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The Development of Autonomous Vehicles and Its Applications in West Kowloon Cultural District

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- Development of Driverless Technology and Examples
- Social Economic Impacts and Current Issues
- The WKCD's Driverless Shuttle Pilot Project

DEFINITION OF DRIVERLESS VEHICLES

Definition of Driverless Vehicles

Driverless Vehicle

- A driverless vehicle is a vehicle that can guide itself without human conduction.

The Technology

- Detect surroundings using a variety of techniques such as:
  - Radar
  - Lidar (Light Detection and Ranging)
  - GPS
  - Odometry (Motion Sensors)
  - Computer Vision, etc.
- Detection of vehicles, obstacles and signage
- Systems interpret sensory information to identify appropriate navigation paths

The Driverless Senor Technology

Google driving to be driverless

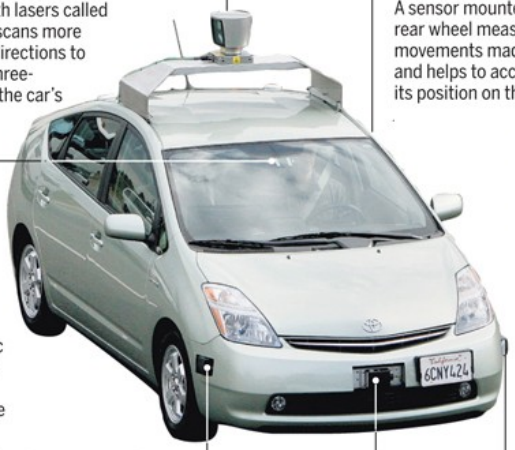
Google's modified Toyota Prius uses an array of sensors to navigate public roads without a human driver. Other components, not shown, include a GPS receiver and an inertial motion sensor.

Laser-guided mapping
A rotating sensor with lasers called a LIDAR on the roof scans more than 200 feet in all directions to generate a precise three-dimensional map of the car's surroundings.

Position estimator
A sensor mounted on the left rear wheel measures small movements made by the car and helps to accurately locate its position on the map.

Video camera

A camera mounted near the rear-view mirror detects traffic lights and helps the car's onboard computers recognize moving obstacles-such as pedestrians and bicyclists.



Radar
Four standard automotive radar sensors, three in front and one in the rear, help determine the positions of distant objects.

Source: Google

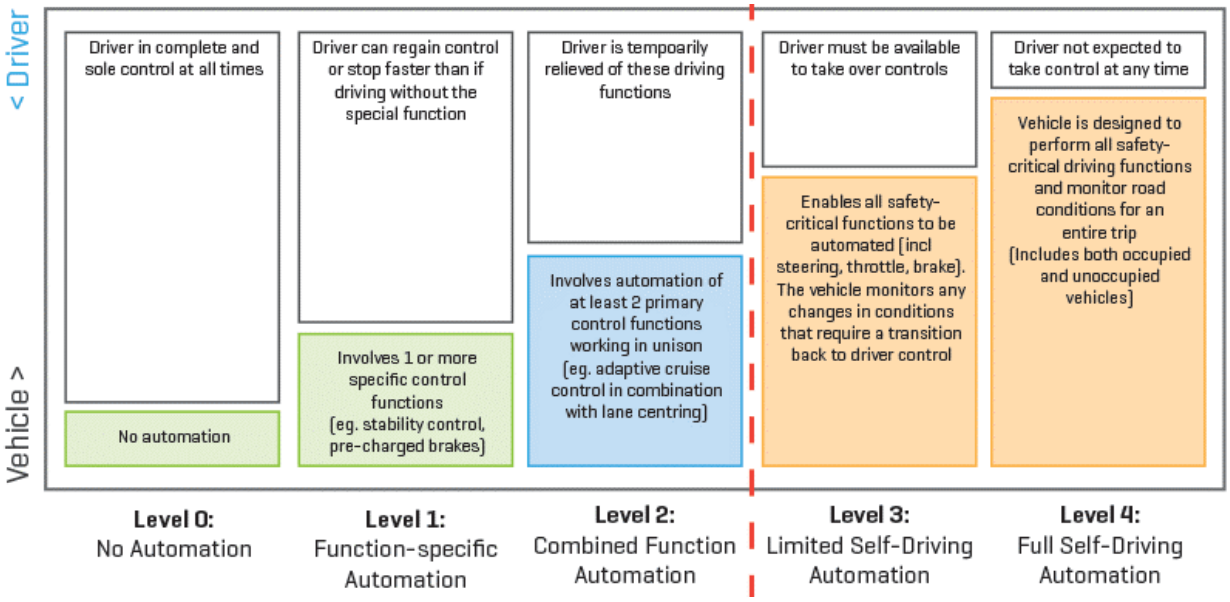
NEW YORK TIMES; PHOTOGRAPHS BY RAMIN RAHIMIAN FOR THE NEW YORK TIMES

CLASSIFICATION OF DRIVERLESS TECHNOLOGY

Classification of Driverless Technology

NHTSA Automated Vehicle Classification

- Classification established by the National Highway Traffic Safety Administration (NHTSA)
- 5-level system from full human control to full automation



DEVELOPMENT OF DRIVERLESS TECHNOLOGY

History and Development of Driverless Cars

1990s

- Use of camera vision to detect and response to object movement; Automated Highway
- e.g. **VaMP Driverless Car (Germany); NAHSC project**

2000s

- Google Self-Driving Project Began in 2009
- e.g. **Google Self-driving Car (US); DARPA Grand Challenge**

2010s

- Tesla's camera based Autopilot released
- e.g. **Tesla Model S (US)**











Development of Driverless Technology and Examples

Current Development - Based on market growth projection

2015
Passive Autonomous
Driver and parking assistance systems

2016
Audi A8 piloted driving

Mercedes F105 prototype

2016–18
BMW Baidu semi-autonomous prototype

2018
Tesla auto-pilot mode

2017–20

2020
Limited Autonomous
Driver intervenes in critical situations

C2X communication

Fully autonomous Mercedes S-class

Google driverless cars

Renault-Nissan autonomous cars

2022
Non-premium OEMs to adopt the semi/ fully autonomous technology

2022–

2025
Semi-Autonomous
Driver attention required with manual override

2030
Fully Autonomous
Driverless cars with no driver backup

Fully autonomous mode shared-commuting

Source: PwC Ltd., a US market research company

DRIVERLESS VEHICLE PROJECT EXAMPLES

Driverless Vehicles Examples

Driverless Cars Examples

Google Self-driving Car
US

Mercedes-Benz Future Bus
Germany

Driverless Vehicles Examples

Driverless Cars Examples

Catapult Transport Systems
UK

Tesla Model S
US

Driverless Vehicles Examples

Driverless Taxi / truck Examples

ロボネコヤマト

Roboneko" (Robot cat)
Japan

Robot Taxi
Japan

Driverless Vehicles Examples

Driverless Car Examples

大白
China

Baidu – BMW Partnership
China

Changan Preton (長安睿騁)
China

SOCIAL ECONOMIC IMPACTS AND CURRENT ISSUES

Potential Advantages of Driverless Technology

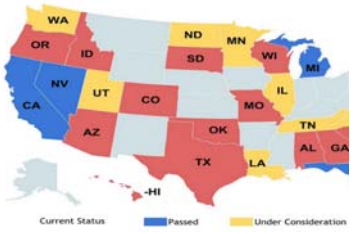
- **Enhancing Safety**
  - Perceiving surrounding environment
  - Elimination of human driver errors
- **Elimination of ability, age factors and driving test**
  - Can be used by the disabled, under / overaged
  - Operation will not be influenced by drunk or drugged drivers
- **Saves labour costs**
- **Reduction in insurance premiums**
- **Coordination / communications between vehicles allowing smoother rides and increased road capacity**
- **Reduce the car parking demand for the city**

Current Issues

- **Legislation of Driverless Vehicles**
  - Amending regulations on how vehicles are used and maintained
  - Criminal and civil liabilities

United States

- Legislatures in automated driving is being considered in the number of States



Germany

- Under current laws, self-driven or robot cars are not allowed on Germany's motorways, because according to the 1968 Vienna Convention on Road Traffic to which the country is enrolled, a human driver must be behind the wheel.
- Testing is however allowed on public roads provided that driver is on board and will take full legal responsibility.
- Present a draft bill on autonomous driving in end July 2016
  - Driver is required
  - Driver's liability shift
  - Equipped with "black box"

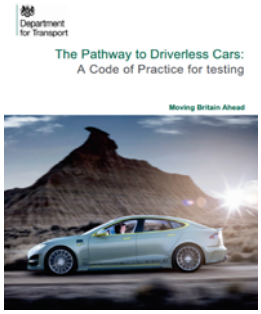
Current Issues

- **Cyber Security**
  - Manual override in case of emergency or malfunction
  - Control system should be “fail safe / virus safe” and protected from unauthorized access
- **Insurance**
  - Should the insurance cover the vehicle? the manufacturer? or the driver?
  - Will premiums be reduced due to the elimination of human error

United Kingdom

A Code of Practice for Testing of Driverless Cars was published in July 2015

- Driverless vehicle can be tested on public roads with a driver present, who must take responsibility for the safe operation of the vehicle
- Test vehicles do not need to obtain specific certificates or permits
- Insurance must be arranged to cover the testing

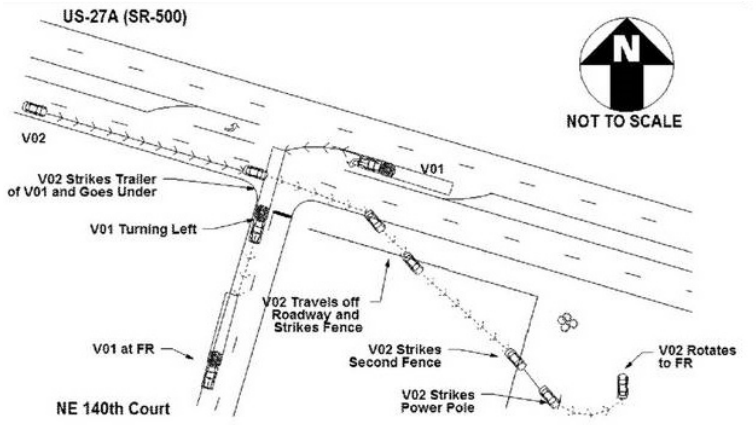


Other Issues

- **Job Reduction**
  - Lack of need for drivers, including lorry and bus drivers
- **Worry of computer crashing or malfunctioning**
  - Resulting in major collision

The Tesla Autopilot Accident

A driver was killed in the 7 May 2016 crash of a Tesla Motors car while using Autopilot driving-assist software.



THE WKCD'S DRIVERLESS SHUTTLE PILOT PROJECT

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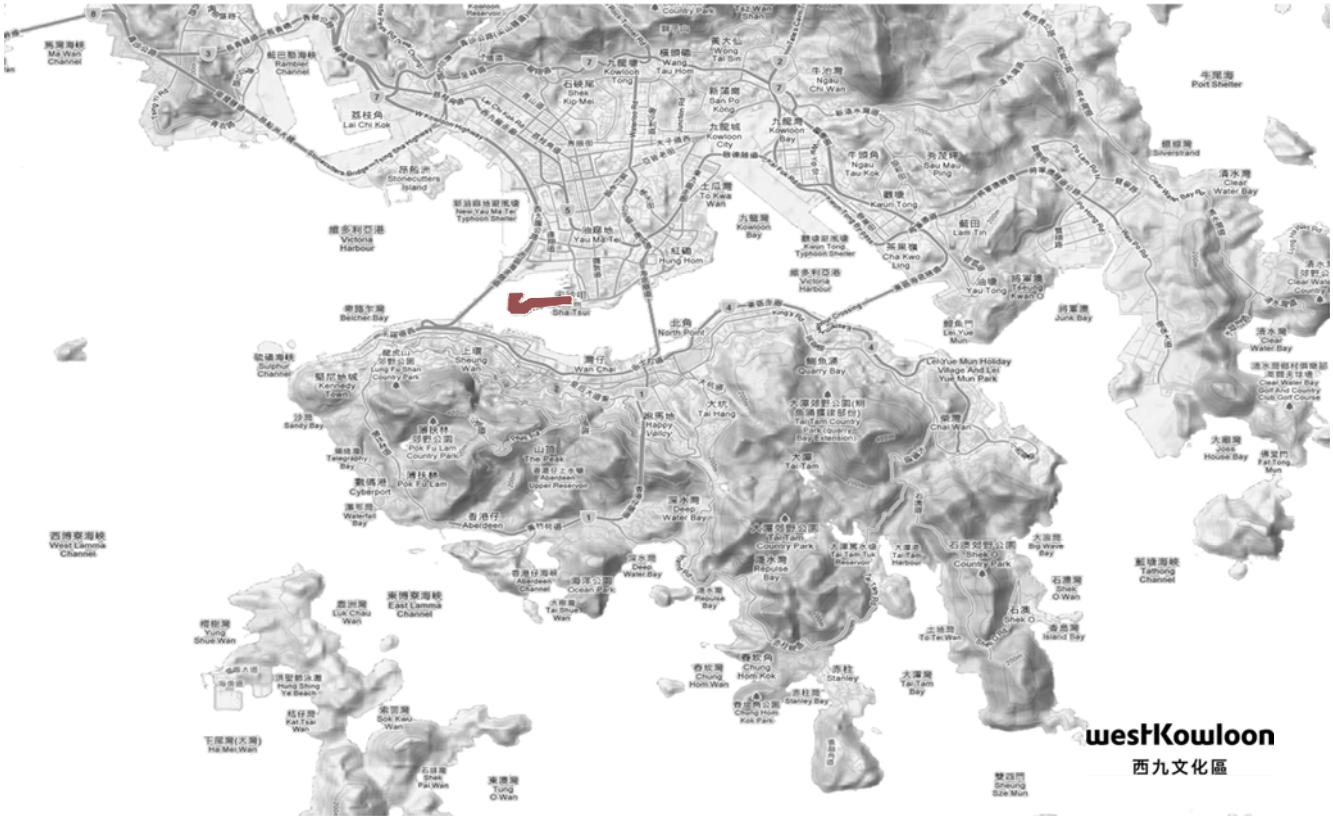
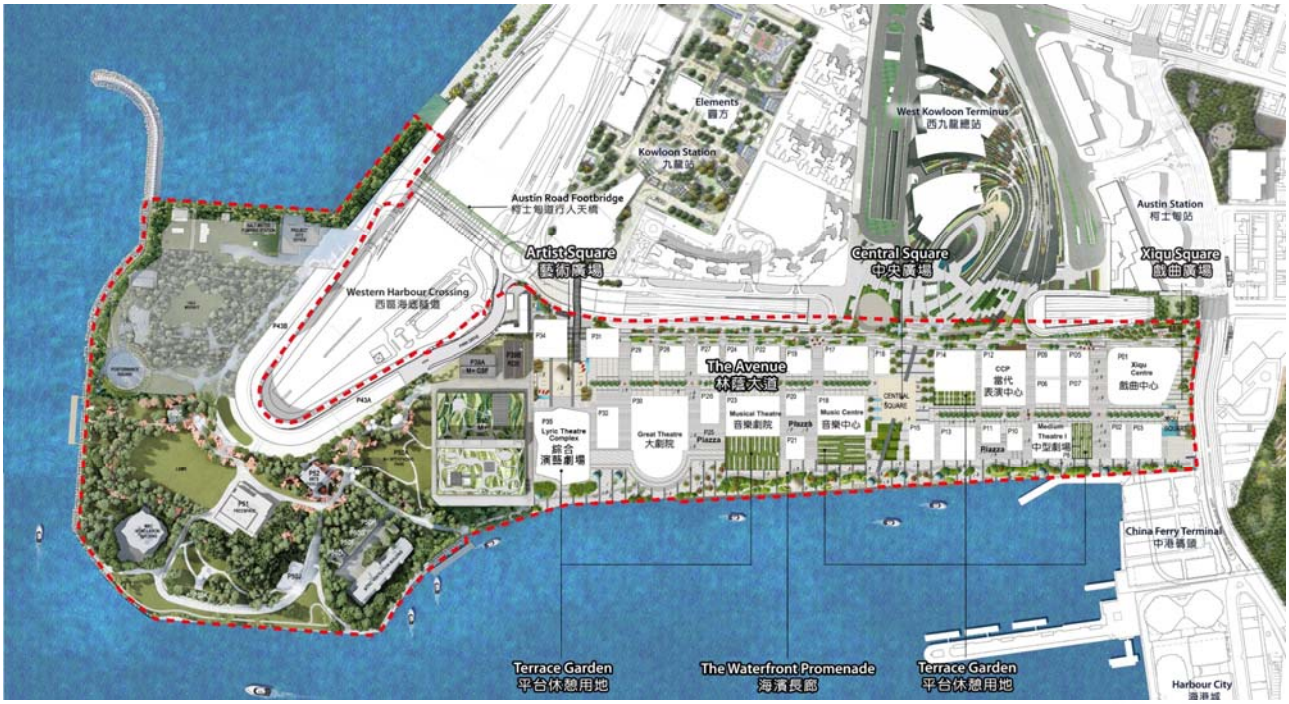
Site Location



West Kowloon Cultural District Overview



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Integrated Basement

- Key design concept in the Development Plan
- Vehicular traffic, ancillary parking, loading/unloading underground
- Free up space for arts and cultural use
- Pedestrian friendly environment at ground level

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Phase 1 – Pilot Run at the Park (2018 – 2022)

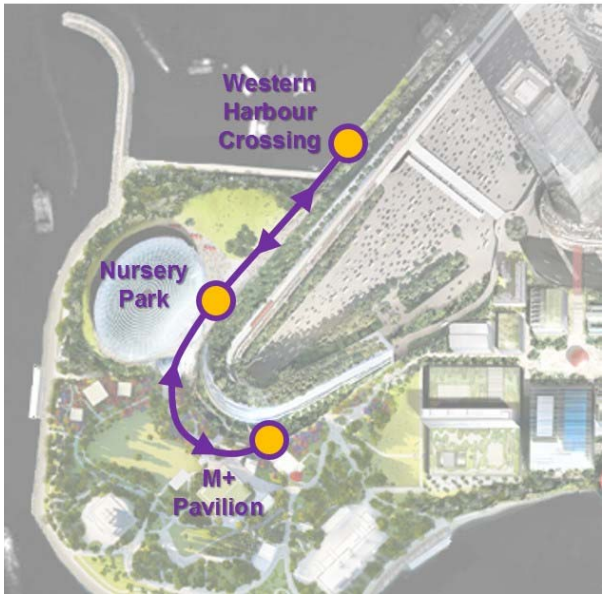
Non-Peak Period

- Passenger demands lower
- Point-to-point "on demand" service
- Service request performed at designated pick-up points, or via booking hotline / smartphone app.

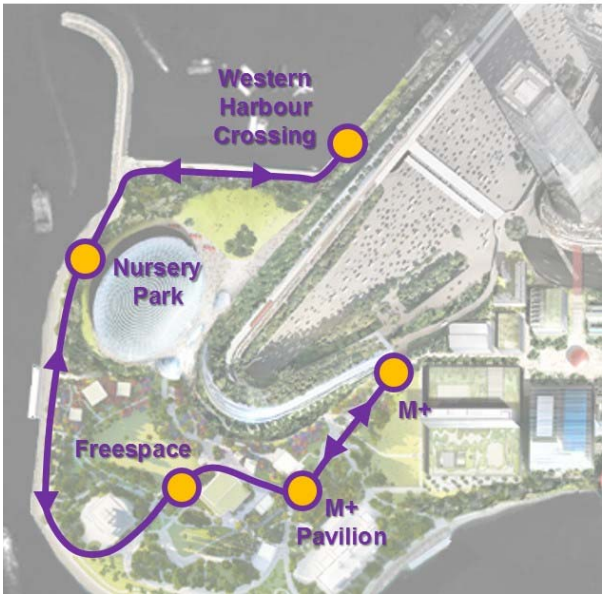
Peak Period

- Passenger demands higher
- Operated as shuttle service
- Predefined route and stop at fixed stations

Before Completion of M+



After Completion of M+



Phase 2 - Implementation at the whole WKCD

(Upon completion of the Avenue and Waterfront Promenade)

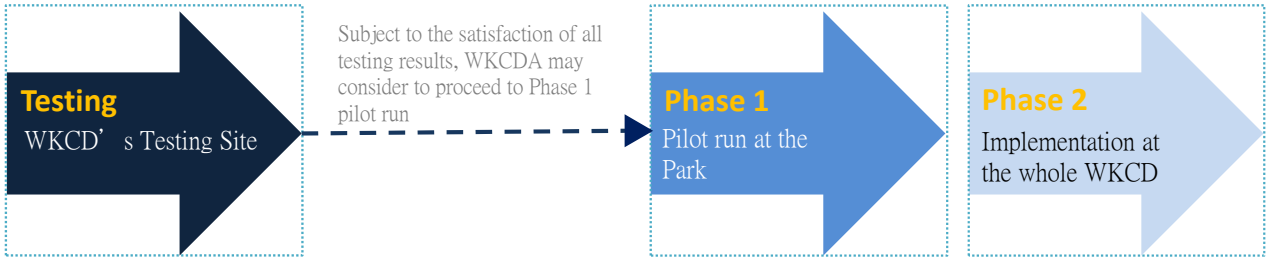
Non-Peak Period

- Passenger demands lower
- Point-to-point "on demand" service
- Service request performed at designated pick-up points, or via booking hotline / smartphone app.

Peak Period

- Passenger demands higher
- Operated as shuttle service
- Predefined route and stop at fixed stations

Implementation Time Line



2017

In parallel to testing, investigation to the following:

- Suitable **license** maybe required if pilot run is fare charged
- **Insurance** maybe required to required to cover for safety of the general public passengers or any other damages
- Current **legislations or regulations** may need to be be amended

2018 - 2022

2022 onwards*

*Year of full implementation shall be subject to the development program of WKCD (subject to the completion of The Avenue and Waterfront Promenade)

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Proposed Trial Run

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Testing of Driverless Vehicles in WKCD

Technical Specifications

Range per Charge:	≥ 100km
Passenger Capacity:	≥ 12 (seating and standing) Accessible by wheelchair
Size (LxWxH):	≤ 6300 x 2300 x 2000mm (TPDM specification for maximum private car)
Power:	Electric battery
Charge:	≤ 4 hours (battery should be replaceable to minimize idling time or an be recharged during operation)
Speed:	30km/hr (Maximum speed) 15km/hr (Proposed operation speed
Turning Radius:	≤ 6m
Gradient:	≥ 15%
Navigating System:	GPS, Lidar, Radar, Camera
Safety Feature:	Collision avoidance system must be the vehicle, the system should be able to avoid and response to all pedestrian movements within its operation area.

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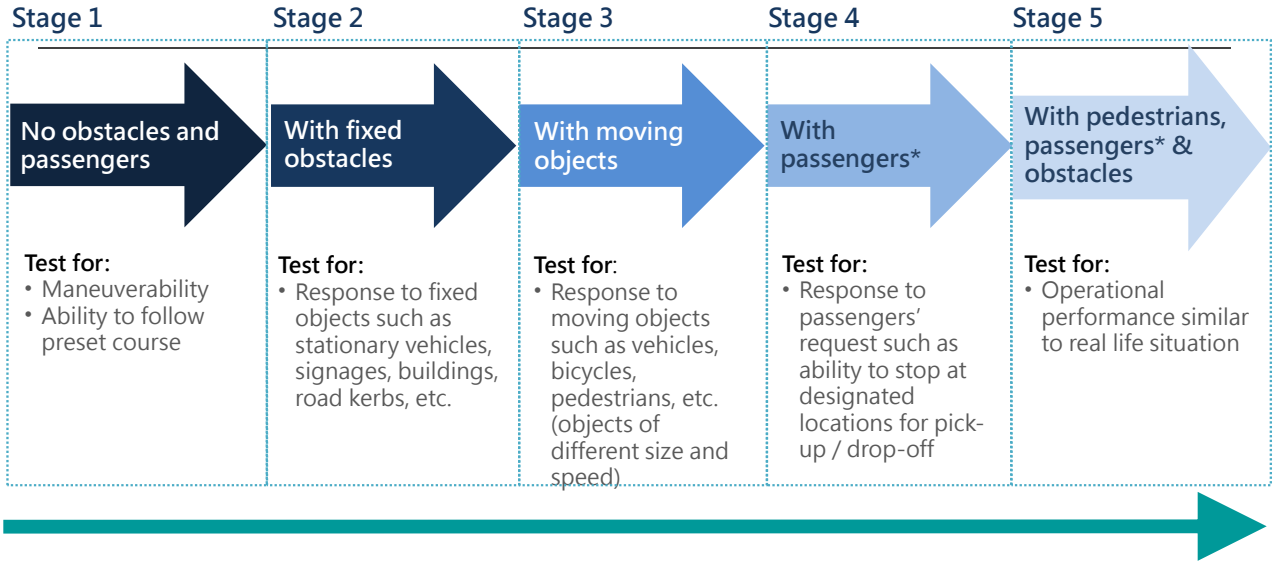
Testing of Driverless Vehicles in WKCD

Proposed Testing Schedule



2017 Q1

*Test passengers can be WKCDA' s staffs or volunteers from the public

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THANK YOU

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