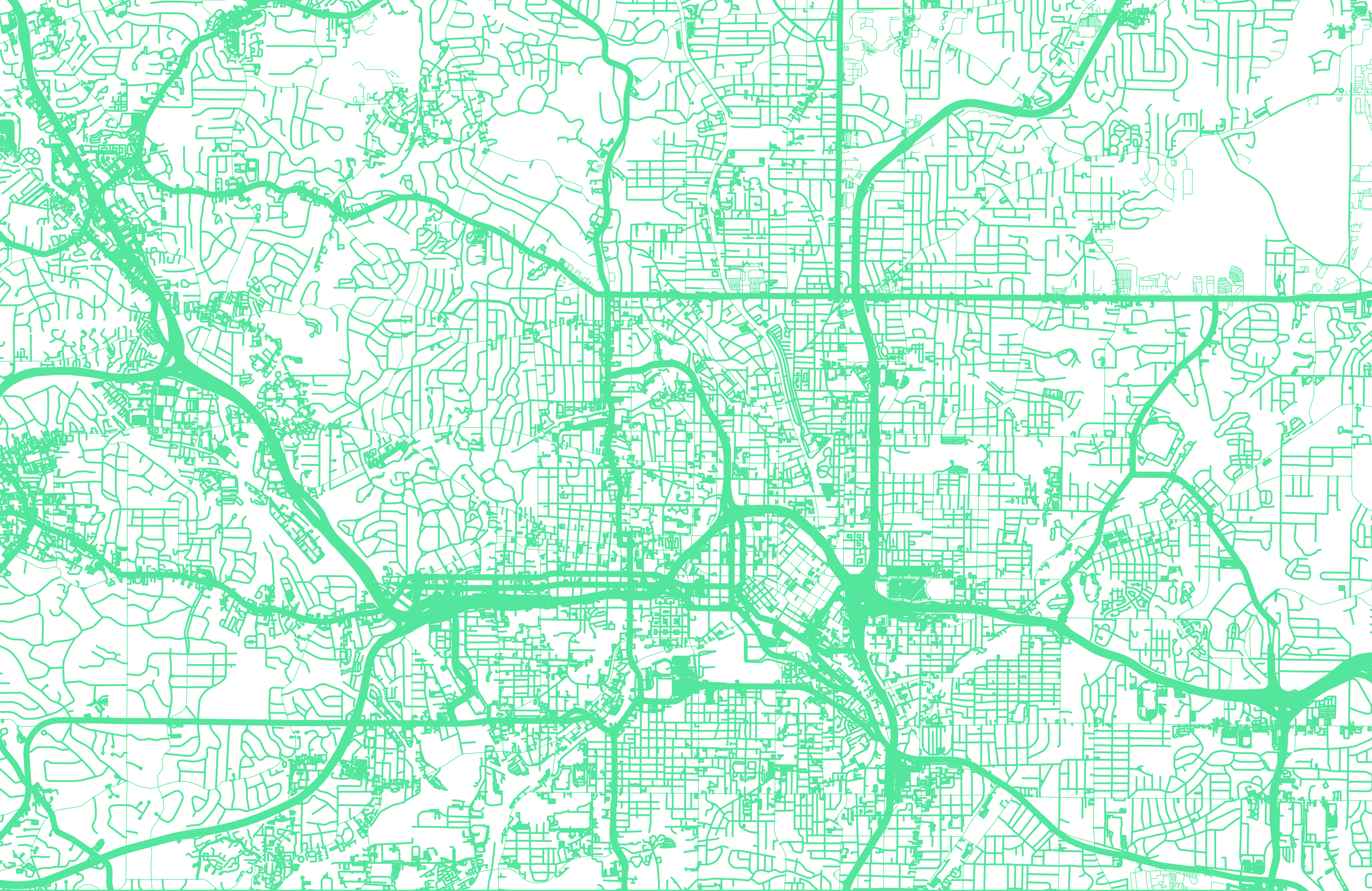

The quick e-Guide to

Transportation Modeling: Mastering sustainability, safety, and efficiency in mobility

For mobility and transport planners

PTV GROUP
part of Umovity

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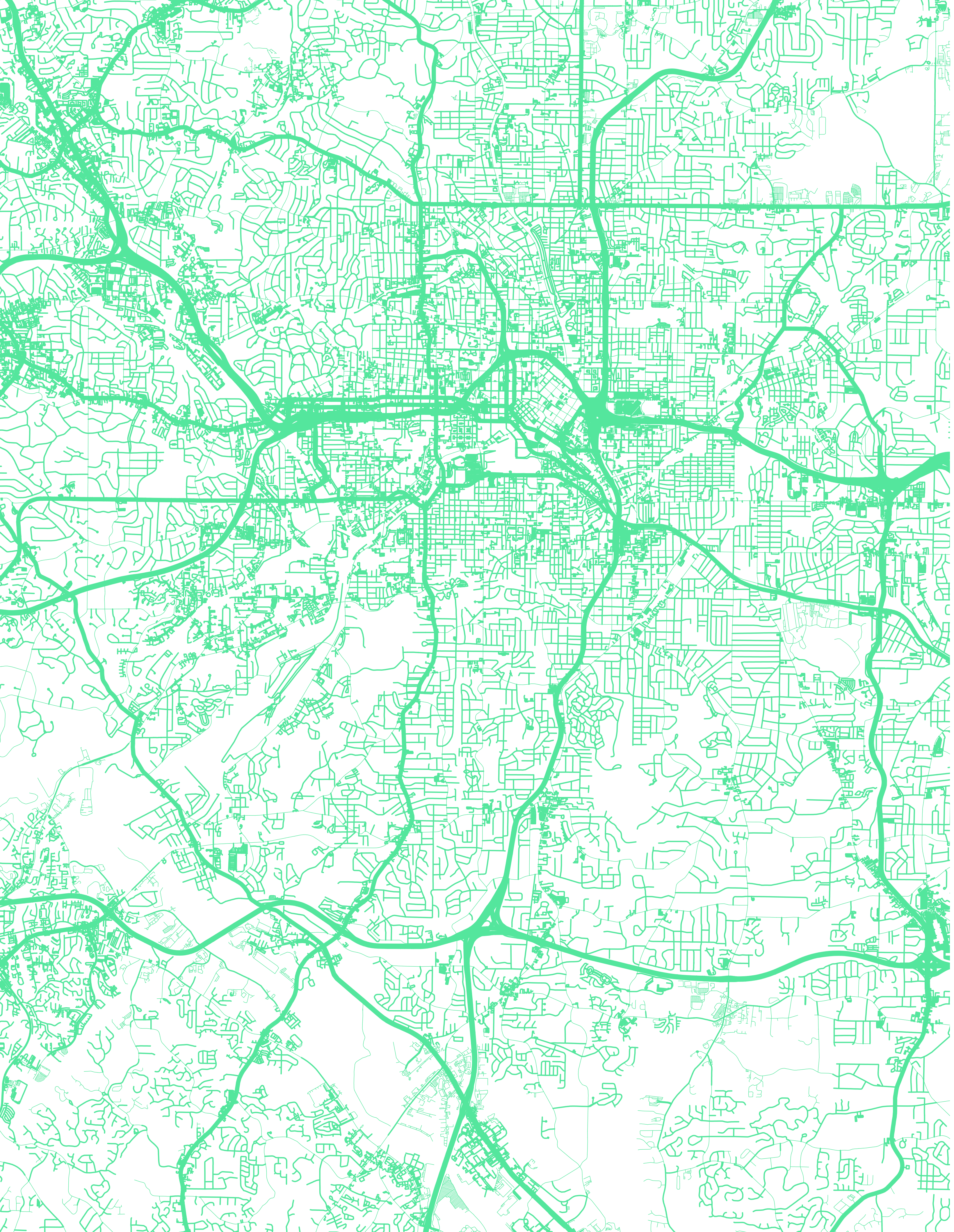

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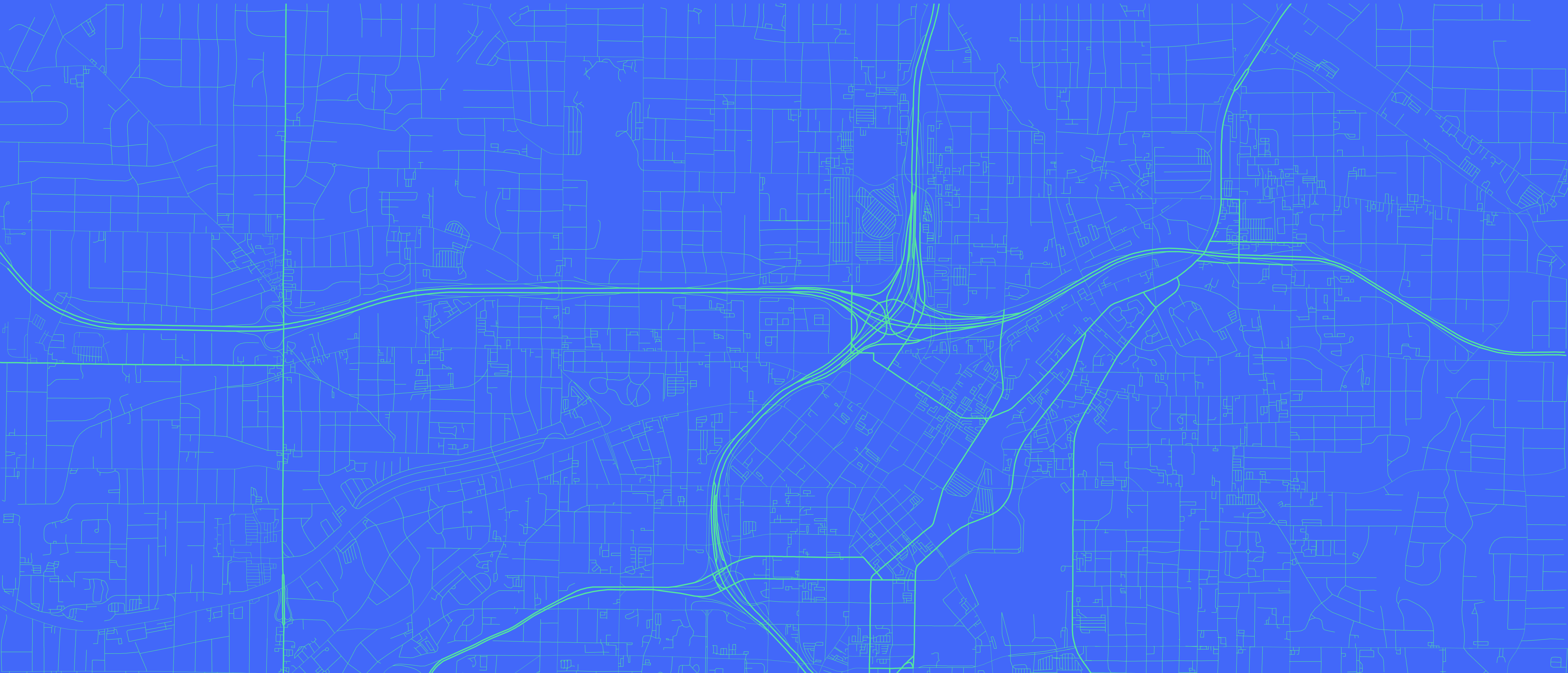


What is transportation modeling?
How do you create a transportation model and how are they used?
What are the so-called “four steps” of transportation modeling?
What is activity- or agent-based modeling?

This e-Guide answers the most important questions concerning this topic.

Prologue

Today, city and traffic planners must balance between various competing demands. The transition towards a more sustainable mobility ecosystem is more urgent than ever in order to meet challenges like climate change and growing urbanization - and to shape livable environments.

At the same time, the demand for mobility and easily accessible means of transport is growing steadily. Everyone expects safe, accessible, fast, and comfortable transportation. Planners are therefore tasked with coming up with reliable transport solutions that are affordable, efficient, and equitable.

In transport planning and the development of advanced mobility systems, forecasting travel behavior and demand for travel plays a crucial role. Only if you can estimate how and where people will be traveling in the coming years, you can make the right decisions for a future mobility system.

Traffic modeling and simulation enables planners to understand the current issues in their transportation system, identify opportunities and forecast and measure effects of development planning. It serves as the base to make sound decisions and set the right framework for the future of transportation.

What is transportation modeling?

A transport model is a detailed digital replica of the complex real-world transport and land use system. It represents the numerous complex travel choices people make, their movement patterns and thus level of demand for travel, as well as the transport system network capacities.

Transportation modeling is not limited to car traffic, it is multimodal. All modes of transport and their interactions can be modeled. This includes bicycles, pedestrians, public transport, new micro-mobility modes, and even air traffic.

Transportation models are a kind of digital playground to assess the impact of different transportation and land use options and to identify how the transport system is likely to perform in the future. These models are a powerful tool to for reliable urban and transport what-if analysis, and for scenario planning.

What is the purpose of a transport model?

Transport models are the foundation of transportation and traffic planning. Transportation systems involve many components and stakeholders, each with their own perspective and interests. Further, transportation is closely linked to many other aspects of society.

Therefore, transportation planning is not usually about finding the 'one optimal solution', but considering a range of possible measures, policies and external conditions and then suggest suitable actions for political or commercial decision making. This is called "what-if" analysis, or scenario analysis.

Transportation modeling tools enable the modeling experts to quickly develop different scenarios for a transport network and test them under a range of assumed future demographic or economic conditions.

The question of where people will live and work in the future and how and where they will travel is crucial for planning infrastructure and transport services and for creating a future-proven mobility system. Travel demand models represent all transport-relevant decision processes that make people move.

Within a model, future scenarios for population growth, land use, transport networks and mobility behavior can be built to assess the impact of these changes. This enables planners to determine whether a new highway lane is needed, how the public transportation network should be expanded to meet demand, where locations for new bus terminals or logistics hubs should be sited, or how people's mobility behavior will change with autonomous vehicles.

Transportation modeling enables planners to:

- develop advanced and future-proofed transport strategies and solutions,
- conduct traffic analyses and forecasts,
- plan public transport services,
- determine ways to implement and foster infrastructure for active mobility, such as cycling,
- set framework to adapt to new mobility services, such as autonomous vehicles.

Transportation modeling success story

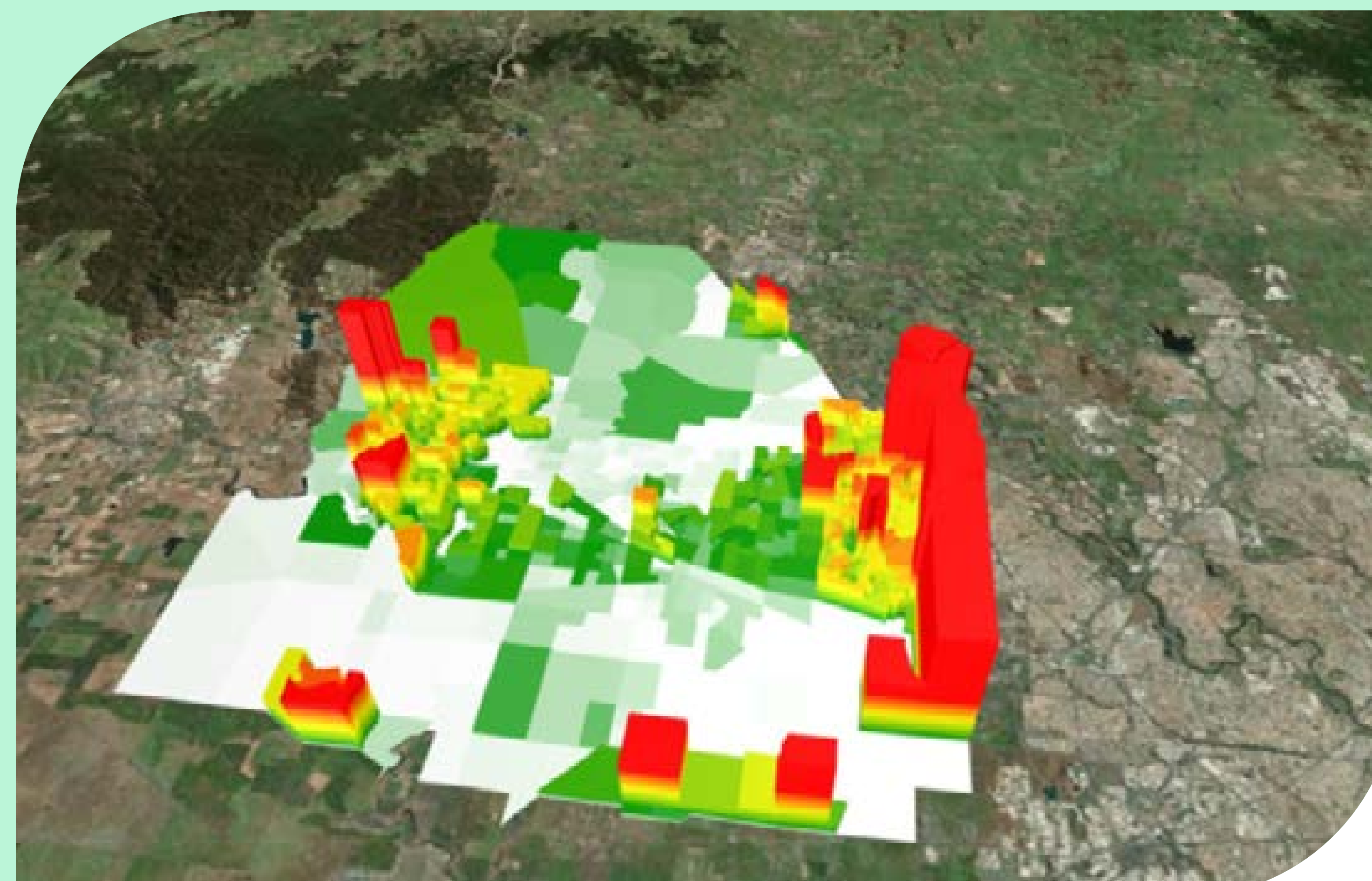
Demand model helps Australian city grow

Melton, northwest of Melbourne, is one of the fastest growing population centers in Victoria, Australia. With a population of over 200,000, it is forecast to grow to over 450,000 inhabitants by 2051.

On such a rapid growth trajectory, Melton faces a lot of challenges to ensure its infrastructure and its connection to Melbourne are keeping up. Therefore, the city council decided to develop an integrated transport model, set up with PTV Visum.

PTV Visum was selected because of its advanced demand modeling and public transport functionalities, as well as its unique Simulation Based Assignment (SBA). SBA is a mesoscopic assignment method that enables planners to simulate individual vehicles and their interaction with each other and the road network. The result is a more detailed and realistic performance representation. SBA is also extremely helpful to understand the impacts of signals and other intersection types on the flow of traffic.

The city-wide model was deployed in June 2022, covering 836 travel zones, 432 intersections and 103 signals. Since then, it has been used in the planning of major infrastructure projects, as well as in the planning for the city's population growth.



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What are transport models used for?

Transportation masterplans & infrastructure planning

Cities and transportation agencies today face the challenge of creating a mobility infrastructure that satisfies all needs. Not only in terms of efficient movement of people and goods, but also concerning planning goals such as safety and sustainability. Transport modeling helps to plan and design new infrastructure while taking future developments into account and making them easily adaptable to changing demographic, economic or spatial conditions.

Transportation modeling supports:

- Planning & design of new infrastructure
- Long term development of transportation infrastructure according to demographic projections and land use development
- Accessibility to different services and by various modes of transport

Public Transport planning

A comprehensive public transportation system supports a sustainable, livable city where more people use transit as a preferred transportation choice. Concurrently, as public transport should be accepted and used by every citizen, it should be inclusive and accessible to all.

To make public transportation the preferred choice of more people, planners need to address multiple questions: How can the public transport network be expanded? Where does a new bus line make sense, where are new stops needed? Which frequency serves the demand and creates an attractive offer?

Transport modeling provides a detailed representation of all modes of public transport such as bus, taxi, as well as heavy and light rail. It allows planners to design reliable transit services which optimally serve passengers needs and allow efficient operations.

Transport models support:

- Development of future lines & timetables (1, 5, 10 years)
- Fleet planning & long-term vehicle procurement, vehicle allocation
- Planning for operation of electric buses
- Planning of services
- Subnetwork tendering in public transit agencies
- Allocation of revenues & subsidies to operators by agency
- Evaluation of fare structures
- Analysis of passenger counts
- Rider equity analysis

Development of transportation policies and regulations

Transportation models provide an important basis for defining framework conditions and regulations in transportation policy. For example, in the introduction of low emission zones or other traffic regulations, or as a basis for efficient traffic management.

New mobility planning

The future of mobility is gearing towards electric and autonomous vehicles. In addition, ride and vehicle sharing are increasingly important. Transport planners must adapt to these new mobility services and make the necessary changes to serve their community's needs. How can the charging infrastructure for e-mobility be strategically planned? What impact will autonomous vehicles have on traffic flow and road capacity? How can on-demand and sharing services be planned in such a way that they enrich existing public transport services? Transportation modeling is indispensable for setting the right course for a future-oriented mobility ecosystem.

Transportation modeling success story

EU-wide model improves transport & energy

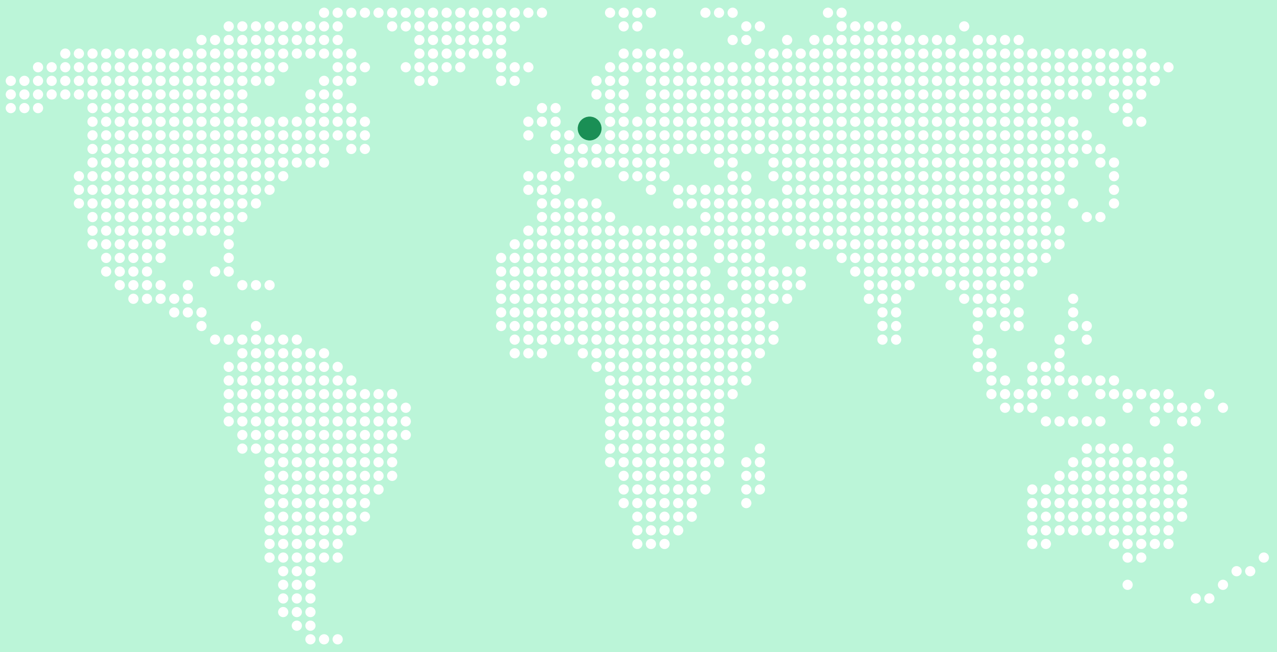
Most borders across the European Union are open, allowing free movement of people and goods without bureaucracy. To ensure the continent's transportation networks continue to flow, the EU Commission now uses modeling software PTV Visum, supplied by PTV Group.

PTV Visum is used in the development of TRIMODE - a multimodal transport model covering in detail all freight and passenger transport movements across Europe. The model also considers economic factors that generate transport demand, and how mobility affects the environment and the energy market.

TRIMODE is to become a robust, fully operational, and integrated modeling system, with PTV Visum at its core. The overall development phase lasted 43 months.

Based on PTV Visum, TRIMODE combines information about private modes of mobility, local and international public transport, demand models for passengers and freight, and economic and energy models.

TRIMODE will be used to forecast transport flows and to assess planning strategies and policies, considering population and economic growth, and infrastructure schemes. The model forecast up to the year 2050 but can be extended even further.



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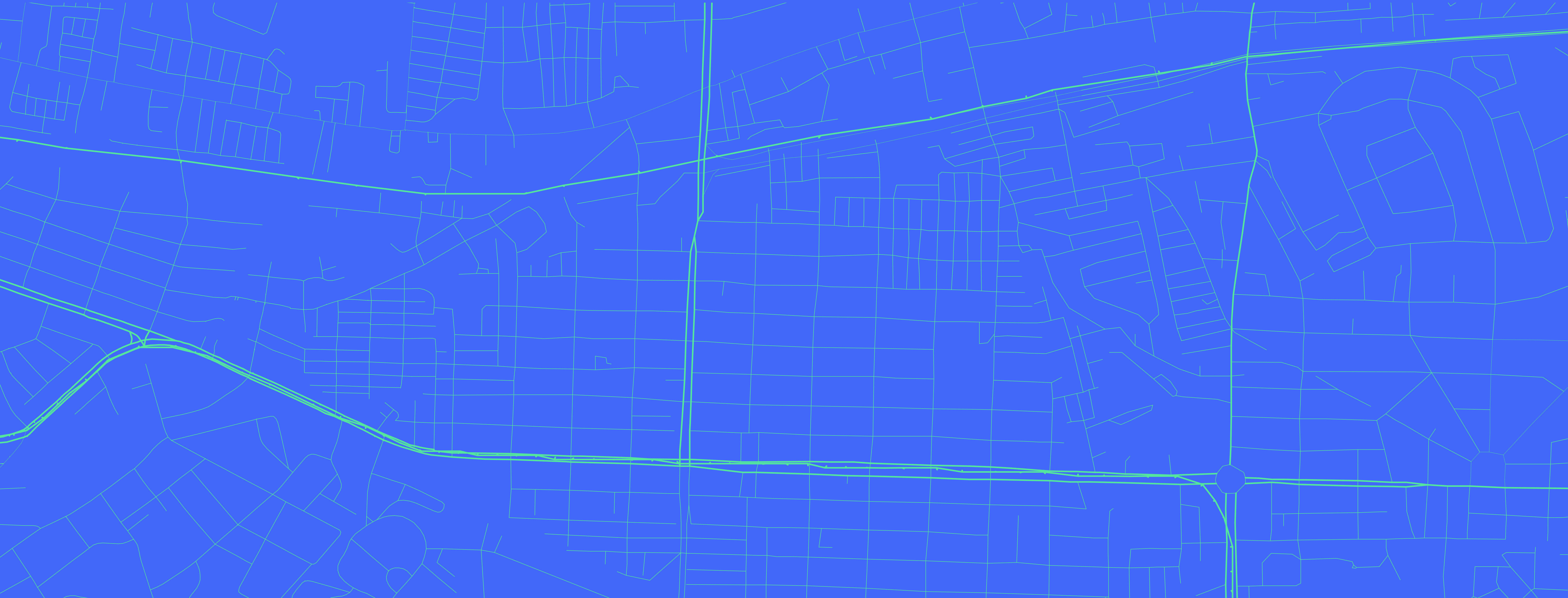
Principles and methods of transportation modeling



What are macroscopic, mesoscopic, and microscopic models?

The three terms refer to the level of detail in which road traffic, in particular, is modeled.

In **macroscopic models**, traffic is modeled with a flow model like fluids, generating outputs as fractional volumes on links and turns. Macroscopic models can be used to assess traffic in large scale networks, at the expense of simulation detail.

In contrast, **microscopic models** provide a detailed simulation of individual vehicles, with their acceleration, deceleration, and precise movements along links and through intersections. The output of microscopic models are therefore detailed trajectories of individual vehicles. The higher computational requirements render them less applicable to large scale networks.

Mesoscopic models, also known as simulation-based assignment models, combine aspects of both models, by simulating traffic in large scale networks through a simplified vehicle movement models which omit aspects like acceleration or deceleration. Mesoscopic models provide enough detail for assessment of traffic management measures and others, while still being applicable to large scale networks.

Transport modeling success story

London's new standard for traffic model runtime

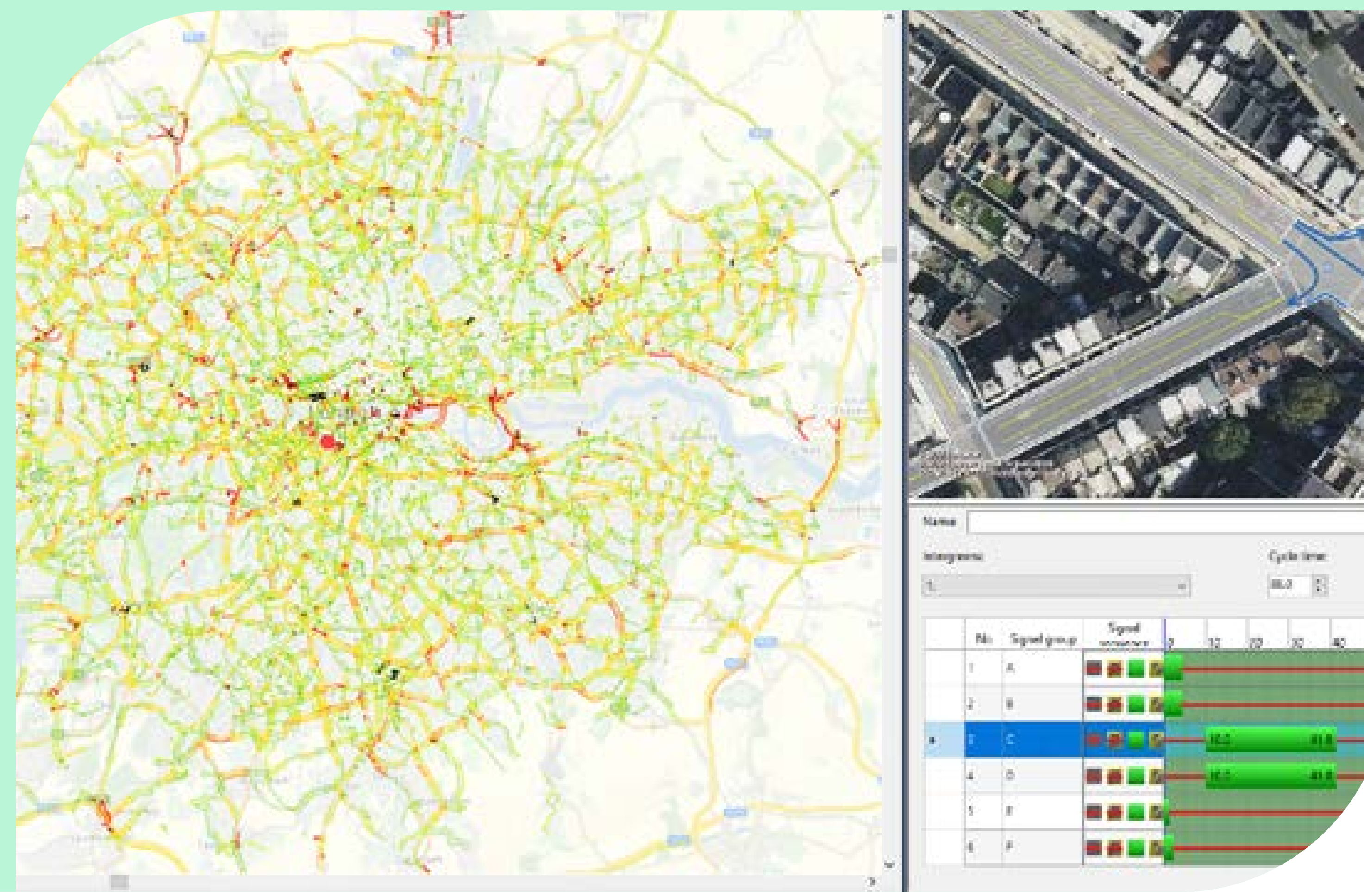
Transport for London (TfL) is responsible for the capital city's transport system. Its Operational Network Evaluator (ONE) is a tactical highway traffic assignment model, used to assess the impact of schemes and to evaluate mitigation strategies.

Built in PTV Visum, ONE provides a simplified representation of real-world road traffic conditions. It is one of the largest and most detailed junction-based highway models in the world: It covers 5,692 zones; 53,500 kilometers of links; and over 17,000 junctions modeled in detail, of which more than 5,500 are signalized.

The ONE model in PTV Visum has been intensively used by TfL for many years, with excellent results. It has helped to assess the impact of schemes including cycle routes and major road redesign schemes. It also helped the operational analysis of road and river crossing closures, and their impact on bus journey times.

Recently, TfL updated the model with the latest version PTV Visum 2022, which includes a move from scripted to built-in assignment. As a result, the model sets a new standard for the industry for highway assignment runtimes on regular hardware. It converges within 2.5 hours, including a bespoke outer loop for taxi in bus-lane adjustments. Without this outer loop, which is unique to TfL's application, the runtime would be even shorter - less than 1 hour!

These faster run times will significantly increase the computation resources available for the TfL team and speed up the assessment of transport schemes in London.



What methods are used for transportation modeling?

Depending on the required level of detail and accuracy, the forecast period, available input data, resources and know how, different mathematical approaches can be used.

Historically, an aggregate methodology referred to as the 4-step-model, or trip-based model, has been most used. Recently, more detailed disaggregate approaches referred to as activity-based models or agent-based models (ABM) have been implemented in many locations.

Both approaches, and some other model types are explained in the following:

The classical 4-step travel demand modeling process

The 4-step-process is an established methodology for urban, regional, and national travel demand modeling. The aggregate planning transportation model compromises of four steps related to travel choices.

Step 1: Trip generation – how many trips are generated?

This deals with the question of how many trips originate in or are destined for a particular travel analysis zone (TAZ). The trips generated are related to different purposes, for example, work, shopping, or leisure. The production and attraction of trips are driven by so-called trip rates, averages based on the number of people in households or the number of vehicles available. The output of the trip generation step is a set of production and attraction values associated with each zone.

Step 2: Trip distribution – where do trips go?

Destination choice is the second component of four-step transportation planning. The trip distribution step matches trip origins with destination. This is done by weighing the attractiveness of the potential destination and the effort required to get there such as road distance, travel time, and toll/cost. The result is that the original demand of a TAZ is split across several destination zones. Depending on the segmentation of the model, multiple distribution matrices may be generated, for example by trip purpose or household income.

Step 3: Mode Choice – what travel mode is used for each trip

In the third step, trips between the TAZs are allocated to different transport modes. The mode of transport people use depends on their preferences, and personal aspects such as car ownership. Other factors that affect the modal split are travel time, cost, parking availability, and number of transfers. These variables and parameters are typically incorporated into a logit model to calculate the split of demand across the modes. As an output of the mode choice procedure, the trip matrices from the distribution step are further refined into trip matrices per mode.

Step 4: Trip Assignment – what is the route of each trip?

In the assignment step, the trips between an origin and destination by a particular mode are 'assigned' to a specific path. This means that the trip matrices from the prior steps are used as an input to assign route flows to the actual transportation network. Traffic volumes for road segments (or links) and transit vehicle loads are generated, and often analyzed as a result.

There are different network assignment procedures for different types of transport modes:

- **Road traffic assignment:** For road-based traffic by cars, heavy goods vehicles, etc., which are constrained by road capacity, iterative equilibrium network assignment procedures are applied. The assignment procedures shift fractions of travel demand between different routes, until all routes allocated to each pair of origin-destination zones experience similar travel time (or generalized cost).

- **Public Transport assignment:** The process of assigning public transport trips works differently from road assignments. Public transit networks consist of distinct transit lines with specific service frequencies and possible stop waiting times. Different factors influence the journey experience, such as travel and waiting times and number of transfers, and they are considered in a choice model. Various trip connection alternatives are derived from the public transit network and the timetable. Trips are then distributed to these alternatives based on traveler preferences and the resulting public transit network line, stop, and vehicle boardings and volumes available for analysis.
- **Active modes / Bike assignment:** Route choices and travel speeds of cyclists are influenced by other factors than of drivers. Therefore, choice models reflecting this are applied for assigning active mode travel to different route alternatives.

Disaggregate Activity-based / Agent-based models (ABM)

In contrast to aggregate trip-based models, disaggregate models model people and/or households individually and often with more precise home and activity locations. Since individual data is not available for the entire population, a 'synthetic population' of households and persons is generated from statistical data and distributions of key variables such as household income and person age.

The general choice model structure applied in ABM is very flexible. The person and household attributes attached to each individual, as well as their previous decisions, can be considered in each subsequent choice step. This allows a more realistic representation of their mobility in terms of travel during the simulation day as household context variables, long-term decisions (e.g., car ownership), and tour variables (e.g., drove to work) can be used to estimate travel decisions more precisely. Understanding of time and space is typically more precision as well which makes estimating tolled/priced travel and active mode travel more accurate.

ABM models generate daily activity plans covering each person's relevant activities along with their location, timing, mode, and in some cases route. This synthetic travel diary provides much higher spatial and temporal resolution of model outputs for analysis. As the results are generated as individual tours, trips, and activities, they are easier for non-experts to understand than the traditional fractional traffic flows generated by aggregate models. On the other hand, setting up and calibrating ABM models is more complex than aggregate models.

Transport modeling success story

Swiss trains plan the future with ABM modeling

Swiss Federal Railways (SBB) carries every day over 1.3 million passengers and 200,000 tons of goods. It operates over 10,000 trains daily.

SBB aims to enable customer-oriented door-to-door mobility solutions for future travelers. To that end, it applies an Activity-Based Model (ABM) that simulates travel as individual and interwoven decisions for each inhabitant of the country on a typical weekday. In 2018, PTV Group and SBB initiated a collaboration for the development of an ABM of Switzerland, using PTV Visum software.

Fully disaggregated mobility decisions for every single inhabitant over the course of a day result in a large and comprehensive data set. PTV Visum is used to generate, store, manage, and visualize the model data. The outputs are used for planning processes at SBB, including decisions about future investments, rail service concepts, and strategies.

The PTV Visum model provides:

- Efficient data structure
- Methodology for an ABM model
- Optimized solutions for certain model steps
- Run time of 12 hours for country-wide demand scenario

Those features allow SBB to simulate and deliver a wide range of scenarios and forecasts, as well as customer-oriented mobility solutions.

Other modeling methods

- **Aggregate tour-based / activity-based models**
  While maintaining the spatial aggregation and segmentation of the classical 4-step models, aggregate tour-based models consider tours of individuals spanning multiple activities at different locations. They incorporate some aspects of ABM models and some aspects of the traditional aggregate models.
- **Incremental / pivot-point models**
  Pivot-point models are like simple growth models that relate growth to a relevant variable (such as change in ticket price) in that they estimate changes in travel demand from changes in travel cost. But instead of simply applying a fixed elasticity related to one or a few selected variables, they typically reflect the complex choices travelers take in an incremental logit model. As this approach allows to consider various variables influencing travel choices, it has been widely adopted in transportation planning. Some national guidelines for project appraisal provide detailed instructions and model parameters for the workflow.
- **Multimodal modeling**
  For many travelers, mobility is not limited to using a single mode of transportation for a trip. Instead, they may take their private car to reach a park & ride facility, use public transit to get to the city center and then continue their journey by e-scooter to reach their destination. Other examples are car sharing or ride sharing systems, which are operated by cars, but to the user they appear much like a public transit mode. For multimodal modeling these special requirements and framework conditions need to be considered.

How is freight transport and commercial traffic considered?

Freight transport, as well as commercial and service activities, generates a large share of the overall traffic volume. Due to the large variety of operations involved, and the heterogeneity and complexity of logistics chains, modeling commercial and freight transportation is less standardized. The availability of input data and the calibration of models restrains a wide application of these models.

Many smaller scale models (for urban areas) only roughly assess commercial and freight traffic. More complex, bespoke models are often built on the national scale for assessing freight transport based on internal and external supply chains

How are aggregated transportation models structured?

- **Spatial model structure: What are transport analysis zones (TAZ)?**

  The core principle of aggregate models is the spatial dissection of the study area into travel analysis zones (TAZ). These zones cover the study area and are often associated with statistical units, such as communities and census tracts. Most inputs and outputs are aggregated to these TAZ and can be prepared and analyzed with GIS tools. Since TAZs are the core units of the model computations, many outputs are generated in form of square matrices. The rows are the origin zones, and the columns are the destination zones.

- **Population segmentation**

  People have different travel patterns depending on their life situation and other aspects. In 4-step-models, this is reflected by segmentizing the total population of the TAZ into different groups or "demand segments". The number of segments and the characteristics considered for the segmentation (e.g., age, employment status, car availability) depend on model scope, budget, and data availability. For each segment, individual parameters for trip characteristics can then be applied in the modeling steps.

- **Consideration of time – temporal scope**

  Most travel demand models are used for strategic considerations. The planning horizon is in the range of years. So, it is often sufficient to consider average daily traffic volumes. Thus, many strategic models are designed to model traffic volumes and trips per average day. As travel patterns tend to have a high degree of temporal clustering, and because transportation infrastructure needs to be designed to meet peak demands, separate models for peak hour traffic estimates are often created. If models are used for more operational studies, then a higher temporal resolution of demand may be required.

04

How to skillfully build a transportation model?

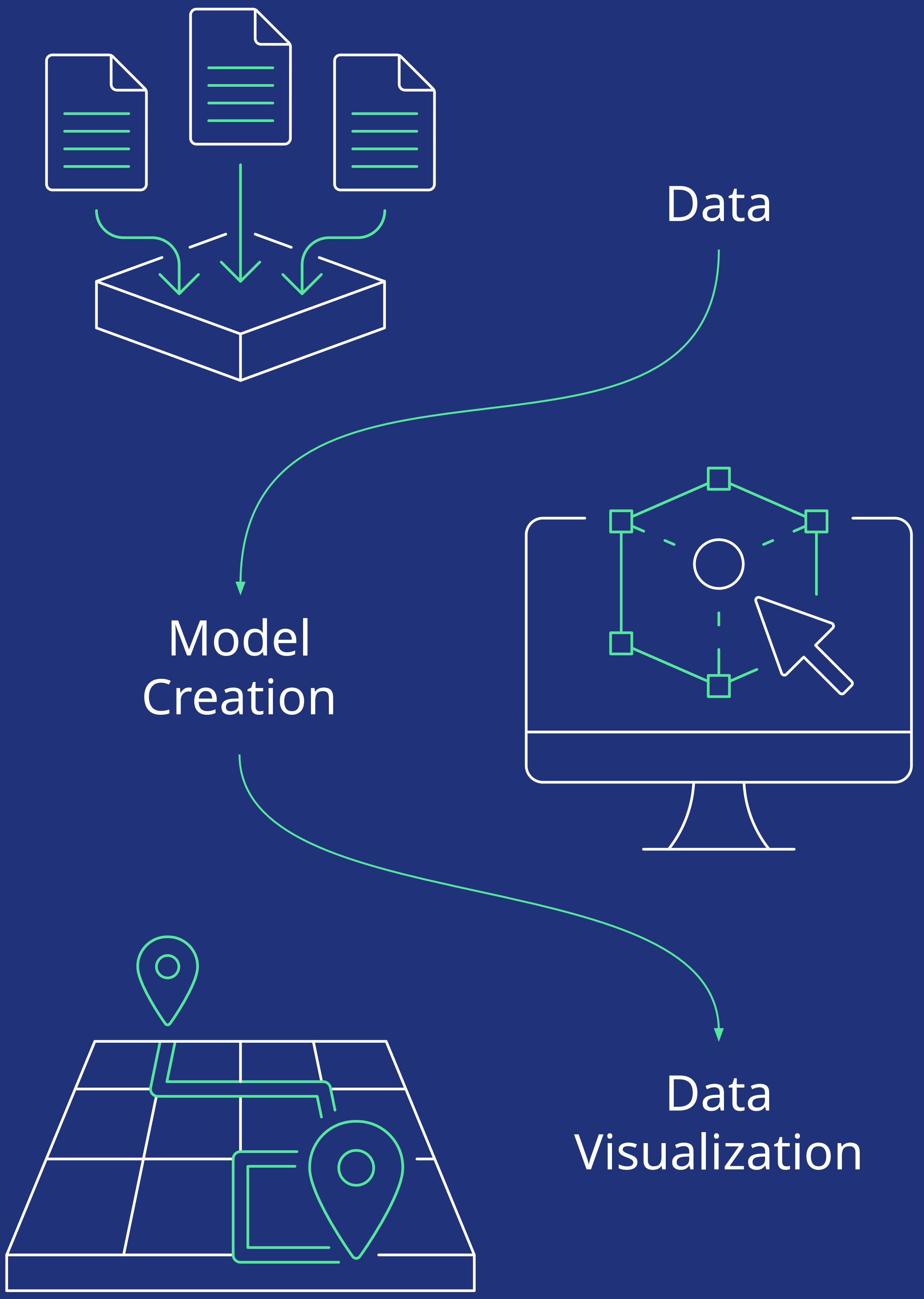
Developing, maintaining, and applying a transport model

For strategic transportation planning there is a relatively clear distinction between model development and model application.

Model development is the process to set up a base model which reproduces the mobility in the planning regions at a given time (the base year). This model is built from various data sources, which all should relate to the base year. By adjusting various parameters and inputs, the model is calibrated to match traffic counts and various survey data, such as vehicle counts, public transit passenger boardings, trip distance distributions. Those are also collected for the base model. Due to these data and calibration requirements, the base year of the model will often be an earlier year than the actual year when the model is developed.

Once calibrated and approved, this base (year) model can then be used in many different applications to develop projects and test scenarios. This model may then be handed to different agencies or consultants for their project studies.

As the transport system evolves over time, also the base model needs to be maintained and updated to accurately represent the model region. Bigger updates to the model will usually also require a recalibration. The frequency of such updates depends on the scope of mobility changes in the region and the project timeline and budget.



How are transportation models built?

Data

For setting up transportation models, existing datasets are processed and combined wherever possible. In general, several different types of input data are required to build a model.

- **Transportation networks and supply data**
  Transportation networks form the base for any transportation model. Road networks can be extracted from navigation databases or from GIS datasets. Some processing may be required to provide essential attributes specific to transportation models, such as capacity. Public transit networks and timetables are often available in common formats such as GTFS from scheduling systems. Other networks – for cycling, sea, or air traffic – may be available from GIS datasets or other online sources. Although not required for most calculations, its best if the modal networks can be merged into a single multi-modal network. This enables multimodal analysis and consideration of interactions between modes.

- **Land use, demographic, and economic data**
  Land use data, demographic variables, and other data are needed to assess the origins and destination of travel demand. Much of this data is available from census data and land use monitoring in databases or GIS formats. For aggregated models, this information is usually condensed to the TAZ level, while ABM models preserve the individual activity locations, household locations and synthetic population.

- **Travel behavior parameters**
  Most calculations in the transportation modeling process – regardless of the model type – are based on parameters describing human travel behavior. These parameters can be estimated from household travel diary surveys or estimated by statistical methods from other datasets such as mobile phone data.

- **Observed control data**
  Although they are not needed for the model calculation itself, control datasets are important for the model calibration process. These can be observed traffic volumes from manual or automated vehicle counts, transit passenger counts from automated count systems or ticketing systems, or similar. Observed distributions - of actual trip distances, travel times, etc. - are also useful for calibrating demand models and often come from household travel surveys or Big Data.

Transport modeling success story

Abu Dhabi creates a public transport system from scratch

In 2008, the Abu Dhabi's Department of Transport (DoT) launched The Public Bus Transportation Service, aiming to create an integrated world-class public transport network. The bus network now carries over 50 million annual passengers in the Emirate.

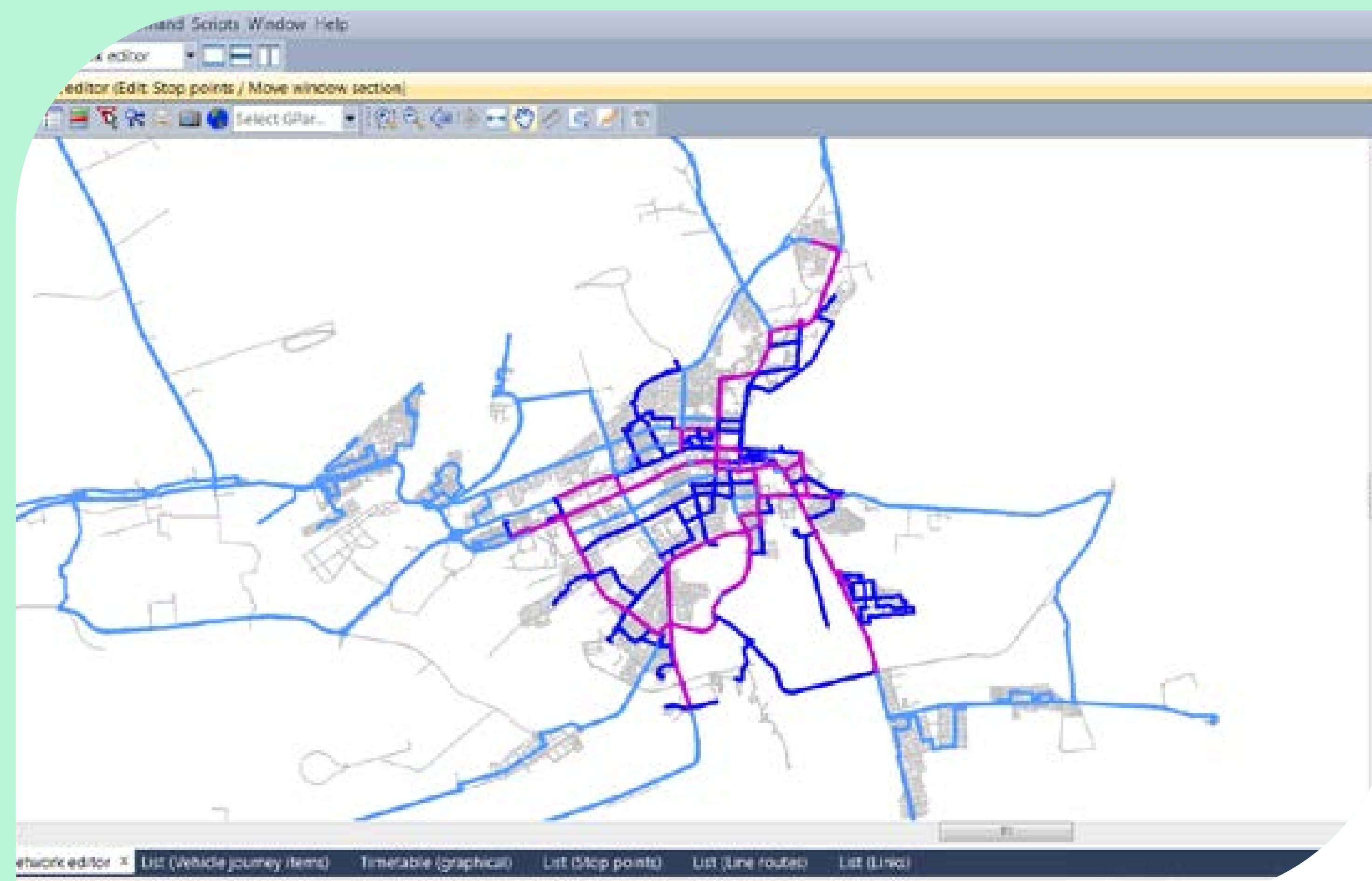
Setting up a public transport system in a culture dominated by cars was a specific challenge. Overcoming it involves not only installing a new mode of transport, but also convincing the population to change their travel habits.

To analyze if the planned network would be sufficient for the expected travel demand, a Bus Planning Model was created using PTV Visum. PTV Visum considers all road users and their interactions and is used as standard in transport planning.

Using the PTV Visum transport model, DoT can now:

- Plan and evaluate the network
- Plan timetables, based on realistic runtime profiles
- Estimate line blocking and number of required vehicles
- Connect with other solutions - scheduling software, automated fare collection system, etc.

With PTV Visum, DoT planners incorporate passenger volumes from automatic fare collection system and runtimes directly into the network, to support bus planning. This has helped to streamline DoT's planning process and allowed implementation of a twice-yearly network planning cycle.

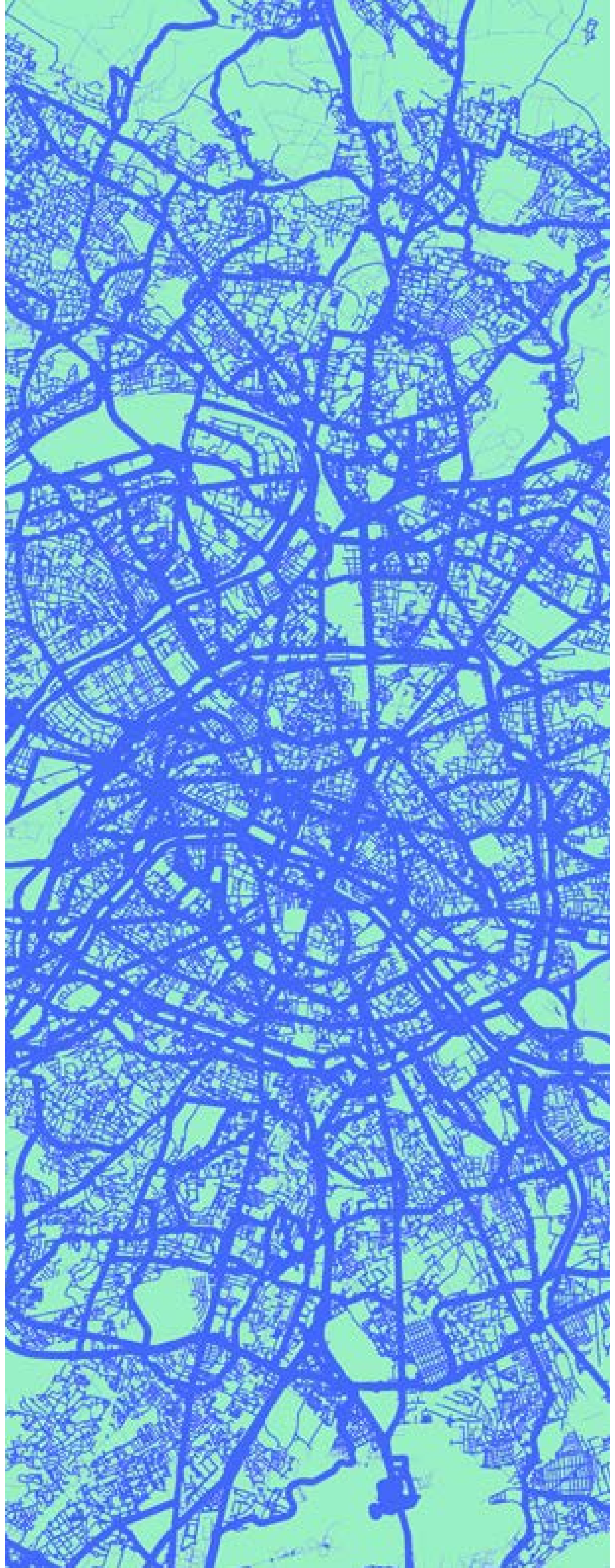


Model calibration

To be used as a planning tool, transportation models must achieve an accurate replication of travel patterns in the base year. Only thereby can future scenarios be assessed in a meaningful way. To achieve this, model results are compared to observed data, usually at least vehicle counts, public transport passenger counts and/or trip distance and travel time distributions.

Based on these comparisons, model parameters and other aspects are adjusted until the calibration requirements are met: A maximal deviation of 5% at 85% of the count locations.

Calibration is often a time-consuming process, requiring expert knowledge and experience. Several automated procedures can be applied to automatically adjust model components to match observed counts. For example, by adding constants to utility functions or by automated a posteriori matrix adjustment. While speeding up the calibration process, these methods can have issues regarding model expressiveness and can lead to model overfitting.



How are transportation models analyzed?

Outputs and results

Transport models provide various results on different levels of detail and segmentation.

The most frequently used outputs are traffic volumes for different modes of transport on the links. These provide direct insights into local traffic impacts, for example noise and levels of emissions. For public transit planning, comparable outputs are volumes on transit lines or individual services, or boarding, alighting, and transferring at individual stops. The assignments generate full paths from trip origin to trip destination through the network, along with the respective volumes. This allows for detailed analysis of which travelers use each link. It is helpful, for example, when planning roadworks and bypasses.

For more comprehensive scenario assessments, a multitude of global KPIs can be provided for the full network, or for subsections like certain relations or destinations. For studies regarding decarbonization, this can be metrics such as total mileage or congestion length. For transit studies, KPIs like total ridership, average travel time or number of transfers, estimated fare revenues, operating cost are provided. The various network skim matrices generated during the model computation provide valuable insights on issues related to accessibility and connectivity

Tools to analyze transport model outputs

Many of the outputs produced by transportation models can easily be analyzed in tables, charts, or GIS maps. For visualizing link volumes, 2D or 3D bar maps are a popular rendering.

The richness and structure of outputs from transportation models allows for much more sophisticated analysis. Several of the numerous tools are described below:

- One of the most important tools is the "**flow bundle" or "select link" analysis**. This tool extracts all the paths traversing selected network elements. Analysts can assess which travelers will be affected by changes to these elements.
- **Isochrone calculations** provide insights to accessibility based on detailed information on travel times and network connectivity contained in a transport model.
- The information captured in **network skim matrices and trip demand matrices** can be visualized and aggregated to identify demand flows and overall travel patterns.
- The **time profiles of activities** at selected locations can be investigated, for example the charging of electric vehicles at charging facilities or the presence of visitors at a shopping center.
- **Crowding profiles** and **transfer locations** of transit lines or signalization coordination in green bands can be analyzed in specialized time-space diagrams.

05

Achieving sustainability, safety, and efficiency in mobility

Connecting transportation models to other plannings and applications

Mobility is at the heart of human activity. That's why transportation planning never stands alone. It is linked to many other urban planning activities and provides invaluable inputs to the respective processes and tools. Some examples are:

- **Air quality assessment and climate change**
  Road traffic is responsible for a large share of carbon emissions and other pollutants affecting air quality in cities. Many transportation planning projects therefore aim to reduce those emissions, e.g. by introducing Low Emission Zones in city centers. Transportation models compute the traffic volumes resulting from such measures, while also indicating unwanted side effects like overall increases in trip lengths. The combination with emission models enables planners, for example to assess different fleet compositions of electric and combustion engines.

- **Noise evaluations**
  Like air quality, traffic volumes computed by transportation models can also feed into noise emission models. Based on detailed models of the built-up environment, planners can assess the noise exposure and possible reductions with dedicated tools.

- **Accessibility and equity**
  Access to different types of services like health care, education, or groceries is strongly dependent on transportation – while not all mobility alternatives are equally suitable for all people. The detailed representation of all modes and the segmentation of transportation models for different population types allow concise planning for equity in service provisioning.

- **Public transit, rail and ride sharing fleet planning**
  The procurement of vehicles for public transit, rail services or ride sharing offers requires huge financial investments and has long lead times. Therefore, implementing or adjusting such services is usually not a short-term matter but requires proper advance planning. In particular, the conversion of gasoline bus fleets to e-bus fleets requires careful assessment of the different operational concepts (overnight charging, opportunity charging, etc.) and the needed charging infrastructure. Transportation models can be used to evaluate the fleet of vehicles required to operate a planned service or to assess how different types of vehicles will perform in the planned service.

- **Roadworks planning**
  When infrastructure needs to be maintained or replaced, or other roadworks affect the available road capacity, transportation models help to assess the relocation of traffic flows and to ensure sufficient capacity and smooth operation on the alternate routes.

- **Land use & energy grids**
  When zoning systems and land use of a city or region are designed, transportation systems need to be adjusted. Transportation models play a major role to support this process. With the shift towards electric mobility, other parts of the urban infrastructure such as the electric grid also may need adjustment. Transportation models provide key insights for helping to dimension these assets.

- **Road safety**
  Road safety plays a major role in providing livable cities. Transportation models can help in identifying and analyzing accident hot spots and designing network alternatives for mitigation.

Transport modeling success story

Preparing EV charging infrastructure

The need to plan for a future dominated by electric vehicles (EV) is pressing. In northwest England, PTV Group, together with other stakeholders, used PTV Visum to develop a detailed transport model for EV charging requirements.

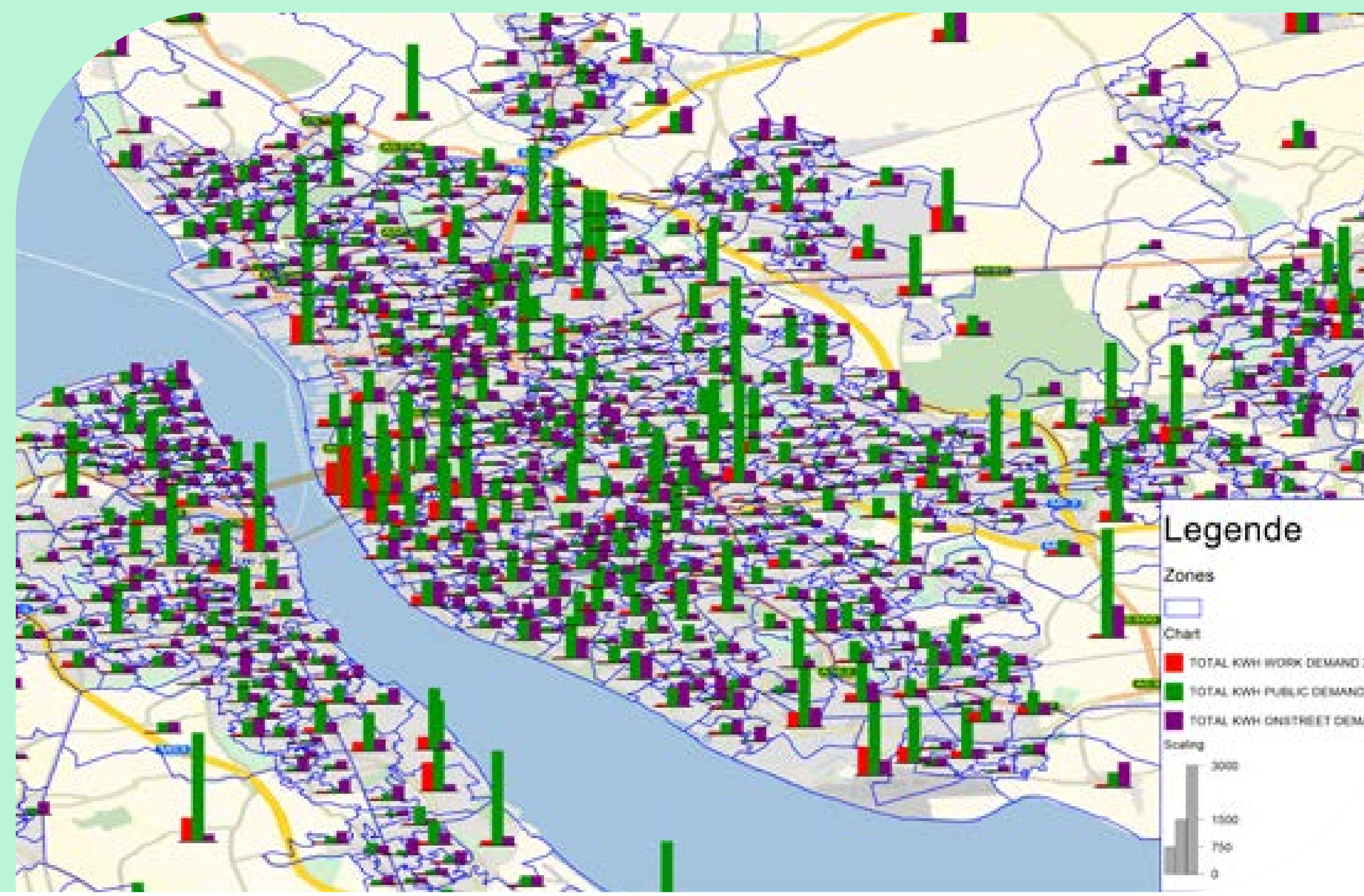
Using PTV Visum, the demand for charging has been quantified, to understand where and when EV are likely to charge.

Prior to building the model, scenarios were developed to explore the uncertainties around the EV market, such as electricity demand and infrastructure needs. But rather than providing a single outlook, the scenario results highlight a range of plausible outcomes up until the year 2050, allowing for robust analysis and decision-making.

The project tackled another critical issue: The capacity of the electricity networks. Overlaying the transport model with electricity capacity data made it possible to estimate how the charging demand will affect the power network.

Using the data from the PTV Visum model, a free online tool was developed. It provides planners, local authorities, and charging point installers with data to explore where public charging points will be needed, and where connections to the grid can be made.

Authorities in the region can now better plan and coordinate the rollout of charging infrastructure by understanding drivers' needs



Transportation modeling with PTV Group technology

- **PTV Visum**

  The world's leading transport planning software. It is the standard for macroscopic simulations and macroscopic modeling of transport networks and transport demand, public transport planning, and for the development of transport strategies and solutions. With PTV Visum, you create transportation models that provide insights for long-term strategic planning and short-term operational use.

- **PTV Model2Go**

  The ground-breaking new technology in the field of city and transport planning, delivers a ready-to-use model for any city in just one week. Automatically, fast, and cost-efficient. Model2Go reduces the time and resources needed to set-up a transport model and enables transport planners to focus on what matters – improving mobility in cities.

- **PTV Vissim**

  The world's leading multimodal traffic simulation software. PTV Vissim digitally reproduces the traffic patterns of all road users. Trusted by traffic planners and engineers, PTV Vissim evaluates and improves the performance of your traffic facilities.

- **PTV Hub**

  PTV Hub is a cloud-based collaborative modeling platform for mobility planning, design, and optimization. Seamlessly connect your PTV desktop software to the cloud, run computations faster, and streamline your entire dashboard experience.

Want to transform your transportation modeling?
Contact the PTV expert team!

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