Presentation

Studying autonomous vehicle policies with Urban Planning in Singapore

Author(s): Trinh, Le Thi Diem; Fourie, Pieter Jacobus; Seshadri, Ravi; Nagel, Kai; Hoerl, Sebastian; Wang, Biyu; Wang, Hua; Lee, Der-Horng

Publication Date: 2017-10

Permanent Link: https://doi.org/10.3929/ethz-b-000388120

Rights / License: In Copyright - Non-Commercial Use Permitted

This page was generated automatically upon download from the ETH Zurich Research Collection. For more information please consult the Terms of use.
<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter/Moderator</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.00 – 14.05</td>
<td>Le Thi Diem Trinh</td>
<td>Welcome &amp; Introduction</td>
</tr>
<tr>
<td>14.05 – 15.30</td>
<td><strong>Pieter Fourie</strong></td>
<td><strong>Description of AV scenario elements to consider for the project</strong></td>
</tr>
<tr>
<td></td>
<td>Ravi Seshadri</td>
<td>SimMobility: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td></td>
<td>Prof Kai Nagel</td>
<td>Autonomous vehicles in MATSim: The implementation of DVRP and some results</td>
</tr>
<tr>
<td></td>
<td>Pieter Fourie/ Sebastian Hoerl/</td>
<td>MATSim: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td></td>
<td>Biyu Wang</td>
<td></td>
</tr>
<tr>
<td>15.30 – 15.45</td>
<td></td>
<td><strong>Break</strong></td>
</tr>
<tr>
<td>15.45 – 16.05</td>
<td>Wang Hua</td>
<td>Optimizing charging locations for EVs: proposed methods, data requirements, challenges</td>
</tr>
<tr>
<td>16.05 – 17.00</td>
<td>Prof Lee Der-Horng</td>
<td>Discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1) incorporation of EV in MATSim/SimMobility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) definition of AV scenarios: parking, ride-sharing constraints, fleet mix etc.</td>
</tr>
</tbody>
</table>
Urban Planning for Autonomous Vehicles in Singapore

Understand how AV can reduce the use of private cars, increase public transport mode share, improve urban quality and support higher density.

1. Examine AV deployment systems and concurrent urban design strategies through scenario building. Study the impacts and associated trade-offs of different scenarios.

2. Investigate if AV will lead to increase in total vehicle-km travelled, energy consumptions, carbon emission, last mile accessibility in the region.

Source: Michael van Eggermond
Present Discourse

Fears

- Low speed, less efficiency
- Spatial segregation
- Increased Sprawl
- Loss of Privacy and security concerns
- Decline in walking and cycling modal share
- Car dominated street design
- More congestion
- More VMT

More Accessibility
- For people with disabilities
- For aging population
- Children

More Productivity
- Efficient use of in-vehicle time
- Door to door connectivity
- No more parking hassles
- Fewer crashes
- Mobility for ped. & cyclists
- Fuel savings
- E-mobility
- Less congestion

Increased Safety
- Fewer crashes
- Mobility for ped. & cyclists

Efficient use of Road Space
- Smaller ROW
- Smaller headways
- Fewer Signages
- Infill potential

Infill potential

Source: Tanvi Maheshwari
Present Discourse

Fears

- Decline in walking and cycling modal share
- Car dominated street design
- More congestion
- More VMT
- Loss of Privacy and security concerns
- Increased Sprawl
- Low speed, less efficiency

More Accessibility

- For people with disabilities
- For aging population
- Children

More Productivity

- Efficient use of vehicle time
- No more parking hassles
- Door to door connectivity

Increased Safety

- Fewer crashes
- Mobility for ped. & cyclists

Environment friendly

- Fuel savings
- E-mobility
- Less congestion

Efficient use of Road Space

- Smaller ROW
- Smaller headways
- Fewer Signages
- Infill potential

Source: Tanvi Maheshwari
<table>
<thead>
<tr>
<th>Type of AV Policies</th>
<th>Operating Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxi and Ridesharing Model</td>
<td>Laissez Faire</td>
</tr>
<tr>
<td>Eg. Uber</td>
<td></td>
</tr>
<tr>
<td>• Pooling of rides</td>
<td></td>
</tr>
<tr>
<td>• Variable costing</td>
<td></td>
</tr>
<tr>
<td>• Self-organisation vs centralised dispatch</td>
<td></td>
</tr>
<tr>
<td>• Multiple operators?</td>
<td></td>
</tr>
<tr>
<td>Personal Ownership Model</td>
<td>Private</td>
</tr>
<tr>
<td>Eg. American Model</td>
<td></td>
</tr>
<tr>
<td>• Subscription model?</td>
<td></td>
</tr>
<tr>
<td>• Utility function components</td>
<td></td>
</tr>
<tr>
<td>• Parking</td>
<td></td>
</tr>
<tr>
<td>Govt. Regulated Fleet</td>
<td>Structured</td>
</tr>
<tr>
<td>• Autonomous transit-on-demand</td>
<td></td>
</tr>
<tr>
<td>• Multi-modal routing</td>
<td></td>
</tr>
<tr>
<td>• Fleet size &amp; mix</td>
<td></td>
</tr>
<tr>
<td>• Network constraints</td>
<td></td>
</tr>
<tr>
<td>Demand Management Model</td>
<td></td>
</tr>
<tr>
<td>Eg. COE</td>
<td></td>
</tr>
<tr>
<td>• Constrained multi-modal routing</td>
<td></td>
</tr>
<tr>
<td>• Multiple operators?</td>
<td></td>
</tr>
<tr>
<td>Automated transit</td>
<td></td>
</tr>
<tr>
<td>(i.e. on-demand)</td>
<td></td>
</tr>
<tr>
<td>Multi-modal routing</td>
<td></td>
</tr>
<tr>
<td>Fleet size &amp; mix</td>
<td></td>
</tr>
<tr>
<td>Network constraints</td>
<td></td>
</tr>
<tr>
<td>Autonomous transit-on-demand</td>
<td></td>
</tr>
<tr>
<td>Multi-modal routing</td>
<td></td>
</tr>
<tr>
<td>Fleet size &amp; mix</td>
<td></td>
</tr>
<tr>
<td>Network constraints</td>
<td></td>
</tr>
<tr>
<td>Multi-modal routing</td>
<td></td>
</tr>
<tr>
<td>Fleet size &amp; mix</td>
<td></td>
</tr>
<tr>
<td>Network constraints</td>
<td></td>
</tr>
<tr>
<td>Possible Scenario Dimensions</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Study area</strong></td>
<td></td>
</tr>
<tr>
<td>Central SG</td>
<td></td>
</tr>
<tr>
<td>Whole island</td>
<td></td>
</tr>
<tr>
<td><strong>Mode interaction</strong></td>
<td></td>
</tr>
<tr>
<td>AV + Car</td>
<td></td>
</tr>
<tr>
<td>AV + Transit</td>
<td></td>
</tr>
<tr>
<td>AV + Car + Transit</td>
<td></td>
</tr>
<tr>
<td><strong>Operator</strong></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td></td>
</tr>
<tr>
<td>Multiple</td>
<td></td>
</tr>
<tr>
<td><strong>Sharing</strong></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>Shared A-B/A-A</td>
<td></td>
</tr>
<tr>
<td>Pooled</td>
<td></td>
</tr>
<tr>
<td>Soc. Coord.</td>
<td></td>
</tr>
<tr>
<td><strong>Transit integration</strong></td>
<td></td>
</tr>
<tr>
<td>AV First/Last mile/transfer support</td>
<td></td>
</tr>
<tr>
<td>Autonomous Transit-on-demand</td>
<td></td>
</tr>
<tr>
<td><strong>Network constraints</strong></td>
<td></td>
</tr>
<tr>
<td>AV lane</td>
<td></td>
</tr>
<tr>
<td>Vehicle size constr.</td>
<td></td>
</tr>
<tr>
<td>Area constraint</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td><strong>Vehicle size</strong></td>
<td></td>
</tr>
<tr>
<td>1-2 seater</td>
<td></td>
</tr>
<tr>
<td>4 seater</td>
<td></td>
</tr>
<tr>
<td>10-15 seater</td>
<td></td>
</tr>
<tr>
<td>50 seater</td>
<td></td>
</tr>
<tr>
<td>Modular</td>
<td></td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td></td>
</tr>
<tr>
<td>Non-blocking inf.</td>
<td></td>
</tr>
<tr>
<td>Capacitated</td>
<td></td>
</tr>
<tr>
<td><strong>Service</strong></td>
<td></td>
</tr>
<tr>
<td>Central dispatch</td>
<td></td>
</tr>
<tr>
<td>Self-organised</td>
<td></td>
</tr>
<tr>
<td>Street hailing</td>
<td></td>
</tr>
<tr>
<td><strong>Parking</strong></td>
<td></td>
</tr>
<tr>
<td>Ignored</td>
<td></td>
</tr>
<tr>
<td>Always roam</td>
<td></td>
</tr>
<tr>
<td>Pre-allocated</td>
<td></td>
</tr>
<tr>
<td>Dynamic alloc.</td>
<td></td>
</tr>
<tr>
<td>Self seeking</td>
<td></td>
</tr>
<tr>
<td><strong>Road pricing</strong></td>
<td></td>
</tr>
<tr>
<td>Ignored</td>
<td></td>
</tr>
<tr>
<td>ERP I</td>
<td></td>
</tr>
<tr>
<td>ERP II</td>
<td></td>
</tr>
<tr>
<td><strong>Dynamics</strong></td>
<td></td>
</tr>
<tr>
<td>Platooning</td>
<td></td>
</tr>
<tr>
<td>Intersection coord.</td>
<td></td>
</tr>
<tr>
<td><strong>Electric vehicles</strong></td>
<td></td>
</tr>
<tr>
<td>Static charge</td>
<td></td>
</tr>
<tr>
<td>Dynamic charge</td>
<td></td>
</tr>
<tr>
<td>Capacity-constr.</td>
<td></td>
</tr>
<tr>
<td>Bid-to-charge</td>
<td></td>
</tr>
<tr>
<td>Grid constr.</td>
<td></td>
</tr>
<tr>
<td><strong>Pricing</strong></td>
<td></td>
</tr>
<tr>
<td>Fixed</td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td></td>
</tr>
<tr>
<td>Self-org (bidding)</td>
<td></td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td></td>
</tr>
<tr>
<td>Mesoscopic</td>
<td></td>
</tr>
<tr>
<td>Microscopic</td>
<td></td>
</tr>
<tr>
<td>Hybrid</td>
<td></td>
</tr>
</tbody>
</table>
Limiting the search space

**Combinatorial explosion**
The grid in the previous slide can result in excess of 15 million possible scenarios.

**Integration!**
Each n combination of dimensions introduces \( n^2 \) possible sites of failure.

**Emergent effects, e.g. self-inflicted congestion problem**
When the dispatcher routes vehicles, has to keep track of already-assigned routes to prevent congestion.

**Need to identify scenarios of interest and maximum value, while limiting possible integration issues, and maximising use of existing capabilities**
<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter/ Moderator</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.00 – 14.05</td>
<td>Le Thi Diem Trinh</td>
<td>Welcome &amp; Introduction</td>
</tr>
<tr>
<td>14.05 – 15.30</td>
<td>Pieter Fourie</td>
<td>Description of AV scenario elements to consider for the project</td>
</tr>
<tr>
<td></td>
<td><strong>Ravi Seshadri</strong></td>
<td><strong>SimMobility: Current capabilities, work-in-progress, development timeline</strong></td>
</tr>
<tr>
<td></td>
<td>Prof Kai Nagel</td>
<td>Autonomous vehicles in MATSim: The implementation of DVRP and some results</td>
</tr>
<tr>
<td></td>
<td>Pieter Fourie/ Sebastian Hoerl/ Biyu Wang</td>
<td>MATSim: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td>15.30 – 15.45</td>
<td></td>
<td>Break</td>
</tr>
<tr>
<td>15.45 – 16.05</td>
<td>Wang Hua</td>
<td>Optimizing charging locations for EVs: proposed methods, data requirements, challenges</td>
</tr>
<tr>
<td>16.05 – 17.00</td>
<td>Prof Lee Der-Horng</td>
<td>Discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1) incorporation of EV in MATSim/SimMobility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) definition of AV scenarios: parking, ride-sharing constraints, fleet mix etc.</td>
</tr>
<tr>
<td>Time</td>
<td>Presenter/Moderator</td>
<td>Content</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>14.00 – 14.05</td>
<td>Le Thi Diem Trinh</td>
<td>Welcome &amp; Introduction</td>
</tr>
<tr>
<td>14.05 – 15.30</td>
<td>Pieter Fourie</td>
<td>Description of AV scenario elements to consider for the project</td>
</tr>
<tr>
<td></td>
<td>Ravi Seshadri</td>
<td>SimMobility: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td>Prof Kai Nagel</td>
<td></td>
<td><strong>Autonomous vehicles in MATSim: The implementation of DVRP and some results</strong></td>
</tr>
<tr>
<td></td>
<td>Pieter Fourie/Sebastian Hoerl/Biyu Wang</td>
<td>MATSim: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td>15.30 – 15.45</td>
<td></td>
<td>Break</td>
</tr>
<tr>
<td>15.45 – 16.05</td>
<td>Wang Hua</td>
<td>Optimizing charging locations for EVs: proposed methods, data requirements, challenges</td>
</tr>
<tr>
<td>16.05 – 17.00</td>
<td>Prof Lee Der-Horng</td>
<td>Discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1) incorporation of EV in MATSim/SimMobility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) definition of AV scenarios: parking, ride-sharing constraints, fleet mix etc.</td>
</tr>
<tr>
<td>Time</td>
<td>Presenter/ Moderator</td>
<td>Content</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>14.00 – 14.05</td>
<td>Le Thi Diem Trinh</td>
<td>Welcome &amp; Introduction</td>
</tr>
<tr>
<td>14.05 – 15.30</td>
<td>Pieter Fourie</td>
<td>Description of AV scenario elements to consider for the project</td>
</tr>
<tr>
<td></td>
<td>Ravi Seshadri</td>
<td>SimMobility: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td></td>
<td>Prof Kai Nagel</td>
<td>Autonomous vehicles in MATSim: The implementation of DVRP and some results</td>
</tr>
<tr>
<td></td>
<td><strong>Pieter Fourie/ Sebastian Hoerl/ Biyu Wang</strong></td>
<td><strong>MATSim: Current capabilities, work-in-progress, development timeline</strong></td>
</tr>
<tr>
<td>15.30 – 15.45</td>
<td></td>
<td>Break</td>
</tr>
<tr>
<td>15.45 – 16.05</td>
<td>Wang Hua</td>
<td>Optimizing charging locations for EVs: proposed methods, data requirements, challenges</td>
</tr>
<tr>
<td>16.05 – 17.00</td>
<td>Prof Lee Der-Horng</td>
<td>Discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1) incorporation of EV in MATSim/SimMobility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) definition of AV scenarios: parking, ride-sharing constraints, fleet mix etc.</td>
</tr>
</tbody>
</table>
Two example visions of autonomous vehicles

**Autonomous taxi**
- Island-wide operation, unconstrained
- No private cars, transit as alternate mode
- Single operator
- 1-4 occupants
- No transit integration
- Infinite drop-off capacity, anywhere
- Vehicle off-network during standby
- Central dispatch
- No parking, road pricing
- Increased flow capacity
- No charging
- Fixed pricing

**Transit-on-demand**
- Area-constrained operation
- Private cars compete
- Single operator
- Mixed fleet: 6-60 occupants
- Dynamic aggregation and routing along stops
- AV-only lanes along parts of route
- Vehicle at charge station/depot during standby
- Central dispatch
- No parking, road pricing
- Limited speed in mixed-use areas
- Induction charge during pickups, at depot
- Dynamic, demand-driven pricing
Two example visions of autonomous vehicles

**Autonomous taxi**
- Island-wide operation, unconstrained
- No private cars, transit as alternate mode
- Single operator
- 1-4 occupants
- No transit integration
- Infinite drop-off capacity, anywhere
- Vehicle off-network during standby
- Central dispatch
- No parking, road pricing
- Increased flow capacity
- No charging
- Fixed pricing

**Transit-on-demand**
- Area-constrained operation
- Private cars compete
- Single operator
- **Mixed fleet: 6-60 occupants**
- Dynamic pooling and routing along stops
- AV-only lanes along parts of route
- Vehicle at charge station/depot during standby
- Central dispatch
- No parking, road pricing
- Limited speed in mixed-use areas
- **Induction charge during pickups, at depot**
- Dynamic, demand-driven pricing

*Source: CURBED magazine, 28.06.2016*
Autonomous transit-on-demand

The starting point is the one taxi example in DVRP:

**Step 1:** Implementation of the autonomous vehicle (Mandatory)
approx. 2-4 weeks

**Goal:** Run Sioux Falls scenario with multiple shared autonomous vehicles

1. Multiple autonomous vehicles (I have already implemented that in my paper presented in hEART)
2. Define fleet size: fixed or defined by pre-simulation
3. Define vehicle capacity: fixed
4. Shared vehicle with multiple passengers
   - No passenger in the vehicle: request must be accepted
   - Passengers in the vehicle, but the capacity of the vehicle is not reached: simplified pooling algorithm currently in use
5. Request dispatching
   - Centralised request dispatching system
Autonomous transit-on-demand

**Step 2:** Implementation of dedicated stops (Mandatory) *approx. 2-4 weeks*

**Goal:** Run Singapore scenario with autonomous transit-on-demand
1. Reconstruct all existing bus stops as dedicated stops for autonomous transit-on-demand
   - Check the capability of public transit system, blocking and non-blocking stops, and the capacity of non-blocking stops. If it is needed, a specific capacity should be set in all non-blocking stops.

2. Define new behaviors
   - Walk to AVs: Similar to walk to transit
   - Wait for AVs: Similar to wait for transit

**Step 3:** Integration with MRT (Optional)
**Goal:** Allow people to choose autonomous transit-on-demand to access MRT (multi-modal routing)

**Step 4:** Optimisation of stop location, fleet size, vehicle capacity and stop capacity (Optional)
**Goal:** Solve optimisation problem with MATSim simulation
Current (experimental) developments and low-hanging fruits

**Electric AVs:**
Track the consumption of any AV and send it to recharge once a certain level (or any other condition) is met. The whole process is very flexible, you can choose which recharging station to use, or if the charging just happens at the current place. You can define the recharging time and also abort the recharging process.

**Private / Household AVs:**
AVs which can bring agents to work etc. and then optionally return home and show up at the right time again. The same works in principle for households, though there the whole scheduling aspect has not been covered (i.e. who takes which AV when, etc.).

**Adjustable flow consumption**
To simulate platooning, assume that AV consumes e.g. half the road capacity that car would

(simplest way of correcting for AV/car mixed traffic)

**AV fleet cost calculator**
R scripts that evaluate and adjust pricing of AV fleet according to utilisation, can be modified to take account of e.g. charging, cleaning cost

**Pickup interface:**
Regardless of deployment mode, if AV is a significant mode, then links need to have capacity for simultaneous pickup/dropoff. Initially set to infinite, then check influence of reduction, and consider feedback mechanism
## Possible Scenario Dimensions - revisited

<table>
<thead>
<tr>
<th>Study area</th>
<th>Central SG</th>
<th>Whole island</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mode interaction</strong></td>
<td>AV + Car</td>
<td>AV + Transit</td>
</tr>
<tr>
<td><strong>Operator</strong></td>
<td>Single</td>
<td>Multiple</td>
</tr>
<tr>
<td><strong>Sharing</strong></td>
<td>Private</td>
<td>Shared A-B/A-A</td>
</tr>
<tr>
<td><strong>Transit integration</strong></td>
<td>AV First/Last mile/transfer support</td>
<td>Autonomous Transit-on-demand</td>
</tr>
<tr>
<td><strong>Network constraints</strong></td>
<td>AV lane</td>
<td>Vehicle size constr.</td>
</tr>
<tr>
<td><strong>Vehicle size</strong></td>
<td>1-2 seater</td>
<td>4 seater</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>Non-blocking inf.</td>
<td>Capacitated</td>
</tr>
<tr>
<td><strong>Service</strong></td>
<td>Central dispatch</td>
<td>Self-organised</td>
</tr>
<tr>
<td><strong>Parking</strong></td>
<td>Ignored</td>
<td>Always roam</td>
</tr>
<tr>
<td><strong>Road pricing</strong></td>
<td>Ignored</td>
<td>ERP I</td>
</tr>
<tr>
<td><strong>Dynamics</strong></td>
<td>Platooning</td>
<td>Intersection coord.</td>
</tr>
<tr>
<td><strong>Electric vehicles</strong></td>
<td>Static charge</td>
<td>Dynamic charge</td>
</tr>
<tr>
<td><strong>Pricing</strong></td>
<td>Fixed</td>
<td>Variable</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>Mesoscopic</td>
<td>Microscopic</td>
</tr>
</tbody>
</table>
The biggest challenge

**INTEGRATION, INTEGRATION, INTEGRATION**

Need a process of systematic automated integration testing, that allows for functionality to be brought online piecewise, and hopefully allow easier detection of bugs, interaction effects. Sebastian is working on a framework for robust scenario generation, hoping to address such concerns.
<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter/ Moderator</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.00 – 14.05</td>
<td>Le Thi Diem Trinh</td>
<td>Welcome &amp; Introduction</td>
</tr>
<tr>
<td>14.05 – 15.30</td>
<td>Pieter Fourie</td>
<td>Description of AV scenario elements to consider for the project</td>
</tr>
<tr>
<td></td>
<td>Ravi Seshadri</td>
<td>SimMobility: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td></td>
<td>Prof Kai Nagel</td>
<td>Autonomous vehicles in MATSim: The implementation of DVRP and some results</td>
</tr>
<tr>
<td></td>
<td>Pieter Fourie/ Sebastian Hoerl/ Biyu Wang</td>
<td>MATSim: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td>15.30 – 15.45</td>
<td></td>
<td><strong>Break</strong></td>
</tr>
<tr>
<td>15.45 – 16.05</td>
<td>Wang Hua</td>
<td>Optimizing charging locations for EVs: proposed methods, data requirements, challenges</td>
</tr>
<tr>
<td>16.05 – 17.00</td>
<td>Prof Lee Der-Horng</td>
<td>Discussion (1) incorporation of EV in MATSim/SimMobility (2) definition of AV scenarios: parking, ride-sharing constraints, fleet mix etc.</td>
</tr>
<tr>
<td>Time</td>
<td>Presenter/ Moderator</td>
<td>Content</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>14.00 – 14.05</td>
<td>Le Thi Diem Trinh</td>
<td>Welcome &amp; Introduction</td>
</tr>
<tr>
<td>14.05 – 15.30</td>
<td>Pieter Fourie</td>
<td>Description of AV scenario elements to consider for the project</td>
</tr>
<tr>
<td></td>
<td>Ravi Seshadri</td>
<td>SimMobility: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td></td>
<td>Prof Kai Nagel</td>
<td>Autonomous vehicles in MATSim: The implementation of DVRP and some results</td>
</tr>
<tr>
<td></td>
<td>Pieter Fourie/ Sebastian Hoerl/ Biyu Wang</td>
<td>MATSim: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td>15.30 – 15.45</td>
<td></td>
<td>Break</td>
</tr>
<tr>
<td>15.45 – 16.05</td>
<td>Wang Hua</td>
<td>Optimizing charging locations for EVs: proposed methods, data requirements, challenges</td>
</tr>
</tbody>
</table>
| 16.05 – 17.00 | Prof Lee Der-Horng | Discussion  
(1) incorporation of EV in MATSim/SimMobility 
(2) definition of AV scenarios: parking, ride-sharing constraints, fleet mix etc. |
<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter/ Moderator</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.00 – 14.05</td>
<td>Le Thi Diem Trinh</td>
<td>Welcome &amp; Introduction</td>
</tr>
<tr>
<td>14.05 – 15.30</td>
<td>Pieter Fourie</td>
<td>Description of AV scenario elements to consider for the project</td>
</tr>
<tr>
<td></td>
<td>Ravi Seshadri</td>
<td>SimMobility: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td></td>
<td>Prof Kai Nagel</td>
<td>Autonomous vehicles in MATSim: The implementation of DVRP and some results</td>
</tr>
<tr>
<td></td>
<td>Pieter Fourie/ Sebastian Hoerl/ Biyu Wang</td>
<td>MATSim: Current capabilities, work-in-progress, development timeline</td>
</tr>
<tr>
<td>15.30 – 15.45</td>
<td></td>
<td>Break</td>
</tr>
<tr>
<td>15.45 – 16.05</td>
<td>Wang Hua</td>
<td>Optimizing charging locations for EVs: proposed methods, data requirements, challenges</td>
</tr>
<tr>
<td>16.05 – 17.00</td>
<td>Prof Lee Der-Horng</td>
<td>Discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1) incorporation of EV in MATSim/SimMobility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) definition of AV scenarios: parking, ride-sharing constraints, fleet mix etc.</td>
</tr>
</tbody>
</table>