

City Mobility Simulator

A high-performance digital twin solution for city-scale transport systems





What is **Simulation?**



Simulation is the abstraction and reduction of the real world in a computer program. High-detail simulations create digital twins – virtual testbeds to develop solutions to real-world problems in a cost and time-efficient manner.

Simulations enable the analysis of "what if" questions as well as insights into otherwise unavailable metrics. Microscopic simulators such as CityMoS are able to capture the complex interactions of simulated entities, and are considered the more powerful tool over static system analysis.



What is Mobility Simulation?

Mobility simulation aims at replicating movement patterns of people in a region. In contrast to classic traffic simulation, which primarily focuses on traffic-related aspects such as throughput or average speeds, mobility simulation also takes into account the individual person, and tries to represent their respective short and midterm travel patterns as well as route and mode choices.

Mobility simulation is useful to solve a range of urban challenges, such as "what if 100% of all vehicles were electric?" or "what is the effect on passenger travel times if the subway system is disrupted?".





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What is CityMoS

CityMoS, the **City Mo**bility **S**imulator, is a highperformance, multi-core, agent-based, microscopic mobility simulator capable of simulating city-scale transport systems at high resolution, including private, public, and commercial transport.

CityMoS has been and can be used to support the transition to electric vehicles, the design of novel intelligent transport system solutions, the introduction of new modes of public transport, or the mitigation of traffic emissions such as carbon dioxide or heat. Contrary to existing traffic simulators, CityMoS focuses not only on traffic patterns but on the mobility of individuals, that is, trip chains, activities, and mode choices.

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Our Competitive Edge

Why Choose CityMoS

CityMoS utilises a modern computer science approach to push back the frontiers of microscopic simulation by balancing accuracy, scalability, and performance.



CityMoS includes many participants of the transport system, private vehicles to public transport. Advanced models for motion, comfort, energy, and safety grant detailed and holistic insights into the performance of the transport system.

Unlike other high-detail mobility simulators, CityMoS can simulate mobility at city and state scale. This enables insights into how local changes can have system-wide effects. CityMoS can also deliver highfidelity results for large-scale highway networks.

PERFORMANCE

CityMoS does not require expensive supercomputers to provide performance. It runs on consumer hardware to master challenging simulation scenarios. Results for an entire week of large vehicle populations are ready in only a few hours.

Application Areas

Tackling the mobility challenges of today and tomorrow





Application Areas of CityMoS



APPLICATION AREAS



Holistic Transport System Evaluation and Exploration





Analysing Private, Public, and Commercial Transport

- Extracting metrics that may not be accessible in the real world such as travel times, waiting times, change of transport mode, energy consumption, etc.
- Studying the effect of alterations to the road network such as adding or removing roads, changing speed limits, varying traffic light programs, etc.
- Simulating extreme events such as accidents, road blockages, and increased traffic caused by special events

Detailed Public Transport Simulation

- Testing the effect of different schedules, headways, or vehicle capacities
- Studying the impact of new bus lines, railway lines, or completely new modes of transport
- Analysing and mitigating effects such as bus bunching or unmet passenger demand



APPLICATION AREAS

Greener Transport Systems



Transport System Electrification

CityMoS can analyse spatiotemporal energy consumption and charging demand. CityMoS supports the planning of charging infrastructure, resources, and incentive policies. It can also help strategise the electrification of the public transport system by identifying the bus lines which can be electrified and the impact of taxi/private hire car fleet electrification.



Environmental Aspects

CityMoS can be used to accurately study mobility-related environmental parameters on a city-scale such as fuel consumption, emissions of pollutants (e.g. CO₂ or NO_x), and heat caused by traffic. Additionally, CityMoS serves as a simulation tool to study the impact of alternative fuels such as hydrogen to support more sustainable transport.



Holistic Analysis

CityMoS can be integrated with other models to study the effects of, e.g. weather or complex human behaviour. It can be coupled with other software such as power systems simulators. This enables CityMoS to examine if the underlying electric grid can support the demand caused by electric vehicles, and in turn support charging infrastructure planning.

CityMoS

APPLICATION AREAS

Commercial Fleet Analysis

Operation Optimisation

Logistics & Traffic Management

- Evaluating different vehicle-to-task assignment strategies
- Examining different fleet compositions
- Inspecting rebalancing strategies, effects of demand prediction, etc.
- Analysing refuelling/charging strategies



Charging & Energy Management

- · Charging strategy for commercial vehicles
- Studying the potential benefit of decentralised energy storage (e.g. second-life batteries)
- Feeding in of depot-based renewable energy (e.g. PV panels)
- Analysis of specialised task assignment with the consideration of range limitations and charging requirements
- Smart charging and vehicle-to-grid communication

Fleet Performance



- Evaluation of holistic operation metrics
- Costs for fuel and energy
- Task completion times and delays
- Environmental aspects



APPLICATION AREAS

Intelligent Transport Systems





Case Studies

CityMoS can be utilised to serve different needs. With its enhanced capabilities, CityMoS can reflect complex real-world scenarios and solve related mobility challenges.



HOLISTIC TRANSPORT SYSTEM EVALUATION & EXPLORATION

Large-Scale Modelling of Electric Public Bus Operation and Charging

CityMoS comprises a comprehensive model of mixed-fleet public bus operation and charging. It provides highly detailed insights into the energy demand, battery state, and charging demand of e-buses for an entire bus transportation network, down to the level of individual vehicles and charging stations.



GREENER TRANSPORT SYSTEMS

Singapore Integrated Transport & Energy Model

SITEM supports Singapore's planning for the transition to electric vehicles nationwide. SITEM is used to conduct a comprehensive analysis of projected EV charging patterns and energy demand, while integrating multiple aspects of mobility and energy modelling, including movements of individual vehicles, drivers' charging decisions, and the interaction of EV charging demand with electricity grid capacity.



Case Studies

CityMoS can be used in various application areas. With its powerful features, CityMoS delivers the answers to a wide range of mobility related what-if questions.



GREENER TRANSPORT SYSTEMS

Traffic Emission Modelling for Singapore

Cooling Singapore, a program by the Singapore ETH Centre in collaboration with NUS, TUMCREATE, SMART, SMU and CARES, focuses on tackling the urban heat island effect – the artificial warming in cities caused by humans and man-made infrastructure. With CityMoS, we modelled to what extent traffic contributes to an increased temperature in Singapore.



COMMERCIAL FLEET ANALYSIS

In the City Logistics Charging Project (CiLo Charging), CityMoS is used to support the planning of a newly built logistics terminal. CityMoS serves as a digital twin to study potential fleet compositions, different task assignments, evaluation of charging management, as well as the feasibility of the approach with respect to available power grid capacity.

Product Offerings

Product features, track record, and collaboration opportunities





Capabilities of CityMoS

PRIVATE TRANSPORT

- Private vehicles (electric and ICE cars, motorbikes) with individual trip chains
- Demand: zonal, activity-based itineraries, flows
- Routes: OD only, way points, fully defined routes

PUBLIC TRANSPORT

- Buses (stops, termini, depots), dispatching, off-duty trips
- Trains (lines, stations), transfer between lines
- Individual multi-modal passengers with origins and destinations, mode choice

FLEETS AND COMMERCIAL TRANSPORT



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- Taxi fleets (depots, stands), multi-shift, passenger demand
- Private hire vehicles
- Commercial fleets and depots (e.g. logistics, carriers)

COMPOSABLE MODEL DESIGN

- Adjustable driver behaviour models (car following, lane changing, charging, etc.)
- Vehicle component models (engine, battery, fuel)

CITYMOS SUITE: POWERFUL CREATION AND EDITING TOOLBOX

- User-friendly, graphical editor to maintain simulation scenarios
- Road networks, traffic lights, travel demand, infrastructure, models, etc.

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CALIBRATION

- Powerful graphical tool to calibrate simulation parameters for realistic simulation
- Calibrate driver behaviour, travel demand, traffic assignment

EV/ ROAD INFRASTRUCTURE

- Static, time-tabled, dynamic traffic lights
- Charging infrastructure to study effects of vehicle electrification
- Detectors and sensors (e.g. induction loops)

DATA INPUT/OUTPUT

- Input data conversion (SUMO, XODR, Shape Files, VISSIM)
- Highly configurable data output (SQLite, PostgreSQL, CSV)
- Coupling with other simulators (TraCl, gRPC)



DATA VISUALISATION

- Interactive 3D environment for live monitoring and control
- Overlay of statistics, heatmaps, road colouring, vehicle information
- Keyboard and mouse, touchscreen capabilities



CityMoS and CityMoS Suite

The CityMoS Suite is a powerful and easy-to-use toolbox to create, edit and configure CityMoS simulation scenarios.



INPUT AND PREPARE SCENARIO

CityMoS Suite

Road networks, travel patterns, simulation parameters and calibration - all accessible via a graphical user interface.



RUN AND VISUALISE SCENARIO

CityMoS

CityMoS can be run both remotely or on a local machine. CityMoS provides a modern 3D visualisation for instant visual feedback and easy demonstration.



Features of CityMoS Suite



Network Editing

- Map overlay from Google Maps, OpenStreetMap, or custom tile servers
- Visualisation of different topology, connections, terrain levels
- Creating and editing traffic lights, bus lines, bus stops, and routes



Interoperable

Importing networks from SUMO, Vissim, OpenDrive, and ESRI Shapefiles



Travel Demand

• Creating different types of travel demand (e.g. zonal demand, flows, trips, etc.)



Calibration

• Calibration tool to automatically calibrate model parameters (e.g. driver behaviour or route choices)



Configuration

- Editing buildings and other visual features to be shown in the 3D version of CityMoS
- · Specifying used models and parameters
- Setting output metrics and formats



Seamless Process

Output Formats

The simulation output is supported in a variety of formats, such as SQLite, PostgreSQL, and CSV. Enjoy the flexibility to select what best serves your needs.





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Seamless Process

Supported Input Formats

- SUMO Road Networks, Traffic Demand, and Traffic Lights
- Vissim Road Networks and Traffic Lights
- OpenDrive Road Networks
- ESRI ShapeFiles





the mind of movement







ROAD NETWORKS



TRAFFIC LIGHTS



TRAFFIC DEMAND



SHAPEFILES

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Collaboration Opportunities

Utilise our powerful simulator in your work. Here are some ways we can collaborate:

License Agreements

- License Only
- Assisted License

CityMoS is operated through a commercial license. Tier 1 support (basic assistance) or Tier 3 support (in-depth technical assistance and guidance) is offered.

Simulation Studies

- Scenario Studies
- Full Study
- Tailored Study

The simulation is created based on provided requirements and respective input data. The simulation is run and evaluated, and a final report can be prepared.

Partnerships

Joint R&D Lab

A joint R&D lab fosters a close longterm relationship which focuses on in-depth R&D to grant our partner a specialised version of CityMoS, tailored to their digital twin.

Track Record

Awards Received



Borderless Silver Award 2022 Firefly Awards by the Ministry of Trade and Industry (MTI), Singapore

Best Contributed Applied Paper Award

2020 IEEE/ACM Winter Simulation Conference

Best Paper Award

2018 ACM SIGSIM Conference on Principles of Advanced Discrete Simulation (PADS)

Best Paper Award

2018 IEEE International Symposium on Distributed Simulation and Real-Time Applications (DS-RT)

Industry Partners Government Partners Academic Partners





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