



D 4.7

Simulation of road user behaviour and interactions

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Prepared by: **Peter Sukennik**

Checked by: **Inga Luchmann**

Verified by: **Jochen Lohmiller**

Paulo Anciaes

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1 Introduction

The task of (re-)designing urban streets is on the agenda, but it is highly context dependent. Therefore, there is no standard solution for a modern, sustainable street space allocation. Different design options might be considered. Before implementing costly infrastructure projects, it makes sense to test and validate the different measures for the reallocation of street space in a virtual environment. Models can help to realistically simulate and analyse a city's current and future traffic and run through different what-if scenarios.

Simulation by PTV Vissim (<https://link.edgepilot.com/s/c261e808/7unV5RXPfkmxYO08W0YAZQ?u=https://www.ptvgroup.com/en/solutions/products/ptv-vissim>) gives a realistic and detailed overview about the status quo of the traffic flow and impacts, with the possibilities to define multiple what-if scenarios. Simulations assess how traffic flows and street-based activities perform under particular design and infrastructure options through various measures. Vissim supports the selection of an optimal and tailor-made design solution.

The extension of the existing PTV Vissim microscopic traffic simulation software allows an easier and more realistic simulation of the multimodal traffic flows as well as quicker comprehensive evaluations. It addresses the cities' needs of simulating multimodal transport and interaction on the street, at the kerbside, in the stopping and loading areas as well as in the squares.

This deliverable involves an extension of the existing PTV Vissim microscopic traffic simulation software, to better represent the presence and influence of:

- kerbside activities (parking, loading, etc.),
- place-activities on the footways (pedestrians chatting, resting, window shopping, etc.),
- interactions between motor vehicles and pedestrian crossing the road (at both formal and informal crossing points), and
- the impacts of new technologies, such as automated road vehicles on the footway.

The model will provide outputs in the form of the Key Performance Indicators (KPIs) identified in MORE Task 1.4 and will be used to help in simulating the impacts of different dynamic road-space allocation strategies.

Since this is not a completely new tool, but an extension of an existing software tool, only innovations and changes are described in detail in this document.

2 Aim of PTV Vissim and PTV Viswalk

The aim of the tool (i.e. the extension to the existing PTV Vissim software) is to provide microsimulation-based evaluation of road use in the base situation and scenarios with different measures and/or design changes in individual use-cases.

PTV Vissim is the leading microscopic simulation program for modelling multimodal transport operations and belongs to the Vision Traffic Suite software. Realistic and accurate in every detail, Vissim allows the testing of different traffic scenarios before their realization. Vissim is now being used worldwide by the public sector, consulting firms and universities. In addition to the simulation of the movement of motorised vehicles, based on the Wiedemann car following model¹, PTV Vissim can be used to perform simulations of pedestrian and cycle movement.

PTV Viswalk is the leading software for pedestrian simulation. Based on Helbing's Social Force Model², it reproduces the human walking behaviour realistically and reliably. The software is used to simulate and analyse pedestrian flows, outdoors or indoors. Viswalk is used by traffic planners and traffic consultants, architects and owners of publicly accessible properties, event managers and fire safety officers. However, motorised vehicle flows cannot be simulated using PTV Viswalk alone. To simulate vehicle and pedestrian flows, Vissim requires the add-on module PTV Viswalk. The user can then choose to use the Helbing or Wiedemann modelling approach.

¹ Wiedemann, R (1974) Simulation des Straßenverkehrsflusses. Schriftenreihe des IfV, 8, 1974. Institut für Verkehrswesen. Universität Karlsruhe. [In German].

² Helbing, D., Molnar, P. (1988) Social force model for pedestrian dynamics. *Physical Review* **E51**, 4282-4286.

3 Structure of PTV Vissim

PTV Vissim and PTV Viswalk offer graphic user interfaces which are adjustable by the modeller (Figure 1). The modelling process is realised in a 2D network editor. The basic transport network is based on a flexible link-connector structure. A 3D editor is used for visualization, video making and static 3D-object editing. Several 3D models for vehicles and pedestrian are available within the installations. Additional models can be imported from Sketch-Up software or created by using the V3D modeller.

For a detailed description of the software see the manual (available within the installation) or the [online help](#).

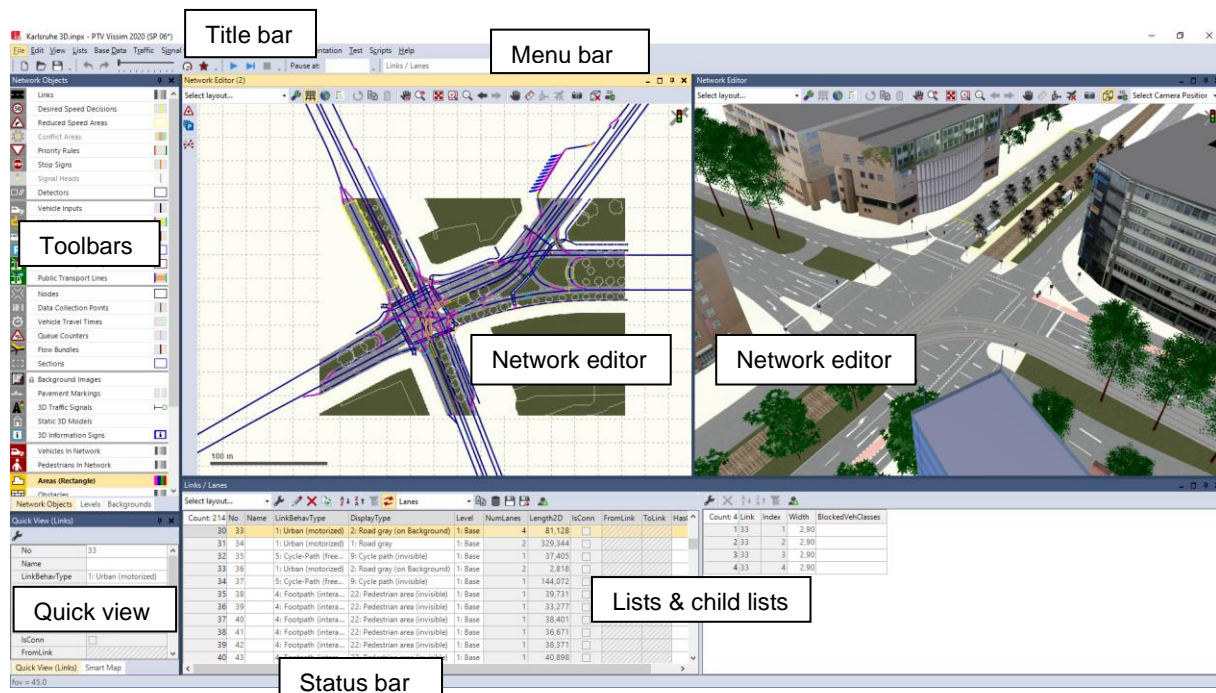


Figure 1 PTV Vissim user interface

PTV Vissim is a desktop application running under Microsoft Windows OS, a Linux kernel is offered as well. Advanced simulation of pedestrians is available within Viswalk add-on module for PTV Vissim, or as standalone version called PTV Viswalk.

The working PTV Vissim versions for the MORE project are as follows:

- The version 2020, available since 8/2019 as beta version and since 10/2019 as a release version.
- The version 2021, available since 8/2020 as a beta version, since 10/2020 as a release version and exclusively available to the project members before its beta/release.
- The version 2022 available since 8/2021 as a beta version, since 10/2021 as a release version.

A demo version of PTV Vissim software can be obtained from
<https://www.ptvgroup.com/en/solutions/products/ptv-vissim/demo-version/>

This version offers limited functionality and specific terms of use.

PTV Vissim software is available under special license conditions for the academic world.

4 New Features and technical enhancements of PTV Vissim

4.1 Pre-development survey to MORE city partners

As part of MORE Task 4.3, PTV and UCL conducted a pre-development survey in order to identify the relevance and importance of a set of proposed features for further development. A pool of possible new features was provided by PTV to the MORE city partners (Budapest, Constanta, Lisbon, London, and Malmo). The cities' responses have been evaluated on the basis of stated importance, as shown in the table below:

Functionality	Degree of importance				Importance & Frequency (1 = high, 4 low importance)				
	VERY	FAIRLY	SLIGHT	NONE	1	2	3	4	Score
V1: Adding ITS Functionality	Budapest Constanta	Lisbon London Malmo			2	3			1.6
V2: Major flow definition at intersections	Constanta Malmo	Budapest Lisbon	London		2	2	1		1.8
V3: Add overtaking in the on-coming lane when traffic free		Constanta	Budapest Lisbon London Malmo			1	4		2.8
V4: Time distributions for pedestrians boarding times, unloading, etc.	Budapest Constanta		Lisbon Malmo	London	2		2	1	2.4
V5: Improved simulation of parking and loading	Budapest Malmo	Lisbon Constanta	London		2	2	1		1.8
V6: Improvements to pedestrian/vehicle interaction	Lisbon Constanta London Malmo	Budapest			4	1			1.2
V7: Simulation of footway activities		Budapest	Lisbon Constanta Malmo	London		1	3	1	3
V8: Automatic generation of footways when creating new links	Lisbon	Budapest Constanta	Malmo	London	1	2	1	1	2.4
V9: New algorithm for pedestrian navigation through large areas		Lisbon Constanta London Malmo	Budapest			4	1		2.2
V10: New types of output variables from the simulations	Constanta London Malmo	Budapest			3	1			1.25

Table 1 Pre-development survey

PTV addressed the feature ideas in the following way:

- V1: ITS tools implemented (See Section 4.2.1)
- V2: Major flow definition implemented (Section 4.2.4)
- V3: Automatic overtaking not implemented (low importance)
- V4: Pedestrian delays implemented (Section 4.2.5)
- V5: Improvements for parking implemented with car park creator (Section 0)
- V6: Pedestrian-Vehicle interactions implemented on technical level (faster simulation of shared space areas with dynamic potential)
- V7: Footway activities not implemented (low importance)
- V8: Automatic footways not implemented (low importance)
- V9: New navigation algorithms not implemented (low importance)
- V10: New output attributes implemented with new parking evaluations (Section 4.4.4)

The questionnaire was completed by the Vissim experts of the MORE cities, who were in the main thinking about improvements to enhance their ability to model current road scheme designs. MORE is placing a greater emphasis on the ‘Place’ aspects of the street than has traditionally been the case, so the final set of improvements (Vissim 2021) is also including kerbside and street activity enhancements.

Besides the feature ideas included into the survey, PTV developed additional features and technical enhancements which are relevant also for the MORE use cases (e.g. lane specific driving behaviour or COVID-based distancing for pedestrians).

4.2 Developments & technical enhancements – Phase I

The features listed below have been added to the PTV Vissim 2020 version and can be used in city models and corridor models within a city.

4.2.1 In-build Intelligent Transport System (ITS) tools

ITS tools are designed to allow simple and quick modelling of basic intelligent transportation systems. No scripting is needed, just a few clicks for object placement and setting necessary parameters. This allows quick simulation tests of such ITS without the need for detailed preparation. If more complex signal control programs are needed, these can be modelled as usually using existing VAP controller (flow-chart-based Vehicle Actuated Programming) or an external signal controller connected with PTV Vissim (several options are available).

a) Pedestrian crossing

This feature (Figures 2 and 3) enables the user to create simple traffic-actuated signal controls of the Pedestrian Crossing type without having to script the necessary run control. In other words, the signal controller will switch to green light for pedestrians (and/or cyclists) only if demand is detected and a minimum defined green time for road traffic was provided. PTV Vissim creates automatically all necessary objects (detectors and signal heads).

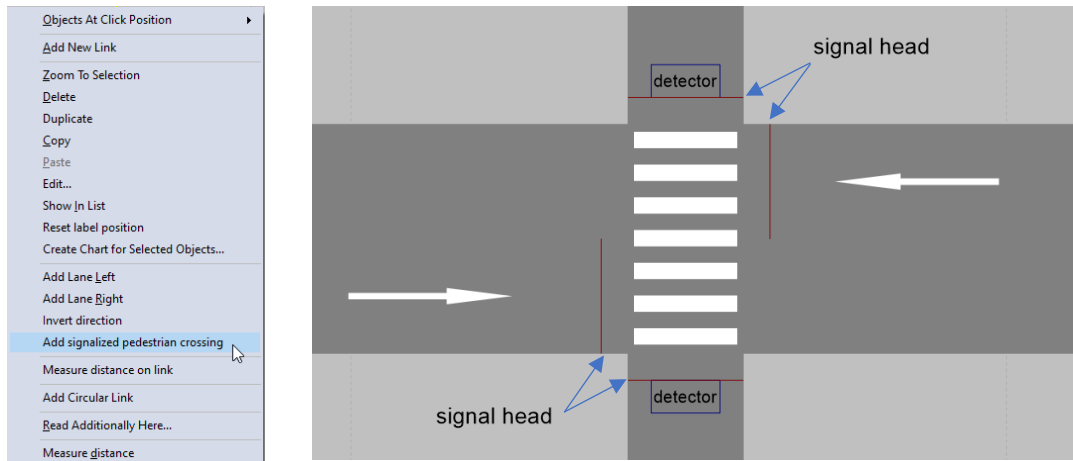


Figure 2 Left: Link context menu with the command; Right: Objects placed automatically for pedestrian crossing (detectors and signal heads)

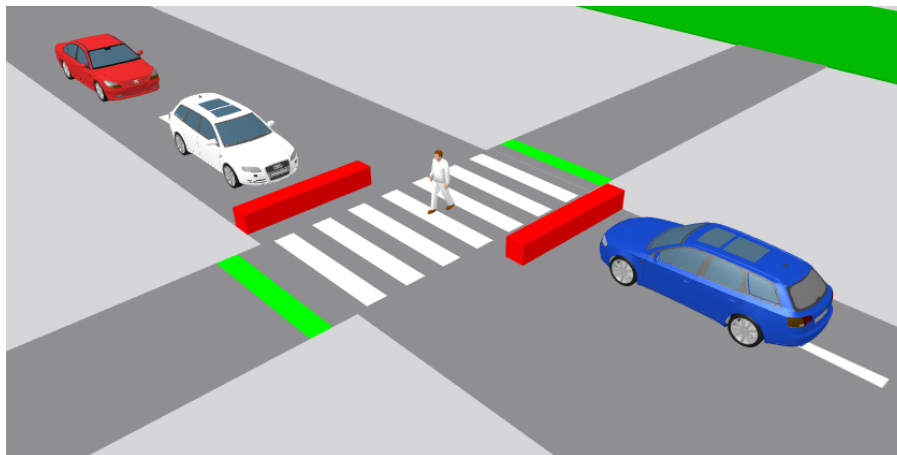


Figure 3 Visualisation of the pedestrian crossing

b) Two-stage controller

This feature (Figures 4 and 5) allows the user to create a simple traffic-actuated control system for controlling traffic at an intersection between roads with major and minor traffic flows, without having to script the required run control. Vissim allocates two signal groups of the type “Standard” and a defined signal sequence to the signal control of the type Two-Stage Controller. In other words, vehicles on the minor road get green signal only if there is a demand and a minimum defined green time for the main flow was provided.

In the modelling process, the major flow definition tool (see chapter 4.2.4) can be used for automatic creation of all necessary objects for 2-stage signal controller (detectors and signal heads).

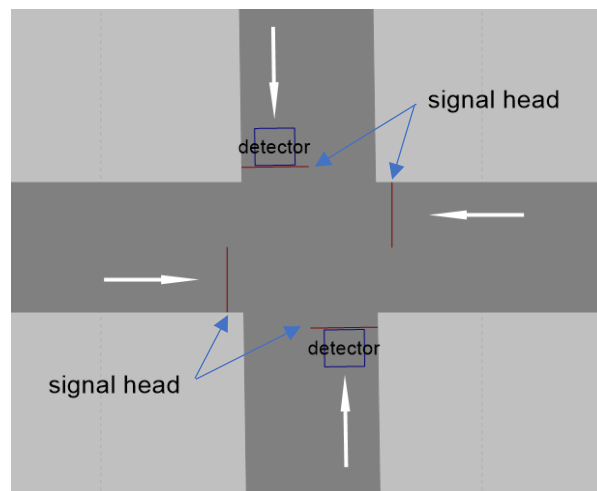


Figure 4 Objects placed automatically for two-stage controller (detectors and signal heads)

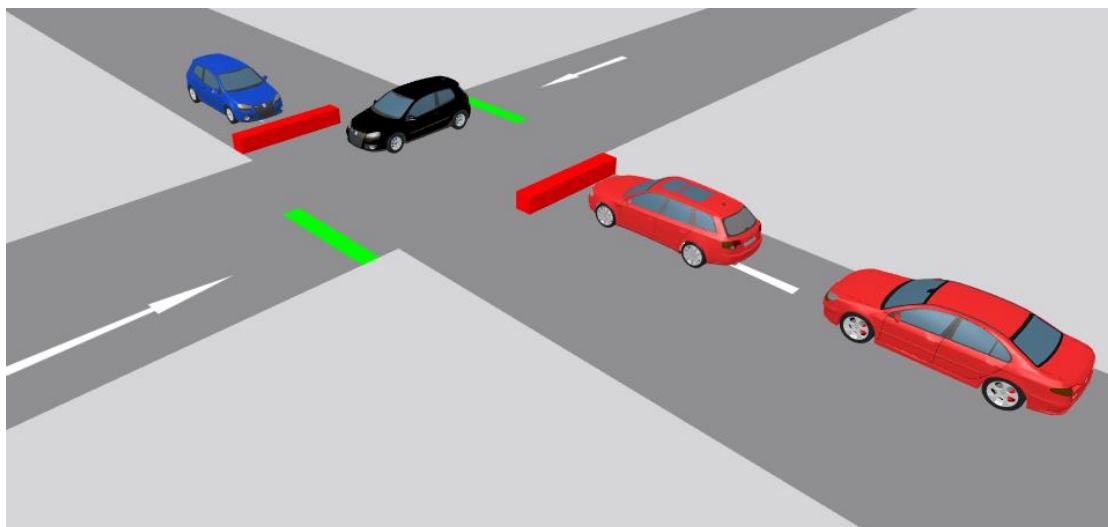


Figure 5 Visualisation of the two-stage signal controller

c) Railway crossing

This feature (Figures 6 and 7) allows the user to create a simple traffic-actuated control for any railway crossing (train or tram) without having to script the necessary run control. Vissim allocates two signal groups of the type “Standard” and a defined signal sequence to the signal control of the type Railway Crossing. In other words, a train or a tram will get a green signal on request (call) and reports when the green signal can be switched back for vehicles (check-out).



Figure 6 Objects for rail crossing controller (detectors and signal heads)

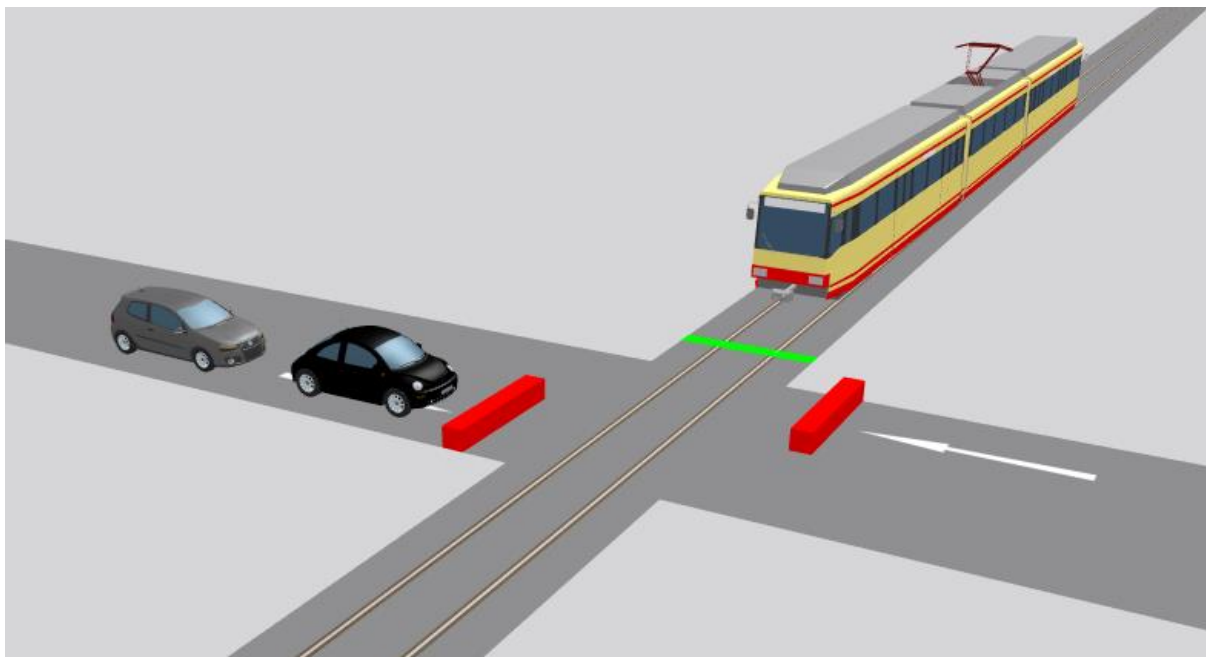


Figure 7 Visualisation of the rail crossing signal controller

4.2.2 Car park creator

This tool (Figure 8) was designed for the quick creation of parking spaces with automatic resolving of vehicle-to-vehicle conflicts around the created parking spaces. PTV Vissim automatically creates objects called “parking lots”, each one consisting of one parking space. This “parking lot” objects can be used for any type of parking (short-term, mid-term, long-term) and for loading bays or any other kerbside activities, where vehicles are stopped for a certain amount of time.

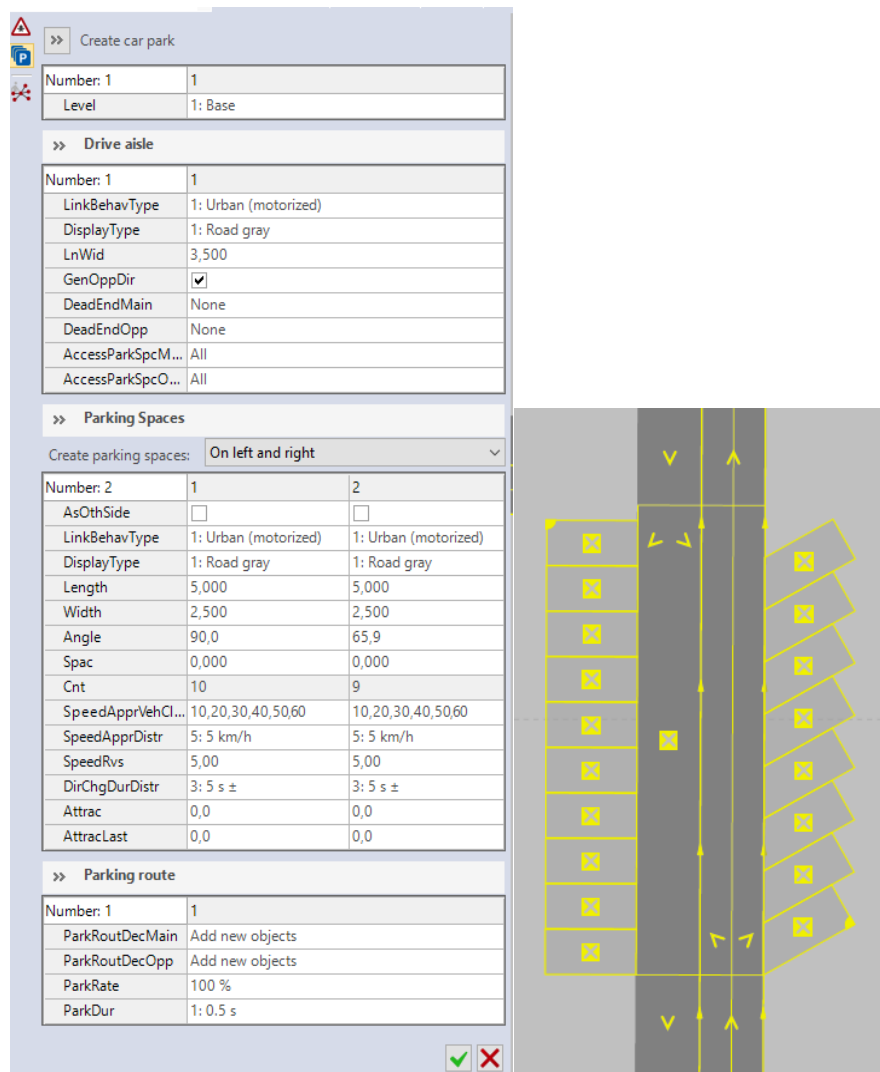


Figure 8 Car park creator tool. Left: Attributes table, right: Construction preview in the network editor

4.2.3 Lane-specific driving behaviour

This feature (Figure 9 & 10) allows the user to define individual “link behaviour type” for each traffic lane, which means that vehicles can use different driving behaviour on each lane. This allows the user to activate some special driving behaviour/parameters only for selected lane(s) (e.g. for automated vehicles, automated pods, unmanned delivery vehicles or conventional vehicles). Link behaviour types for each lane can be set through the link dialog (shown in Figure 10) or a link list with the coupled list and selecting “lanes”.

Count	No	Name	LinkBehavType	DisplayType	Level	NumLanes	Length2D	IsConn	Count	Link	Index	LinkBehavType	Width	BlockedVehClasses
1	1	1: Urban (mot...)	1: Road gray	1: B...	3	71,196			1	1	1	1: Urban (motorized)	3,50	
2	2	1: Urban (mot...)	1: Road gray	1: B...	1	43,896			2	1	2	6: Urban (motorized) - mod. 1	3,50	
3	3	1: Urban (mot...)	1: Road gray	1: B...	1	63,361			3	1	3	7: Urban (motorized) - mod 2	3,50	
4	4	1: Urban (mot...)	1: Road gray	1: B...	1	45,891								
5	5	1: Urban (mot...)	1: Road gray	1: B...	1	71,196								
6	6	1: Urban (mot...)	1: Road gray	1: B...	1	43,896								
7	7	1: Urban (mot...)	1: Road gray	1: B...	1	63,361								

Figure 9 Link behaviour type for lanes in the link list

Link [?] [X]

No.: Name:

Num. of lanes: Link behavior type:

Link length: 61,315 m Display type:

Level:

Lanes	Meso	Pedestrian Area	Display	Dyn. Assignment	Others				
Count: 3	Index	Width	LinkBehavType	Blocke...	Display...	NoLnC...	NoLnC...	NoLnC...	NoLnC...
1	1	3,50	1: Urban (motorized)			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
2	2	3,50	1: Urban (motorized)			<input type="checkbox"/>	<input type="checkbox"/>		
3	3	3,50	6: Urban (motorized; platooning allowed)			<input checked="" type="checkbox"/>	<input type="checkbox"/>		

Has overtaking lane

Figure 10 Link behaviour type for lanes in the link dialog

4.2.4 Major flow definition

This feature (Figure 11) allows the user to define major flow through one or several intersections by defining the start and end section. PTV Vissim automatically sets the status of conflict areas inside temporary or permanent nodes. Temporary nodes are adjustable while using the tool. Permanent nodes can be defined in advance by the modeller. Use of this tool saves modelling time. In a few special cases, where it is not possible to automatically decide about the priority in a conflict area, the status of conflict area remains undefined and the modeller can change it afterwards if needed. This tool can additionally be used for setting two-stage signal controller in an easy way (see Section 4.2.1b).

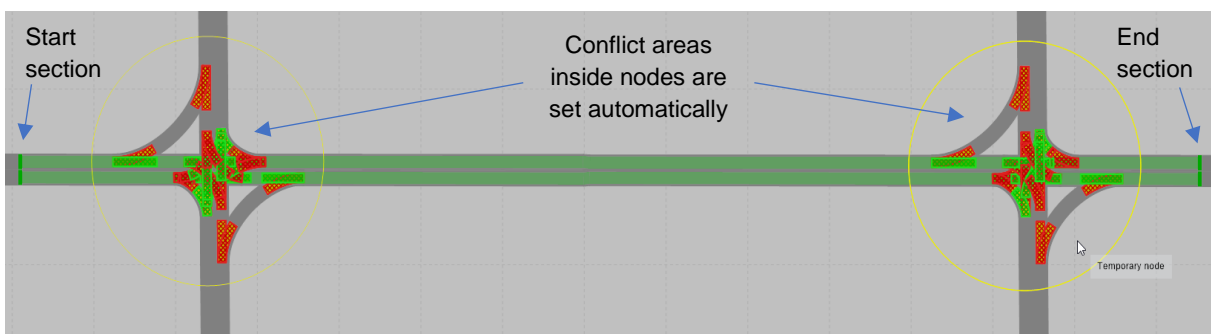


Figure 11 Major flow definition tool flyout

4.2.5 Passenger boarding delays

This feature (Figures 12-14) was designed to model the delays that pedestrians encounter when they board a public transportation vehicle. Such delays occur in reality because of:

- Crowded situations
- Passengers carrying luggage
- Passengers buying tickets from the driver

Therefore, PTV Vissim allows to define boarding delay per vehicle door depending on:

- Relative vehicle occupancy
- Pedestrian class (e.g. pedestrians with luggage, who might be assigned different levels of boarding delays, as shown in Figure 14)

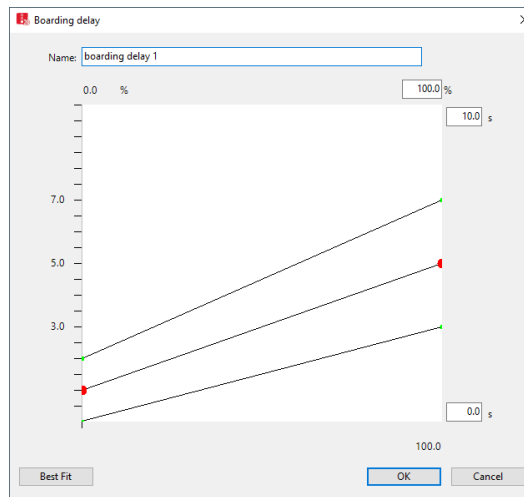


Figure 12 Definition of the function for boarding delay (x-axis = relative vehicle occupancy, y-axis = delay time). Median and boundaries are shown.

Count	Index	File3D	Count	Pos	yOffset	ZOffset	Width	Side	Usage	BoardDelType
7	1	Car - Toyota Yaris (2006).v3d	1	0,44	1,24	0,30	0,76	Right	Boarding	1: delay 1
8	1	HGV - EU 04 Tractor.v3d	2	1,20	1,24	0,30	0,76	Right	Boarding	1: delay 1
9	1	Bus - C2 Standard 2-doors.v3d	3	6,39	1,24	0,30	0,76	Right	Alighting	
10	1	Bus - C2 G 3-doors - front.v3d	4	7,15	1,24	0,30	0,76	Right	Alighting	
11	2	Bus - C2 G 3-doors - rear.v3d								

Figure 13 Assigning of a boarding delay type to a door of a public transport vehicle

Count	No	Name	Count	PedClass	BoardDelFunc	BoardDelType
1	1	1 delay 1	1	10: Man, Woman	1: boarding delay 1	2: delay 2
2	2	2 delay 2	2	40: with luggage	2: boarding delay 2	2: delay 2

Figure 14 Example of boarding delay types and assignment for pedestrian classes

4.2.6 Transparency for shapefile backgrounds

This is a technical enhancement that allows to use transparent backgrounds in Vissim 3D mode. The purpose is to enable easier transfer of design changes made in the design tool developed by Buchanan computing (MORE Task 4.2) into the PTV Vissim model and to enhance the visual impression in 3D simulation mode.

4.3 Further development survey

PTV Group conducted an online survey open for all MORE project members to quantify the importance of selected features available as development candidates. The features were selected by PTV and have very different requirements on development resources. The table below summarizes the results in form of perceived importance of the feature and the development status. Four features from the survey have been implemented, the fifth is in preparation. Two additional features have been added into the development plan and implemented later (after the survey). All other remaining features stay on the wish list and might be implemented in the future (based on future requirements from the Vissim users).

Feature	importance	status
Multi-modal trip chains for pedestrians	4,1	on wish list
"Area-resistance"	4,0	on wish list
Improvements for pedestrian behavior when crossing queued vehicles in motion	4,0	on wish list
Modeling of TAXI pick-ups (uber, lyft etc.)	4,0	on wish list
Number of stops (pedestrians) for area measurements (sections).	4,0	implemented (SP07)
PDF file formal direct as a background file in Vissim	3,6	implemented (V22)
Percentage of vehicles passing through a signalized intersection without a stop or being significantly delayed	3,4	on wish list
Relative boarding volumes at PT stops per formula.	3,3	implemented (V22)
(Automatic) conflict areas for junctions with the "right before left" rule	2,6	on wish list
Attribute decisions with formulas	2,5	implemented (V22)
Reverse parking (with automatic conflict resolving)	2,4	in development (V22)
Parking out backwards: automatic conflict resolving for multilane parking lanes	2,4	on wish list
Pedestrian-Attribut (DwellTm) as for vehicles		implemented (SP06)
The calculation of StopsAvg and StopTmAvg in the pedestrian network performance evaluation		has been fixed (SP05)
OSM-Import for Viswalk (pedestrian simulation)		on the wish list
Links as obstacles for pedestrian simulation		on the wish list

Table 2 2nd PTV Survey results and development status
(V22 = Vissim 2022 version, SP = service pack number of the Vissim 2021 version)

4.4 Developments & technical enhancements – Phase II

4.4.1 Dwell time attribute for pedestrians

New pedestrian attribute "Dwell time" was created. This contains the remaining waiting time if a pedestrian is currently waiting at the head of a queue or on an area with a waiting time distribution, and it is empty in all other cases (including when waiting on a waiting area for PT or an elevator). As long as the value is greater than zero it can be modified from a COM script or attribute modification. If it is set to zero, the pedestrian can move in the next time step.

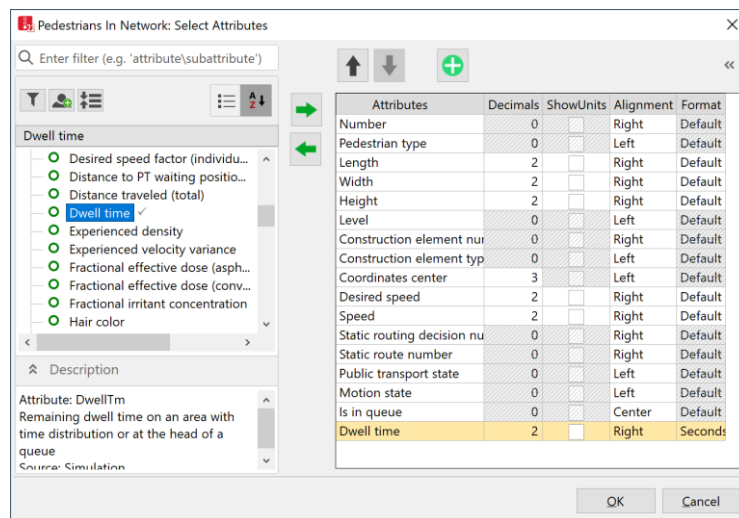


Figure 15 New pedestrian attribute "dwell time"

4.4.2 Parking in reverse

This feature is under construction until the end of 2021 and partially funded by the MORE project. Its deployment into Vissim 2022 version is expected within a service pack in Q1/2022.

Parking lots will get new values "Reverse > Forward" and "Any > Opposite" for the attribute parking direction. This allows to simulate all situation when parking in reverse is expected. Reverse parking option will be also integrated into the car-park creator, which allows to create a higher number of parking spaces very fast and easily, including all necessary objects for conflict resolution.

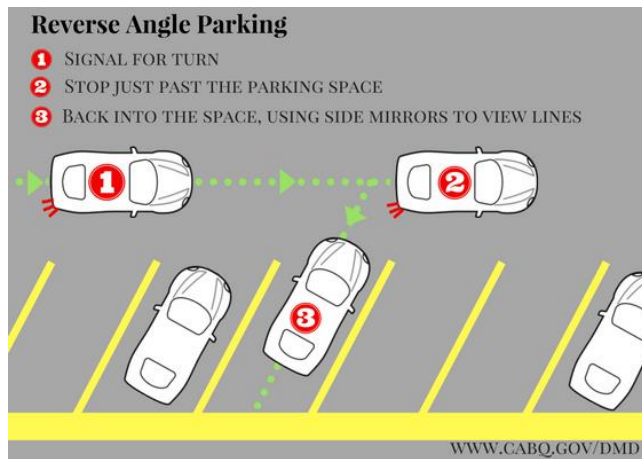


Figure 16 Illustration of reverse parking (picture left: www.cabq.gov/dmd)

Reverse parking is necessary for loading bays but in some countries or for some purposes also required for personal vehicles. Reverse parking can have impact on the road/street capacity.

4.4.3 PDF-file as background

The *.pdf files can now (since Vissim 2022) be used directly as background image objects in PTV Vissim. The user does not need to convert pdf files into other formats in order to use it in the PTV Vissim model as background.

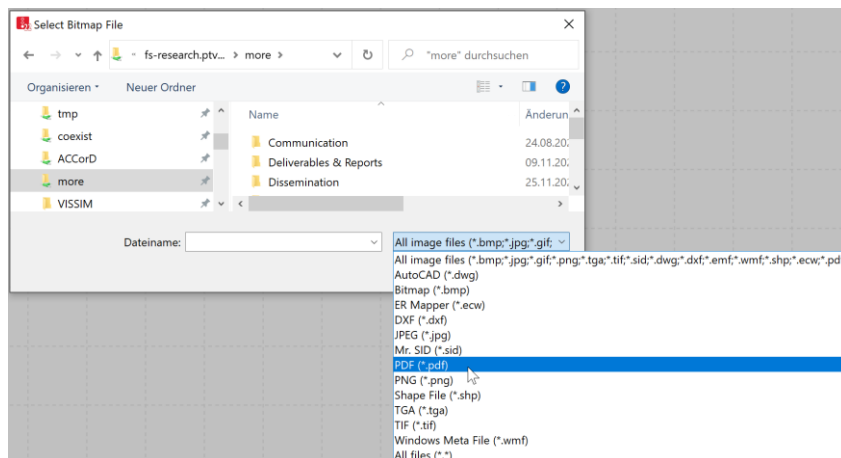


Figure 17 Pdf format available for background files

4.4.4 New evaluations for parking and loading

In PTV Vissim version 2021 (released in 2020) a comprehensive evaluation for parking objects is available (Figures 18 and 19). These objects can be used not only for parking but also for loading bays or other purposes requiring vehicle to stop for certain time. PTV Vissim distinguishes between these model objects:

- Parking space: a space for one parking vehicle
- Parking lot: incorporates one or more parking spaces.

- Parking lot group: incorporates one or several parking lots. The modeller can define the parking lot group number for each parking lot.

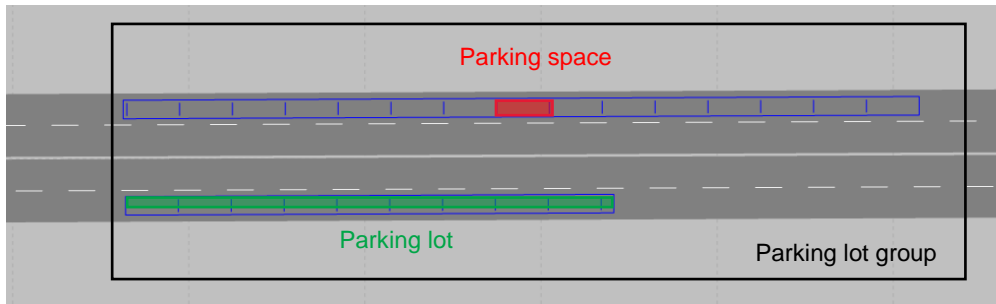


Figure 18 Parking space, parking lot and a parking lot group

Please note that the parking lot attribute “group” known from previous PTV Vissim versions (before 2021) was renamed as “destination group”.

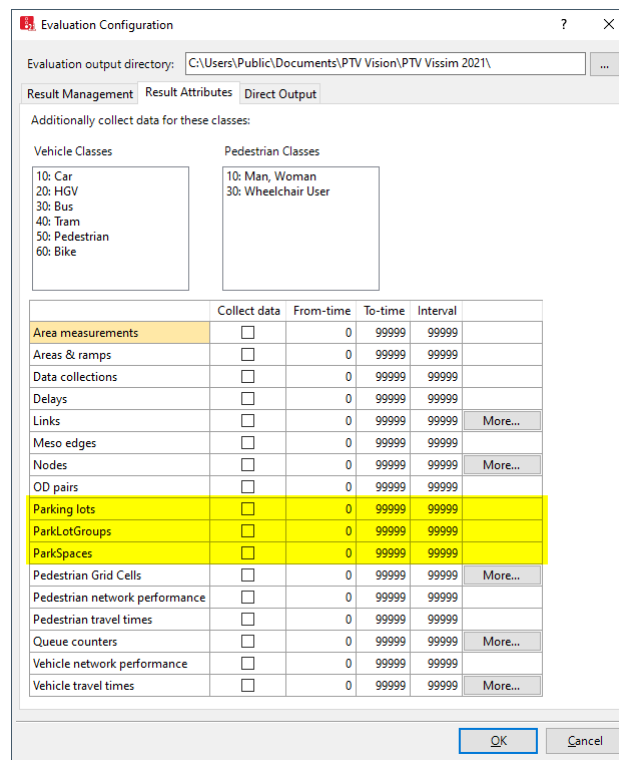


Figure 19 New evaluations available in evaluation configuration dialog

Attributes

PTV Vissim 2021 version (Figure 20) provides new attributes for:

1. Parking spaces, parking lots and parking lot groups
2. Parking routing decisions (a cross-section-based Vissim object, which assigns a specific parking route to vehicle when passing through)
3. Parking routes (not implemented yet, might be added later)
4. Vehicles

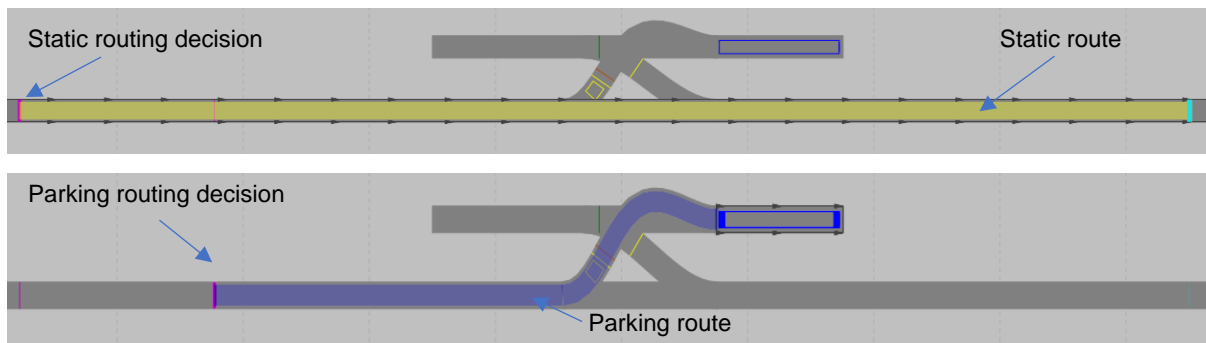


Figure 20 Example of static and parking routing decisions and routes

Evaluation attributes available for parking spaces, parking lots and parking lot groups include:

- **Number of parked vehicles**
Number of vehicles that used the parking space during the time interval.
- **Number of entering vehicles**
Number of vehicles that started a parking event during the time interval.
- **Number of leaving vehicles**
Number of vehicles that finished their parking event during the time interval, even if they could not leave the parking space, for example due to congestion.
- **Parking durations (total)**
Total duration [s] that the vehicles were parked during the time interval.
- **Parking duration (minimum)**
Minimum duration [s] that a vehicle was parked during the time interval.
- **Parking duration (maximum)**
Maximum duration [s] that a vehicle was parked during the time interval.
- **Parking duration (average)**
Average duration [s] vehicles that were parked during the time interval.

- **Utilisation rate**
Share of time interval [0..1] the parking space was occupied by parked vehicles.
- **Blocked duration while leaving parking space (total)**
Total duration [s] in the time interval the parking space was occupied by vehicles which could not leave after parking due to blocking vehicles, for example due to congestion.
- **Blocked rate of leaving vehicles**
Share of time interval [0..1] the parking space was occupied by vehicles which could not leave after their parking time due to blocking vehicles, for example due to congestion.
- **Parking fee (total)**
Total parking fees during the time interval charged for vehicles which were parked in this parking space.

Evaluation attributes for Vissim objects called “parking routing decisions” include:

- **Number of parking requests**
Vehicles request a parking route by driving over a parking routing decision.
- **Number of declined vehicles**
Vehicles that wanted to park but did not get any parking space assigned.
- **Number of accepted parking requests**
Number of vehicles that have been assigned a parking route.
- **Declined parking request rate**
Number of vehicles that have not been assigned a parking route.

Evaluation attributes for vehicles include:

- **Number of parking acts**
Total number of times the vehicle parked in a parking space.
- **Parking duration (current space)**
Parking duration [s] in current parking space.
- **Parking duration (total)**
Total duration [s] of parking in parking spaces.
- **Waiting duration for a free parking space (current)**
Duration [s] the vehicle is waiting for its currently assigned parking space to become available. If the vehicle is not waiting, the value is empty.
- **Waiting duration for a free parking space (total)**
Total duration [s] the vehicle spent waiting for its assigned parking spaces to become available.

- **Blocked duration leaving parking space (current)**
Duration [s] the vehicle is currently waiting to be able to leave its parking space due to blocking elements (e.g. congestion).
- **Blocked duration leaving parking space (total)**
Total duration [s] the vehicle waited to be able to leave parking spaces due to blocking elements (e.g. congestion).
- **Parking fee (total)**
Total parking fees of the vehicle.

Parking states

PTV Vissim 2021 provides more parking states (newly implemented) for vehicles during the simulation compared with previous versions (Figure 21). These states are important to the modeller to understand the behaviour of the vehicles in the simulation. These are the new states:

- **Parked**
Vehicle is parked.
- **Blocked while leaving parking space**
Vehicle cannot move out from the parking space because of other vehicles in the way.
- **Waiting for free parking space**
Destination parking space is occupied; vehicle waits until it is cleared.
- **Driving to parking space**
Vehicle is on the way towards the parking space.
- **Back to route**
The original vehicle route does not need to go through the link where the parking space is located.
- **None**
None from those above applies.

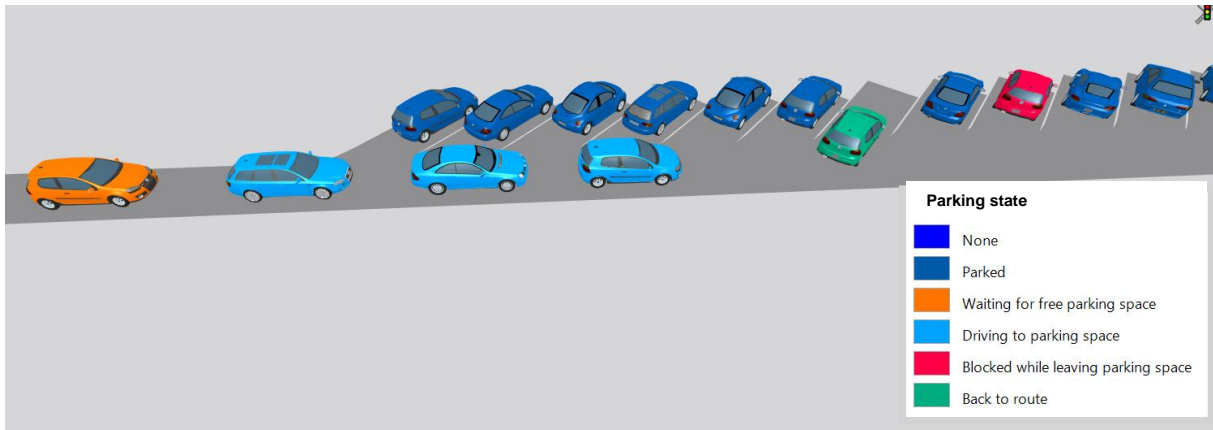


Figure 21 Visualisation of vehicle parking states

Visualisation

Each parking space, parking lot or parking lot group can be coloured based on an attribute value selected in the dialog “Edit Colour scheme for Parking Lots”. The principle is the same as for other objects like links (Figure 22).

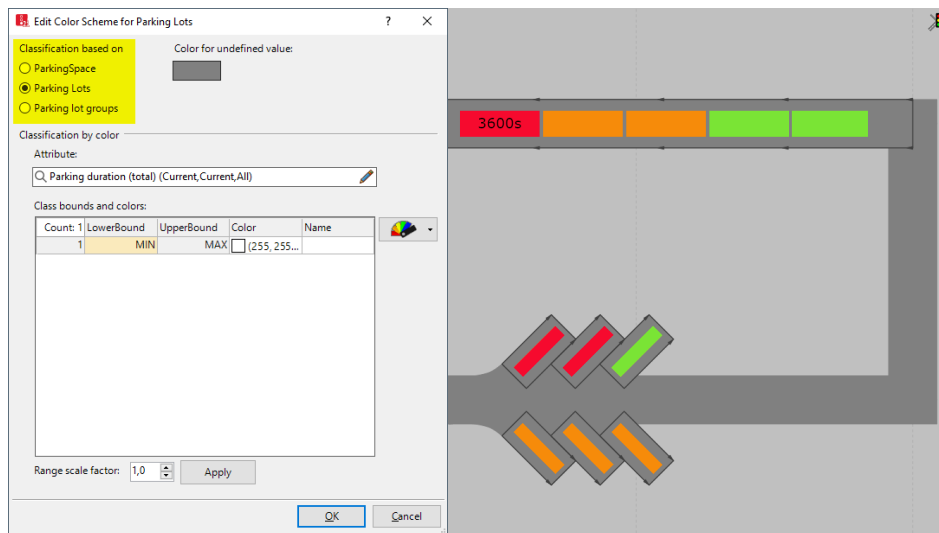


Figure 22 Left: Settings dialog for colour scheme for parking lots;
Right: Example of results visualisation

4.4.5 Number of stops & stop time for pedestrians

New result attributes "Number of stops" and "Stop time (total)" for area evaluations, areas and ramps are available (since PTV Vissim 2021-07). They are calculated the same way as for the pedestrian network performance evaluation, i.e. a stop starts when a pedestrian's speed falls below 0.2 m/s, and the stop ends when its speed increases above 0.2 m/s.

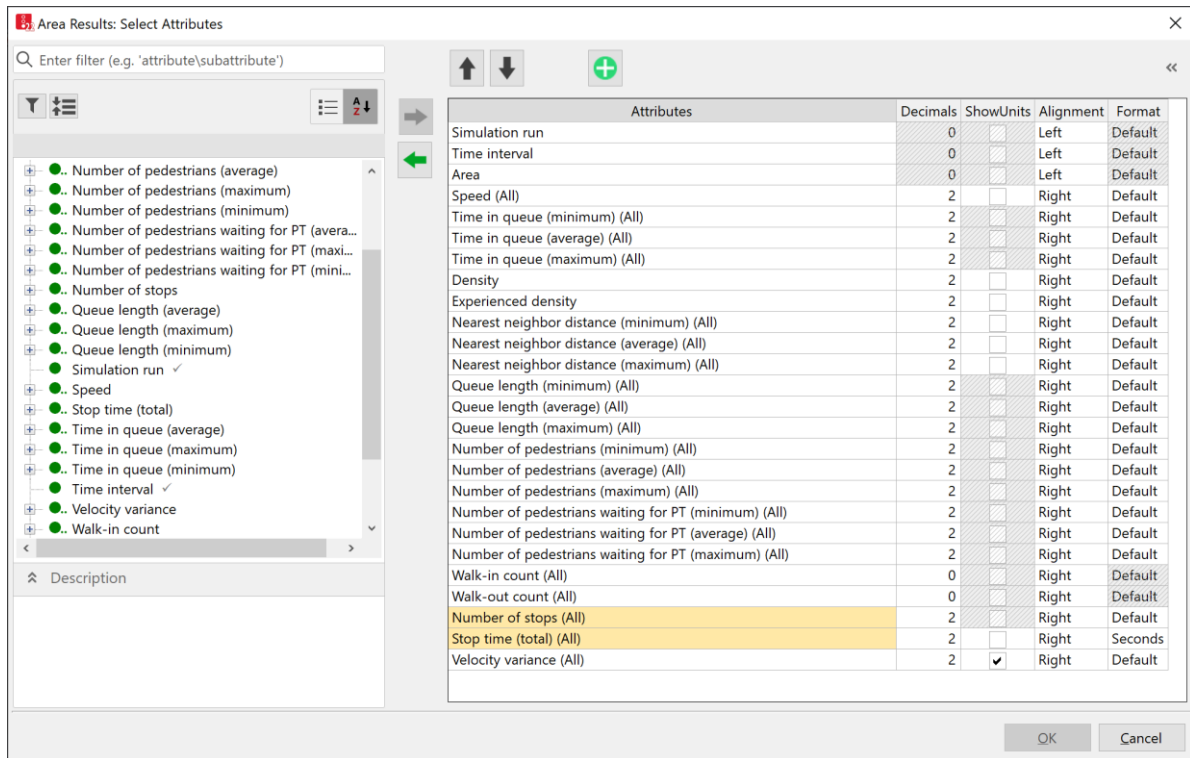


Figure 23 New area evaluation attributes “number of stops” and “stop time” for pedestrians

4.5 Further Developments – besides the project MORE

All developments implemented into a new release version of PTV Vissim software are always listed and described in the document “Vissim <version number> - what’s new.pdf” within the installation folder (e.g. in C:\Program Files\PTV Vision\PTV Vissim 2022\Doc\Eng).

5 How to use PTV Vissim with the new features

Before modelling with PTV Vissim the first time, a training course is recommended. Because of the complexity of microscopic modelling in general, the models should be built, evaluated or at least supervised by experienced modellers with appropriate training. PTV provided support for the modellers within the MORE project.

PTV offers basic 2-day trainings for PTV Vissim and several additional 1-day trainings for specialised topics. Besides that, a [collection of webinars](#), manual and an [online help](#) is available.

5.1 Model building

General recommendations for building up a model can be found in various modelling guidelines, such as:

- [TfL Traffic Modelling Guidelines](#)
- [FHWA Guidelines for Applying Traffic Microsimulation Modelling Software](#)

For the use of specific newly developed features see chapters 4.2 and 4.4.

5.1.1 Input data

Input data can have several sources:

- Macroscopic models
- Statistical data sources
- Data collected on site by third parties or MORE partners

It is recommended that the modellers use the most recent data available and collect all other necessary data in collaboration with city governments. For additional information, see MORE data management plan. Standard modelling guides advise on which type of data is useful for model building (see previous section).

5.1.2 Calibration and validation

Calibration and validation of simulation models ensures the quality of the model; in other words, how good the model replicates real-world situations. PTV Vissim offers various calibration parameters and the modeller should have a basic understanding of the model when changing them. Calibration and validation techniques are described in several modelling guidelines (see chapter 5.1) and academic and technical papers (see for example [these links](#)).

5.1.3 Designing different scenarios

Different scenarios can be kept in different files or more efficiently in one model file with the use of scenario management. Scenario management allows for the management of related transport networks in a single project. The aim is to model comparable cases in these networks and then compare their simulation results. For each case within a project, the user

adjusts the base network and saves it as a new scenario. Then the user can configure the desired evaluations and perform simulation runs for the scenarios whose simulation results should be compared.

The scenario manager offers two methods:

1. Definition of named and logically bordered modifications first. After that, the definition of scenarios is done by choosing applicable modifications from the modification set. Several modifications might be applied on several scenarios. This is recommended if the user wants to build up scenarios from sets of measures, e.g. scenario 1 includes measure 1, scenario 2 includes measures 1 and 2, scenario 3 includes measure 1 and 4, etc.

	Measure 1	Measure 2	Measure 3	Measure 4
Scenario 1	X			
Scenario 2	X	X		
Scenario 3	X			X
Scenario 4	X	X	X	

Table 3 Composing scenarios from modifications

2. Development of complete scenarios consecutively from the base network or from previously defined scenarios.

For detailed description, see [scenario management](#) in the PTV Vissim Help.

5.2 Scripting for individual solutions

Special requirements going beyond built-in features and parameters can be accommodated in the PTV Vissim model. For this purpose, the COM (Component Object Model) interface can be used. It allows the use of internal event-based script (in Python, VBS or JavaScript) inside PTV Vissim.

With scripts, it is possible to control the simulation, to create and manipulate objects (e.g. links or vehicles) in the model and to read and/or set attributes of objects (e.g. speed or appearance).

5.2.1 Visualisation of people-based place activities

The COM scripting approach or attribute modifications can be used to visualise people-based place activities, like sitting on a bench, standing while reading a newspaper, or looking at a smartphone (Figure 24). The built-in functionality in PTV Vissim/Viswalk can be used for letting people wait at certain areas for a certain time. However, the appearance of pedestrians in the 3D model does not change – the pedestrians are only standing or walking towards a route location or a destination. A simple script or an attribute modification can change the 3D-Model of a pedestrian who reached the “waiting area” at the bench (Figure

25). After the pedestrian starts to move again towards the next route location, the script or an attribute modification can change the 3D-Model back to the previous one in order to see a walking pedestrian again. It should be noted that this approach does not contribute to more accurate evaluations but is for visualisation purposes only.



Figure 24 Specific 3D-Models for sitting pedestrians switched by a script or an attribute modification

The script example shown below changes the pedestrian 3D-Model based on the value of a user defined attribute (UDA) “sitting”. This UDA is switched to the value “1” by an attribute decision when the pedestrian reaches the bench area and back to value “0” when he/she starts to move again.

```

# get collection of all sitting pedestrians
sitped=Vissim.Net.Pedestrians.FilteredBy("[sitting]=1")
# change 3D models
for ped in sitped:
    pedtype=ped.AttValue("PedType")
    if pedtype=="100": #if man
        ped.SetAttValue("OriginType", pedtype)
        ped.SetAttValue("PedType", 110)
    elif pedtype=="200": #if woman
        ped.SetAttValue("OriginType", pedtype)
        ped.SetAttValue("PedType", 210)
    elif ped.AttValue("ConstrElNo")!=ped.AttValue("CurDestNo"): #if the pedestrian started to move again
        ped.SetAttValue("sitting", 0)
        ped.SetAttValue("PedType", ped.AttValue("OriginType"))
  
```

Figure 25 Example of a simple script changing the pedestrian 3D-Model

Since version 2021 Vissim offers attribute modifications which can be used instead of COM-Scripts to change specific pedestrian or vehicle attributes.

5.3 Evaluations – general approach

5.3.1 Result attributes

Several result attributes are available directly in PTV Vissim in corresponding lists. The modeller can set the start (from-time), end (to-time) and interval for each evaluation type (Figure 26). Some evaluations offer additional settings in a dialog. The modeller can define own percentiles for all evaluations, which will be provided additionally to common aggregated values like total, minimum, maximum, average and standard deviation.

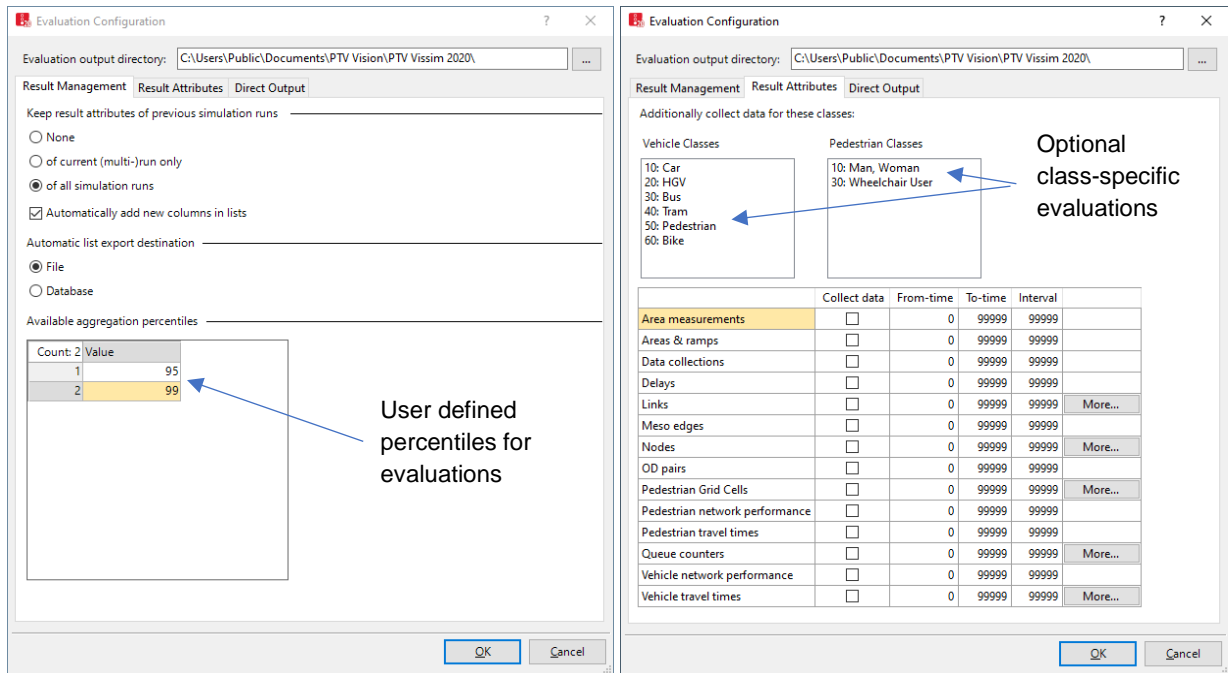


Figure 26 Evaluations; Left: Result management; Right: Evaluation configuration

5.3.2 Direct output & postprocessing

Vissim offers additionally writing of specific results into a csv text file or a database. Especially important are vehicle and pedestrian records, which are often used e.g. for postprocessing evaluations (Figure 27). These records contain information of vehicles and pedestrians for simulation steps (e.g. position, speed, acceleration). For the vehicle and pedestrian record the modeller specifies the set of attributes which should be written, and the evaluation resolution as well. Direct input files with different endings (e.g. *.fzp for vehicle protocol) can be renamed into *.csv files and afterwards opened in Excel directly.

Postprocessing can be used for calculation of any KPI which uses one or several attributes produced by PTV Vissim evaluation.

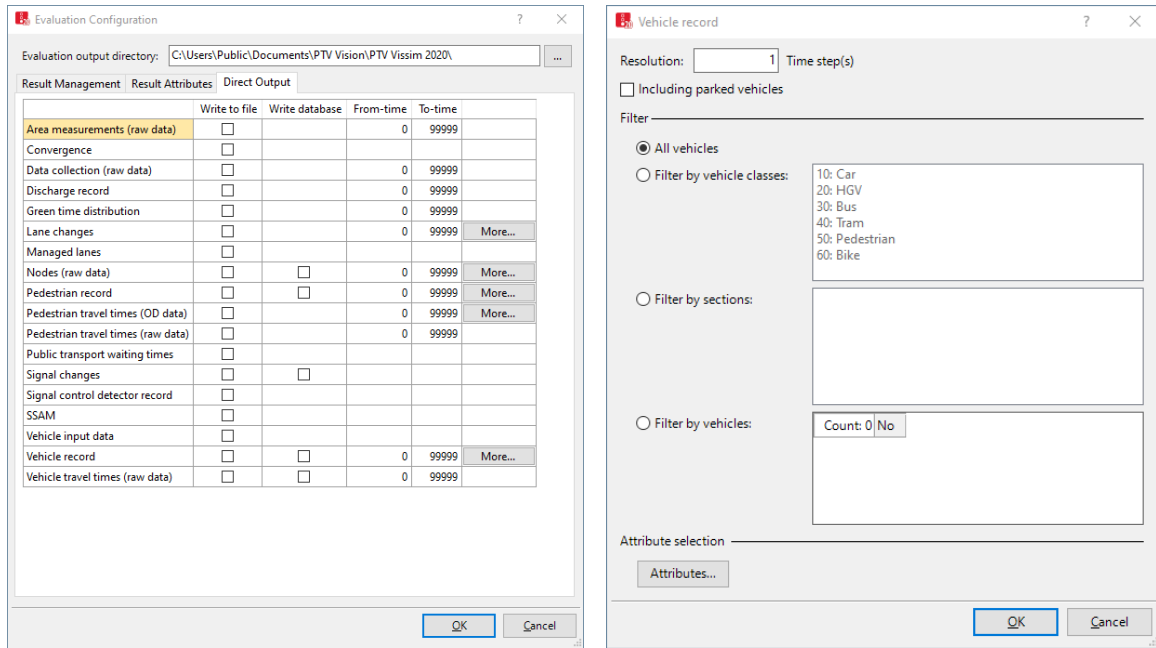


Figure 27 Evaluations; Left: Direct output options; Right: Vehicle record setup

6 How the tool were trialled in the MORE cities

The new features of PTV Vissim have been used in the MORE Stress Sections by the modellers selected by each city. Some cities have own organisations or staff for performing modelling tasks, other relay completely or partially on professional services provided by private companies.

Each city selected an own area or a corridor of interest within the city and defined a stress section to be investigated in detail. After the analyses of the current state, the option generation tool was used to generate design options with relocation of space in busy urban roads. Traffweb & Linemap tools were used afterwards to create new road markings and to collect feedback from all stakeholders on designs or to generate new ideas. The output of all these activities was used as input for developing multimodal microscopic traffic simulation models for investigation of the impacts of design changes and/or measures. The process can be roughly divided into following steps:

1) Development/Adaptation of the model for current state

Some cities already own a microscopic model covering the area of interest completely or partially. In such case, it might need further improvement, re-calibration on current data, finalisation (to cover the whole section) or detail adjustments.

Some cities own a bigger (strategic) macroscopic model which can be used as a base for creation of the microscopic mode (e.g. through export/import functionality and further refinements).

In a case where the city did not have any model available, a new one was created from scratch. PTV Vissim offers the Bing maps as background information and allows to add other backgrounds as well: e.g. shapefiles provided from tools develop by Buchanan Computing or since the newest 2022 version own WMS (Web Map Services).



Figure 28 Model preparation in PTV Vissim: Lisbon, sections under study



Figure 29 Example of a network model in PTV Vissim: London, area one (west)

2) Calibration/Validation of the models

It's a standard procedure bringing the models close to the real data collected. Besides volumes it might be travel times, queue lengths, speeds or other data.

3) Development of scenarios to be simulated

The modelers have basically two options: to use individual model files or to use scenario management functionality in PTV Vissim. Scenarios are based on new proposed designs and measures. They have been developed for future years and for different times of a day (like morning/evening peak hour). The microsimulation models cover usually at least one hour with necessary warm-up and optional (if needed) cool down period.

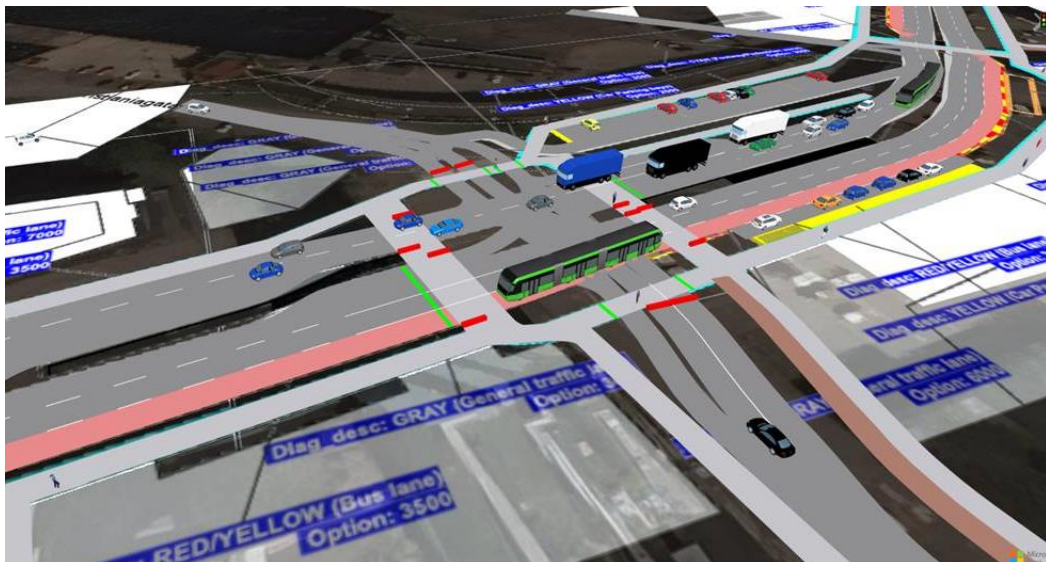


Figure 30 Example of scenario development in PTV Vissim: Malmo, scenario "Mobility, AM Peak"



Figure 31 Simulation of a scenario in PTV Vissim, Lisbon: Rua Morais Soares and Praça Paiva Couceiro, Scenario 2, PM Peak

4) Running Evaluations

After reassuring that the model produces reliable results by calibration/validation and the development of all relevant scenarios, the results can be produced by running several simulation runs with different random seed numbers for statistical evaluation.



Figure 32 Example of evaluation of a simulation model in PTV Vissim: London, pedestrian density (LOS), PM pedestrian place, Segment 1

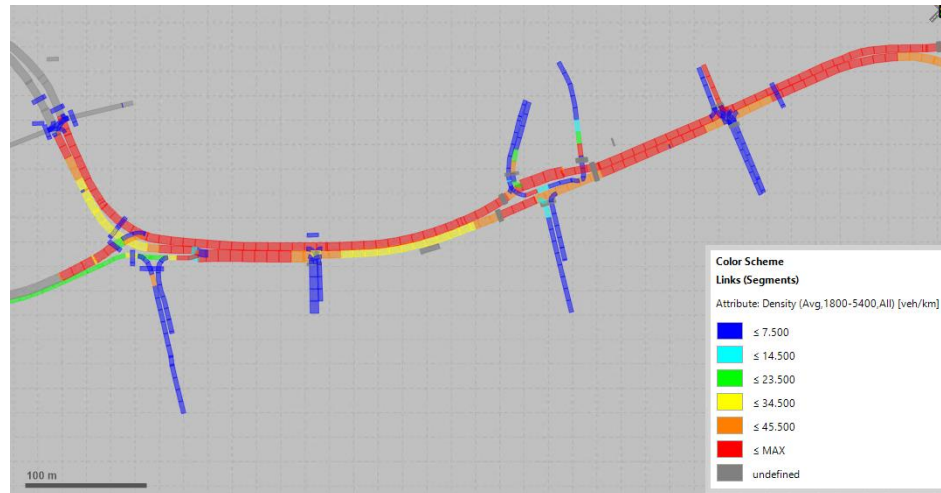


Figure 33 Example of evaluation of a simulation model in PTV Vissim: London, vehicle density, PM current, Segment 1

5) Collecting results, postprocessing and handing over into the tool for the appraisal

PTV Vissim provides the results through result lists or results files/databases. Results values can be directly visualised on the model by colour schemes or bars and labels. If needed, results can be transferred into another tool for postprocessing or further evaluation.

6) Additional non-mandatory evaluations: Emissions with Bosch model

PTV in cooperation with Bosch provided one-month test licences for emission calculations free of charge. It is an advanced state of the art cloud-based emission calculation model developed and maintained by Bosch, accessible directly from the PTV Vissim model. PTV Vissim software uploads results into the computation cloud and downloads the emission results back into the model automatically. The modeller finds the result in the results list and can visualise then on the model as well (e.g. link segments evaluation).

7 Tool refinement

Refinement of the tool is performed on continuous basis by the tool developer PTV. Each year a new version is released with new features and enhancements. Between the main releases several service packs are provided bringing smaller enhancements or bug fixes.

New features included in the main release are listed in the “What’s new” document, changes coming with the service packs are listed in the “Release notes” document. Both documents are located in the documentation folder within the PTV Vissim installation, e.g. C:\Program Files\PTV Vision\PTV Vissim 2022\Doc\Eng. The directory is easily accessible from the main program menu as you can see on the picture below.

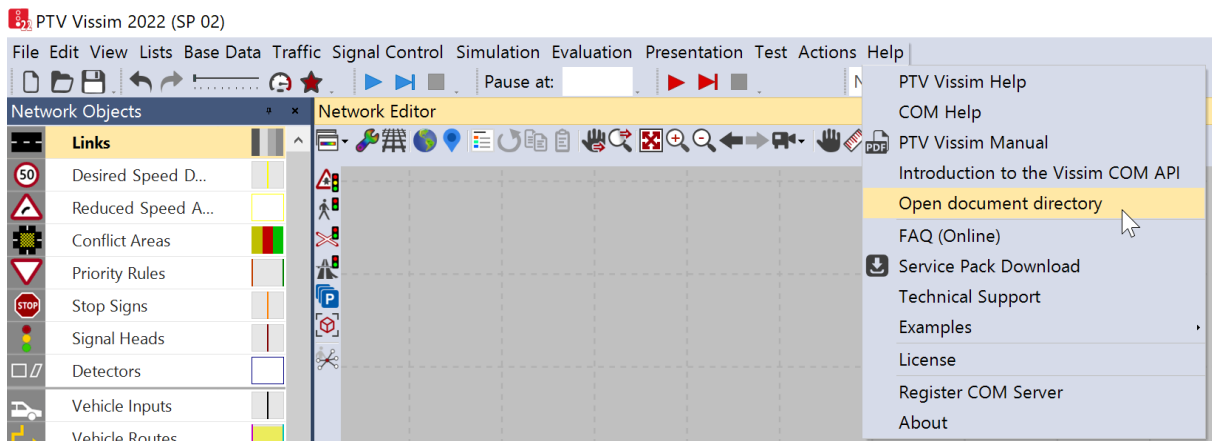


Figure 34 Access to document directory and technical support from the PTV Vissim software

All new ideas/requests for further features or enhancements or notices about bugs can be provided through the technical support which is accessible from the main menu under Help>Technical Support (see the picture above).

Feedback provided within the MORE project is partially integrated in the second development phase (see chapter 4.4). The rest was either answered (how-to or a workaround provided) or landed on the wish list and might be implemented in later Vissim version or a service pack.

8 Exploitation of tools

PTV Group uses several channels to communicate new features and enhancements implemented into the PTV Vissim software:

- PTV Vissim online Help: https://cgi.ptvgroup.com/vision-help/VISSIM_2022_ENG/

Explains all implemented features, parameters, attributes and workflows.

- Webinars & Tutorials

Tutorials are available within the PTV Vissim installation and online as well. Webinars are part of the resource library, available online at

<https://company.ptvgroup.com/en/resources/resource-library>.

- PTV user group meetings

In the year 2021 PTV organised following PTV user group meetings:

- Australia, 2021-11-24, virtual
 - Japan, 2021-11-17, virtual
 - USA, Atlanta, 2021-11-09 in person
 - Germany, 2021-10-27, virtual
 - France, 2021-11-22, in person
 - UK & Ireland, 2021-11-23, virtual
 - China, Guangzhou, 2021-11-03, in person
 - Singapore, 2021-11-18, hybrid
 - Poland, 2021-11-16, virtual
 - Africa, 2021-12-06, virtual
- Linked-In & PTV Vissim Linked-In forum: <https://www.linkedin.com/groups/2524087/>
 - PTV group webpage: <https://company.ptvgroup.com/en/mobility-software-release-2022/release-highlights#c12087>