Simulating Connected and Autonomous Vehicles and Infrastructure Design

– Utilising Deep Reinforcement Learning

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AITPM National Technical Partner Webinar 2022/23:

Beyond Cars – Modelling the Integrated Future of Mobility

Dave Keenan
Regional Head - Business Development – Aimsun Pty Ltd

Tuesday 14th March 2023

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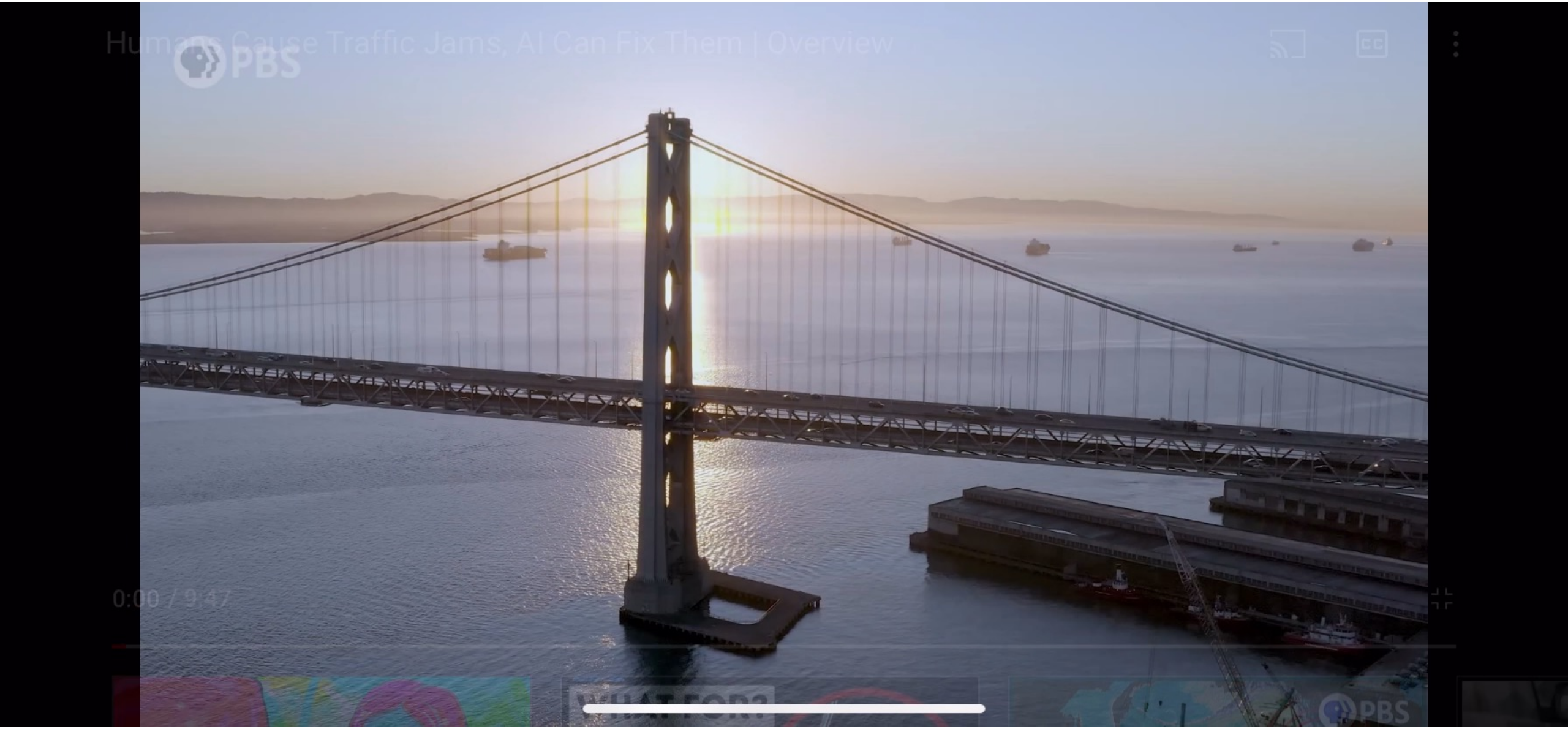


Opening Overview Video above – Full video from which this is extracted is here: https://youtu.be/WMRziLak2Zo
(Play from start on YouTube for the 1-minute video excerpt as featured in Aimsun's overview presentation)

Transportation Modelling and Simulation

– *Changing the Conversation*

- Modelling, and particularly traffic simulation, has been extensively used and proven for “Planning” purposes
- Perhaps it could be argued, less so, in the realm of ITS
- *BUT* – The conversation is beginning to change
- The use and the value of traffic simulation in ITS is being increasingly realised
- This session aims to engage this conversation further – In overview:
  - A brief summary of Aimsun – Our company, software and services
  - A brief summary of our software solutions
  - A presentation and discussion of real-life case studies in which Aimsun, and Aimsun services, are leading in this exciting charge in a global sense

Aimsun

Aimsun is an international leader in mobility planning and transportation management technology.

Founded in Barcelona in 1997

36 years of modeling and simulation research and development

Part of Yunex Traffic Group

Focus Areas:

- Strategic transport planning
- Traffic engineering
- Mobility management
- Autonomous vehicle testing

Worldwide Customers

Aimsun is active in over 100 countries worldwide, working with government agencies, private companies and research institutions.

national highways

WIESBADEN

MAIRIE DE PARIS

NEW YORK CITY DOT

دائرة النقل
DEPARTMENT OF TRANSPORT

Stantec

Transport for London

wsp

Jacobs

OXFORDSHIRE COUNTY COUNCIL

AECOM

Berkeley
UNIVERSITY OF CALIFORNIA

NSW GOVERNMENT Transport for NSW

Land Transport Authority

Massachusetts Institute of Technology

Government of South Australia
Department for Transport, Energy and Infrastructure

Technische Universität München

Aimsun Awards (2021 - 2022)

مركز النقل المتكامل
INTEGRATED TRANSPORT CENTRE

- ITC Abu Dhabi Certificate of Appreciation, 2021
- ITC Abu Dhabi Certificate of Excellence, 2021

ITS United Kingdom
Better transport through technology

Winner of the 2021 ITS UK Award for Innovative Use of Technology

TechWorks

Winner of the 2021 TechWorks Green Technology Award

itsaustralia
Intelligent Transport Systems

Winner of the ITS Australia Awards 2021 for Smart Transport Infrastructure

INTELLIGENT TRANSPORT SYSTEM
ITS ESPAÑA

ITS España 2022 award in the ITS & Smart Cities category

MASTERS OF MODELLING AWARDS 2022

The Masters of Modelling Awards: Lifetime Achievement Award and New Master of Modelling Award

Aimsun - Areas of Activity

Mobility planning for cities, motorways and regions

Real-time transport management

Connected and autonomous vehicles

Shared mobility

Aimsun - Areas of Activity

aimsun.next

Aimsun Next simulates future traffic patterns **offline** by accurately representing individual needs and available city-wide transportation options.

aimsun.live

Live simulates mobility in real time, allowing traffic managers to anticipate congestion on our roads and stop traffic jams before they happen.

aimsun.auto

Aimsun Auto is a new software platform for large-scale testing of path planning algorithms for **autonomous vehicles**.

aimsun.ride

Aimsun Ride is a demand-responsive transportation platform that simulates and analyzes the efficiency of flexible mobility services.

Aimsun Next:
Mobility planning for cities, freeways, tollways and regions

Simulating future traffic patterns:

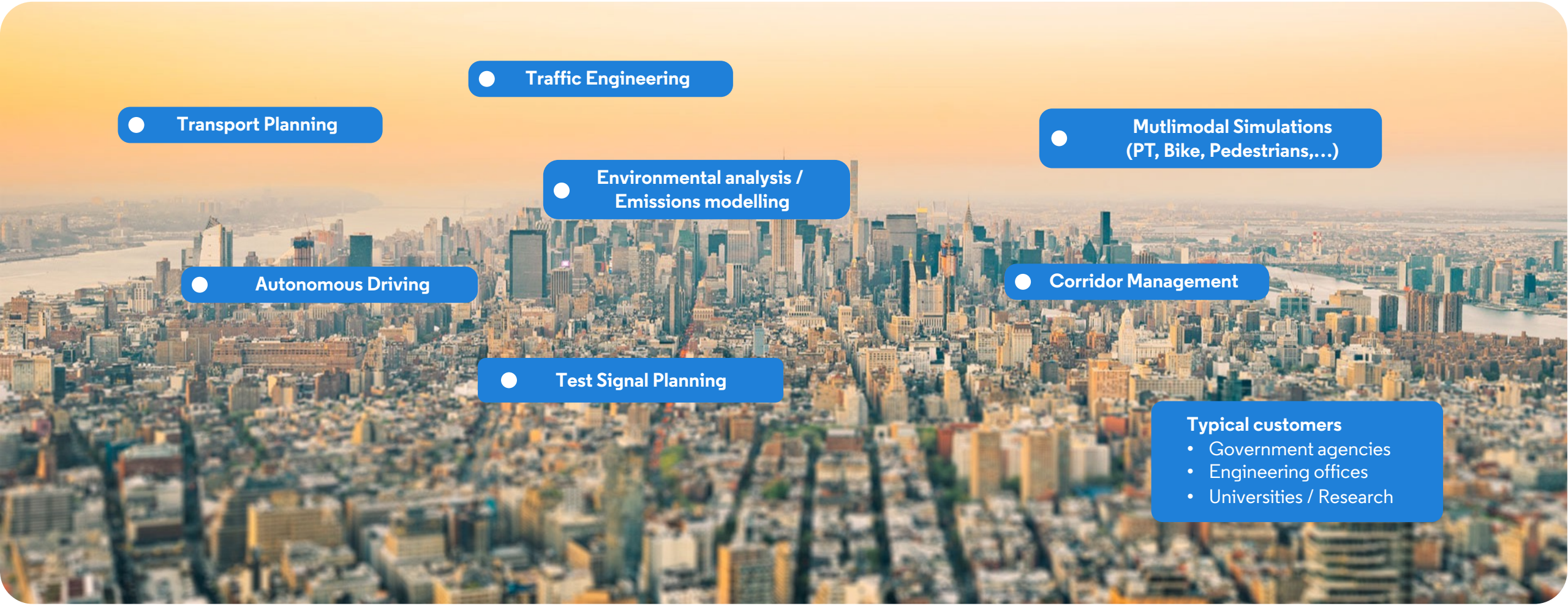
- Offline
- Accurately representing individual needs
- Accurately representing available city-wide transportation options.

Goal:

Consistent simulation of mobility, on all levels, in a single integrated platform

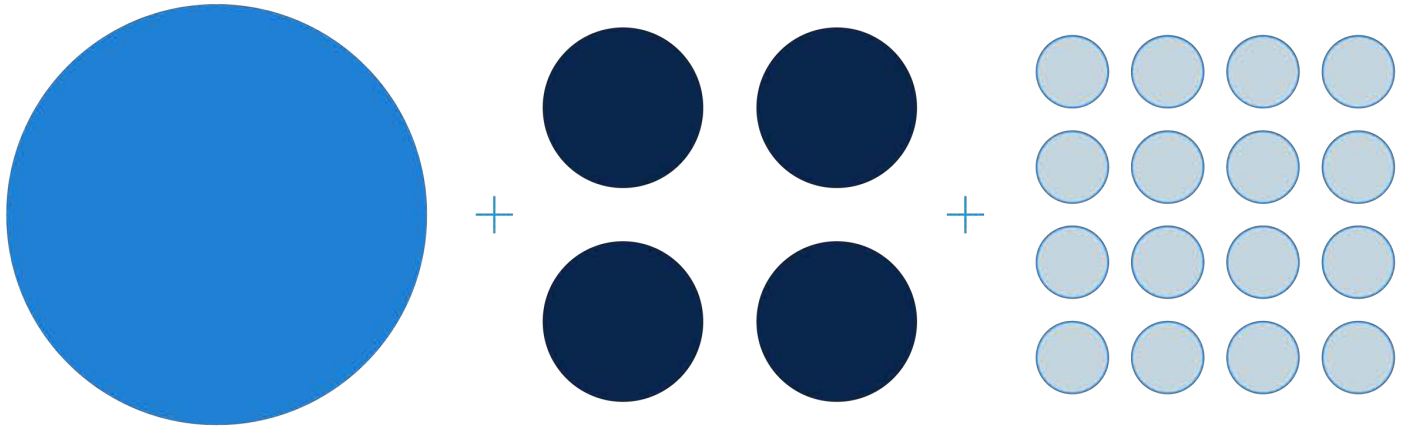
Mobility planning for cities, motorways and regions

Application fields

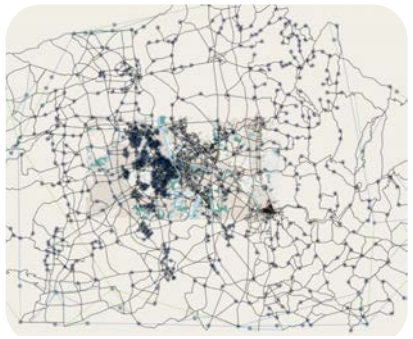


Fully Integrated Models

Legacy Approach

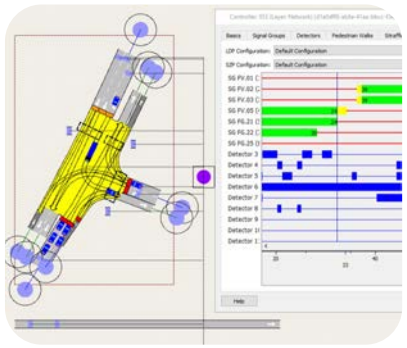


Macroscopic Level



Mesoscopic Level

Microscopic Level



The Aimsun Way

All-in-one

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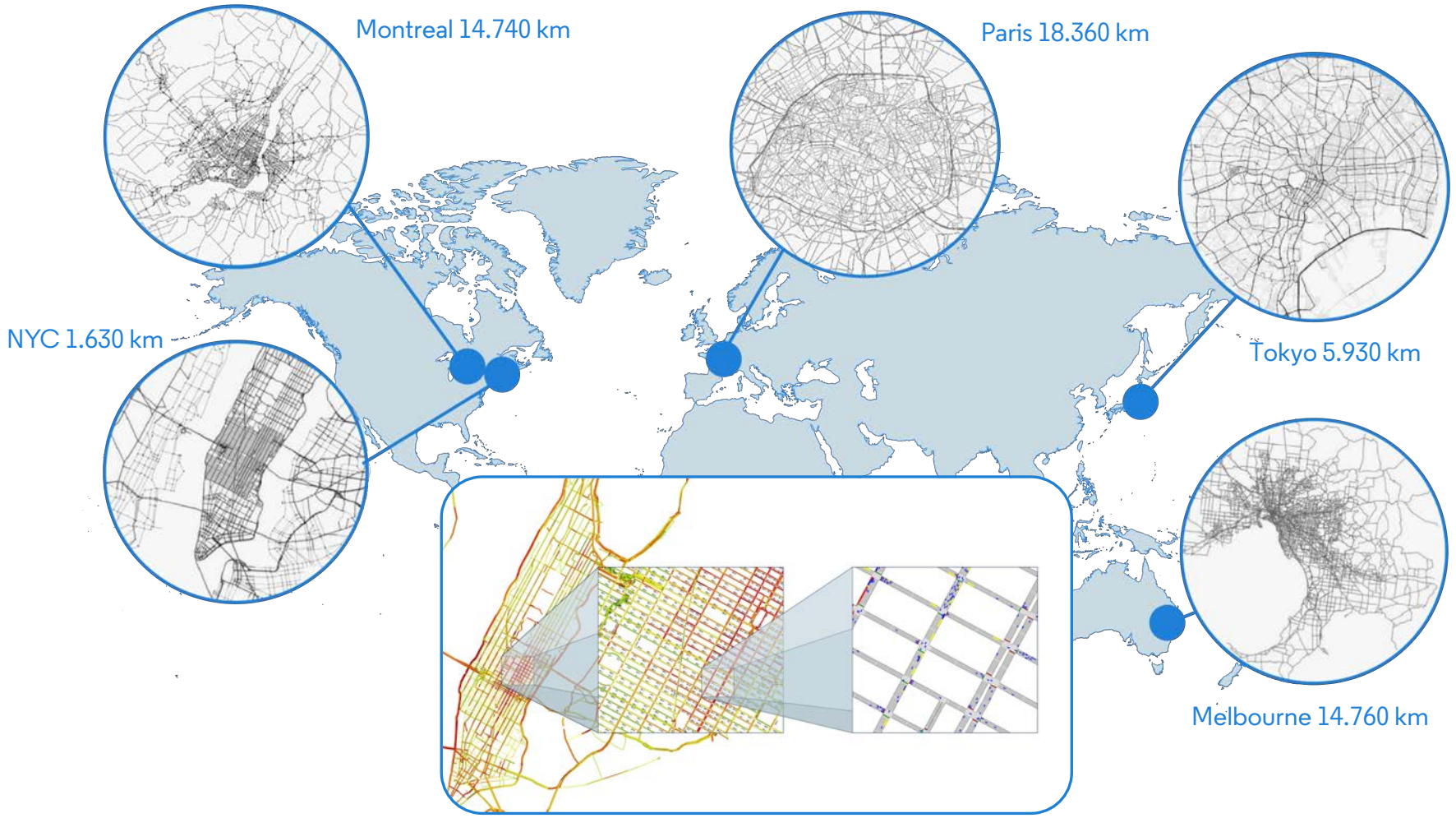
Large-scale, Dynamic Models



Speed / Scalability:

Aimsun handles supersized models without sacrificing speed

New York City:

1,630 km

1.5 million vehicles

14x faster than real-time (mesoscopic)

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Sophisticated Programming and Customisation Capabilities

Scripting

- Python
- Edit the model, access the outputs

API

- Python or C/C++
- Perform actions during a microscopic or mesoscopic simulation

microSDK

- C++
- Implement customized microscopic behavioral model

Introduction to Aimsun Auto

Simulating a “Driverless Future”.

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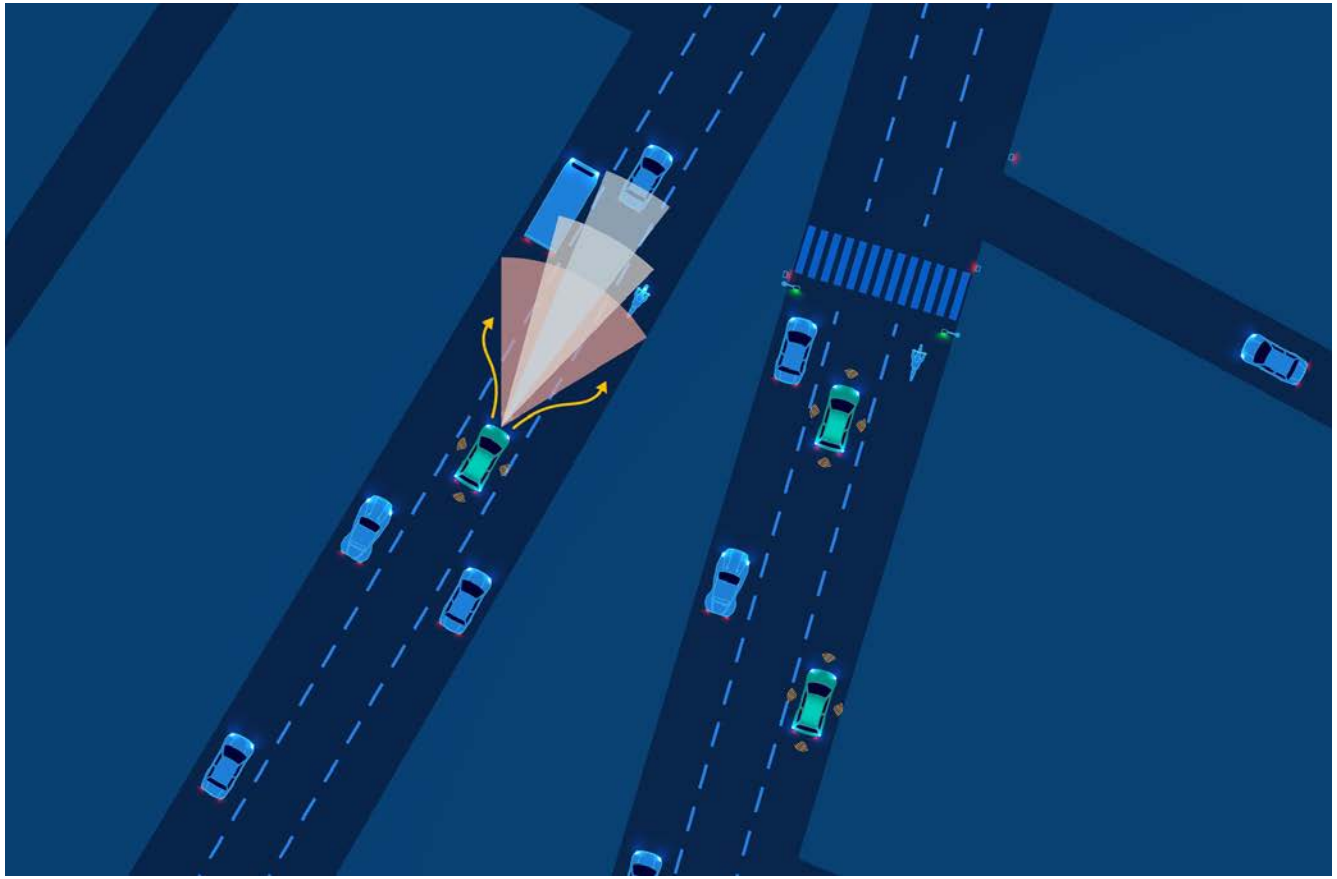
Aimsun Auto performs safe, repeatable, and efficient testing of path planning algorithms for self-driving vehicles on anything from a single intersection to an entire city.

What is Aimsun Auto?

- A software test harness for design and validation of motion planning algorithms for self-driving vehicles
- Perform safe, repeatable and efficient massive-scale testing of autonomy stacks on anything from a single intersection to an entire city
- Used in combination with sensor testing tools, Aimsun Auto provides a full-stack, highly automated and infinitely scalable testing platform
- Customers:
    - OEMs and KI Startups
    - Developers of AV Stacks, AV Test fields



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Why model traffic - Instead of playing (variations of) trajectories?

- Agents around the vehicle under test have more realistic trajectories:
  - They have a reason to behave in a given way
  - The trajectories span across a larger interval
- This is better to test prediction and motion planning:
  - The motion planning is not tricked by unreasonable trajectories over a limited time interval
- Validation of entire trips of the vehicle under test rather than limited parts:
  - Travel time, jerk, compliance to driving rules, not just collision avoidance
- The environment can be used to train AI for motion planning:
  - Variety of situations, reasonable agents
- Multiple vehicles under test can be plugged-in at the same time

Aimsun Auto – Typical Use Cases

- Reaction of vehicles to externally-controlled agents
- Mixed traffic:
  - Vehicles
  - Pedestrians
  - Bikes and motorbikes
- Non-compliant behavior
- High-frequency interface with the driving simulator (10 Hz traffic simulation with interpolation to 100Hz)
- Event detection
- Scenario management
- Windows, Mac and Linux
- Deployment on private clusters or Amazon AWS

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Modelling CAVs with Aimsun Next

Two perspectives

Car Manufacturers, Service Providers

- Implement software for automated vehicles
- Implement services for connected vehicles
- Assess the impact of disruptions in sensors and wireless communication
- Design Mobility-as-a-Service solutions

Public Administration, Road Authorities

- Regulate to drive the technology application towards the utopian scenario
- Assess operational impacts
- Assess mobility impacts
- Traffic management

The role of traffic simulation

Car Manufacturers, Service Providers

- Debugging environment for embedded software
- Virtual testing environment for software (SIL) and hardware (HIL)
- Artificial intelligence training tool
- Platform to optimize and manage a fleet of vehicles, potentially in real-time

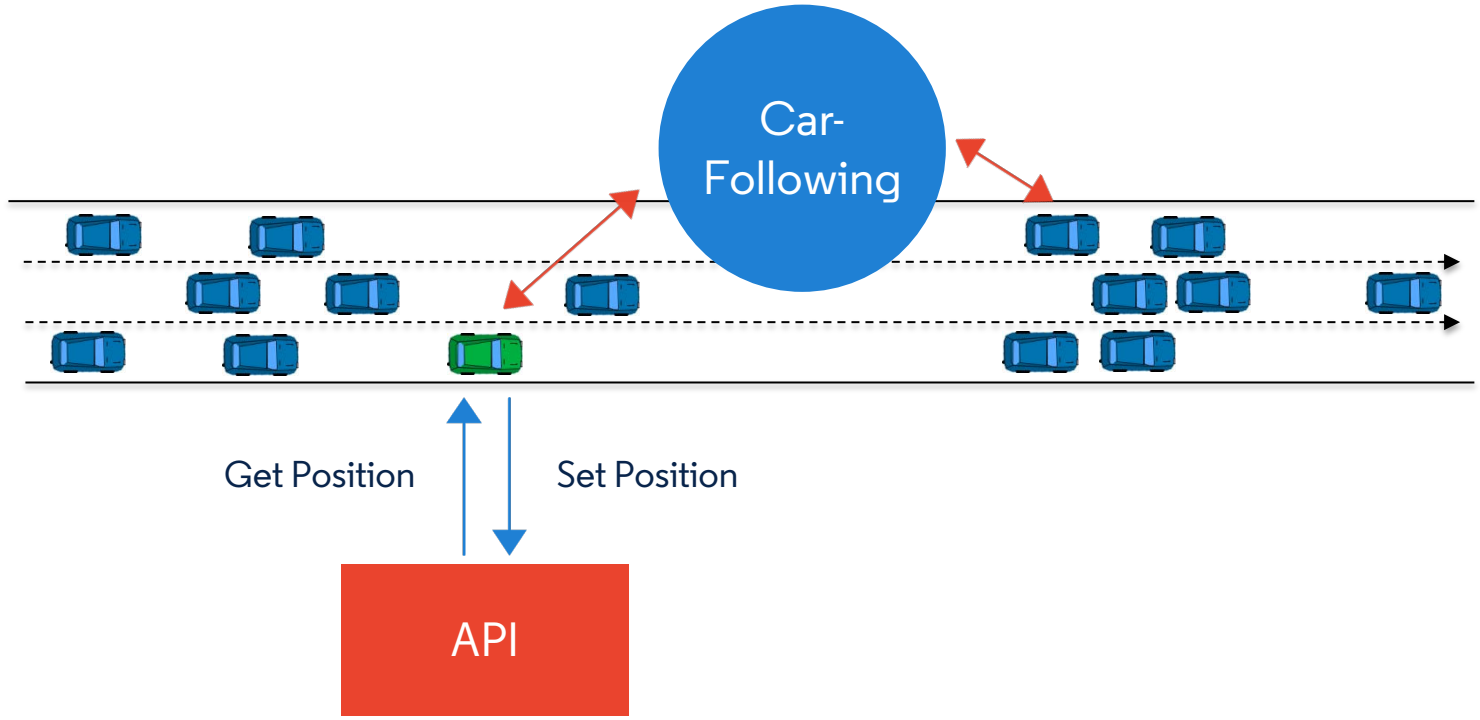
Public Administration, Road Authorities

- Make hypotheses and assess multiple potential scenarios
- Identify investments that perform well under a variety of scenarios, rather than produce the best outcome only under specific conditions

How to model connected and/or automated vehicles

Using API:

- Change of the behavioral parameters during the simulation
- Communication interface that reads and sends information about the vehicles and the infrastructure to an external software and receives back the position and speed of the vehicle



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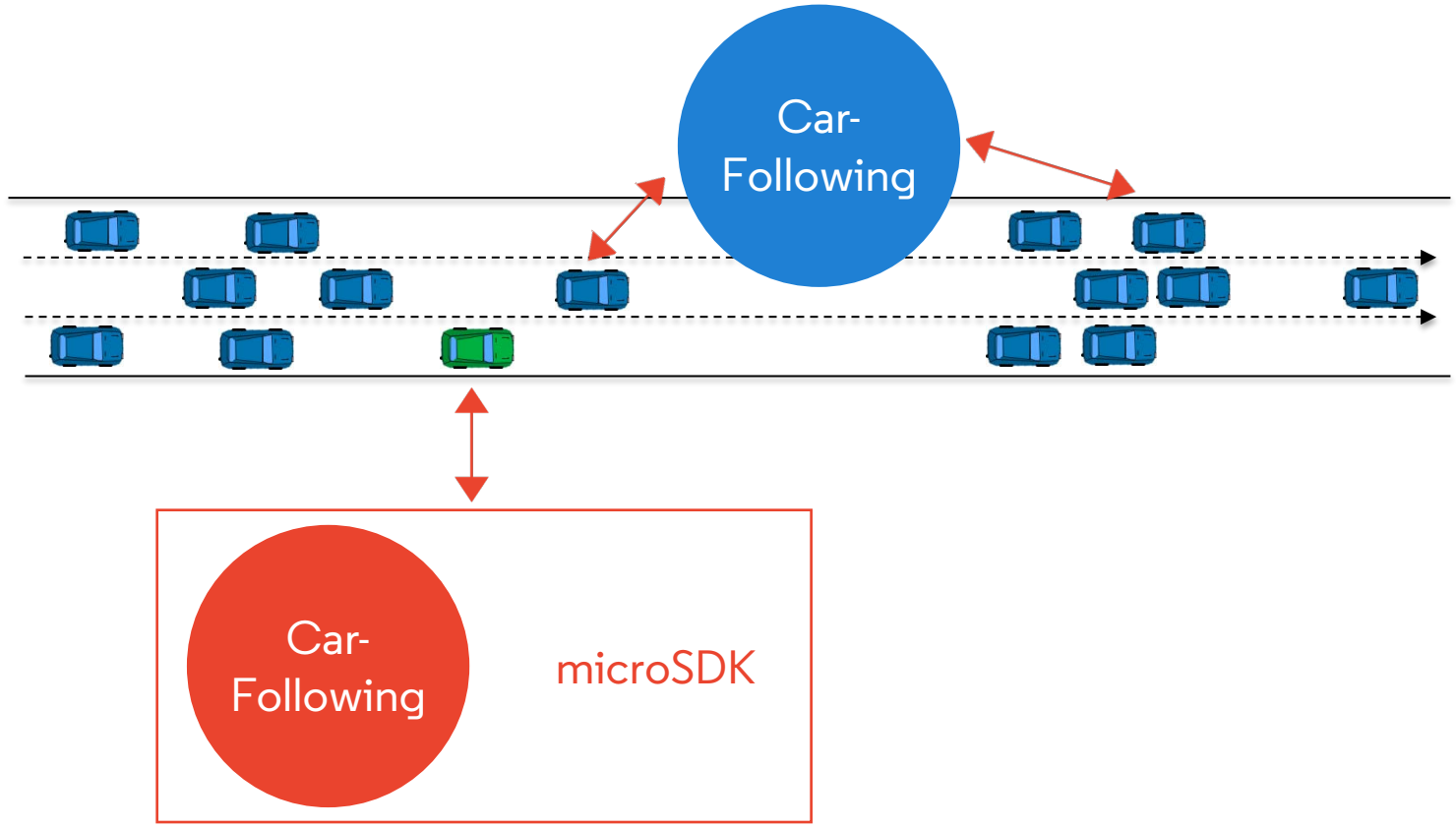
How to model connected and/or automated vehicles

Using microSDK:

- Replace the default car-following, lane-changing and/or gap-acceptance models with custom algorithms
  (The logic is implemented in a DLL run in Aimsun)



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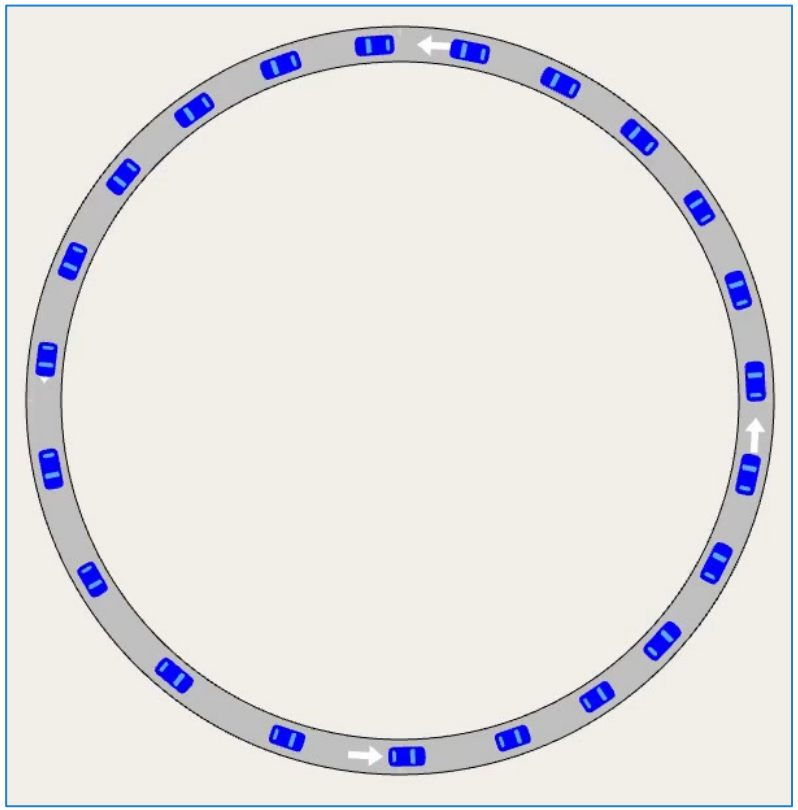
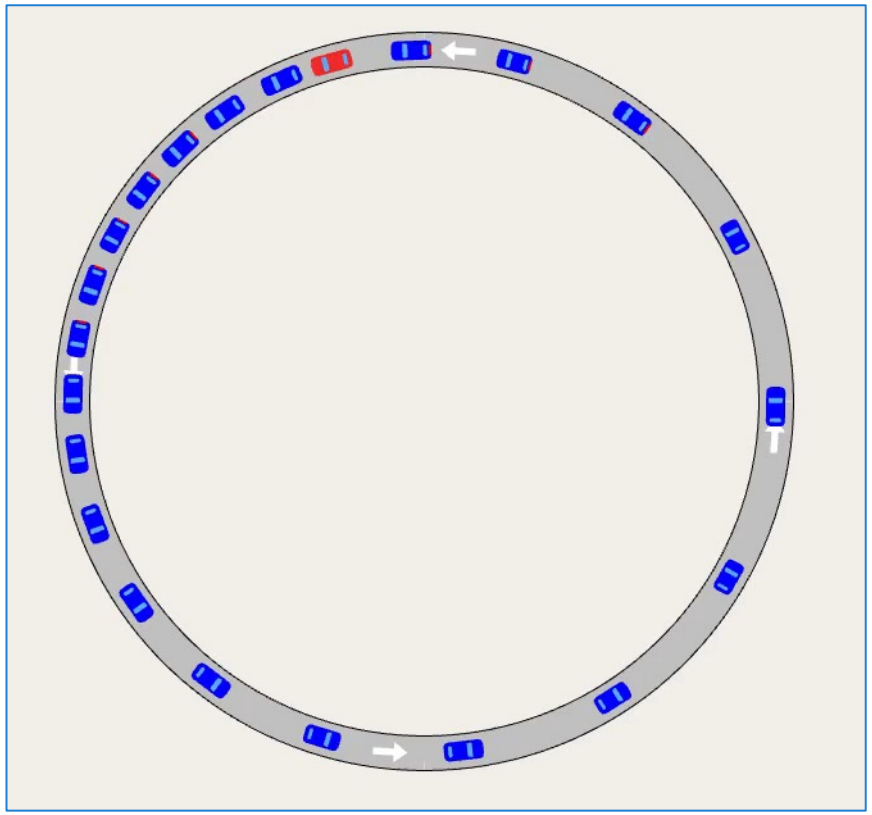
So - What impact can one Autonomous Vehicle (AV) have?



0 AVs, 22 humans



1 AV, 21 humans

AI Control Activated

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ITSBerkeley Institute of Transportation Studies

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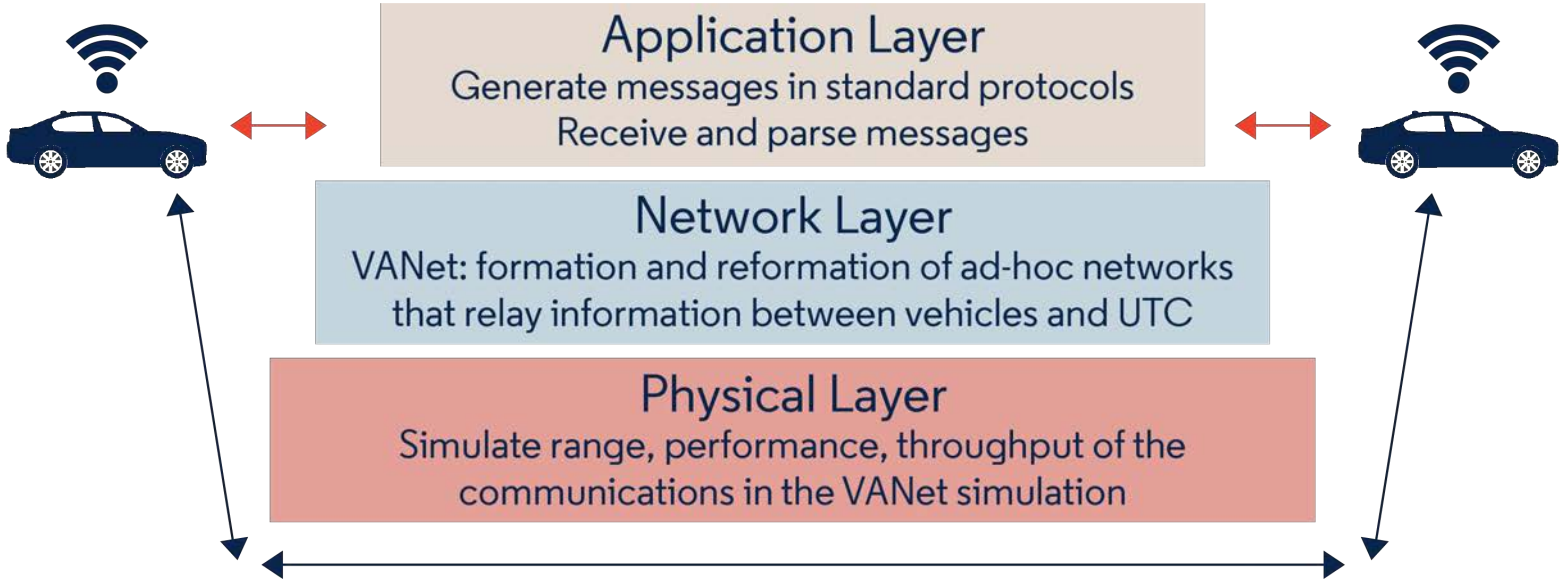
Closing Video Overview above – Full video from which this is extracted is here: https://youtu.be/WMRziLak2Zo
(Go to 4 minutes and 50 seconds for the 2-minute video excerpt as featured in Aimsun's presentation)

A key role for simulation

A platform for developing and testing CV applications

- V2X communication API that
  - Introduces latency and packet loss (physical layer)
  - Creates VANets between connected vehicles and roadside devices within a maximum transmission range
  - Generates and dispatches CAM, DENM, SPATEM/MAPEM messages
  - Allows programming vehicle, local and network rules engines
- Microscopic simulation that models the interaction between vehicles



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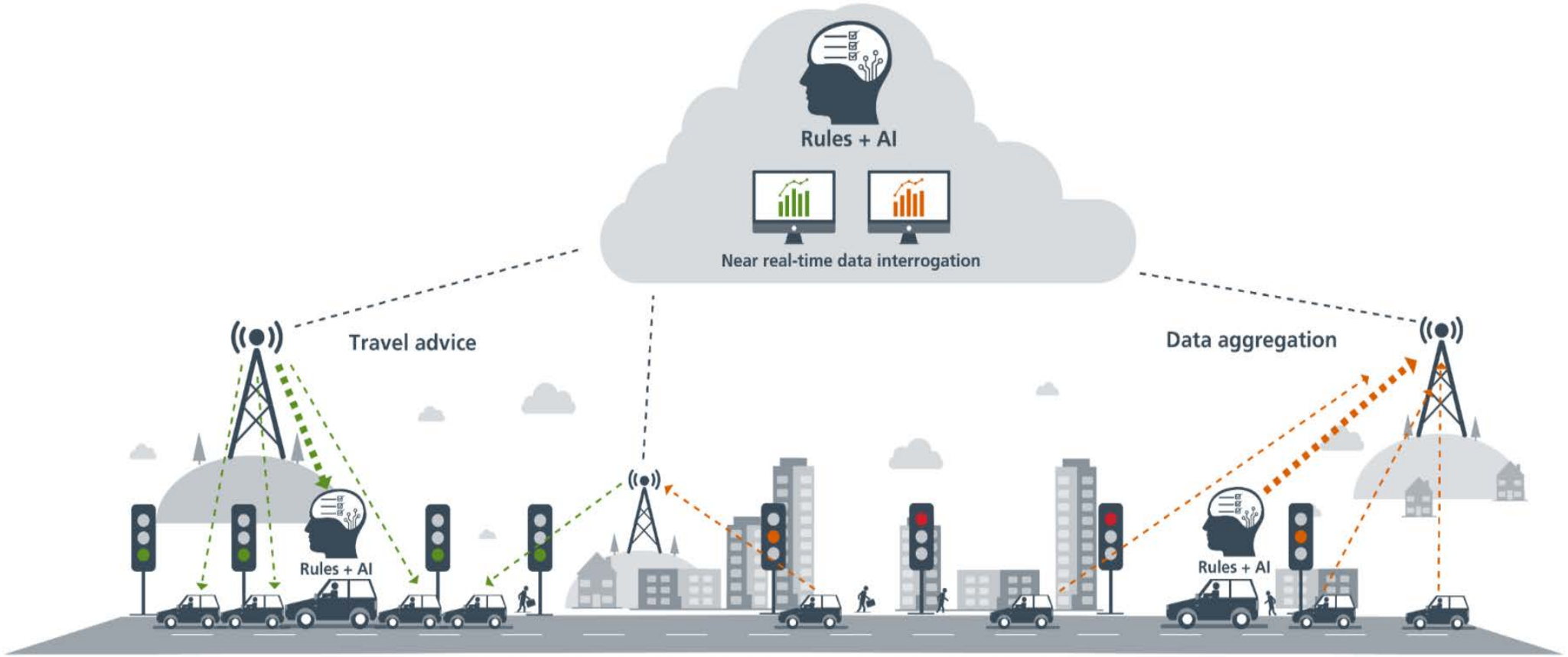
A key role for simulation

A tool to train AI algorithms aimed at achieving a network-wide optimum by routing CVs

- Programmatic creation and simulation of multiple scenarios



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