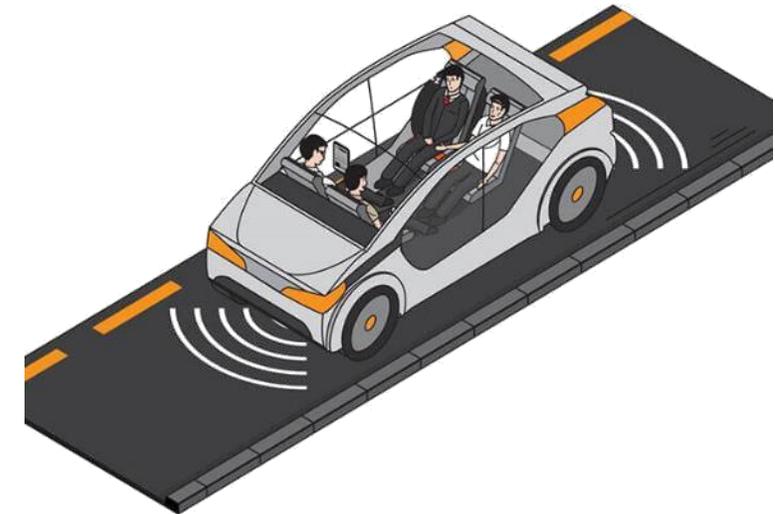# SINGAPORE'S ROADMAP ON AUTONOMOUS VEHICLES (AV)

Dr Chin Kian Keong

Chief Engineer, Roads & Traffic,

Land Transport Authority
We Keep Your World Moving

ASIA

Singapore

5.61 Million
Population

961,000
Vehicles

7,796 persons/ km²
Population density

12% of land
Road network

Source: www.singstats.gov.sg as of Dec 2017

Challenges of Singapore's Urbanisation

Growing Population and Economy

6.5 – 6.9 mil by 2030

>30% aged 65 and above by 2030

Tighter Land Constraints

12% of land for roads

14% of land for housing

Changing Expectations and Norms

Commuter-centric and inclusive transport system

Manpower Crunch

Shortage of drivers (PT, logistics, etc.)

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Singapore's Land Transport Masterplan

By 2030,

8 in 10
households living within a 10-minute walk from a train station

85%
of public transport journeys (less than 20km) completed within 60 minutes

75%
of all journeys in peak hours undertaken on public transport

Value Propositions of Autonomous Vehicles

Increase productivity
Autonomous buses to tackle problem of labour shortage

Increase road safety
Enable ageing population to maintain freedom of mobility while ensuring safe driving

Optimise road capacity
Vehicles can move together in a more compact and platoon manner

Enabling new mobility concept in new towns
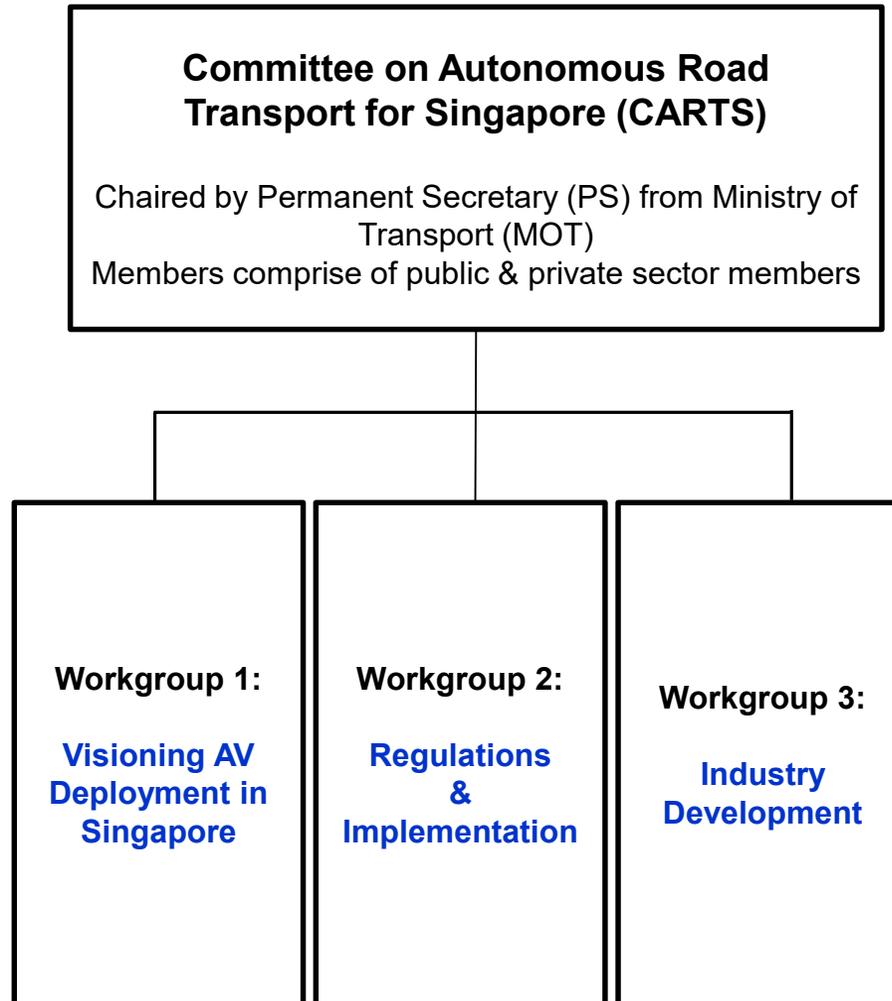AV Mobility-On-Demand and vehicle-sharing schemes to complement walking and cycling in new towns

Increase R&D Value-Add
Singapore is a Living Laboratory and is ideal for conducting test-bed for AV development and deployment

Formation of a Committee on Autonomous Road Transport For Singapore (CARTS)

Committee on Autonomous Road Transport for Singapore (CARTS)

Chaired by Permanent Secretary (PS) from Ministry of Transport (MOT)
Members comprise of public & private sector members

Workgroup 1:

Visioning AV Deployment in Singapore

Workgroup 2:

Regulations & Implementation

Workgroup 3:

Industry Development

Govt Agencies

Private Organisations

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Singapore's vision for Autonomous Vehicle deployment

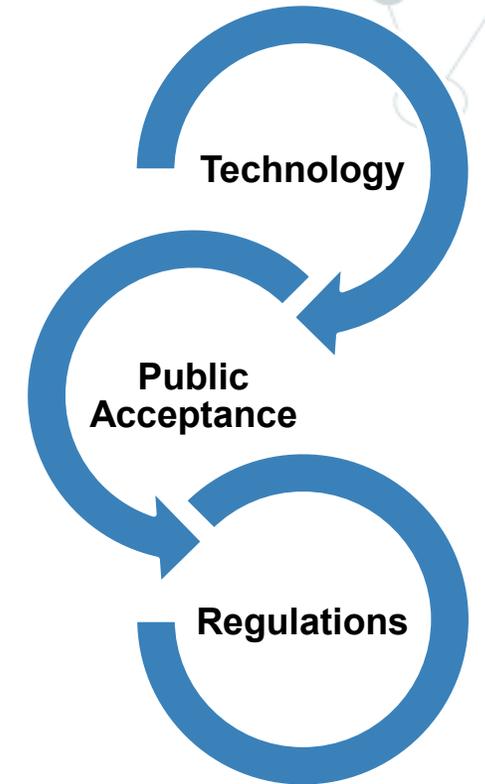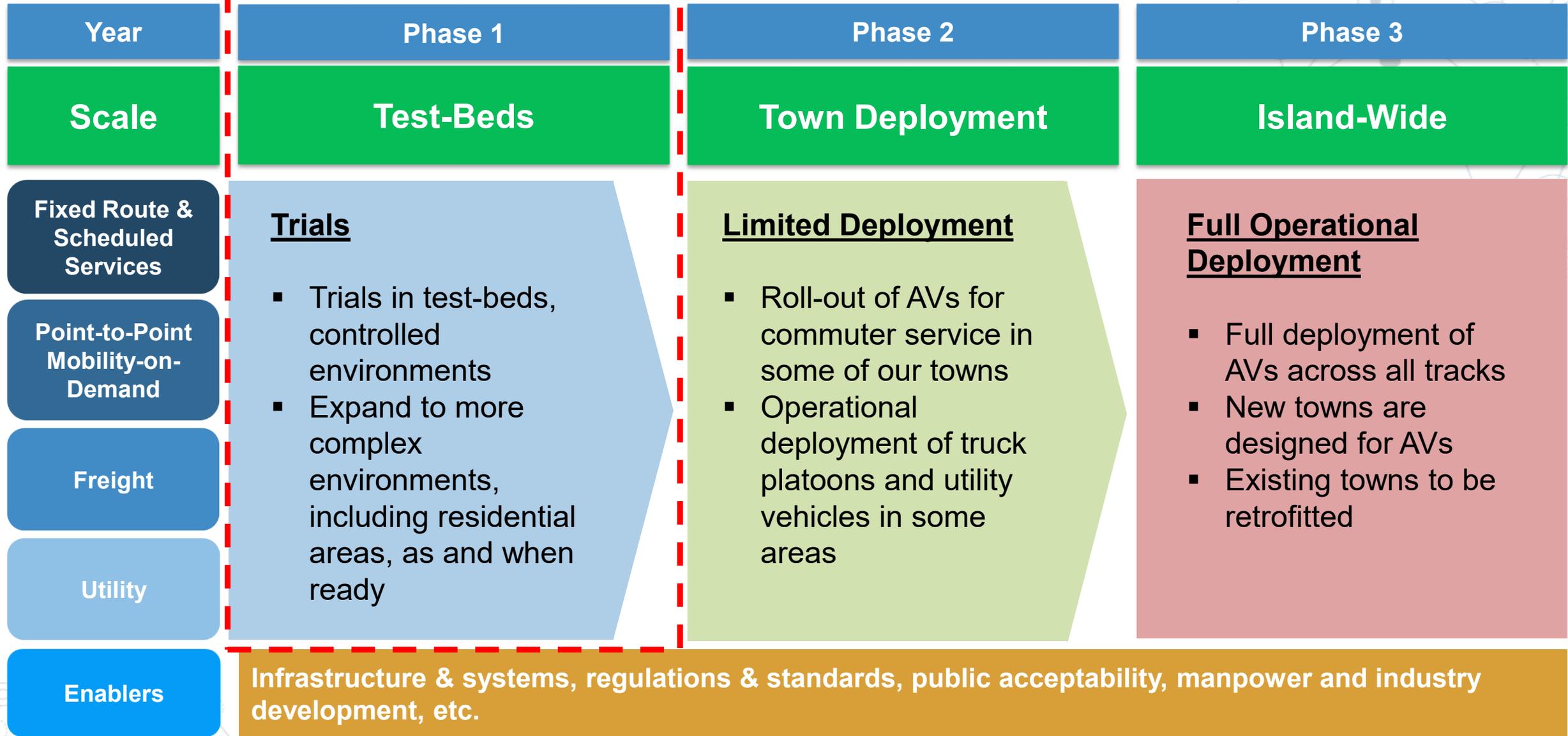|	
Fixed Route & Scheduled Services	**Mass transport for intra- and inter-town travel on a fixed route and scheduled basis**
Point-to-Point Mobility-on-Demand	**Shared services that are dynamically routed in real-time in response to commuters' demand, for point-to-point or first-mile-last-mile journeys**
Freight	**Carriage of goods**
Utility	**Utility operations (e.g. road sweeping)**

Key Enablers

Technology

Public Acceptance

Regulations

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Roadmap for deployment of AVs

Year	Phase 1	Phase 2	Phase 3
Scale	**Test-Beds**	**Town Deployment**	**Island-Wide**

Fixed Route & Scheduled Services

Point-to-Point Mobility-on-Demand

Freight

Utility

Enablers

Trials

- Trials in test-beds, controlled environments
- Expand to more complex environments, including residential areas, as and when ready

Limited Deployment

- Roll-out of AVs for commuter service in some of our towns
- Operational deployment of truck platoons and utility vehicles in some areas

Full Operational Deployment

- Full deployment of AVs across all tracks
- New towns are designed for AVs
- Existing towns to be retrofitted

Infrastructure & systems, regulations & standards, public acceptability, manpower and industry development, etc.

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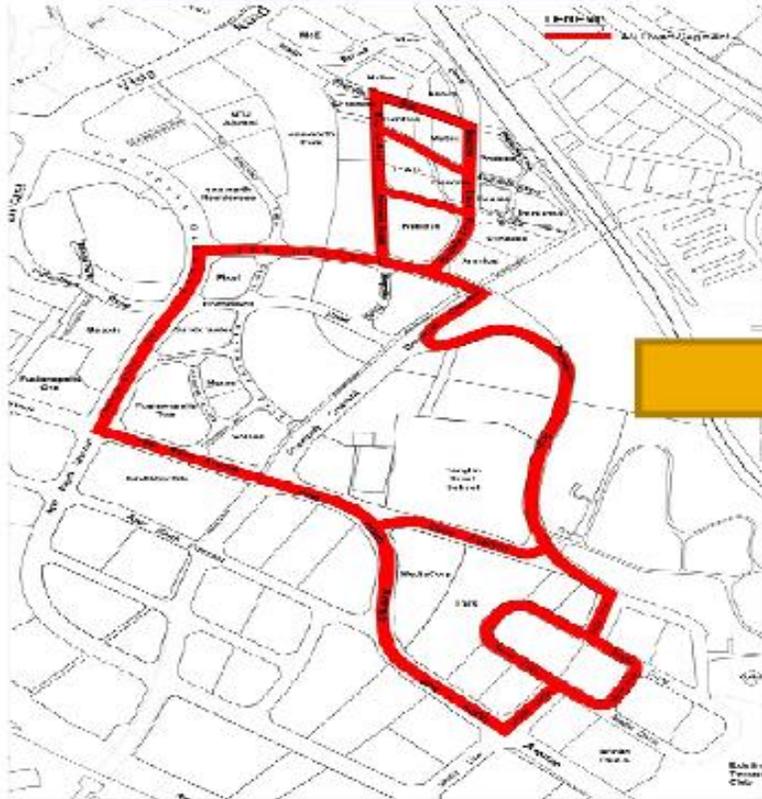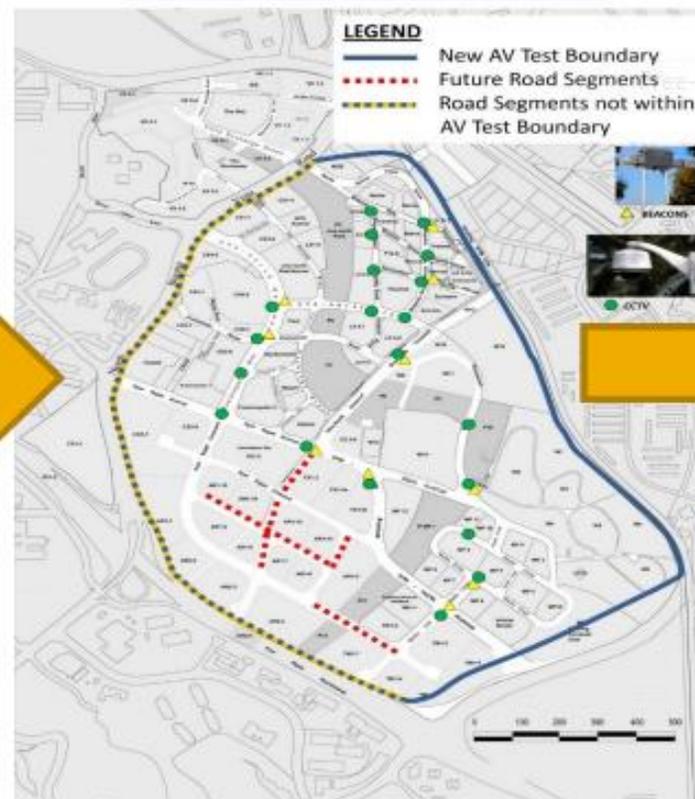
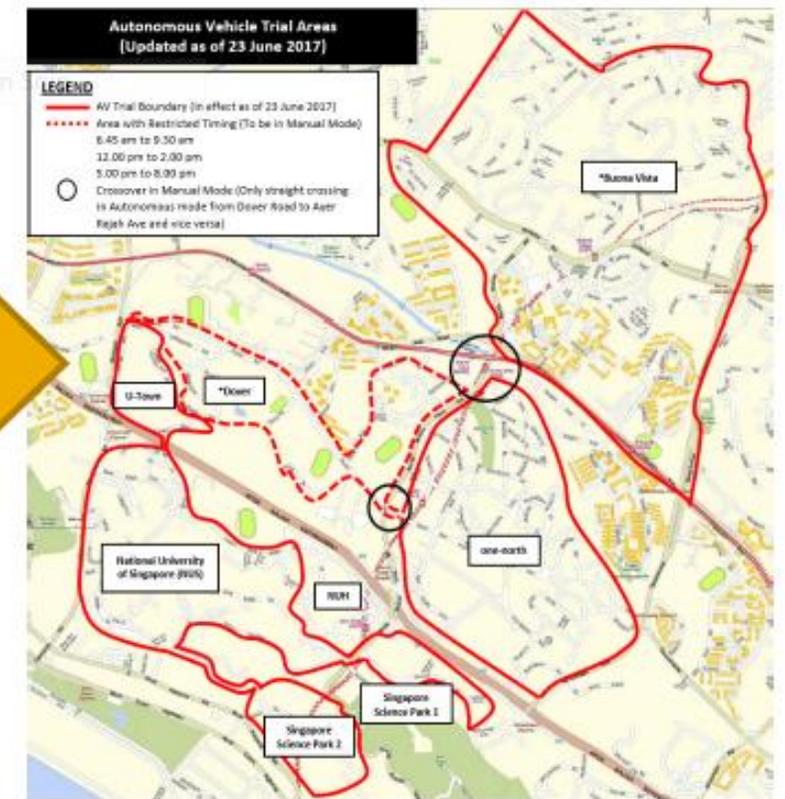# Expansion of test-bed areas through the years

January 2015

In collaboration with JTC, announced 6km of demarcated one-north roads

September 2016
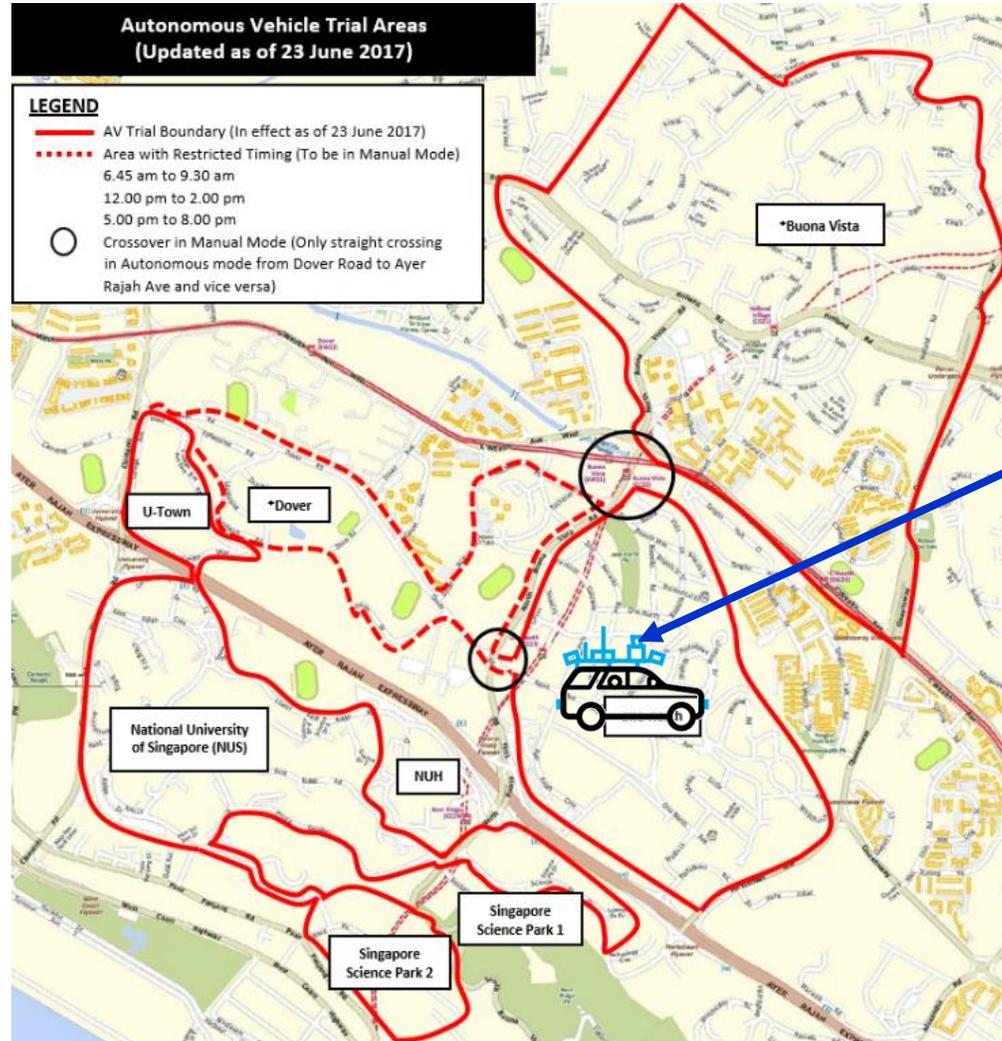
Doubled the length of roads from 6km to 12km

June 2017

Announced expansion of trial areas to include NUS, Singapore Science Park 1 and 2

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Infrastructure and Systems to support AV Trials

Surveillance Cameras

- CCTV placed at strategic and critical locations
- Real time streaming of video feeds
- Video recording
- Enable remote monitoring

Autonomous Vehicle Trial Areas
(Updated as of 23 June 2017)

LEGEND
- —— AV Trial Boundary (In effect as of 23 June 2017)
- ---- Area with Restricted Timing (To be in Manual Mode)
  6.45 am to 9.30 am
  12.00 pm to 2.00 pm
  5.00 pm to 8.00 pm
- ○ Crossover in Manual Mode (Only straight crossing in Autonomous mode from Dover Road to Ayer Rajah Ave and vice versa)

*Buona Vista

U-Town   *Dover

National University of Singapore (NUS)

NUH

Singapore Science Park 1

Singapore Science Park 2

Dedicated Short Range Communications (DSRC) beacons

- Traffic light signal status
- Position augmentation
- V2I information dissemination

AV Performance Evaluation System

- AV Monitoring and Evaluation
- Manage V2I information dissemination

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Centre of Excellence for Testing & Research of AVs-NTU (CETRAN)

On 1 August 2016, CETRAN was launched to:

- Build up **technical capabilities and knowledge** in the testing and certification of AV capabilities

- Facilitate the **drafting of regulations** to allow eventual deployment of AVs on public roads

CETRAN will also operate an AV test circuit that will support AV testing and certification activities.

CETRAN Partners:

Vision:

To position Singapore as a renowned AV Knowledge and Research Centre to catalyse the testing and certification of AV Technology for urban cities

Development of a **Technical Reference (TR)** for AV in Singapore

The creation of this Technical Reference (TR) involves participants from the Government, Academia and industry sectors

Government

Academia

Industry

*Work in progress

Roadmap for deployment of AVs

Year	Phase 1	Phase 2	Phase 3
Scale	**Test-Beds**	**Town Deployment**	**Island-Wide**

Fixed Route & Scheduled Services

Point-to-Point Mobility-on-Demand

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Land Transport Authority
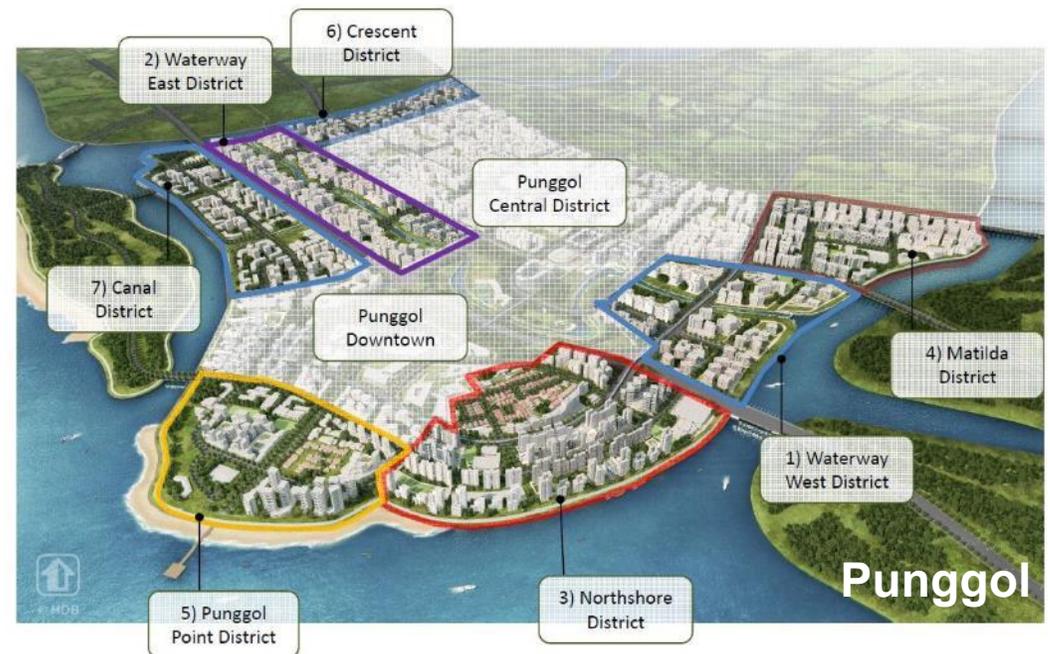
Plans for pilot town deployments in 2022

Plans for pilot deployment of **AVs as public transport** in **3 new towns** – Punggol, Tengah and Jurong Innovation District (JID) from 2022.

A **Request for Information (RFI)** was called in Nov 2017 and closed in May 2018 to **solicit ideas and requirements from industries** for such large-scale live AV deployment.

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Tengah and JID

Punggol

AVs to provide first/last-mile connectivity

Two public transport modes to provide convenient first/last-mile connectivity:

- -

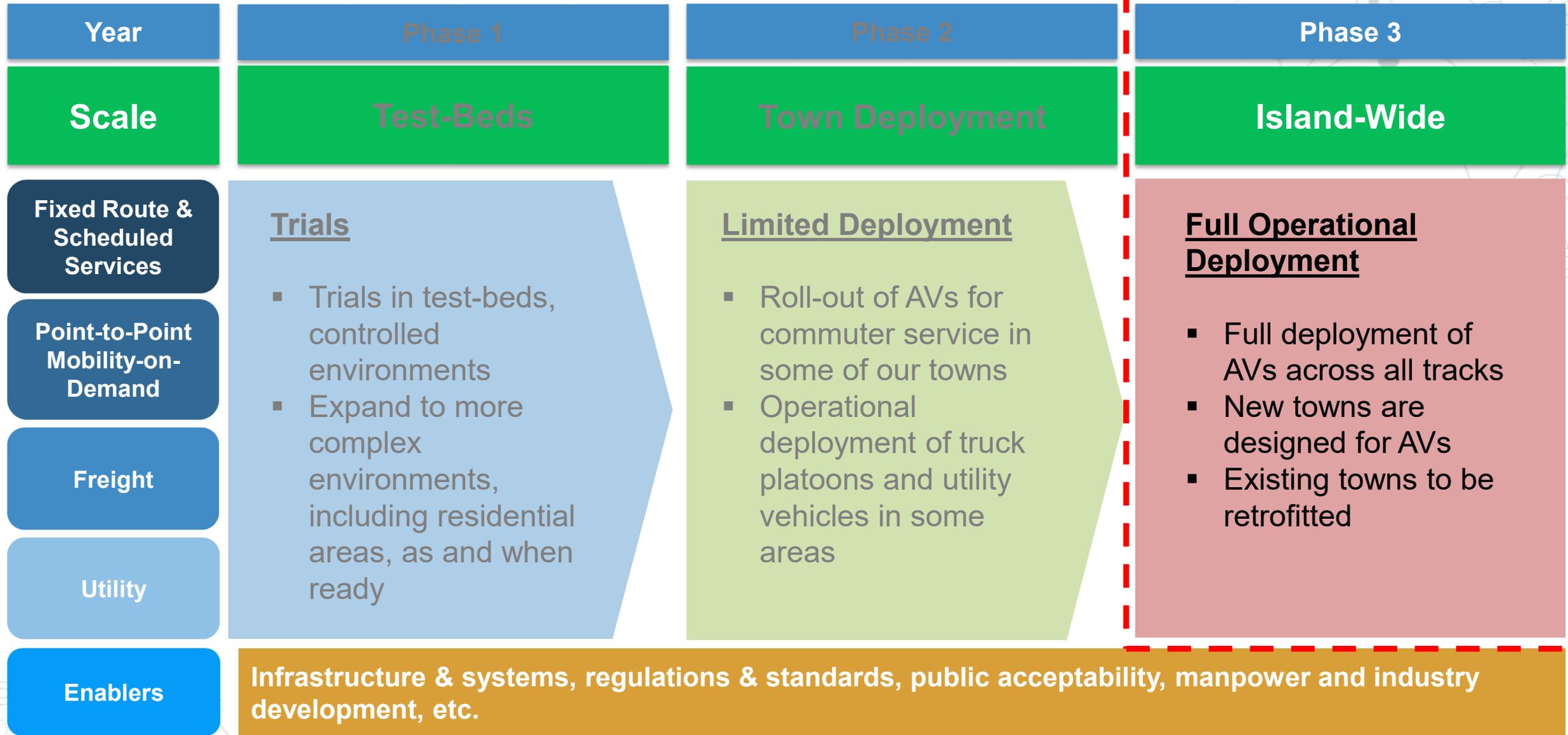**Fixed Route & Scheduled Services**

Autonomous buses (80 pax capacity) for **fixed/scheduled** routes

Point-to-Point Mobility-on-Demand

Autonomous shuttles (e.g. minibuses, MPVs) for **shared, on-demand** services within geo-fences)

* Buses and shuttles should be at least SAE Level 4, capable of handling heavy, mixed traffic on public roads and expressways (without segregated lanes).

Roadmap for deployment of AVs

Year	Phase 1	Phase 2	Phase 3
Scale	**Test-Beds**	**Town Deployment**	**Island-Wide**

Fixed Route & Scheduled Services	**Trials**	**Limited Deployment**	**Full Operational Deployment**
Point-to-Point Mobility-on-Demand	▪ Trials in test-beds, controlled environments	▪ Roll-out of AVs for commuter service in some of our towns	▪ Full deployment of AVs across all tracks
Freight	▪ Expand to more complex environments, including residential areas, as and when ready	▪ Operational deployment of truck platoons and utility vehicles in some areas	▪ New towns are designed for AVs
Utility			▪ Existing towns to be retrofitted
Enablers	**Infrastructure & systems, regulations & standards, public acceptability, manpower and industry development, etc.**		