Future Mobility in Singapore – Turning Disruptions into Opportunities

Jeremy Yap, Deputy Chief Executive (Public Transport, Policy & Planning), Land Transport Authority, Singapore
SINGAPORE
A SMALL BUT DENSELY POPULATED COUNTRY

<table>
<thead>
<tr>
<th></th>
<th>Singapore</th>
<th>Sydney (for comparison)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population (mil)</td>
<td>5.61</td>
<td>5.25</td>
</tr>
<tr>
<td>Land area (km$^2$)</td>
<td>719</td>
<td>12,368</td>
</tr>
<tr>
<td>Population density</td>
<td>7,800</td>
<td>424</td>
</tr>
<tr>
<td>(no. of people/km$^2$)</td>
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Data as of 2016

Source: Singstat
Source: population.net.au
cityofsydney.nsw.gov.au

Source: geodata-musing.blogspot.sg

Legend:
- Blue: 1,000 - 3,000 residents per sq km
- Green: 3,000 - 5,000
- Yellow: 5,000 - 7,000
- Orange: 7,000 - 10,000
- Red: 10,000 - 15,000
- Pink: 15,000 - 20,000
- Brown: 20,000 - 25,000
- Gray: 25,000 - 30,000
- Black: 30,000 - 50,000
- Navy: 50,000 - 100,000
- Light blue: 100,000 - 200,000
OUR UNIQUE LANDSCAPE

Growing Population and Economy
5.8 – 6.0 mil by 2020
6.5 – 6.9 mil by 2030

Changing Expectations and Norms
Commuter-centric and inclusive transport system

Tighter Land Constraints
12% of land for roads
14% of land for housing

Imperative to policy innovate and leverage on technology to address these challenges!

Aging Population
By 2030: Only 2 persons under 65 for every 1 person above 65
In 2015, it was 5 persons to 1

Manpower Crunch
Shortage of drivers (PT, logistics, etc.)
ADDRESSING LAND TRANSPORT GOALS

Singapore

Land Transport Masterplan 2013

Australia

30-minute Cities Plan

More Liveable
More Productive
More Sustainable

Common goal of moving people quickly and efficiently
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

Promoting Public Transport (PT) as the choice mode:
More reliable PT services
Expanded PT network
Better connectivity to PT nodes
Reducing reliance on private transport

Need to go Car-lite
GOING CAR-LITE
MAKING TRANSPORT PUBLIC, SHARED AND ACTIVE

Key Strategies, Walk Cycle Ride SG & Reducing Reliance on Private Transport

Enhance Public Transport
Promote Active Travel
Shared Mobility

Policy Innovation & Capability Building
Enhance Public Transport
DOUBLING RAIL NETWORK TO 360KM

<table>
<thead>
<tr>
<th>LTMP 2013 Project</th>
<th>Est. Completion</th>
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<tbody>
<tr>
<td>Cross Island Line</td>
<td>By 2030</td>
</tr>
<tr>
<td>Jurong Region Line</td>
<td>By 2025</td>
</tr>
<tr>
<td>Circle Line 6</td>
<td>By 2025</td>
</tr>
<tr>
<td>North East Line Extension</td>
<td>By 2030</td>
</tr>
<tr>
<td>Downtown Line Extension</td>
<td>By 2024</td>
</tr>
<tr>
<td>Thomson East Coast Line</td>
<td>By 2024</td>
</tr>
</tbody>
</table>

Legend:
- Existing Rail Lines
- Land Transport Master Plan 2008 Rail Lines
- Land Transport Master Plan 2013 Rail Lines (To be built by 2030)
INCREASING RAIL CAPACITY

NSEWL: 141 trains
- 2016-19: 57 New Trains
- NSL Re-Signalling: Complete by 2016
- EWL Re-Signalling: Complete by 2018

NEL: 25 trains
- 2015-16: 18 New Trains
- ~50% increase in total fleet size by 2019;

CCL: 40 trains
- 2015-16: 24 New Trains

- ~25% improvement in peak period wait time with improvements
  - As short as 100-110 sec peak period wait time, from current 2.3 min

- Wait time no more than 5 min at all times*; achieved for NSEWL and NEL in 2014, CCL in 2016
  - except when trains have to be withdrawn to or launched from depots in the early morning/late nights or for maintenance activities to sustain reliability.

- Peak period wait time no more than 2.7 min, from current 3.5 min
EXPAND BUS FLEET & NETWORK CONNECTIVITY

Bus Service Enhancement Program (BSEP)

- Better Connectivity
- Shorter Waiting Times
- More Space on Board

Bus Service Enhancement Programme 4 Years On

- 820 Buses Added
- 65 New Bus Services
- 174 Improved Bus Services
- 20 City Direct Bus Services

Bus Contracting Model (BCM)

A new bus industry model to better meet the needs of commuters

- Bus packages for tender
- Bus operators will bid for bus route packages
- Govt will retain fare revenue, & operators will be paid a fixed fee to run & maintain the bus services

Transition to the Government Contracting Model

- Call for tenders for bus route packages
- 20% of bus routes come under Govt Contracting
- Gradual transition towards Govt Contracting

The changes will take place over several years to ensure a smooth transition for all stakeholders

As of October 2016
DEMAND RESPONSIVE BUS SERVICES

Normal Bus Services

- Buses ply fixed routes/schedules
- Demand aggregated at designated bus stops

Demand Responsive Bus Services

- No fixed schedules
- On-demand, dynamic routes
Efficiency
Dynamic routing could enable the DRBS to travel on a shorter route based on commuter demand, hence optimizing their waiting & total journey time

Convenience
DRBS can obviate the need for commuters to seek transfer onto connecting bus services as it is not restricted by fixed routes

Affordability
Efficient deployment of resources can bring about cost savings to sustain the improved PT service quality for our commuters (without incurring additional costs)
Promote Active Travel
Beyond LTMP 2013, Singapore has embarked on the Walk Cycle Ride SG strategy to build a car-lite Singapore that is so well connected that people actively choose to walk, cycle, and ride to get around.
WALK2RIDE PROGRAMME

• 200km of new sheltered walkways by 2018
• Sheltered connectivity between transport nodes and:
  ✓ Schools
  ✓ Health care facilities
  ✓ Residential developments
  ✓ Public amenities
  within 400m radius of all MRT stations
  and within a 200m radius of all LRT stations and bus interchange
• Barrier-free connectivity
  ✓ Signage
  ✓ Network maps
BOOSTING CYCLING INFRASTRUCTURE

- 700km of cycling paths by 2030
- Increasing bicycle-friendly infrastructures:
  - Bicycle crossings
  - Bicycle parking facilities
  - Bicycle wheeling ramps
- Improving intra-town connectivity
  - Every HDB town to have cycling network by 2030
  - Connect transport nodes to homes and key amenities
  - Develop model “walking and cycling towns”
ACTIVE MOBILITY INITIATIVES

With the Active Mobility Bill, rules will be put in place to protect you and those around you on public paths and roads.

These standards will come into effect later this year.

SPACES WHERE DEVICES MAY BE USED

Only devices* that follow these standards can be used on public paths.

20kg
Max. weight
Reduces the risk of serious injuries in cases of collision.

70cm
Max. width
Allows devices to cross each other safely.

Capped at 25 km/h
Max. motorised device speed
Ensures users do not exceed the speed limit.

BRING YOUR FOLDABLE BICYCLES / PERSONAL MOBILITY DEVICES ON BOARD TRAINS & BUSES ALL DAY
Enhancing first and last mile connectivity

Key Rules and Guidelines to Observe *

1. Keep your device folded at all times

2. No riding of your device in train stations or bus interchanges

3. Hold your device and do not block doors and pathways

*The full set of rules and guidelines can be found on LTA’s website: www.lta.gov.sg. Those who do not comply with the rules can face enforcement action and be fined up to $500.

Foldable bikes, PMDs on buses, trains all day

After successful six-month trial, move will be made permanent.

The Straits Times
29 May 2017
SHARED MOBILITY
THE RISE OF SHARING ECONOMY

• As people warm up to the concept of a sharing economy, more are “paying-to-use” as opposed to “paying-to-own” – we are seeing the same trends in transport.

• The sharing economy has resulted in disruption to the taxi industry in the form ride-sharing services such as Uber and Grab.
DISRUPTIONS ARE ALREADY HAPPENING
EMBRACING DISRUPTIONS – PRIVATE HIRE CARS

- Innovation should facilitate benefits to commuters
- Vocational Licensing of private-hire car drivers
- "Light touch" regulation of third-party taxi applications
- New regulations will level up driver requirements, protect commuter interests, while allowing the disruptors to grow and offer commuters more options

Law to regulate taxi booking services

The Straits Times
12 May 2015

THE STRAITS TIMES
LTA has received 39,000 applications for the Private Hire Car Driver’s Vocational Licence

The Straits Times
23 June 2017

GrabCar, Uber drivers to be licensed

Transport app drivers will also have to go for medical checks, background screenings

Adrian Lim

The Straits Times
13 April 2016
EMBRACING DISRUPTIONS – PERSONAL MOBILITY SOLUTIONS

- LTA called a tender in July 2016 for a bicycle-sharing scheme comprising 2,300 bicycles and 230 docking stations across Singapore
- Received 13 bids and scheduled to launch scheme by end 2017
- However, with the emergence of market disruptors since early 2017, LTA boldly aborted the bicycle-sharing tender

The Straits Times
25 March 2017
EMBRACING DISRUPTIONS – PERSONAL MOBILITY SOLUTIONS

- Latest solutions offered by the industry
  - Dockless bicycles
  - E-scooter sharing

- Embracing disruptions mean being prepared to abort conventional models to seize opportunities

- Open and ready to welcome new forms of personal mobility solutions as and when the industry is ready

- Allowing space for disruptors:
  - Designating bicycle parking zones
  - Requiring operators to provide direct feedback channels, ensuring prompt bicycle removal

Demarcated area for dockless bicycle parking outside Promenade MRT

Source: Straits Times

Pick up e-scooter or bike at Science Park I

50 e-scooters, 20 bikes will be available for rent across six parking zones in park area

The Straits Times
15 June 2017

Source: Straits Times

Demarcated area for dockless bicycle parking outside Promenade MRT

Source: Straits Times
AVs FOR PUBLIC TRANSPORT

- We envisage AV technology complementing existing public transport system by enhancing connectivity to major transportation nodes (MRT stations and bus interchanges), through:
  - Autonomous buses providing fixed and scheduled services

- Not encouraging private AV ownership but AVs for public transport
  - Point-to-point mobility-on-demand services providing first-mile/last-mile connectivity
  - Backbone of our sustainable urban mobility strategy will still be Public Transport and its mass transit movement
    - Almost all of our metro lines are already driverless!
REGULATORY SANDBOX TO SHAPE OUR REGULATIONS

Passed the Road Traffic (Amendment) Bill in early 2017:

• To provide the Minister with the power to make rules to regulate the use of AVs
• Powers include the ability to exempt or modify existing provisions
  ➢ Changes, if required, can be made quickly to adapt regulations in response to rapid developments in AV technology
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.

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

Driverless vehicle trial routes expand by 55km to NUS, Buona Vista and Dover

LTA extends driverless car test circuit by 55 km
By Soon Wei Lin
@SoonWeiLinBT
Singapore
SINGAPORE is extending the length of its autonomous vehicle test circuit by 55km to NUS, Buona Vista and Dover.

The Straits Times
23 June 2017

The Business Times
24 June 2017
# AN ECOSYSTEM OF TRIALS

<table>
<thead>
<tr>
<th><strong>Fixed Routes &amp; Scheduled Services</strong></th>
<th><strong>Point-to-Point Mobility on-Demand</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Autonomous Vehicle Trials</strong></td>
<td><strong>Autonomous Vehicle Mobility-on-Demand Trials</strong></td>
</tr>
<tr>
<td>@ NTU-CleanTech Park</td>
<td>@ one-north</td>
</tr>
<tr>
<td><strong>Autonomous Bus Trials</strong></td>
<td><strong>Autonomous Shuttle</strong></td>
</tr>
<tr>
<td>@ potential JTC sites, e.g.</td>
<td>@ Gardens by the Bay</td>
</tr>
<tr>
<td>NTU-CleanTech Park, Jurong Island, etc</td>
<td></td>
</tr>
<tr>
<td><strong>Autonomous Shuttle</strong></td>
<td><strong>Development efforts on-going on 2</strong></td>
</tr>
<tr>
<td>@ Gardens by the Bay</td>
<td>Navya Armas and 2 ST-built shuttles</td>
</tr>
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Development efforts on-going on 2 Navya Armas and 2 ST-built shuttles
SHAPING THE MARKET – LEADING DEVELOPMENTS IN AUTONOMOUS BUSES

LTA in partnership with:

<table>
<thead>
<tr>
<th>Energy Research Institute at Nanyang Technological University (ERI@N)</th>
<th>Singapore Technologies Kinetics (STK)</th>
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<tbody>
<tr>
<td>• Signed agreement in Oct 2016</td>
<td>• Signed agreement in April 2017</td>
</tr>
<tr>
<td>• 2 electric autonomous buses</td>
<td>• 2 full-sized 40-seater electric autonomous buses</td>
</tr>
<tr>
<td>• Trialled on roads between NTU and Cleantech Park</td>
<td>• To serve fixed and scheduled services for intra- and inter-town travel</td>
</tr>
<tr>
<td>• Opportunistic charging technology (recharged when they stop at a bus depot or bus stops)</td>
<td>• Trialled in various environments of increasing complexity</td>
</tr>
<tr>
<td></td>
<td>• Subject buses to as many scenarios as possible</td>
</tr>
</tbody>
</table>
ERI@N’S ELECTRIC AUTONOMOUS BUS

- Pantograph Charge Mast
- LIDARS
- High sensitivity, night vision stereoscopic cameras
- Radar
- V2X on-board units
- Differential GPS receiver
- Inertial measurement unit
- Processing and embedded software computing units
STK’S ELECTRIC AUTONOMOUS BUS

Commuters can catch a driverless public bus by 2020

ST Kinetics’ autonomous bus prototype

Connectivity
The autonomous bus will be equipped with vehicle-to-vehicle and vehicle-to-infrastructure connectivity to communicate seamlessly with other autonomous vehicles and infrastructure. The bus will also have Wi-Fi and 4G capabilities.

Precise positioning
The bus will use a Global Positioning System. It will also be fitted with sensors to scan the surroundings and determine the vehicle’s position in any environment.

Perception sensors
Perception sensors will provide 2D and 3D maps of the environment to allow the bus to avoid obstacles.

Vehicle Specifications
- Size: 12m (length) x 2.55m (width) x 3m (height)
- Carrying capacity: 36 seated, 33 standing, 1 wheelchair (configurable)
- Doors: Three
- Maximum operating speed: Up to 60km/h
- Typical range: 30-50km

Body and powertrain
The bus will have an all-aluminium body and chassis. It has electric motors powered by two choices of batteries.

Pedestrian and vehicle detection
Radar and sonars will cover the area within 10m in front of the vehicle and scan the surroundings before the bus moves off. Long-range radars will detect vehicles that are up to 200m ahead. Cameras will detect obstacles and supplement perception maps with environmental analysis and classification (such as road signs and traffic lights).

Source: LTA, STRAITS TIMES GRAPHICS

Consortium led by ST Kinetics expects to unveil battery-powered prototype by early next year.
Ministry of Transport, Sentosa Development Corporation and ST Kinetics signed an agreement in April 2017 to develop and trial 4 mobility-on-demand vehicles (MODVs)

Visitors will be able to call for the MODVs via their smartphones or information kiosks located across the island

When deployed in 2019, the MODVs will provide self-driving shuttle service to island visitors on-demand to serve their intra-island travel needs in Sentosa
AVs FOR FREIGHT AND UTILITY

**Freight**

**Truck Platooning for Port Operations**

- MOT and PSA signed agreements with Scania and Toyota for trials
- Comprises 1 human-driven truck with 3 driverless follower trucks
- Trial in enclosed port area and open roads on West Coast Highway

**Utility**

**Road Sweeping**

- MOT and NEA launched Request for Information on self-driving utility vehicles
- Common mobility platform, multiple use cases
- Functional autonomy, road sweeping etc.
- Specialised self-driving capabilities, e.g. kerb following and obstacle avoidance
BUILDING CAPABILITY

CAPACITY & COMPETENCY

For Conventional Projects & For Emerging Areas

Land Transport Authority
BUILDING CAPACITY AND COMPETENCY FOR EMERGING AREAS

- Develop Enlightened & Innovative Regulatory Frameworks
- Build New Internal Capabilities
- Leverage on Emerging Technologies

- Rules that allow for co-existence of new and conventional mobility markets
- Policy innovation needs to be responsive
- Calibrated licensing for light regulatory touch
- Self-regulation and internal discipline
- Industry activation of market players
- Data Science & Fusion Analytics
- Planning Analytics
- Economics (Social Sciences) Unit
- AV & Automotive Engineering
- Mobility Sensors to improve commuters' experience
- AVs to relieve manpower crunch

Land Transport Authority
BUILDING NEW INTERNAL CAPABILITIES

Data Science and Analytics Division

Planning Analytics Unit

Economics Unit

Ops Research, Automotive and Software Engineers
Restructuring: New “LTA Technology & Industry Development Group”

Future Mobility

Industry Development

SG Rail Academy
UPSKILLING THE TRANSPORT WORKFORCE

Singapore Bus Academy
One-stop training, test and accreditation centre for bus professionals

Continual Training & Skills Deepening
Enhanced Vocational License (VL) Training Programme

Singapore Rail Academy

Training

Research

Schemes

Singapore Rail Academy

Accreditation & Certification

Drive applied research, e.g. predictive maintenance

Schemes, e.g. apprentice scheme, to support training & retraining

Accreditation and certification
LEVERAGING EMERGING TECHNOLOGIES

Improving Commuting Experience Using Mobility Sensors

- **Farecard Data**
  - Now: 15 million/day
  - Future: 36 million/day

- **WiFi Data**
  - Now: 9.1 million/day
  - Future: 36 million/day

- **Telco Data**
  - Now: 1.940 million/day
  - 1.3 mil subscribers

- **Bus Data**
  - Now: 50 million/day

- **Video Data**
  - Now: 172,800/day
  - Future: 26 million/day

- **Train Data**
  - Now: 777,600/day
  - Future: 15 million/day

- **Taxi Data**
  - Now: 80 million/day
# PT INDUSTRY TRANSFORMATION MAP

## PT ITM Vision

A technology-enabled PT industry supported by a highly competent workforce

<table>
<thead>
<tr>
<th>Technology, Innovation &amp; Productivity (Rail)</th>
<th>Technology, Innovation &amp; Productivity (Bus)</th>
<th>Jobs &amp; Skills</th>
<th>Regulations &amp; Internationalisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Leverage on industry partnership to enhance data availability</td>
<td>➢ Enhance bus design, operations and maintenance regime through technology adoption and innovation (e.g. data analytics, EV, AV)</td>
<td>➢ Identify the current, intermediate and long term manpower &amp; skills requirements</td>
<td>➢ Enhance regulatory frameworks to support industry collaboration, facilitate data sharing and encourage technology adoption &amp; innovation</td>
</tr>
<tr>
<td>➢ Enhance rail asset management</td>
<td>➢ Enhance rail reliability through technology adoption/deployment</td>
<td>➢ Capability development through rail/bus academies</td>
<td>➢ Establish and enhance G-G ties to support internationalisation</td>
</tr>
<tr>
<td>➢ Enhance bus interchange management system and network optimisation</td>
<td></td>
<td>➢ Centralised talent pool management</td>
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### Key Enablers

- Government leads and sponsors industry integration and good industry practices (e.g. funding to incentivise technology adoption and innovation)
- Strengthen partnership with the Union to prepare the workforce for industry transformation
CONCEPT OF A FUTURE TOWN CENTRE WITH AUTONOMOUS VEHICLES (DAY TIME)
CONCEPT OF A FUTURE TOWN CENTRE WITH AUTONOMOUS VEHICLES (NIGHT TIME)
WHAT’S NEXT

The Hoversurf Scorpion, a human-carrying drone developed by a Russian startup, has already been prototyped and could be an urban-mobility option for Singapore.

Singapore in talks with firms to try out ‘flying taxis’

Transport Ministry looks at aerial taxis and on-demand dynamic-routing bus services for the future to pay for different mobility services tailored for different kinds of journeys. Mr Pang said that it may thus be possible to ride in a driverless pod to work, cycle to the gym after work, and then take an aerial taxi home.

Source: Volocopter VC200

Source: Ehang 184

The Business Times
24 March 2017
LEARNING POINTS FROM LTA’S TRANSFORMATION JOURNEY

• We are forging ahead with developing an exciting future for mobility and are determined to LEAD the TRANSITION

• While there are technological/digital/business model disruptions, we can turn them into opportunities to improve transportation

• Policy and regulatory innovation are key

• When building capabilities, it is not just the organisational perspective. Industry transformation is also crucial for success
  ➢ Need to develop and transform our industries to take advantage of economic opportunities, elevate the skills and capabilities of our workforce, and create new and better jobs.

• We look forward to developing this exciting future for mobility in Singapore and improving the quality of life and the living environment for Singaporeans
THANK YOU