Shared Autonomous Mobility

Kunal Chandra, Vice President, December 2019, Berlin

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Urban megatrends in 2030 indicate a high demand on city infrastructure systems

**People moving to cities**

790 million

**More megacities**
Cities with a population over 10 million

Source: United Nations Population Division

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Ride hailing cabs unlikely to solve urban mobility problems with only up to 60% utilization rate in even highly urban centers

Ride hailing cabs occupancy rate (in percentage)

Boston, MA: 100, 35, 55
Chicago, IL: 100, 36, 55
Los Angeles, CA: 100, 30, 60
San Francisco, CA: 100, 31, 60
Seattle, WA: 100, 38, 53
Washington DC: 100, 35, 55

Source: Fehr and Peers study commissioned by Uber and Lyft
Our AV-DRT shuttle system allows for safe, cost competitive, reliable, responsive & profitable public transport operations

Solution

**AD Road-side infrastructure**
At traffic critical points

**AV-DRT shuttle system for public transport**
On-demand or fixed scheduled first/last mile services

**Cloud-based software platform**
Simulation, intermodal solutions, fleet management

Integrated cybersecurity system

Cloud-based software platform

- Traffic simulation
- Vehicle simulation
- Intermodal solutions
- Fleet management
- Mission management

2 maps of the environment: 1x from vehicle and 1x from AD Road-side infrastructure – allow safety approval in 2-o-2 logic

AV-DRT shuttle system consists of AD road-side Infrastructure and cloud-based software platform

Integration of different AD shuttles from partners (vehicle agnostic system)

Customer benefits

**Significant OPEX reduction**
>60% lower costs compared to conventional bus operations

**Earlier homologation**
5 years earlier compared to systems w/o infrastructure support; no blind spots on the road

**Technology boost**
Cities and PTOs become competitive against Uber, Lyft, etc.

**Allows for new business models**
Demand-driven mobility services, attract new customers

**Congestion free cities**
Avoids short distance individual ride hailing. Higher energy efficiency through shared mobility

AD: Autonomous Driving | AV: Autonomous Vehicle | DRT: Demand-Responsive Transportation | PTO: Public Transport Operator
Infrastructure provides an additional “pair of eyes” for the shuttles resulting in safer and more comfortable passenger experience.
In certain situations, the role of infrastructure becomes highly critical.

**Roadway junction**

**Roadway connectivity**

**Steep hill scenario**

**Hairpin turn**

“Sun blinding” of sensors

Localization...

Higher road safety  Increased road efficiency  Mobility system improvements
Second source of information likely to shorten time to homologation for autonomous shuttle services

Faster homologation

Challenges

- Globally no legal framework in place that judges autonomous driving
- Technical standards and norms need to be revised to cover the requirements of autonomous systems
- New set of risks consisting of human/machine interaction with machine dependency

Solution

Digital Twin: Verification and validation with simulation

- Intensive testing in a virtual environment (vehicle/infrastructure) with a pool (~10^6) of dedicated real-life scenarios
- Hardware in the Loop (HiL): Test of embedded systems and its control algorithms by outputting actuator control signals

**Benefit:** Simulation achievements can be fast and with less efforts implemented in the development

Additional information for the vehicle by road-side infrastructure

- Detection, sensor data fusion and object classification by a smart pole consisting of sensors like lidar, radar and camera
- Trustworthy signal (SIL 3) transmitted from the infrastructure (occupancy grid) to the vehicle through a secure communication channel

**Benefits:** Enhanced environmental perception, valuable support from a second source for driving decisions

AD infrastructure incl. simulation tests of an AD system significantly helps to overcome homologation challenges – we expect time savings of 50% for permits for an AD infrastructure supported system compared to stand-alone vehicle solutions.
At Siemens we combine wide range of expertise for end to end development, validation and deployment of AV-DRT systems

Traffic simulation

Verification & validation

Mobility management

Intermodal solutions

Drive new product development

Use the strengths of the Siemens eco-system
Verification and validation

Scenario simulation using vehicle sensors and V2V automation limits **turn at intersection to 10 km/h**

V2V

Scenario simulation using vehicle sensors, **V2V and V2I** turn at intersection can be executed at **25 km/h**

V2V and V2I
Fast pace development through deployment in strategic projects in partnership with our key customers

Urban

- Munich
  - OTS 1.0

- Singapore
  - CETRAN, etc.

Interurban

- Hamburg
  - HEAT

- KoRa9

Other projects

- Rail adaption
  - Potsdam

- Other projects
  - Interurban

- Urban
  - Munich
  - Singapore
  - Hamburg
  - Interurban
  - Other projects

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CES Press Event