V2X Applications for Public Transport
Leong Hin Cheong
ST Electronics (Info-Comm Systems)
Agenda

► Background
  ► Introduction on DSRC Development
  ► Singapore Public Transport

► V2X Applications for Public Bus Services
  ► Improving Bus Service KPI
  ► Improving Estimated Time of Arrival (ETA) Service
  ► SPaT (Signal Phase And Time) for Bus Service

► V2X Applications for Taxi Services
  ► Passenger Queue Management
  ► Taxi Queue Management

► Q&A
Guiding Framework for ITS

- Richer information to meet different needs
- Safer and secure roadway environment
- Greater convenience for traveler
- More environmental friendly

Core Focus
- In Safety & Mobility
- Interactive
- Green Mobility
- Human

Applications
- Track dangerous goods
- Support vehicle
- Manage electronic systems

Telematics Service Hub
- GPS, Laser, Inductive Loops, Radar, Microwaves

Supporting Technologies
- Richer information
- Safer and secure roadway environment
- Greater convenience for traveler
- More environmental friendly

Service Delivery Platform
- Applications in Safety & Mobility

ITS
- Assistive
- Informative

ST Electronics (Info-Comm Systems)
Co-Confident
Smart Move thru DSRC Connected Vehicle

- Unified solution for vehicles tracking & management
- Informative, interactive, assistive functionalities & Green Mobility
Introduction - 5.9 GHz DSRC

- 5.9 GHz DSRC is short-to-medium range wireless link for high data, low latency for fast mobility
- Critical for V2V (Vehicle-to-Vehicle) automobile safety applications as well as V2I (Vehicle-to-Infrastructure)
- Based on IEEE802.11P/WAVE (Wireless Access in Vehicular Environment) with 1 Control channel and 6 Service channels
DSRC Spectrum Band & Channels (U.S)
Singapore DSRC Standardization Status

- IDA Draft the National DSRC Standard
- Final Stage in Consulting the Public
- Expected to have 1st released in 3Q 2016

Singapore DSRC Spectrum Power Limit

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Power Limit</th>
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<tbody>
<tr>
<td>5,865</td>
<td>39dBm</td>
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<tr>
<td>5,875</td>
<td>33dBm</td>
</tr>
<tr>
<td>5,885</td>
<td>SRD requirement = 20dBm</td>
</tr>
<tr>
<td>5,895</td>
<td></td>
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<tr>
<td>5,905</td>
<td></td>
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<tr>
<td>5,915</td>
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<tr>
<td>5,925</td>
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</tr>
</tbody>
</table>

- Ch 172 ISM SCH
- Ch 174 ISM SCH
- Ch 176 V2V SFCH
- Ch 178 PPCCH Public/Private
- Ch 180 PPSCH
- Ch 182 RP SCH Road Pricing Service
- Ch 184 LR CH Long Range
DSRC / WAVE Standards

- **802.11p physical Layer**
- **WAVE (Wireless Access in Vehicular Environment)**
  - IEEE 1609.1 core system
  - IEEE 1609.2 Security Service
  - IEEE 1609.3 Network Service
  - IEEE 1609.4 Multi channel management
DSRC Performance Envelopes

- **Data Transfer and Internet Access Services**
- **Safety Message Services**
- **Emergency Vehicle Services**
- **Toll and Payment Services**

- **5850 - 5925 MHz Band Performance Envelope** (Approximate)

- **902 - 928 MHz Band Performance Envelope**

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ST Electronics (Info-Comm Systems)  
Co-Confidential
DSRC in Urban Mobility Landscape
Evolution of ITS

**Operation Efficiency**
- Congestion Management
- Incident Management
- Traffic Enforcement
- Traffic Surveillance
- Fleet Management

**Information Sharing**
- Public Information Dissemination
- Integrated Transport Management

**Interactive & Customized Service**
- Personalized Multi-modal Information
- Vehicle to Vehicle (V2V)
- Vehicle to Infrastructure (V2I)
- Vehicle to Pedestrian (V2P)

1995 - 2005
2005 - 2010
2010 - now
About Singapore Public Transport

► Main Public Transport Operator (Bus)
  ► SBS Transit Ltd
  ► SMRT Buses Ltd
  ► Tower Transit Singapore

► Key Monitoring Standards
  ► Land Transport Authority and the Public Transport Council work closely together to monitor the level of service and performance of bus services in Singapore
  ► Performance based on:
    ► Operating Performance Standards
    ► Service Provision Standards
About Singapore Public Transport

► Operating Performance Standards

<table>
<thead>
<tr>
<th>Operating Performance Standards</th>
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<tbody>
<tr>
<td><strong>Reliability</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Loading</strong></td>
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<tr>
<td><strong>Safety</strong></td>
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</table>

► Service Provision Standards

<table>
<thead>
<tr>
<th>Service Provision Standards</th>
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</thead>
<tbody>
<tr>
<td><strong>Availability</strong></td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td><strong>Integration</strong></td>
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<tr>
<td><strong>Information</strong></td>
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</tbody>
</table>

Regulate bus headways

Provide Bus Arrival Time
About Singapore Public Transport

► Main Public Transport Operator (Taxi)
  ► Six major taxi operators

► Key Monitoring Standards
  ► Land Transport Authority monitors the service and safety performance of taxi operators and drivers
    ► Taxi Booking Service
    ► Safety
    ► Taxi Driver’s Conduct
    ► Taxi Availability
    ► Waiting time at taxi stands
Improving Bus Service KPI: Regulate Bus Headway

- Public Transport Operators track and manage bus fleet in real-time through a Common Fleet Management System.
- For headway operations, the time is defined by the regularity required at a bus stop.
- Bus Captains provided with indicators to follow.

Headway is measured at the stops. Departure time to last departure time.
Improving Bus Service KPI

► Challenges Faced
   ► Road conditions – traffic jams, accidents, etc.
   ► Long dwell time at bus stops

► Road Conditions
   ► Currently road conditions are feedback through Bus Captains that encounter the situation. There is a time lag between the occurrence and the reporting. Through V2X, road conditions information can be shared through other vehicles to public buses. Affected routes can be quickly identified and corresponding actions can be swiftly taken.
Improving Bus Service KPI

► Challenges Faced
  ► Road conditions – traffic jams, accidents, etc.
  ► Long dwell time at bus stops

► Long Dwell time at bus stops
  ► Typically caused by buses pile up at bus stops. Through V2X, expected vehicles arriving at a bus stop can be regulated at real time and avoid jamming up
  ► Special needs – wheel chair needs or senior citizens. Provision of “special needs” button at bus stops to relay information to Bus Captains to prepare to assist. The information can be relayed through V2X infrastructure to the designated bus captain
V2X Application for Public Bus Service

► Dissemination of the bus arrival time information on LTA MyTransport.SG mobile application/web portal and selected bus stops
Improving Estimated Time of Arrival (ETA) Service

► Challenges Faced
  ► Road conditions – traffic jams, accidents, etc.
  ► Bad coverage areas for GPS

► Real-time information from affected vehicles to send to backend for re-calculation of ETA

► V2X infrastructure to improve coverage
SPaT (Signal Phase And Time)

► **Synchronization with Traffic Light for Bus Services**
  ► Reduce number of times Public Buses needed to stop at traffic junction
    ► Reduce Emission
    ► Fine-tuning of bus performance due to local adjustments
V2X Applications for Taxi Services

► **Key Monitoring Standards**

► LTA monitors the service and safety performance of taxi operators and drivers
  ► Taxi Booking Service
  ► Safety
  ► Taxi Driver’s Conduct
  ► Taxi Availability
  ► Waiting time at taxi stands
V2X Applications for Taxi Services

Passenger queue alerts

Monitoring and managing taxi queue

Credit: Straits Times File Photo

Credit: Straits Times File Photo

Credit: Straits Times File Photo

Credit: Straits Times File Photo
Passenger Queue Management

► Current Implementations
  ► Sensors at taxi stands to detect passenger queue
  ► Demands at taxi stands are sent to the taxi operators

**Average Hourly Passenger Waiting Time in Minutes (Apr 2016)**

<table>
<thead>
<tr>
<th>Orchard Cluster</th>
<th>(1) Tanglin Shopping Centre (F55)</th>
<th>(2) Orchard Towers (F50)</th>
<th>(3) Liat Towers (F49)</th>
<th>(4) Far East Plaza (F52)</th>
<th>(5) ION Orchard</th>
<th>(9) Lucky Plaza (A01)</th>
<th>(7) Paragon Shopping Centre (A02)</th>
<th>(10) Cairnhill Place (A06)</th>
<th>(9) Wisma Atria (A08)</th>
<th>(11) Ngee Ann City (A09)</th>
<th>(12) Centrepoint (A11)</th>
<th>(13) Plaza Singapura (A16)</th>
<th>(14) Cathay Building (A17)</th>
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<tr>
<td>5pm-6pm</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>5</td>
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<td>4</td>
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<tr>
<td>6pm-7pm</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>9</td>
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<td>7</td>
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<td>3</td>
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<td>2</td>
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<tr>
<td>7pm-8pm</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
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<td>4</td>
<td>2</td>
<td>3</td>
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<tr>
<td>8pm-9pm</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>6</td>
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<td>2</td>
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<tr>
<td>9pm-10pm</td>
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<td>5</td>
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<td>3</td>
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<tr>
<td>10pm-11pm</td>
<td>5</td>
<td>3</td>
<td>6</td>
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<td>11pm-12am</td>
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*Note:
1. Surveys were conducted from 1 - 4 (Fri-Mon) Apr 2016 at all locations except Cairnhill Place.
2. Survey at Cairnhill Place was not conducted in Apr 2016 due to temporary closure of taxi stand.
3. The above figures represent the number of minutes a passenger may need to wait for a taxi.*
Passenger Queue Management

► V2X Applications
  ► By making use of V2X, information from sensors can be quickly relayed to taxis within the vicinity
  ► Demands are instantly sent to nearby available taxis.
  ► Unmatched demands will then lead to enlarged vicinity area
Taxi Queue Management

► **Current Challenges**
  ► Taxis spent long periods queuing for passenger in airport and places of interests
  ► Taxis may missed on the taxi availability KPI if long hours are spent on the waiting time

► **V2X Applications**
  ► Optimize the demand and supply conditions
  ► Demands to be sent via V2X infrastructure to available taxis in vicinity, or with common destination match
INNOVATING TRANSPORT FOR LIVEABLE CITIES

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- Sponsorship opportunities still available

At the last SITCE 2013, there were:

3,865 trade visitors and delegates from 43 countries
154 speakers from 27 countries
99 exhibitors from 22 countries
74 partners from 10 countries

Preliminary Programme

<table>
<thead>
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<th>20 Oct 2016 (Thu)</th>
<th>21 Oct 2016 (Fri)</th>
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<td>Technical Visits</td>
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<td>Congress Programme Day 2</td>
<td>Congress Programme Day 3</td>
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<td>Welcome Reception</td>
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<td>Gala Dinner</td>
<td>Closing Ceremony</td>
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People and Technology in Motion

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Thank You

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