTV Navigator and PTV Driver App. Also the central service TelematicService is supported, which enables the intergration of additional providers (e.g. ®Teletrac Navman).

## 20.15   Options for the communication service and notification.

E-mail provider data, SMS provider data and user access data for communication service are available under **Options** in **Communication Service Settings**. These settings for sending e-mails and SMS are required for sending notification messages to the customer.

In the Options settings for the Notification, various parameters are configurable as the language, accuracy, notification time window, timetable and the template for the notification message to the customer.

## 20.16   Options for PTV Drive&Arrive

The access key (token), required for using **PTV Drive&Arrive**, can be stored under **Options** for **PTV Drive&Arrive**.

## 20.17   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.

## 20.18   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.

# 21    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. In the process, the program either works with a pre-calculated reference distance matrix or with dynamic distance matrices.

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 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.

## Connecting PTV Drive&Arrive

Connecting **PTV Route Optimiser** to **PTV Drive&Arrive** enables arrival times (ETA) for stop-off points to be monitored and a corresponding web link for the current forecast ETA times to be sent by e-mail or SMS to customers and drivers. A pre-configured PTV arrival board is also supported.

# 22    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.

➡ **Historical traffic data** (Routing with historical traffic data)

Allows avoiding foreseeable disturbances and traffic jams.

➡ **SAP- interface**

Allows you to import and export order data and locations using the SAP IDoc interface.

➡ **Telematics function**

Note: The add-on module is available in two versions "Send tours" and "Send and receive tours and status messages".

Integrates telematics applications directly into the planning interface and speed up communication between driver and dispatcher (see Chapter 15.13).

➡ **Notification** (Notify Messaging Service)

Note: The add-on module is available in two versions "without ETA service" and "with ETA service".

Allows the notification of planned arrival times. The information displayed in the notification and the layout can be configured individually (see chapter 14.16).

➡ **Route planner**

Allows free, non-order-dependent routing between the chosen stop-off points (see chapter 19.1).

➡ **Cargo** (Freight cost calculation)

Allows calculation of freight and transport costs (see chapter 19.2).

➡ **Road-Editor** (as a separate application)

Allows route sections to be blocked in the map network.

➡ **Trip Display** (HTML-Tourviewer)

Visualizes the data and results from trip planning via a web browser in the company network. The installation of a PTV Route Optimiser ST is not necessary.

➡ **Multi Dima**

Allows you to create your own routing and speed profiles for different vehicle types, such as HGVs and small vans.

➡ **Plan/Actual comparison**

Enables direct comparison between the planned trips and the trips actually carried out (see chapter 19.3.).

# 23      System requirements

The hardware system requirements for trip planning tools are very due to the many components and computationally intensive algorithms they use.

For more detailed information about the hardware and system software requirements, please see the "System Requirements" document.

# 24    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. Higher values are possible with adjusted system requirements.<br>Maximum number of orders in trip planning: 20.000. |
| Number of orders in the programme area Order management. | Maximum of 50.000 |
| Number of sites in the programme area Master data | Maximum of 50.000 |
| Number of opening intervals for orders per day | 5 |
| Number of handling time classes | 99 |
| Number of order quantities | 10<br>Three quantity amounts are provided by the system (weight, volume, loading metre). Seven additional quantities are available for selection. |
| Number of assignments per vehicle | 20 |
| Number of trips | 2000 trips per planning |
| Orders per groupage order | 500 |
| Number of sites (stops and depots) in the distance matrix | 32.700 |
| Number of objects in the programme area Plan/actual comparison | Max. Number of vehicle messages: 200.000<br>Max. Number of trips: 1.000 |

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