

# AGENT

*Demand modelling platform and key applications*

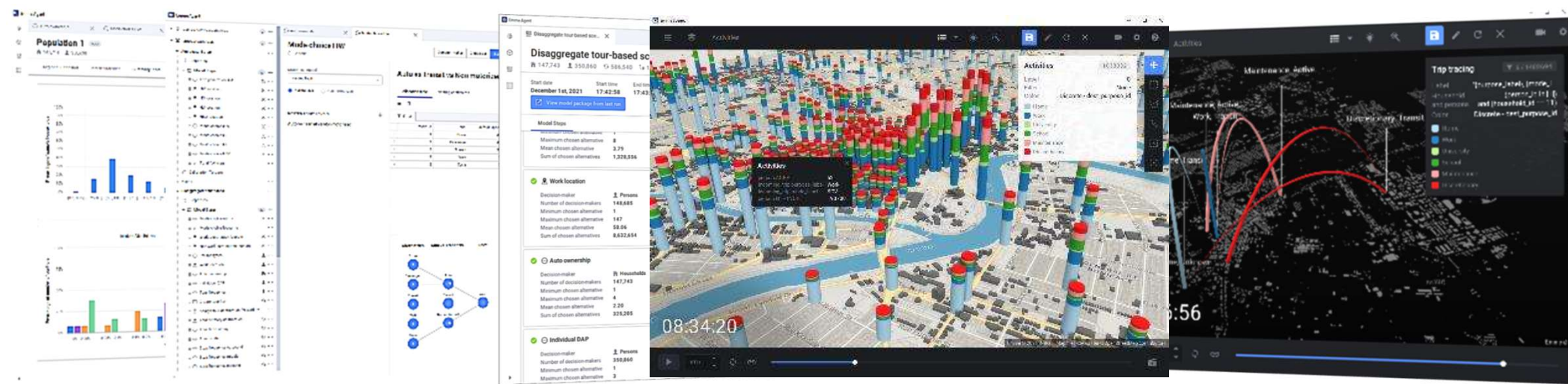
Gaurav Vyas

Product Manager, Bentley Systems

© 2024 Bentley Systems, Incorporated

**Bentley**<sup>®</sup>

# AGENT is a platform to assemble, calibrate and apply travel demand models



- Assemble virtually any travel demand model structure from 4-step to ABM
- Enjoy transparent access to a full travel demand model UI
- Maintain different model structures or versions in parallel
- Upgrade and advance models over time with new features

### Four-step

This screenshot shows the 'Aggregate four-step' model structure. It includes a 'Properties' section and a 'Model Steps' section with the following items:

- Trip generation AM
- HW location
- HS location
- HU location
- HBO location
- Mode choice HW
- Mode choice HS
- Mode choice HU
- Mode choice HBO
- Total AM trips

At the bottom, there is a 'Calibration Targets' section.

### Hybrid

This screenshot shows the 'Hybrid' model structure. It includes a 'Properties' section and a 'Model Steps' section with the following items:

- Mode choice utility
- Mode choice logsums
- Work destination logsum
- Non-work destination logsum
- Person types
- Auto ownership
- Individual DAP
- Home-based trip frequency
- Aggregate trips
- Trip distribution for work
- Trip distribution for university
- Trip distribution for school
- Trip distribution for maintenance
- Trip distribution for discretionary
- Mode choice for work
- Mode choice for university
- Mode choice for school
- Mode choice for maintenance
- Mode choice for discretionary
- Time-of-day split

At the bottom, there is a 'Calibration Targets' section.

### Simple ABM

This screenshot shows the 'Disaggregate tour-based' model structure. It includes a 'Properties' section and a 'Model Steps' section with the following items:

- Mode choice utility
- Mode choice logsums
- Work destination logsum
- Non-work destination logsum
- Person types
- Work location
- Auto ownership
- Individual DAP
- Tour frequency
- Create tour list
- Assign tour destination for work to...
- Tour primary destination
- Tour time-of-day
- Tour mode
- Stop frequency outbound
- Stop frequency middle
- Stop frequency inbound
- First stop outbound purpose
- Second stop outbound purpose
- Third stop outbound purpose
- First stop middle purpose
- Second stop middle purpose
- First stop inbound purpose
- Second stop inbound purpose
- Third stop inbound purpose
- Create trip list
- Tag trip directions
- Trip destination with time-space co...
- Add origin zone id
- Trip mode
- Trip departure

### ABM

This screenshot shows the 'MTC 1\_5 Style' model structure. It includes a 'Properties' section and a 'Model Steps' section with the following items:

- Prep
- Calculate dc size terms
- Compute exponentiated utility
- Compute accessibility
- School location
- Work location
- Add OD relation for home to work
- Calculate person auto savings ratio
- Auto ownership
- Free parking
- COAP
- Mandatory tours models
- Add primary location to tours
- Mandatory tour scheduling
- Joint tour frequency
- Insert joint tours
- Joint tour composition
- Joint tour participation
- Delete non participants
- Joint tour destination
- Add OD relations to joint tours
- Joint tour scheduling
- Assign joint tour information to tours
- Non mandatory tour frequency adults
- Non mandatory tour frequency children
- Insert non-mandatory tours
- Non mandatory tour destination
- Add OD relations to tours
- Non mandatory tour scheduling
- Tour mode choice
- At work tour frequency
- Insert into sub-tours
- At work sub-tour destination
- Add OD relations to sub-tours
- At work scheduling
- At work tour mode choice
- Stop frequency on tours
- Stop frequency on at work tours
- Add frequency attributes for insert into tr...
- Insert into trips



- Assemble virtually any travel demand model structure from 4-step to ABM
- Enjoy transparent access to a full travel demand model UI
- Maintain different model structures or versions in parallel
- Upgrade and advance models over time with new features

Input Schema

**Agent Schema**

Constants

Time of Day

THROUGH-SEGMENTS

Purposes

Modes

Person Types

Daily Activity Patterns

Modes

Person Types

Daily Activity Patterns

CONSTRAINTS

Person Types & Daily Activity Patterns

Purposes & Daily Activity Patterns

Modes & Person Types

**Agent Schema**

AGGREGATE

Zones

Network zones

O-D

TRAVEL

Tours

Sub-tours

Trips

TRAVEL

Tours

Sub-tours

Trips

VEHICLE

Cars

POPULATION

Households

Persons

JOINT TRAVEL

Fully joint tours

Joint tour participants

JOINT TRAVEL

Fully joint tours

Joint tour participants

- Assemble virtually any travel demand model structure from 4-step to ABM
- Enjoy transparent access to a full travel demand model UI
- Maintain different model structures or versions in parallel
- Upgrade and advance models over time with new features

The screenshot shows the Emme Agent software interface. The main window title is "Disaggregate tour-based scenario". Below the title, there are statistics: 147,714 households, 350,607 persons, 587,470 trips, and 1,536,586 trips. The interface displays a data table with a filter set to "person". The table has 6 columns and 6 rows. The first row is the header, and the second row contains numerical data.

househ	Context	person											
1	AGEP												
2	constants												
3	dap												
4	dap ls												
5		4	1	66	0	0	5	2	0	0	0	0	0
6		4	0	60	0	0	5	0	0	0	0	0	0

**Disaggregate tour-based scenario**  
 147,714 350,607 587,470 1,536,586

Start date: December 14th, 2021  
 Start time: 18:20:15  
 End time: 18:21:56  
 Duration: 00:01:40.73

**Model Steps**

- Work location**
  - Decision-maker: **Persons**
  - Number of decision-makers: 148,606
  - Minimum chosen alternative: 165
  - Maximum chosen alternative: 9,438
  - Mean chosen alternative: 709,81981
  - Sum of chosen alternatives: 105,483,483
- Auto ownership**
  - Decision-maker: **Households**
  - Number of decision-makers: 147,714
  - Minimum chosen alternative: 1
  - Maximum chosen alternative: 4
  - Mean chosen alternative: 2.21842
  - Sum of chosen alternatives: 327,692
- Individual DAP**
  - Decision-maker: **Persons**
  - Number of decision-makers: 350,607
  - Minimum chosen alternative: 1
  - Maximum chosen alternative: 3
  - Mean chosen alternative: 1.32967
  - Sum of chosen alternatives: 466,192
- Tour frequency**

### Auto vs Transit vs Non motorized

**Allocation table** Nesting coefficients

	mode_id	label	default_speed
1	1	Driver	45
2	2	Passenger	45
3	3	Transit	35
4	4	Walk	3
5	5	Cycle	5

**Alternatives** Auto vs Transit vs... Root

```

  graph LR
    Driver((1)) --- Auto((0.9))
    Passenger((1)) --- Auto
    Transit((1)) --- Transit((1))
    Walk((1)) --- NonMotorized((0.5))
    Cycle((1)) --- NonMotorized
  
```

### Daily Activity Pattern

Component expression: **dap\_type\_id**  
 Utility specification type: **Wide**

Displaying 22 of 22 rows

	description	agent_filter	agent_expression	(dap_type_id) == 1	(dap_type_id) == 2	(dap_type_id) == 3
17	High income hhs	person_type == 7	hh.HINCF > 75000	0.000000	0.000000	-0.100000
18	High income hhs	person_type == 8	hh.HINCF > 75000	0.000000	0.000000	-0.100000
19	Number of cars		hh.num_cars	0.000000	0.000000	-0.300000
20	Linear age		AGEP	0.045000	0.000000	0.000000
21	Age squared		AGEP * JGEP	-0.000500	0.000000	0.000000
22	non work accessibility		hh.network_zone.non work dest 1s	0.000000	0.150000	0.000000

### Calibration Targets

Displaying 4 of 4 rows

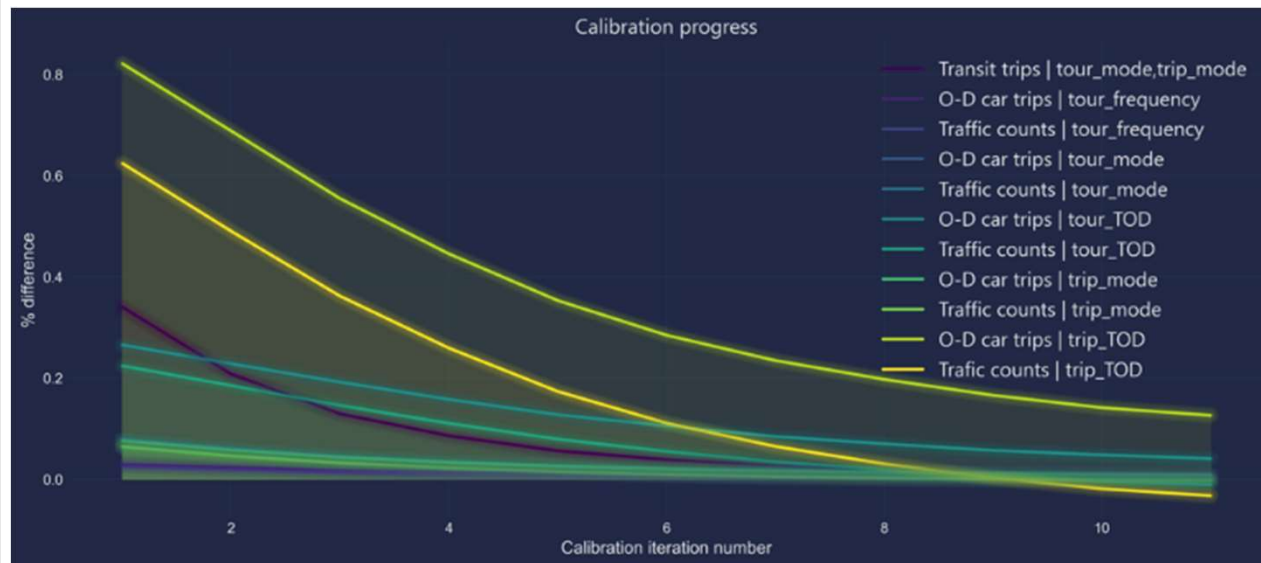
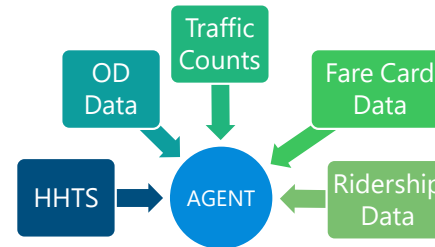
	name	description	table	filter_expression	value_expression	aggregation_function	target_min_value	target_max_value
1	tot_cars	Total number of cars	Households		num_cars * weight	Sum	150000.000000	180000.000000
2	tot_trips	Total number of trips	Trips		tour.person.hh.weight	Sum	1500000.000000	1600000.000000
3	mean_distance	Mean trip distance	Trips		od.autoDistanceOffPeak	Mean	5.500000	6.000000
4	rum_transit_trips	Total transit trips	Trips	mode_id == 3	tour.person.hh.weight	Sum	150000.000000	200000.000000

- Assemble virtually any travel demand model structure from 4-step to ABM
- Enjoy transparent access to a full travel demand model UI
- Maintain different model structures or versions in parallel
- Upgrade and advance models over time with new features

The screenshot displays the EMME AGENT software interface. On the left, a tree view under 'Disaggregate tour-based' shows a list of model steps. The 'Stop frequency middle' step is highlighted with a green box. On the right, the 'Schema Browser' window shows a table of attributes for the 'Disaggregate tour-based' model. The table has columns for 'name', 'dtype', and 'sources'. The row for 'num\_maint\_mid' is highlighted in blue, and its 'sources' column contains the value 'Stop frequency middle'.

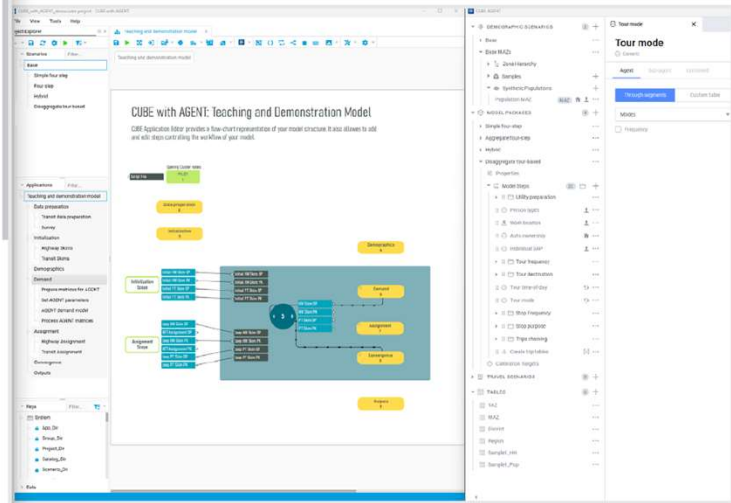
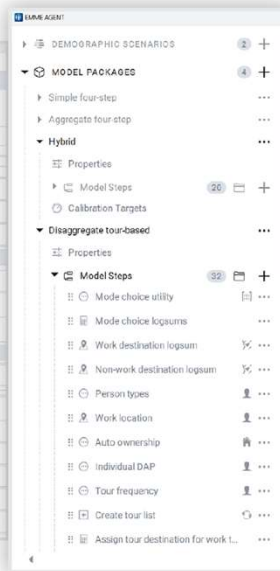
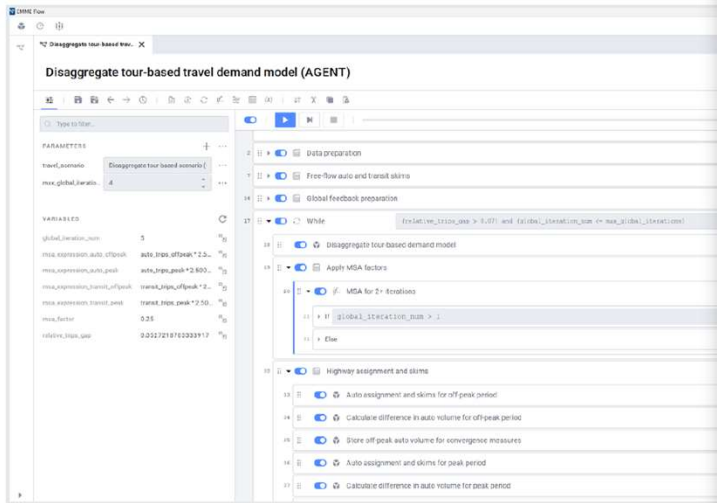
	name	dtype	sources
9	num_work_out	int64	Stop frequency outbound
10	num_univ_out	int64	Stop frequency outbound
11	num_disc_out	int64	Stop frequency outbound
12	num_maint_out	int64	Stop frequency outbound
13	to_prim_dest	int64	Stop frequency outbound
14	total_outbound	int64	Stop frequency outbound
15	tot_out_1	int64	Stop frequency outbound
16	tot_out_2	int64	Stop frequency outbound
17	tot_out_3	int64	Stop frequency outbound
18	num_work_mid	int64	Stop frequency middle
19	num_disc_mid	int64	Stop frequency middle
20	num_maint_mid	int64	Stop frequency middle
21	total_mid_stops	int64	Stop frequency middle
22	tot_mid_1	int64	Stop frequency middle
23	tot_mid_2	int64	Stop frequency middle
24	mid_exist	int64	Stop frequency middle
25	num_work_in	int64	Stop frequency inbound
26	num_univ_in	int64	Stop frequency inbound
27	num_disc_in	int64	Stop frequency inbound
28	num_maint_in	int64	Stop frequency inbound
29	to_home	int64	Stop frequency inbound
30	total_inbound	int64	Stop frequency inbound
31	tot_in_1	int64	Stop frequency inbound
32	tot_in_2	int64	Stop frequency inbound

- Leverage automated calibration procedures
- Improve model calibration and validation results
- Minimize risks and costs associated with costly trial-and-error approaches to calibration
- Helps keep travel demand models up-to-date across mobility changes
- Incorporate all mobility data sources including big data





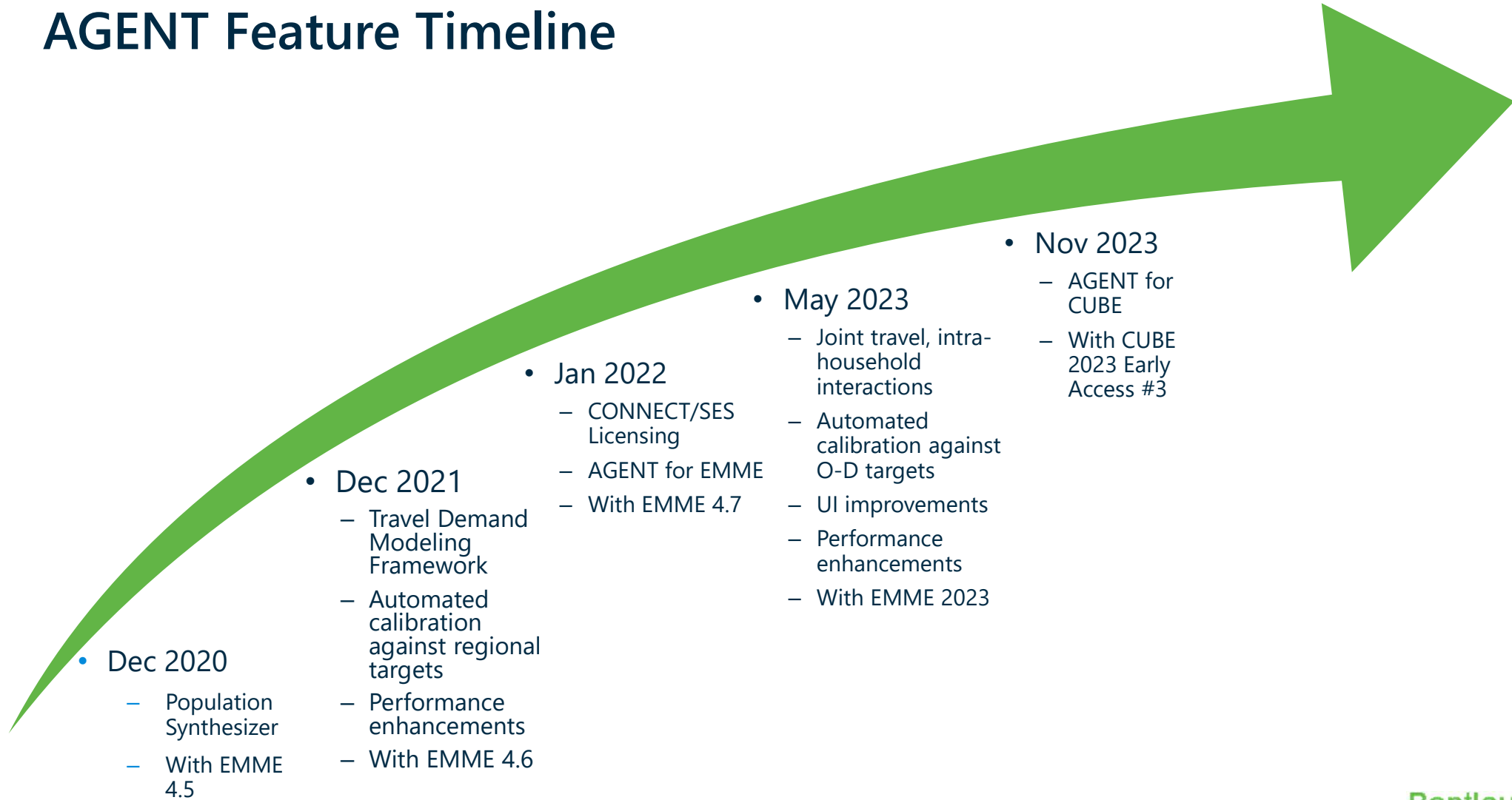
# AGENT works with CUBE and EMME



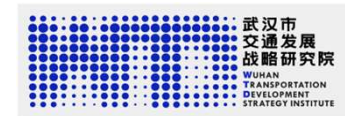
Leverage EMME features like Modeler, APIs, Notebooks, Scenes, and Flow with AGENT.

Leverage CUBE features like Application Manager, Scenario Manager, and Voyager with AGENT.

# AGENT Feature Timeline



# AGENT Users



JERUSALEM TRANSPORTATION  
MASTER PLAN TEAM



ARUP



An aerial photograph of a modern, curved coastal highway bridge. The bridge spans across a rocky coastline, with waves crashing against the shore. The road is paved and has a metal guardrail. The surrounding landscape includes green hills and a clear blue sky.

## Examples of recent applications

# National model: Sweden

- One model for 5 regions
  - Differential sampling weight to represent “halo” and external zones for each region
- Total population: 10M
  - Effective population after differential sampling: 3-5M

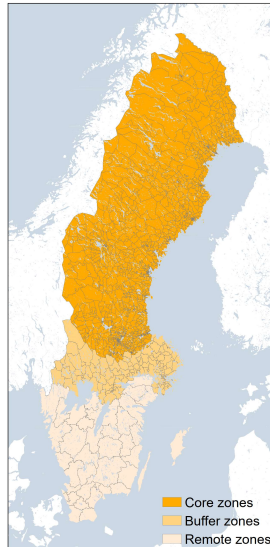
10,997 zones



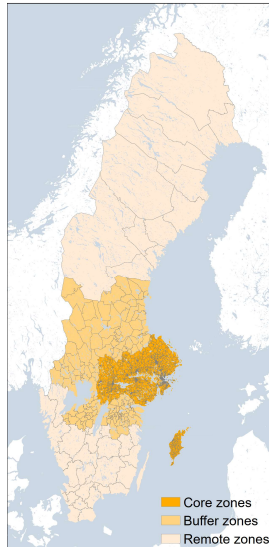
682 zones



2,103 zones



3,110 zones



1,952 zones



2,982 zones

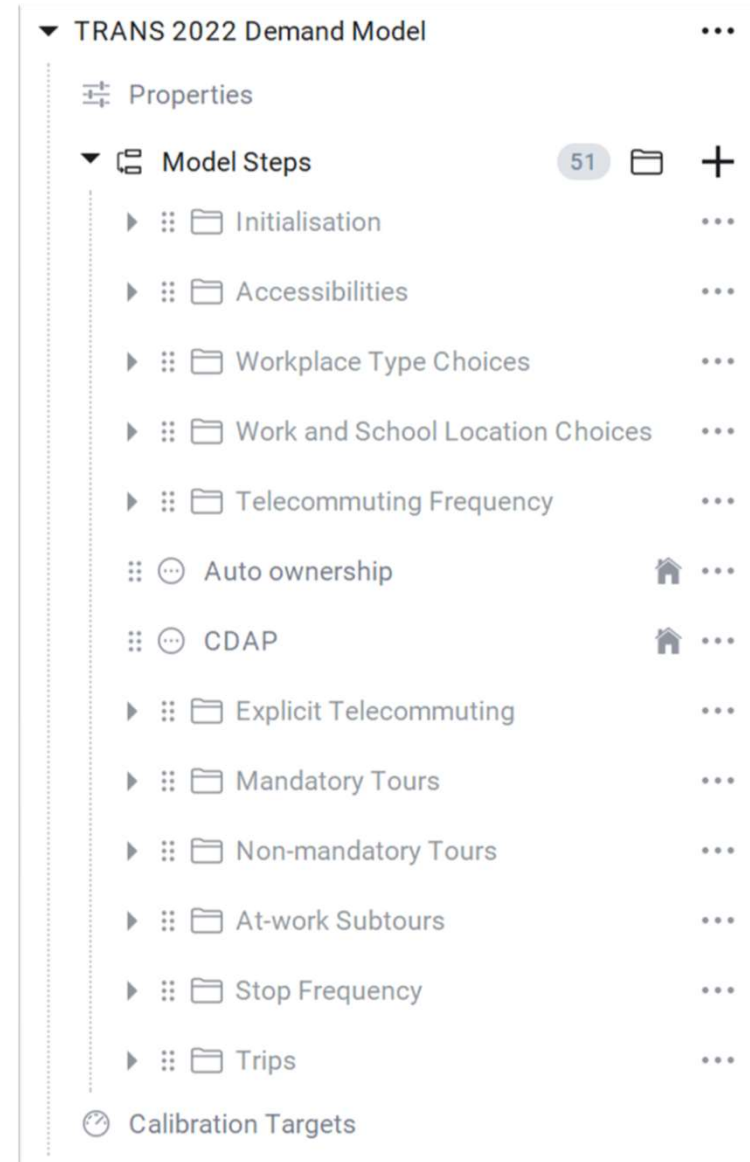


2,253 zones



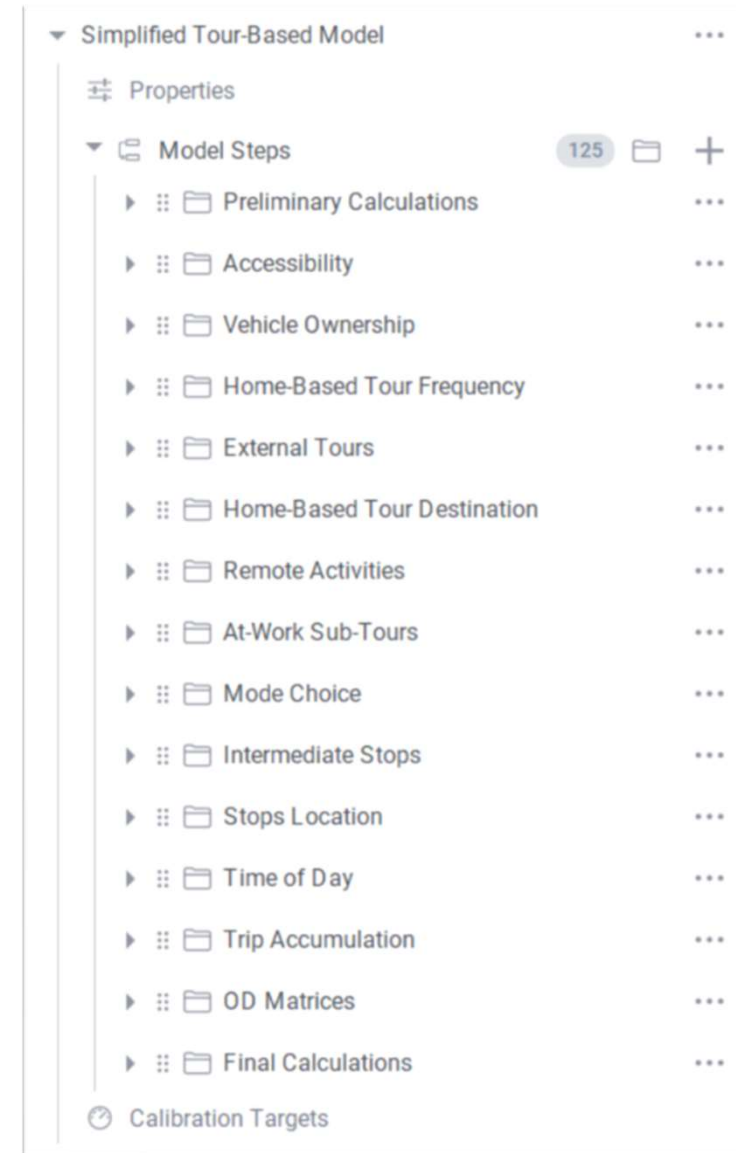
# TRANS Model: Ottawa

- Development of new regional model in AGENT
- Population: 1.4M
- Calibration data sources:
  - Household travel survey
  - Traffic counts
  - Transit counts
- Runtime for 1 iteration of demand model
  - ~12 mins on Intel® 2.4GHz, 16 cores, 32 GB RAM



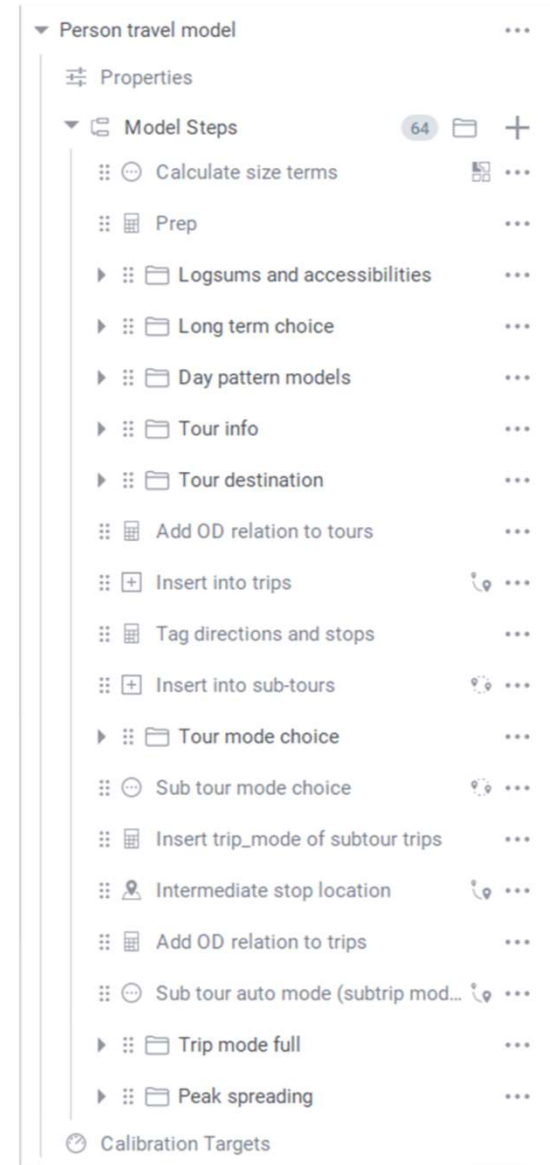
# Simplified Tour-Based Model (STBM): Perth

- Re-platform demand model to AGENT and auto-calibrate
- Population: 2M
- Calibration data sources:
  - Household travel survey
  - Census
  - Traffic counts
  - Transit counts
- Runtime for 1 iteration of demand model
  - ~15 mins on Intel® 2.4GHz, 16 cores, 32 GB RAM



# Person Travel Model (PTM): Edmonton

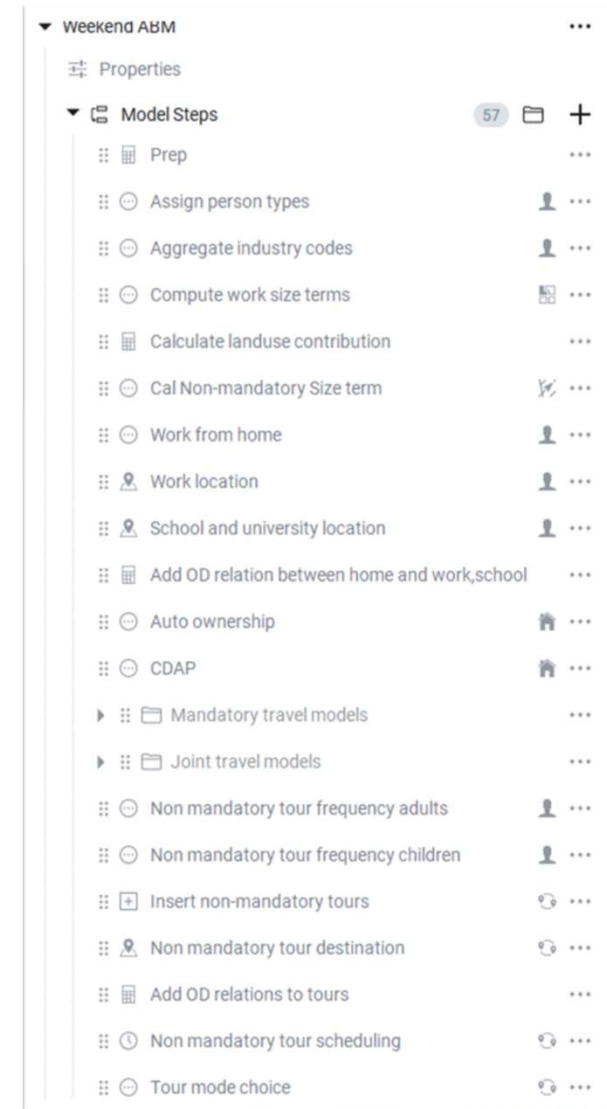
- Re-platform demand model to AGENT
- Data-driven day pattern model
- Population: 1.3M
- Runtime for 1 iteration of demand model
  - ~90 mins\* on Intel® 2.8GHz, 32 cores, 128 GB RAM





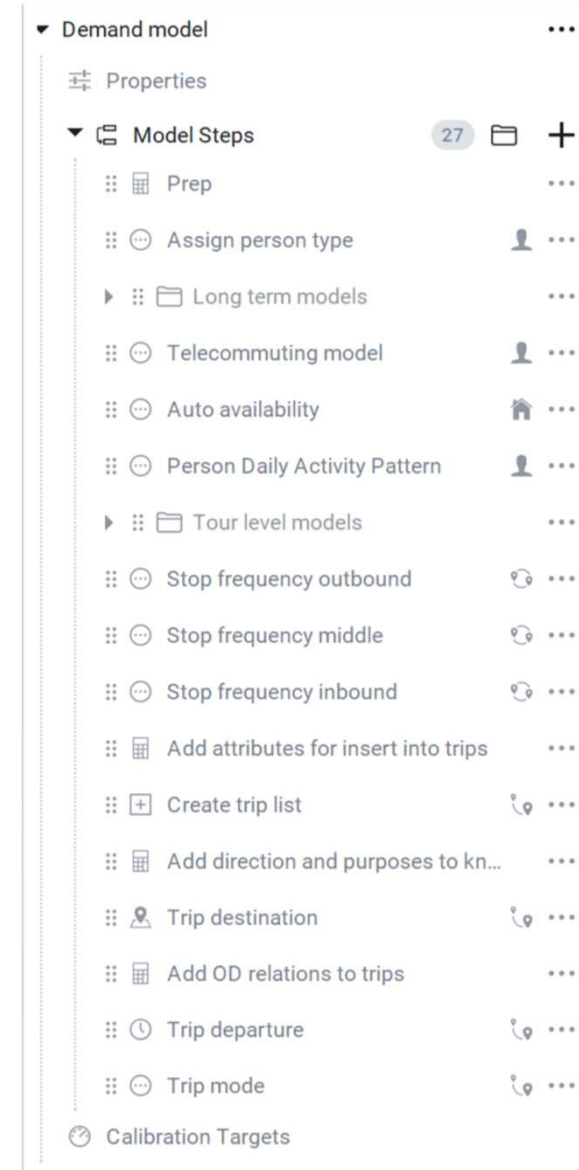
# Weekend model: MAG

- ABM for new weekend travel demand model
- Population: 5M
- Transfer of weekday model to weekend:
  - No HTS for weekend travel behavior
  - Available data: AirSage data, traffic counts
- Runtime for 1 iteration of demand model
  - ~80 mins\* on Intel® 2.8GHz, 32 cores, 128 GB RAM



# Tour-Based Model: Hong Kong

- Development of new tour-based model for Hong Kong
- Population: 6.8M
- Calibration data sources:
  - Household travel survey
  - Traffic counts
  - Transit counts
- Runtime for 1 iteration of demand model
  - ~40 mins on Intel® 2.4GHz, 16 cores, 32 GB RAM



# Key benefits (1)



## Shorter model configuration time

Examples:

Perth STBM → 4-5 weeks

TRANS Ottawa → 3-4 weeks

PTM Edmonton → 2-3 weeks



## Easy to understand interface allowed collaboration

Everyone in the team could participate in model updates, QC and validation



## Faster runtimes

Re-platformed models experienced substantial improvement in runtime:

- STBM Perth: 35 mins vs 15 mins in AGENT
- PTM Edmonton: 120 mins vs 90 mins in AGENT

## Key benefits (2)



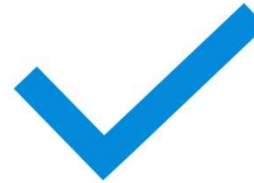
### **Automated calibration**

Easier to transfer models from one region to another → Ex: Parts of MAG, ARC, GGHM, 3C for TRANS Ottawa

Accelerated model calibration → Ex: Calibration to HTS in less than a week for TRANS Ottawa

Leverage multiple data sources for model calibration → Ex: AirSage O-D data + traffic counts for MAG weekend Model

Demand model as a common denominator to understand multiple dataset



### **Managing stochasticity**



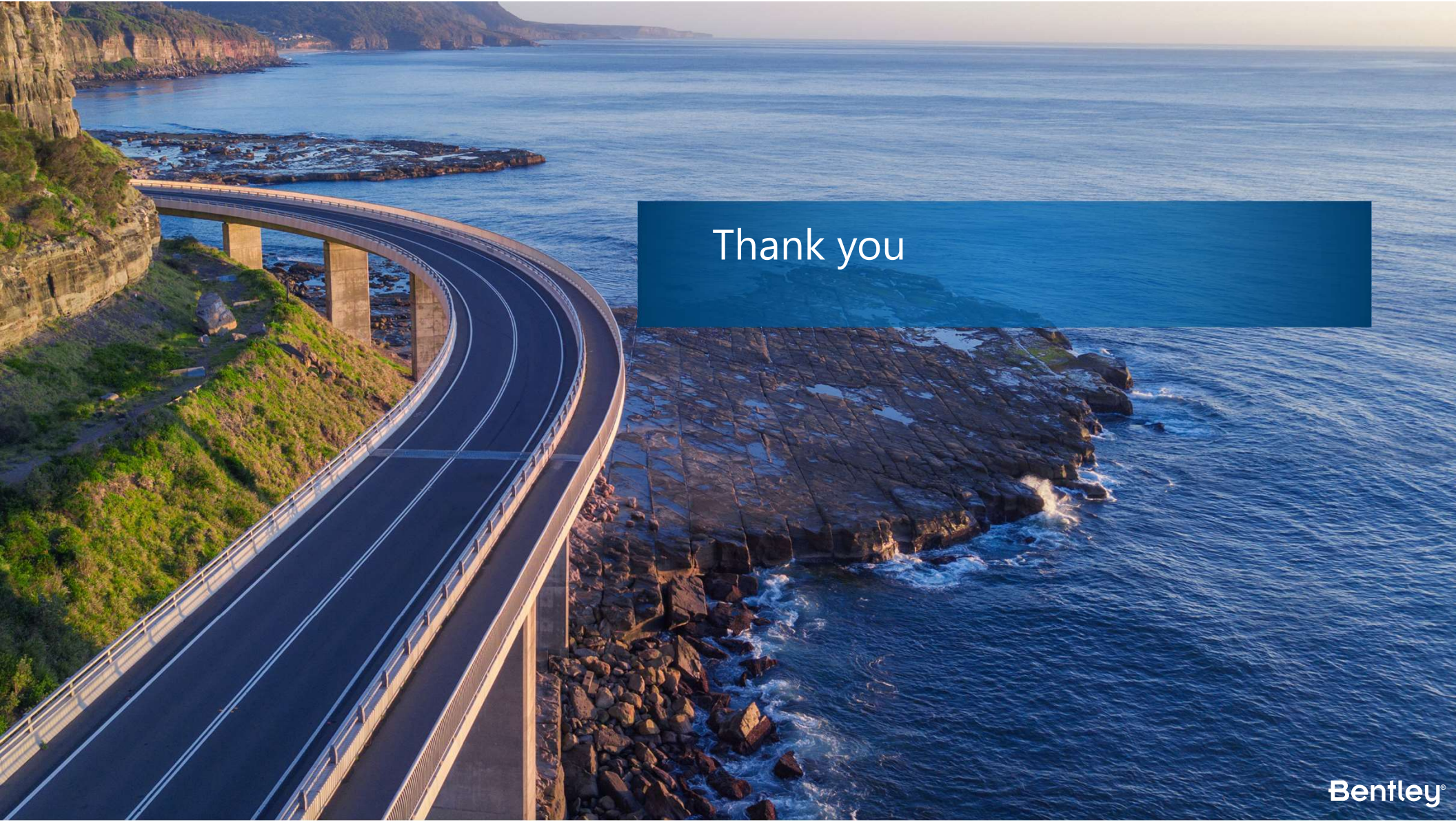
*AGENT provided us with a **transparent modelling environment** where the complete definition of utility functions, data and model results can be studied without ...specific programming skills. Our impression so far [of AGENT] is that we have a model with **low cost of maintenance** that can be further developed to address new questions.*

- Svante Berglund  
Trafikverket, Sweden



*[AGENT's] easy to use interface, calibration frameworks, multi level and comprehensive use of big data sources, and pre-built modelling paradigms has provided practitioners and users flexibility and access to cutting edge ideas that was previously out-of-reach without a significant investment in time and resources.*

- Mausam Duggal  
National Director, Transportation Planning and Science,  
WSP Canada



Thank you