



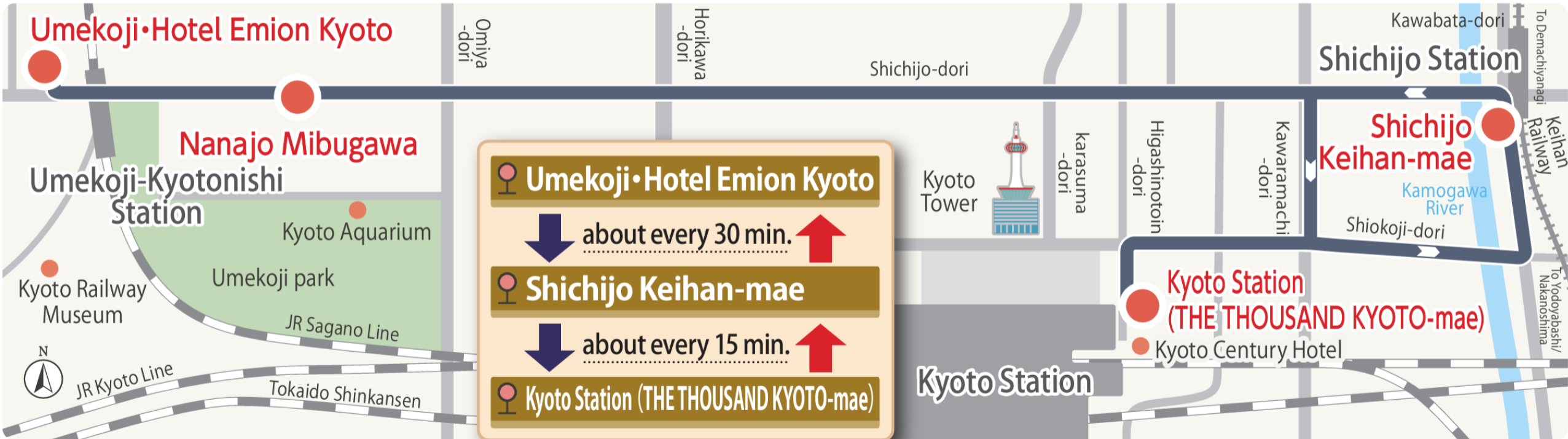
Keihan 300 Direct Link Loop Bus

# Demonstration of the Operation of the Kyoto Keihan e-Bus with the SUMO simulation platform

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# Route Map of the Keihan 300 Direct Link Loop Bus



Collected trajectories of the electric bus usage on March 10, 2024, via two A-GPS-based tracking apps (Strava and Komoot)



# Background: Simulating Public Transportation with a focus on Buses in Kyoto

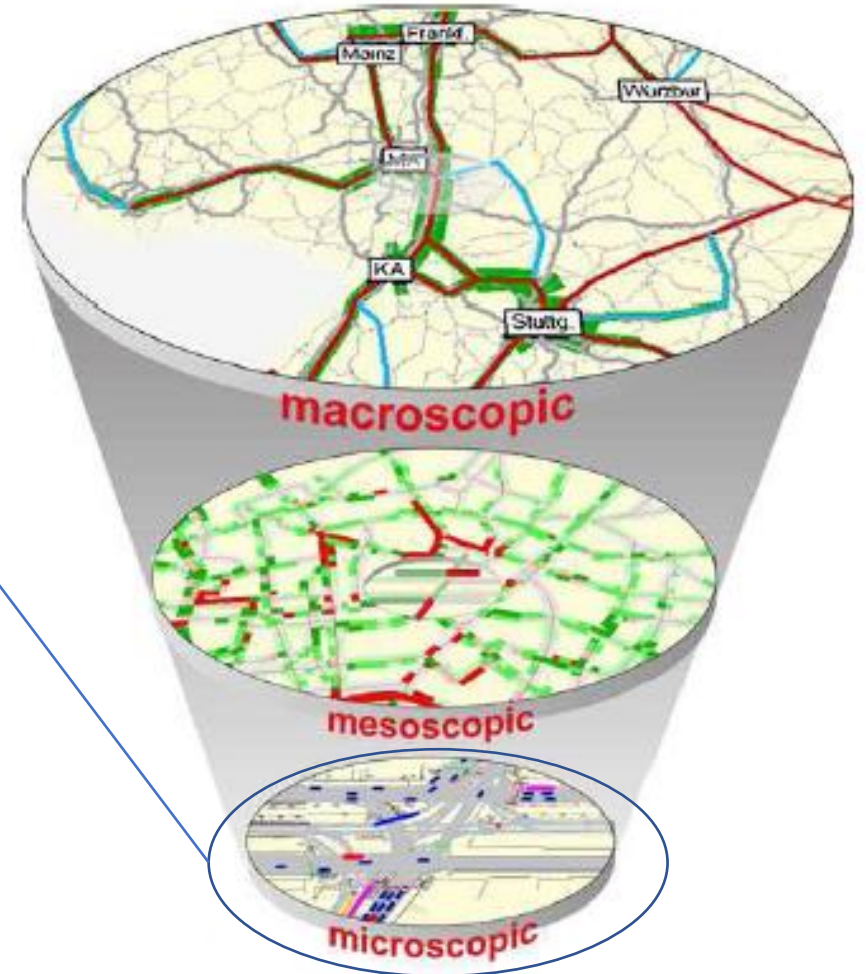
- August 2023 - July 2025: JSPS International Research Fellow at Kyoto University, ITS Laboratory
- “Fusing Map, Accident and Public Transport Data Sources for Simulation of Urban Mobility: Towards a Digital Twin for Kyoto”
- One of 4 Framework Segments: Traffic Efficiency - Simulation with a Focus on Bus Service Reliability
- Segment 4 – Kyoto SUMO+ as Testbed for Future Scenarios
- Core of the Framework: Simulation Network, Calibration and Validation



Source: [Sumo - Wikipedia](#)

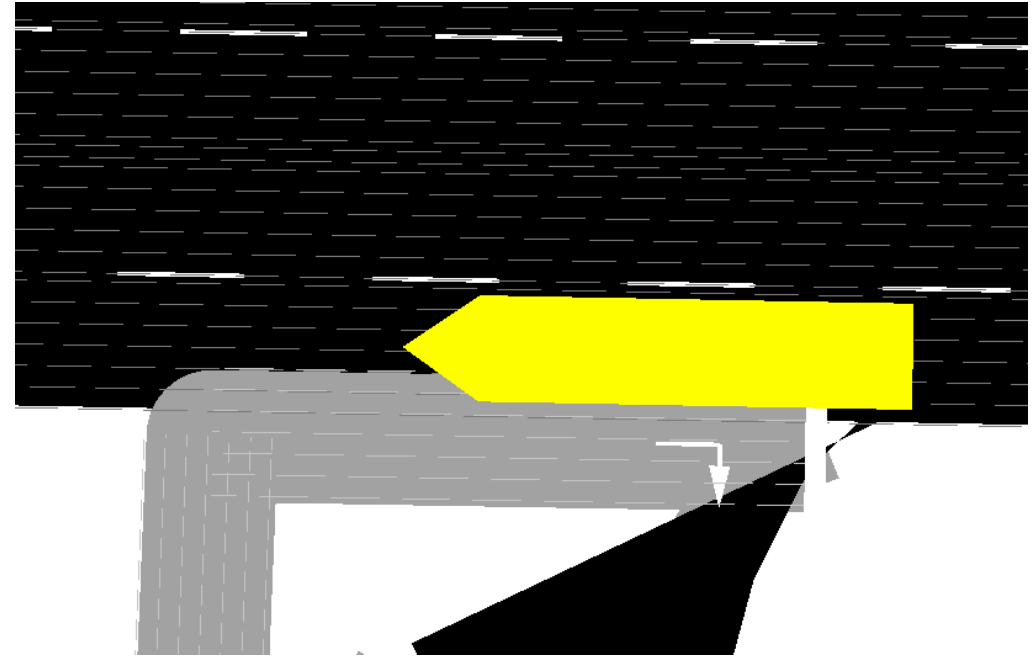
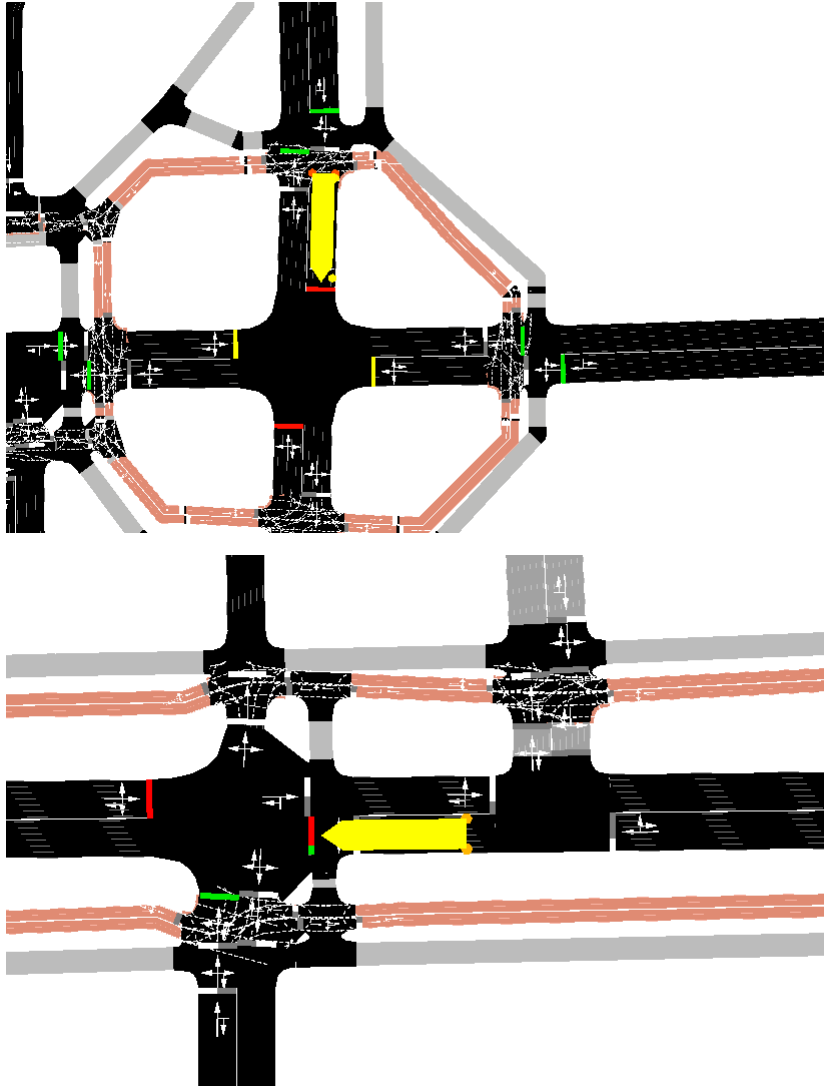


## Modeling Levels:



# Road Network and PT export from OSM

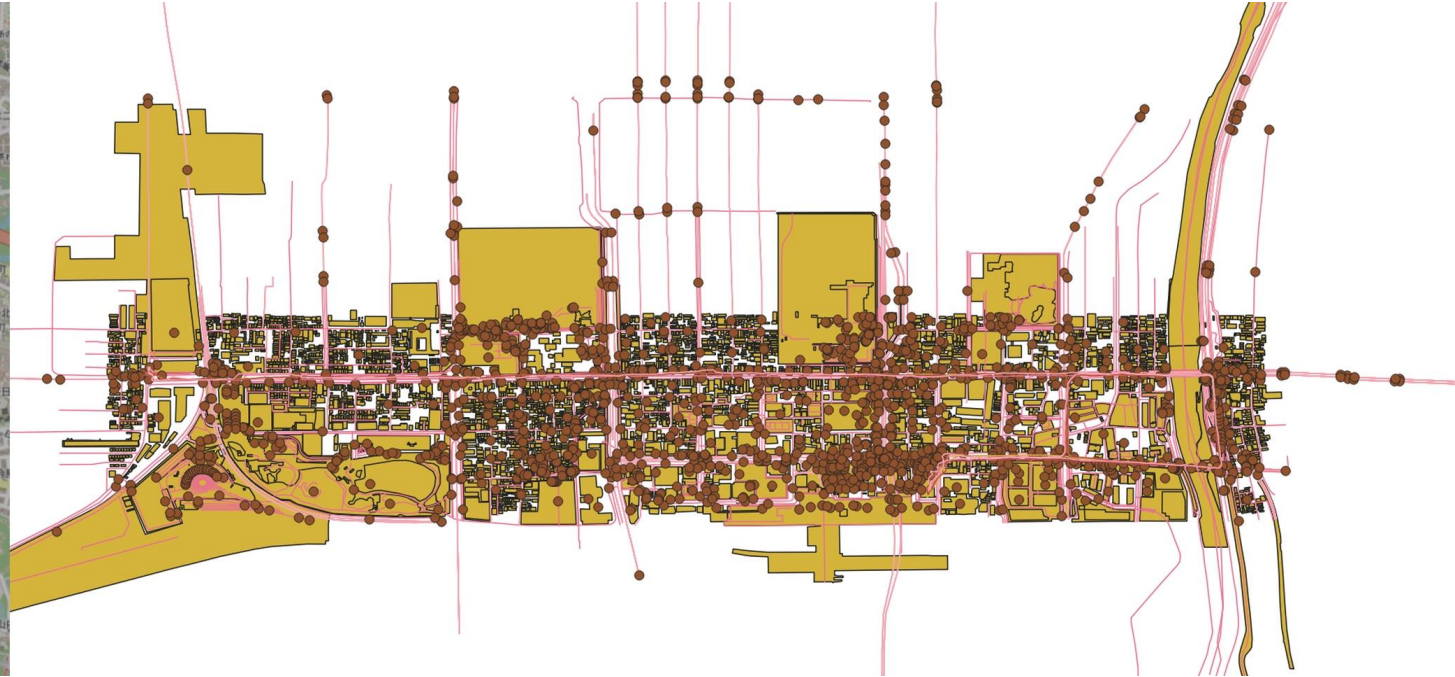
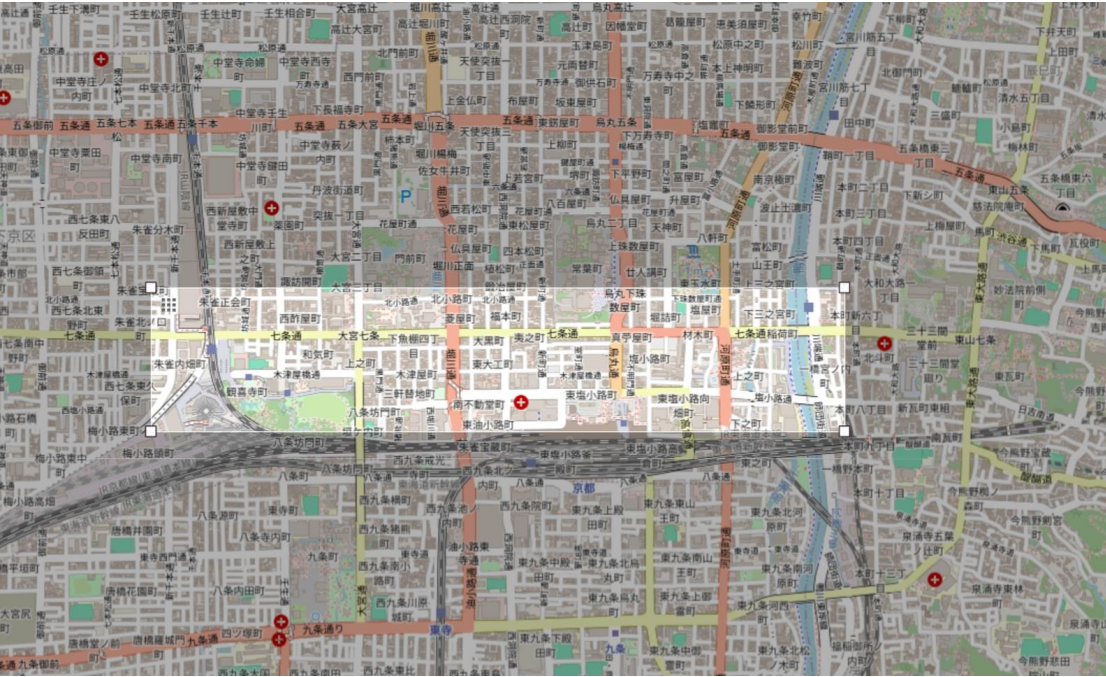
– Base for Creating Micro-Simulation Networks via SUMO NetConvert (1)



Manifold Modeling Options for Headways, Waiting Times at Bus Stops and their Delays, but as well: Waiting Queues of potential Passengers; Interactions and Conflicts (and Surrogate Safety Measures) from the Perspective of the Bus Driver

# Road Network and PT export from OSM

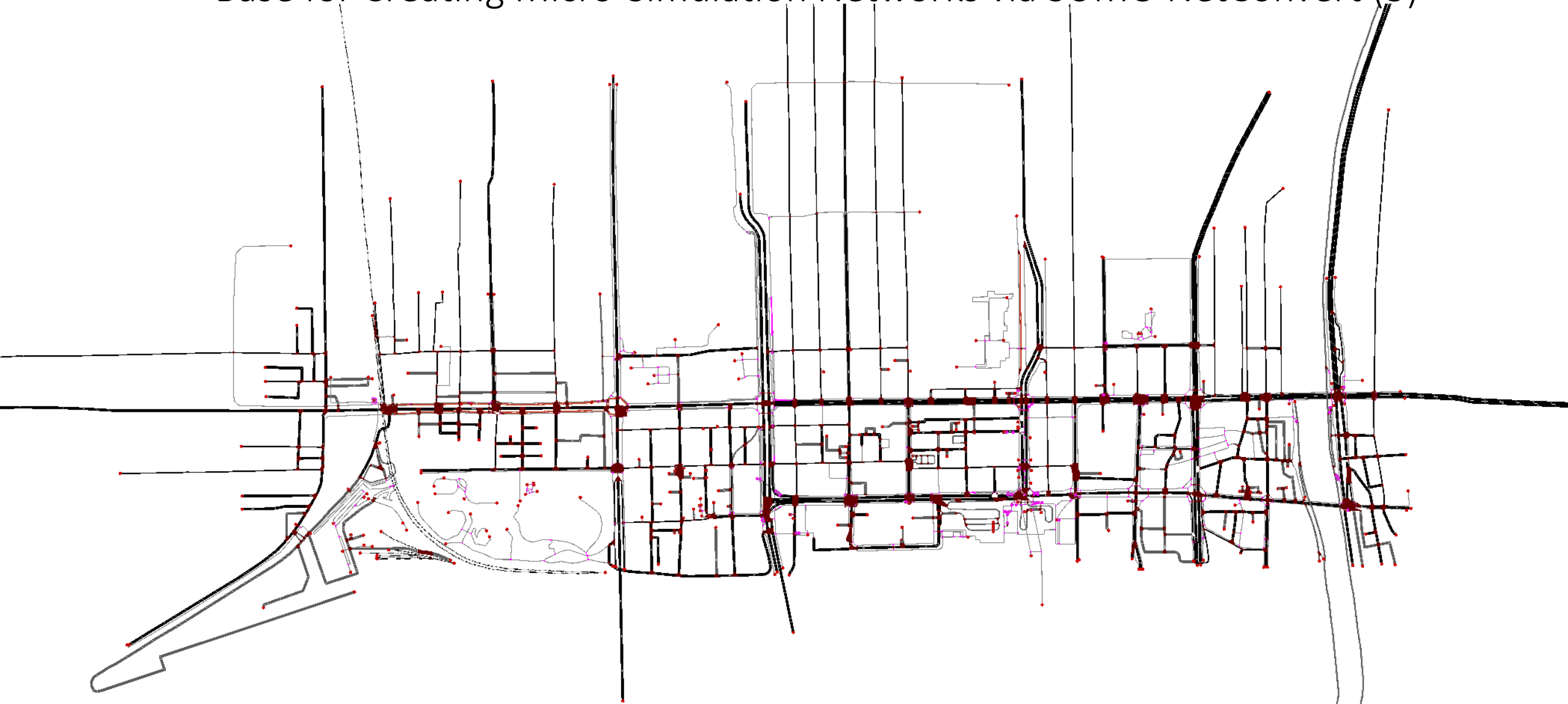
## – Base for Creating Micro-Simulation Networks via SUMO NetConvert (2)



- Quality of Volunteered Geographic Information together with Public Transport Representations (stations, stops and routes) has great variety
- Manifold redundant geoinformation and delayed infrastructural monitoring are challenges in designing micro-simulation networks

# Road Network and PT export from OSM

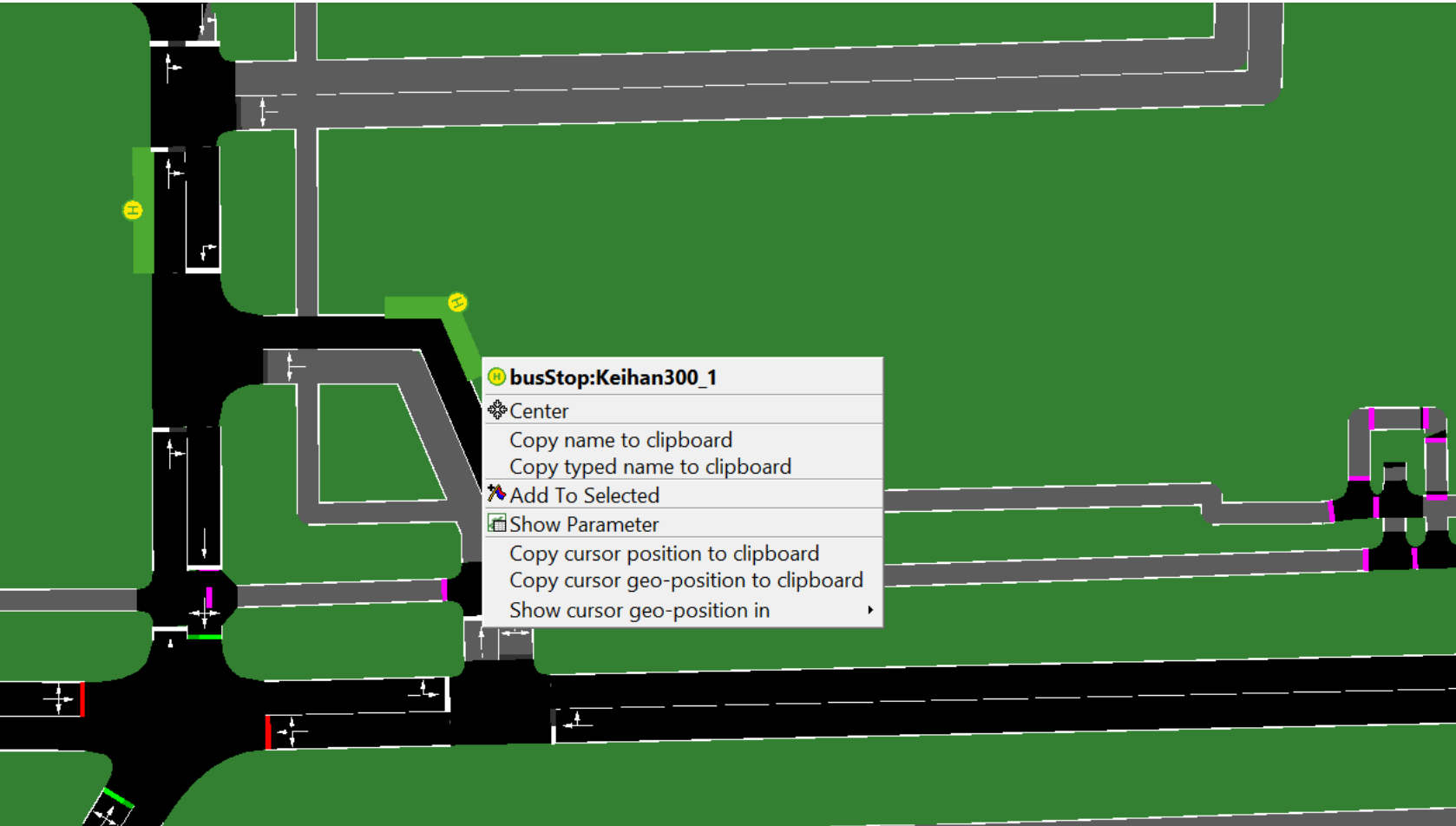
– Base for Creating Micro-Simulation Networks via SUMO NetConvert (3)



# Designing the Keihan 300 bus Simulation based on the tracking experiment

## Timetable Same on weekdays, weekends and

Departing from Umekoji · Hotel Emion Kyoto	—	—	7:23	—	7:53	—	8:23
Arriving at/departing from Shichijo Keihan-mae	7:05	7:20	7:35	7:50	8:05	8:20	8:35
Arriving at/departing from Kyoto Station (THE THOUSAND KYOTO-mae)	7:13	7:28	7:43	7:58	8:13	8:28	8:43
Arriving at/departing from Shichijo Keihan-mae	7:18	7:33	7:48	8:03	8:18	8:33	8:48
Arriving at Umekoji · Hotel Emion Kyoto	—	7:42	—	8:12	—	8:42	—
Departing from Umekoji · Hotel Emion Kyoto	11:53	—	12:23	—	12:53	—	13:23
Arriving at/departing from Shichijo Keihan-mae	12:05	12:20	12:35	12:50	13:05	13:20	13:35
Arriving at/departing from Kyoto Station (THE THOUSAND KYOTO-mae)	12:13	12:28	12:43	12:58	13:13	13:28	13:43
Arriving at/departing from Shichijo Keihan-mae	12:18	12:33	12:48	13:03	13:18	13:33	13:48
Arriving at Umekoji · Hotel Emion Kyoto	—	12:42	—	13:12	—	13:42	—
Departing from Umekoji · Hotel Emion Kyoto	16:53	—	17:23	—	17:53	—	18:23



```

49 </formats>
50
51 </configuration>
52 -->
53
54 <additional xmlns:xsi="http://www.w3.org/20
55 <!-- StoppingPlaces Keihan300 bus-
56 <busStop id="Keihan300_0" name="Shichij
57 <busStop id="Keihan300_1" name="Umekoji
58 <busStop id="Keihan300_2" name="Kyoto S
59 <busStop id="Keihan300_3" name="Nanajo
60 <busStop id="Keihan300_4" name="Nanajo
61
62
63 <busStop id="-1854039396" name="塩小路高倉・京都市立芸術大前(京都芸大前)" lane="-946510947#1_0" startPos="0.00" endPos="15.00" friendlyPos="true"
64 <busStop id="-4213489997" name="梅小路公園・JR梅小路京都西駅前" lane="-724814712#2_0" startPos="11.73" endPos="26.73" friendlyPos="true" lines=

```



# Extracting Trajectories from Keihan 300 bus Simulation Experiments



# Simulation Outputs compared to Collected Trajectories

Collected trajectories of the electric bus usage on March 10, 2024, via two A-GPS-based tracking apps



Simulated trajectories of the electric bus usage via one SUMO Simulation run



# Simulation Outputs from Batteries and Charging Stations (1)

## Electric Vehicle Definition

key	Value Type	Default	Description
maximumBatteryCapacity	float	35000 (Wh)	Maximum battery capacity $E_{max}$
maximumPower	float	150000 (W)	Maximum power which the vehicle can reach (unused)
vehicleMass	float	1830 (kg)	Vehicle mass $m_{veh}$
frontSurfaceArea	float	2.6 (m <sup>2</sup> )	Front surface area $A_{veh}$
airDragCoefficient	float	0.35	Air drag coefficient $c_w$
rotatingMass	float	40 (kg)	(Equivalent) mass of internal rotating elements
radialDragCoefficient	float	0.1	Radial drag coefficient $c_{rad}$
rollDragCoefficient	float	0.01	Rolling resistance coefficient $c_{roll}$
constantPowerIntake	float	100 (W)	Avg. (constant) power of consumers $P_{const}$
propulsionEfficiency			
recuperationEfficiency			
stoppingThreshold			

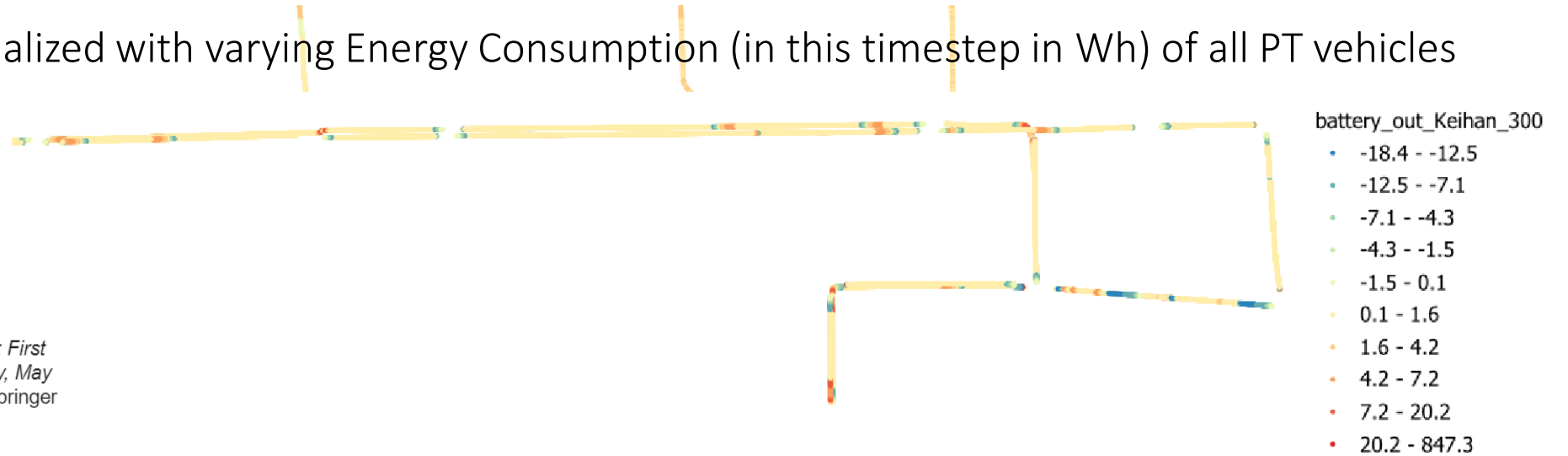


```
<!-- BYD-J6_(similar_to_Hino-Poncho)-->
```

```
<vType id="BYD-J6" vClass="evehicle" guiShape="bus/coach" accel="2.6" decel="4.5" length="6.99" width="2.08" maxSpeed="100.0"
  <param key="has.battery.device" value="true"/>
  <param key="maximumBatteryCapacity" value="161000"/>
  <param key="maximumPower" value="105600"/>
  <param key="vehicleMass" value="7925"/>
  <param key="frontSurfaceArea" value="5"/>
  <param key="airDragCoefficient" value="0.6"/>
  <param key="rotatingMass" value="100"/>
  <param key="radialDragCoefficient" value="0.5"/>
  <param key="rollDragCoefficient" value="0.01"/>
  <param key="constantPowerIntake" value="100"/>
  <param key="propulsionEfficiency" value="0.9"/>
  <param key="recuperationEfficiency" value="0.9"/>
  <param key="stoppingThreshold" value="0.1"/>
</vType>
```

# Simulation Outputs from Batteries and Charging Stations (2)

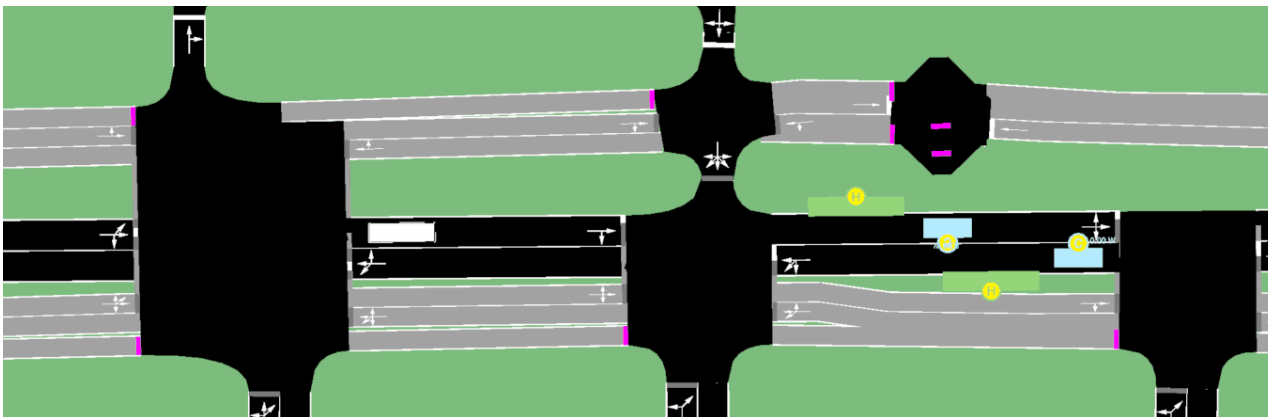
Simulated trajectories visualized with varying Energy Consumption (in this timestep in Wh) of all PT vehicles



## Model Details:

Kurczveil, T., López, P. Á., & Schnieder, E. (2014). Implementation of an Energy Model and a Charging Infrastructure in SUMO. In *Simulation of Urban Mobility: First International Conference, SUMO 2013, Berlin, Germany, May 15-17, 2013. Revised Selected Papers 1* (pp. 33-43). Springer Berlin Heidelberg.

## Charging Stations implemented in the PT simulation



```
<vehicle id="Keihan300bus_Depart_from_9-53_AM" type="BYD-J6" depart="0" color="1,1,1">  
<route repeat="3" cycleTime="3600" edges="1076090464#2 117606485#9 724814712#2 724814712#1">  
<stop busStop="Keihan300bs_1" until="0" duration="20" />  
<stop busStop="Keihan300bs_4" duration="20"/>  
<stop chargingStation="ChargingStation_02" until="350"/>  
<stop busStop="Keihan300bs_0" until="720" duration="20"/>  
<stop busStop="Keihan300bs_2" until="1200" duration="20"/>  
<stop busStop="Keihan300bs_0" until="1500" duration="140"/>  
<stop busStop="Keihan300bs_2" until="2100" duration="20"/>  
<stop busStop="Keihan300bs_0" until="2400" duration="20"/>  
<stop busStop="Keihan300bs_3" duration="20"/>  
<stop chargingStation="ChargingStation_01" until="2600"/>  
<stop busStop="Keihan300bs_1" until="2940" duration="660"/>  
</vehicle>
```



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