THE SUMMARY OF LAST MILE VEHICLE (LMV) PILOT RESEARCH

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EXECUTIVE SUMMARY

• Case Study Overview

• Comparison and analysis:
  • Key Technology & Solution

• Summary:
  • Main Issues
  • Opportunities & Risks
  • Future Roadmap
REGIONS

➢ EUROPE
   • France (EasyMile)
   • France (Navya)

➢ ASIA-PACIFIC
   • China (BAIDU)
   • Australia (Flinders Autonomous Shuttle Trial)
   • Australia (RAC Intellibus) by Navya
   • New Zealand (HMI)

➢ NORTH AMERICA
   • US (Drive.ai/ Optimus Ride/ May Mobility/ Ridecell/ Local Motors
   • US (Waymo, Uber, GM)
   • Canada (ELA) – by EasyMile
EASYMILE

EZ10 DRIVERLESS SHUTTLE FOR FIRST & LAST MILE JOURNEY

- UP TO 15 PASSENGERS AND 25 MILES/HOUR
- IN-BUILT ACCESS RAMP FOR MOBILITY-CHALLENGED PASSENGERS
- OPERATES ON FIXED OR ON-DEMAND ROUTES
- SUPERVISED BY EASYMILE'S FLEET MANAGEMENT SOFTWARE
- OPERATES ON EXISTING ROADWAYS WITH NO ADDITIONAL INFRASTRUCTURE REQUIRED

The EZ10 driverless shuttle has already been deployed in 20 countries across Asia-Pacific, Middle-East, North America and Europe.
• The "metro" mode, stop at each station:
EZ-10 operates just like a metro line. It then covers systematically each predefined station on a transport line, with no specific request from passengers and with regularity and predefined commuting times.

• The "bus" mode, stop on request:
EZ-10 operates like a public transport bus which covers a predefined route, by stopping at known stations with, however, the possibility for users to request for a stop. In this mode, EZ-10 moves according to a predefined traffic frequency.

• The "on request" mode, maximum flexibility:
The users ask for the arrival of a vehicle from a parking terminal or on a smartphone application, The supervision system then calculates the best and shortest route to send a EZ-10 The route can be modified before the arrival of the EZ-10 to destination, if a user makes the request. However, the regularity of the service is guaranteed by the supervision agent.
EASYMILE
EZ10C DRIVERLESS SHUTTLE FOR COMMUNITIES

• SPEED LIMITATION AT 18 MILES PER HOUR

• IDEAL FOR CORPORATE CAMPUSES, PARKING LOTS, COMMUNITY DEVELOPMENTS, INDUSTRIAL SITES, SPORTS STADIUMS, AND OTHER SIMILAR LOCATIONS

• ONLY ON PRE-MAPPED AREAS; RECONFIGURABLE IF NEEDED

• ON-DEMAND MODE, WITH DEDICATED APPLICATION

• VEHICLE DRIVING AUTOMATION:

  LEVEL 4/5 - HIGH AUTOMATION (ACCORDING TO SAE J3016)
NAVYA (FR)
ARMA AUTONOM SHUTTLE

• Up to 15 people

• Data from Lidar sensors, cameras, GPS RTK, IMU and odometry is merged together and interpreted by deep learning programs.

• A three-pronged approach:
  • perception, allowing the shuttle to understand the surroundings in which it is located, to detect obstacles and to anticipate movement.
  • decision, where the shuttle calculates and determines its route and path.
  • action, where the shuttle carries out the decisions made by the vehicle’s computer to the best of its ability.
Fig. 1  Active SAV pilots in the U.S., as of February 2018

Source from online
DRIVE.AI (ARLINGTON, TEXAS, USA)
SELF-DRIVING VAN-NISSAN NV200S

• a safety driver will be in the vehicles at first, but that person will soon move to a chaperon role.

• sensor suite — 10 cameras, four lidar, and a radar system — are off-the-shelf, but its software stack — the AI brain, perception, motion-planning, decision-making, and the mobile app — are all developed in-house.

• triple-redundancy cellular modem connection

• deploy on public roads and honed in on a tight, geofenced area.

• ride-hailing 6-month pilot
• test highly automated vehicles in the Commonwealth of Massachusetts
• Union Point neighborhood, which occupies 1,550 acres over 10 miles south of Boston.
• This represents “the word’s first revenue generation autonomous vehicle pilot program,” meaning the first in which members of the public will pay for access to a commercial service offering.
• The goal is to begin picking up passengers with the new service starting in early 2018 and to incorporate other smart infrastructure tech into the Union Point development, which is being built from the ground up as a model smart city.
EXHIBIT 2 | Two Change Scenarios: Evolutionary Versus Revolutionary

BOSTON TODAY

- Public transit: 56%
- Traditional personal vehicle: 33%
- Traditional taxi and ride hailing: 11%

SCENARIO A: Gradual shift from private to shared and from human-driven to AV

- Public transit: 50%
- Shared autonomous taxi: 22%
- Autonomous personal vehicle: 11%
- Traditional personal vehicle: 11%
- Traditional taxi and ride hailing: 6%

SCENARIO B: Disruptive shift from private and human-driven to shared and AV

- Public transit: 34%
- Autonomous shuttle bus: 28%
- Autonomous taxi: 24%
- Shared autonomous taxi: 14%

Sources: World Economic Forum; BCG analysis.

*This mix of transportation modes is representative of the study area only. Most trips into and out of the study area are work commutes. The model assumes a simplified modal mix without walking and cycling.*
MAY MOBILITY (MICHERGAN, USA)

- six-seat electric shuttles
- top speed of 25 miles per hour
- The one-year pilot will begin March 2019.
- low-speed autonomous shuttles that are designed to run along a specific route in business districts or corporate and college campuses.
- The fleet will operate on a 3.2-mile section of an existing bus route that provides access to downtown and two of the city’s business districts. The route includes 22 stops, 30 traffic lights and 12 turns, including three left turns, according to the initiative.
- a redundant suite of lidar, radar and camera sensors adding radio frequency signals embedded in streetlights or signs along the route to provide an added measure of safety

a monthly fee for its shuttle service, which includes mapping, monitoring and maintaining the vehicles
on-demand autonomous shuttle mobility service in low-speed, private-road settings

places like universities, theme parks, resorts, business parks, retirement communities — where the regulations will allow cruising around and picking up people

The added efficiency could come at the cost of jobs.

Autonomous vehicles are already expected to eliminate a large number of professional driving jobs. Limiting the number of human beings needed to manage fleets could reduce jobs even further.
Waymo (USA)

Early Riders with Valley Metro RideChoice
Chrysler Pacifica Hybrid Minivan

- launch service to the public **by the end of 2018**.
- in partnership with Valley Metro, the Phoenix area’s regional public transportation authority.

**Connecting people to public transportation**
- expand the program and provide first-and-last mile travel to Valley Metro RideChoice travelers, which covers groups traditionally underserved by public transit.
- always had a human behind the wheel, just in case.
- Through deals with Walmart, AutoNation, Avis and others, Waymo will pick up customers and drive them to businesses in the Phoenix area.
RESIDENTS’ FEEDBACKS

• *Riding from point A to point B is simple.*
• *Contacting us is easy.*
• *Ride for every reason.*

Rather than offering people one or two rides, the goal of this program is to give participants access to our fleet *every day, at any time, to go anywhere* within an area that’s about twice the size of San Francisco.
GENERAL MOTORS (US)

CRUISE AUTOMATION

- Chevy Bolt EV (Cruise AV)
- **Level 3** autonomous driving system
- Adaptive speed cruise control from stop and go traffic to highway speed
- Active lane keeping/lane steering
- Automatic emergency braking
- Side collision avoidance
- Cruise will have human support staff to initiate contact with passengers when assistance is needed.

*SuperCruise with Cardilac CT6 is estimated to be in late 2018*
LOCAL MOTORS (US)

OLLI SHUTTLE

- mostly 3D printed body
- capable of seating 8 passengers and reaching 25 mph.
- using IBM Watson’s IoT and cloud-based cognitive computing technologies to analyze transportation data
- developed with the input of people with disabilities

The Olli project — co-managed by the New York State Energy Research and Development Authority (NYSERDA) and the New York State Department of Transportation (NYSDOT) — supports Gov. Andrew M. Cuomo’s ambitious clean energy goal to reduce greenhouse gas emissions by 40 percent by 2030.
The Flinders Autonomous Shuttle Trial (FAST):
a collaboration between project partners Flinders University and RAA together with eight industry partners the SA Government, Cohda Wireless, SAGE Automation, SIEMENS, Telstra, transdev, UPG and ZENEnergy.

• a connection between bus stops on South Road, the Clovelly Park train station and all the businesses within the Tonsley Innovation Precinct.

• focused on putting driverless shuttles on to public roads within the Tonsley precinct before connecting them to bus stops on South Road and the Clovelly Park train station.

It’s predicted that by 2020 many known automobile manufacturers and new entrants will have driverless electric car models on the road, with the AEV world market heading for an estimated US$7 billion by 2050.
• The third stage shuttle trial will focus on servicing parts of the Sydney Olympic Park precinct by testing a variety of uses, including transporting office workers, residents, and other precinct workers.

• The trial will run for 12 months in three phases that the government said will have gradually increasing levels of operational complexity in real-world environments.

• The focus is on how to ensure road safety during testing on public roads, what constitutes as a driver "being in control", and understanding how the technology will interact with the state's transport system.
The Ohmio HOP is a 4-6 seater autonomous shuttle intended for indoor and outdoor mixed environments. Its LiDARs allow it to navigate areas which may contain pedestrians. The Ohmio HOP is a solution for short distance leisurely travel.

The Ohmio LIFT is Ohmio's flagship autonomous shuttle capable of carrying up to 20 passengers. It is a completely modular and flexible autonomous platform with systems that can be added or removed based on its intended deployment. Ohmio LIFT is a complete Level 4+ autonomous shuttle solution.
BAIDU (CHINA)

APOLONG, AUTONOMOUS MINI BUS

- up to 14 people capability
- China’s first L4 self-driving minibus powered by Apollo platform, has entered volume production stage with King Long (the second largest commercial bus maker in China).
- Apolong is outfitted with Baidu’s Apollo autonomous driving system will initially be deployed in tourist spots, airports and other controlled, or geo-fenced areas.
EasyMile is the SAV manufacturer:

- Livermore Amador Valley Transit Authority in Livermore, Calif.
- Bishop Ranch Office Park in San Ramon, Calif.
- GoMentum Station in Concord, Calif.
- City of Arlington in Arlington, Texas

Each SAV can carry 12 passengers and can operate for 14 hours on one battery charge.
ELA (ELECTRIC AUTOMATION) (CA)
THE FIRST ELECTRIC AUTONOMOUS SHUTTLE IN CANADA

- up to 12 people at a time; speed limited to 12 km/h
- fully accessible for people who use wheelchairs
- a backup system in case emergency human intervention is needed
- the route will be on a segregated road, separated from other vehicle and pedestrian traffic
- ELA is manufactured by EasyMile. (more than 170 incident-free deployments in more than 20 countries)

The test will run up to a month
• The ELA, which is made by the French company EasyMile, is fully electric and has no steering wheel. It uses 3D mapping and localization data from four sensors and additional video cameras as it steers itself.

• It can connect to a 4G network, which allows for remote supervision and data monitoring by both Pacific Western Transportation and researchers at the University of Alberta and the University of Calgary.

• Information collected by the program will inform future urban planning decisions and help academics understand how people respond to changing technologies.
**RAC INTELLIBUS** (PERTH, AU)

AUSTRALIA’S FIRST PUBLIC AUTONOMOUS VEHICLE TRIAL

- Up to 11 passengers; an average speed of 25 km/h
- Using *light detection and ranging*, *stereovision cameras*, *GPS*, *odometry*, and *autonomous emergency braking* to detect and avoid obstacles.
KEY ISSUES
SAFETY CONCEPT

Situation Analysis & Hazard Identification:
• Vehicle Usage
• Environmental Conditions
• Foreseeable driver use and misuse
• Interaction between vehicle systems

Technical Safety Concept:
• Technical safety requirements
• Refinement of functional safety requirements defining mechanisms to detect faults and mitigate or control failures (inherit the ASIL)
• Defines system architectural design

Implementing management plan for all phases of the safety lifecycle, including:
• Overall safety management
• Project dependent safety management
• Safety management for production, operation, service and decommissioning
SENSITIVITY ANALYSIS

- battery lifetime
- daily operation distance
- price of battery
- price of electricity
- charging time
- infrastructure upgrade of city roads
- government intervention
- traffic congestion & human interference
- potential environmental influence
- external influence on the vehicle itself
- floating parking fee strategy
LEGAL ASSESSMENT & TRUSTING ISSUE

- Liability of the vehicle keeper/ the driver
- High and full automation measurement
- Motor vehicle liability insurance
- Product liability of the manufacturer
- Product liability in highly and fully automated systems
- misusing cases/ special case: emergency stop system
- people with special needs (disabilities, illness)
- readiness of technology
- social acceptance of high or full automation
- job losing concern
ROUTES LOCALIZATION
- **ABB fast e-vehicle chargers:**

  Cloud-based technology connects the chargers to the Microsoft Azure cloud-based platform to drive greater value and efficiency.

**Charging Categories**

- **slow-charging (up to 3kW)**
  - essentially meaning a 6-8 hours all-day or all-night charge;

- **fast-charging (7-22kW)**
  - allowing a full recharge in 3-4 hours;

- **rapid-charging (43-50kW)**
  - the super-fast version offering 80% charge in around 30 minutes to an hour.
MOBILITY HUBS

• Any **transit stop** can be turned into a Mobility hub where the first and last mile vehicles are serviced, charged and stored when not in service.

• At these hubs passenger experience can be improved with digital information signs that respond to real-time conditions, improved lighting, improved pedestrian safety, bike racks, improved safety including CCTV cameras, and much more.
INTELLIGENT TRANSPORT SYSTEM (ITS)

1. Advanced Traffic Management System
2. Advanced Traveler Information System
3. Advanced Vehicle Control system
4. Advanced Public Transportation System
5. Advanced Rural Transportation Systems
6. Advanced Commercial Vehicles Operations system
WIRELESS ACCESS IN VEHICULAR ENVIRONMENTS (WAVE)

• It aims to support interoperability and robust safety communications in a vehicular environment.

• Using WAVE, each vehicle will broadcast its location, speed and direction of travel 10 times per second. Nearby vehicles and roadside infrastructure will receive these broadcasts.

IEEE 1609 series contains four standards that are under development, three are published and one is already withdrawn. Then the study discusses the technical details of IEEE 1609.4 for multi-channel operation and highlights the new features of WAVE Media Access Control (MAC) layer.
V2V COMMUNICATION

• An intelligent transport system will use the data from vehicle-to-vehicle communication to improve traffic management by allowing vehicles to also communicate with roadside infrastructure such as traffic lights and signs.

• *Automotive manufacturers working on ITS and V2V include GM, BMW, Audi, Daimler and Volvo.*
“WIFI DIRECT”

- GM is using WiFi Direct as some kind of intelligent, very cheap radar.
- GM could also provide a companion app.
- It is still in experimental stage.
PREDICTIVE MODELING FOR BETTER DATA PROCESSING
TRANSIT ORIENTED DESIGN

STREAMING
- sensors
- signals
- vehicles
- weather

AT-REST
- schedules
- special events
- energy metrics
- weather plans
- forecasts

CLOUD
- Filter
- Clean
- Validate
- Tag
- Sort
- Compress
- GeoSpatial Analysis
- Feature Extraction

MODEL, SIMULATE, ANALYZE, PREDICT
- Energy
- Economics
- Human Behavior
- Demographics
- Land Use

SCALABILITY PERFORMANCE ACCELERATION

TALTECH
5G or LORA
LONG RANGE CONNECTIVITY

• LoRa (Long Range) (https://lora-alliance.org/) is among a clutch of narrowband technologies that connect devices cheaply over unlicensed spectrum and vast distances and needs very little power.
• LoRa is a narrowband standard adopted by the likes of Cisco and IBM, is capable of working on thumbnail-sized radios that send and receive data that sell for a dollar or less.
• Narrow-Band IoT (NB-IoT) and LTE-M (mobile) for 5G
REAL TIME KINEMATIC (RTK)

LONG RANGE CONNECTIVITY

- A technique used to enhance the precision of position data derived from satellite-based positioning systems such as GPS.
- It relies on a reference stations to provide real-time corrections, providing up to centimeter-level accuracy.
- RTK is a technique that uses carrier-based ranging and provides ranges (and therefore positions) that are orders of magnitude more precise than those available through code-based positioning. RTK techniques are complicated.
- The basic concept is to reduce and remove errors common to a base station and rover pair.
Ultra-Wide Band (UWB) is a communication method used in wireless networking that uses low power consumption to achieve high bandwidth connections.

It's meant to transmit a lot of data over a short distance without using too much power.

It is several times better than traditional positioning systems based on Wi-Fi or GPS.

At longer distances, UWB data rates drop considerably.
NEW TECH
MOBI and ShareRing are bringing together automakers, suppliers, startups, and government agencies in a way that would never have been possible prior to the development of blockchain technology and the changes are sure to affect every aspect of the transport industry.

It appears as though blockchain technology is set to revolutionize this sector and reduce most of the waste that currently plagues the market.
DAIMLER AND BOSCH

• Due to launch a pilot project in Silicon Valley in California in the second half of 2019.
• select Nvidia AI platform
THANK YOU

RUXIN WANG
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