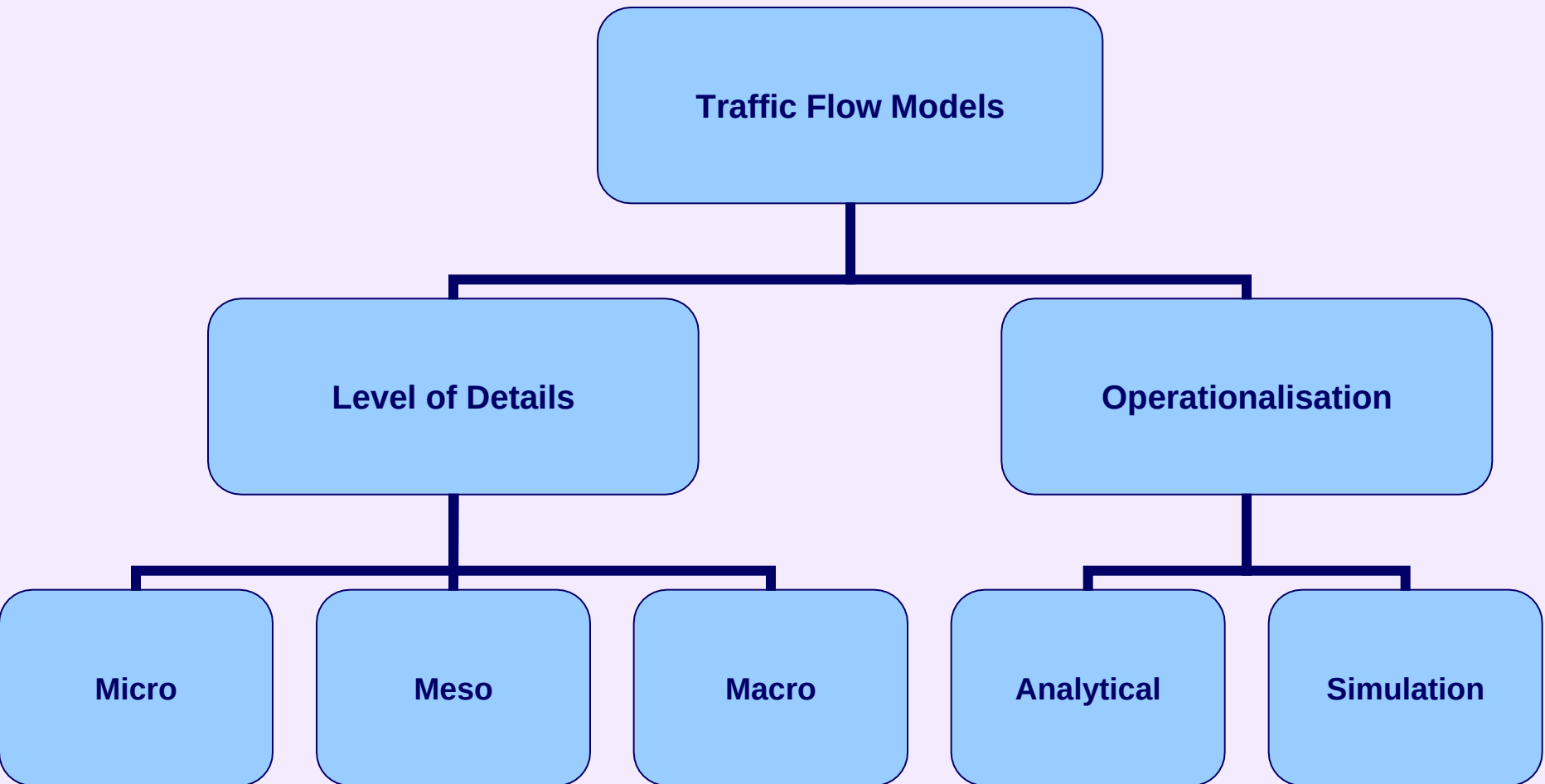


TRAFFIC SIMULATION MODELLING

Traffic Models



Traffic Models

نماذج حركة المرور

من حيث مستوى الدقة

من حيث التشغيل (العمليات)

ميكروسوبية

ميسوسكوبية

ماكروسكوبية

تحليلية

محاكاة

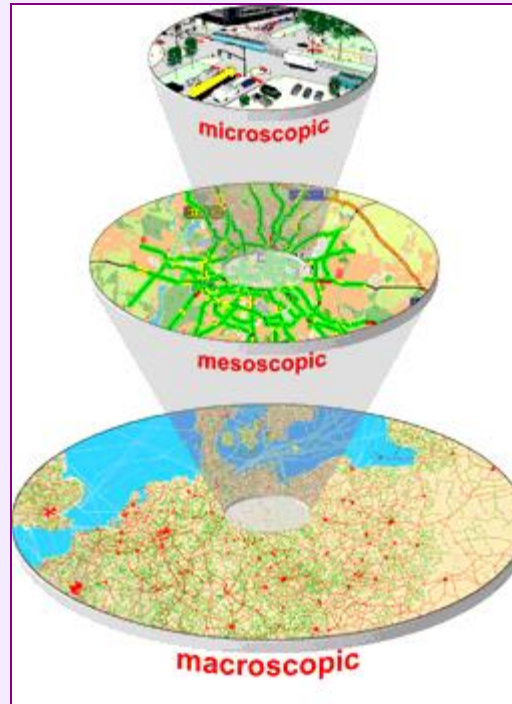
- **نماذج تحليلية:** حيث يكون الحل مجموعة معادلات تفاضلية تصف نظام المرور يتم الحصول عليها بطريقة تحليلية (التفاضل والتكامل)، ويمكن أن تكون هذه النماذج ستاتيكية أو ديناميكية، وتستخدم الطرائق العددية للوصول إلى الحلول.

- تتطلب النماذج التحليلية مجموعة كبيرة من البيانات الحقلية مثل: عرض الطريق، عرض حارة المرور، الخشونة، كافة المعلومات الهندسية التصميمية، نوع العربة، حجوم المرور، السرعات والكثافة وغيرها..
- هذه النماذج مكلفة بشكل كبير ومملة وهناك دوماً شكوك حول البيانات.

- The *analytical* models are, where the solution to a set of differential equations describing the traffic system is obtained analytically (using calculus)
 - Analytical models can be static and dynamic
 - Numerical methods are used for solutions
- But analytical models require large amount of field data such as, road width, lane width, roughness, complete information on geometric design, vehicle composition, type, traffic volumes, speeds & density etc.
 - Extremely costly & tedious
 - Often uncertainties are involved in the data

- في نماذج المحاكاة تكون هناك تغيرات متعاقبة في نظام المرور خلال الزمن (تغيرات المسافة – الزمن)، ويتم إنتاج هذه التغيرات بشكل تقريبي في النموذج.
- تكون نماذج المحاكاة ديناميكية ، ويمكن أن تكون ماكروسكوبية أو ميسوسكوبية أو ميكروسكوبية.

- The *simulation* models are, where the successive changes of the traffic system over time (space-time dynamics) are reproduced (approximated) in the model.
 - Simulation models are dynamic
 - Macroscopic, mesoscopic and microscopic



عوامل أساسية في محاكاة الحركة المرورية

Main factors of traffic simulation

1. Advanced research in traffic theory
2. Advancement in computer hardware technology
3. Advancement in computer software technology
4. Development in information, communication infrastructure
5. Increased importance of traffic and transportation in the society

Road Traffic as a Simulation Object

1. Transport networks cover wide physical areas
2. Large number of active participants or users and interaction among them
3. Objectives of the participants can be individualistic or social
4. Presence of independent variables outside the control of the operator and the participants (the weather conditions, the number of users, etc.)
5. The road & highway traffic variables can be stochastic (inherent randomness) and time varying in nature
6. Transportation systems involve both human interaction and vehicle interaction with surroundings

Advantages of Traffic Simulation

1. Simulation is cheaper than many forms of field experimentation and analytical modelling, in terms of time, resources and cost.
2. Simulation is a powerful tool for comparing the consequences' of a number of alternative strategies and improvement plans.
3. The task of developing the logic of various events and their occurrences involves the collection of pertinent data. The engineer gains an insight into the traffic characteristics and the way traffic interaction takes place during the process of collection of data and modelling. This may ultimately lead to a better formation of an analytical model.
4. In real life situations, it is extremely difficult to obtain conditions in the field which are needed for building a better analytical formulation.

Advantages of Traffic Simulation

5. Simulation techniques can be employed to check uncertain analytical solutions.
6. Simulation techniques provide opportunity for controlled experimentation, altering one variable at a time or specific variables simultaneously, and the final effect can be observed. Traffic systems in particular, are highly complex systems, with many variables, interactions and sub-systems.
7. In the case of many analytical models certain assumptions have to be made to simplify the task. Often these assumptions are of a doubtful nature. Simulation models can overcome such deficiencies,
8. Simulation models are "transparent," in the sense that anyone who wishes to know how they work can see through the model.

Limitations of traffic simulations

- Simulations are resource limited
 - Resolution: Level of detail
 - Fidelity: Degree of realism
 - System size: The network size to be covered
 - Simulation speed: Speed of simulation compared to real time
 - Resources: Computational resources, programming time

Steps in Simulation

Certain sequential operations are involved in any problem wherein Simulation techniques are adopted.

These are:

1. Definition of the problem.
2. Field studies to determine inputs needed for model formula.
3. Development of Logic.
4. Development of Computer Simulation Programme
5. Calibration of Model
6. Validation of Model

Modelling Approaches

- Scope
 - Micro (around 65 software packages in 2005)
 - Macro (around 16 software packages in 2005)
 - Meso (around 3 software packages in 2005)
- Discrete time vs. Continuous
- Situations
 - Intersections
 - Road sections
 - Network

Macroscopic Traffic Simulation

- Based on macroscopic traffic flow theory
- Continuous flow simulation, mainly used in traffic flow analysis
- Originated from the late 1960's and the early 1970's
 - British TRANSYT Program
 - Simulation of urban arterial traffic signal control
 - American FREQ Program, FREFLO Program
 - Motorway applications

Transyt

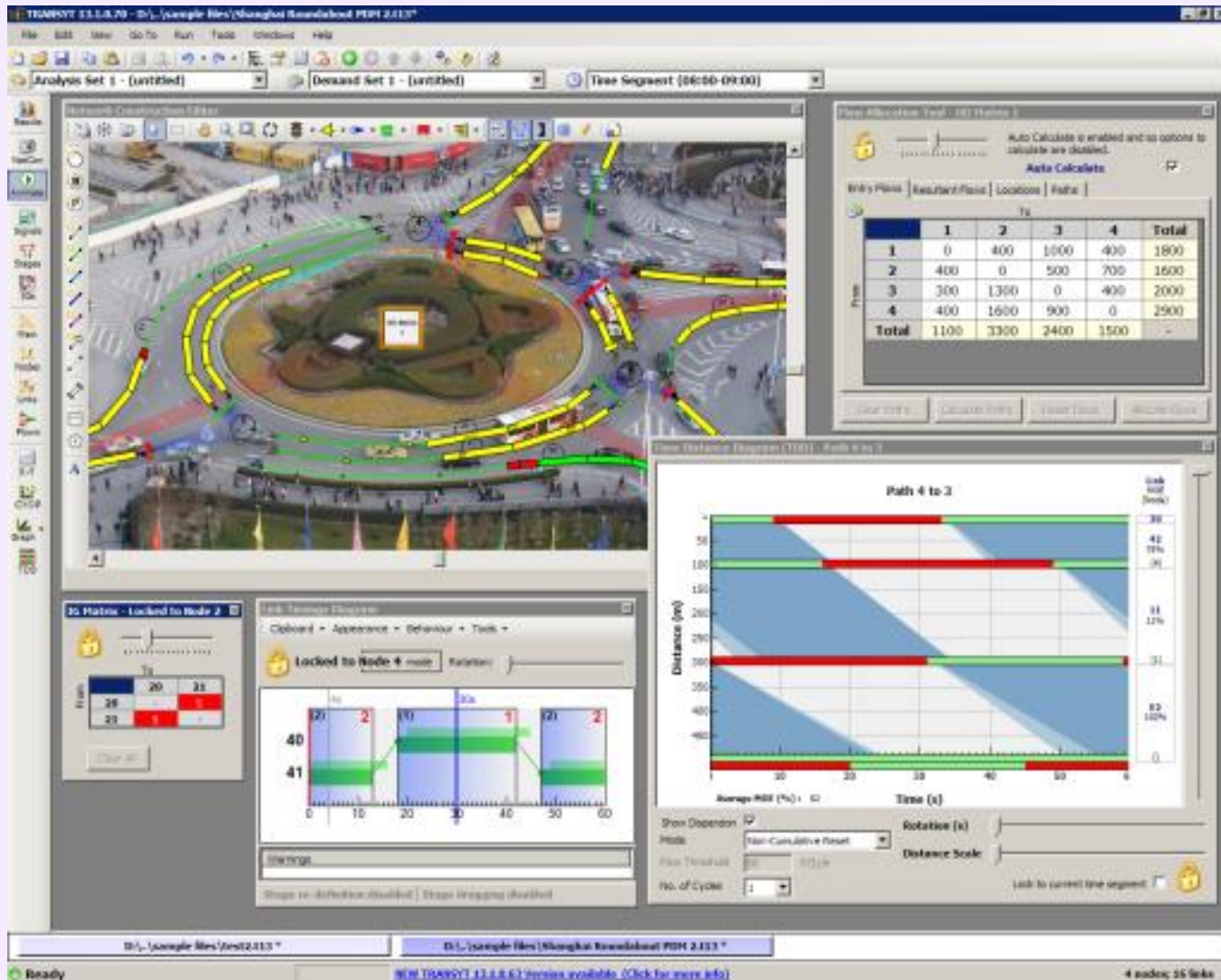
Traffic signal co-ordination for networks and signalled roundabout

It is an off-line computer program for determining and studying optimum fixed-time co-ordinated traffic signal timings in any network of roads for which the average traffic flows are known.

It uses cell-transmission model which is a numerical solution of the hydrodynamic traffic flow model.

Within its core, a traffic model of the network calculates a Performance Index (PI) in monetary terms (based on delays and stops), whilst an optimising routine searches for the timings which reduce the PI to a minimum value - subject to minimum green and other constraints.

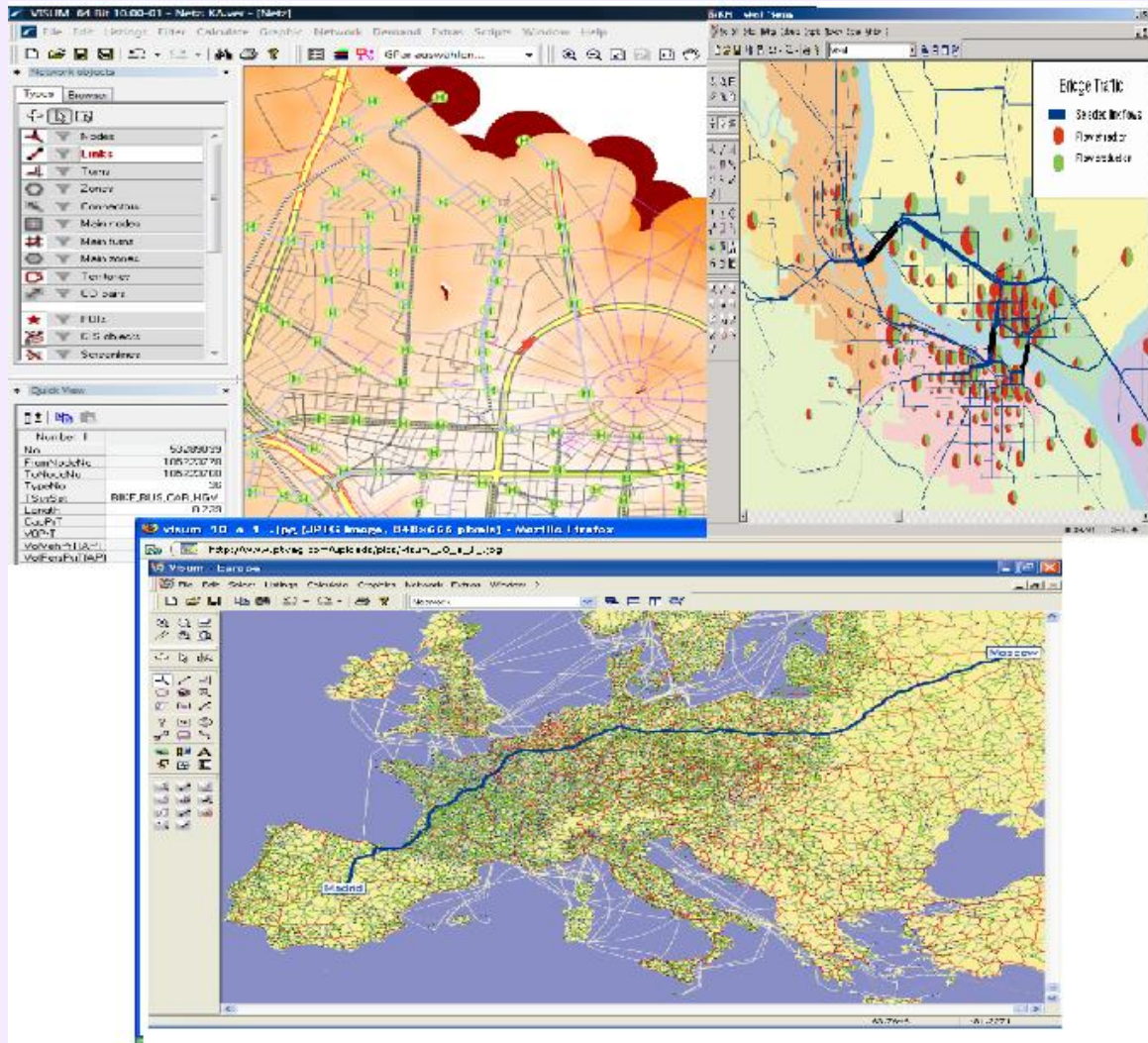
Transyt



VISUM

- VISUM is a comprehensive, flexible software system for transportation planning, travel demand modelling and network data management.
- VISUM is used on all continents for metropolitan, regional, state wide and national planning applications.
- Designed for multimodal analysis, VISUM integrates all relevant modes of transportation (i.e., car, car passenger, goods vehicles, bus, train, motorcycles, bicycles and pedestrians) into one consistent network model.

VISUM



Microscopic Traffic Simulation

- The models, that try to describe the actions and reactions of the particles that make up the traffic as accurately as possible, are called *microscopic models*.
- Dynamic behaviour of individual agents is explicitly simulated over both time and space to generate aggregate system behaviour
- 'Micro' refers to the resolution at individual vehicle level – inevitable requirement of detailed analysis

Objectives

- From model designer point,
 - Quantify the benefits of Intelligent Transportation Systems (ITS), primarily Advanced Traveller Information Systems (ATIS) and Advanced Traffic Management Systems (ATMS)
 - Evaluation prior and in parallel with on street operation

Modelled features of traffic

- study of dynamic traffic control
- incident management schemes
- real-time route guidance strategies
- adaptive intersection signal controls
- ramp and mainline metering
- toll plazas and lane control systems (lane use signs, electronic toll collection, high occupancy vehicle lane, etc.)
- assessing the impact and sensitivity of alternative design parameters

Basis of Microsimulation

- Car-following model
- Lane-changing model
- Gap-acceptance model
- Lane-choice model
- Models of intersection controls

Car-following models

نماذج تتالي العربات (العربة التالية)

- نماذج لسلوك تتابع العربة بشكل فردي ضمن تيار واحد لحركة المرور (حارة مرور واحدة) بدون إمكانية التجاوز،
- تفترض هذه النماذج أن هناك علاقة بين العربات ضمن مجال تداخل المسافات الذي يؤخذ من ٠ إلى ١٠٠-١٢٥ متر،
- يتم اعتبار كل سائق في تتالي العربات كعنصر تحكم فعال ويمكن التنبؤ بوضعه ضمن نظام سائق - عربة - طريق.
- Models of individual vehicle following behaviour
 - In a single stream of traffic (lane disciplined)
 - No overtaking

The car following behaviour controls the motion of the vehicles.

The models assume that there is a correlation between vehicles in a range of inter-vehicle spacing, from 0 to about 100 to 125 meters.

Each driver in a following vehicle is supposed to be an active and predictable control element in the driver-vehicle-road system

VISSIM

- VISSIM is a microscopic, time step and behavior based simulation model developed to model urban traffic and public transit operations.
- The program can analyze traffic and transit operations under constraints such as lane configuration, traffic composition, traffic signals, transit stops, etc.
- The traffic simulator in VISSIM is a microscopic traffic flow simulation model including the car following and lane change logic.

Information obtained from VISSIM

- Travel Time data (for a single link, route, node or for the entire network)
- Capacity and Saturation Flow data
- Delay and Queue data (Average queue length, total queue length and location of queues)
- Traffic Counts (Probably by vehicle type and time period at various locations)
- Journey Time and Speeds

Examples in 2D

- Non-signalised intersection modelling
- Signalised intersection modelling
- Roundabout modelling
- Pedestrian modelling

Examples in 3D

- Intersection modelling
- Roundabout modelling
- Public Transport Priority modelling
- Parking modelling