



**Smart and sustainable urban  
transportation for ASEAN region**

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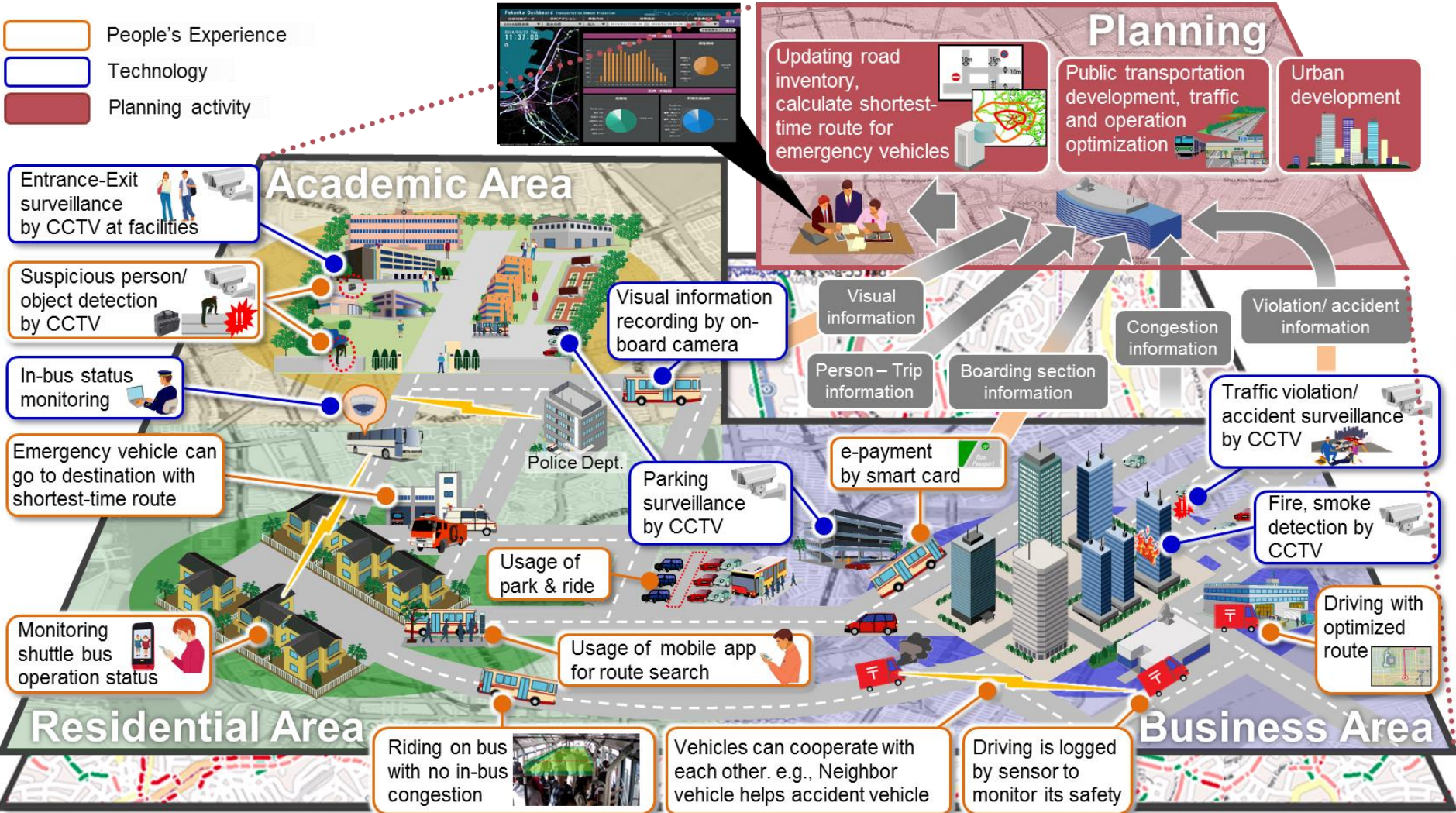
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**Hitachi India Pvt. Ltd.**

1. Introduction
2. Research Focus and Key Technologies
3. Public Transport Optimization
4. Video Analytics for City Traffic Control
5. Conclusion

# 1-1. Introduction

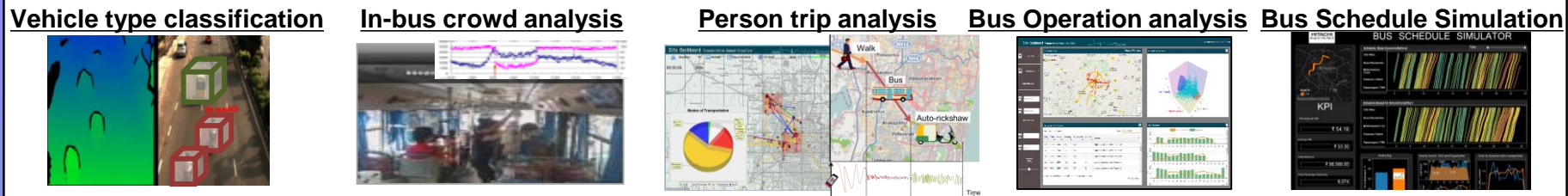
Contribute to ASEAN and India by developing smart and sustainable urban transportation



# 2-1. Research Focus and Key Technologies

- 1. Visualize:** Intuitive visualization of bus operations through IoT analytics combining traffic congestion, people mobility and spatio-temporal demand variations.
- 2. Analyze:** Analytics on heterogenous information sources such as in-vehicle video, roadside camera, Automatic Fare Collection System (AFCS), road quality information, GPS and trip schedules to generate Key Performance Indicators (KPI)
- 3. Optimize:** Impact assessment of traffic events, modeling and simulation of route networks to generate optimal schedules.

ANALYSIS

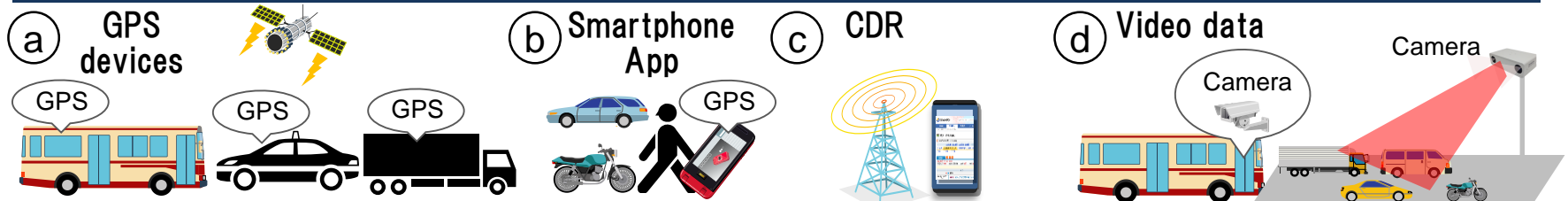


Traffic congestion info.

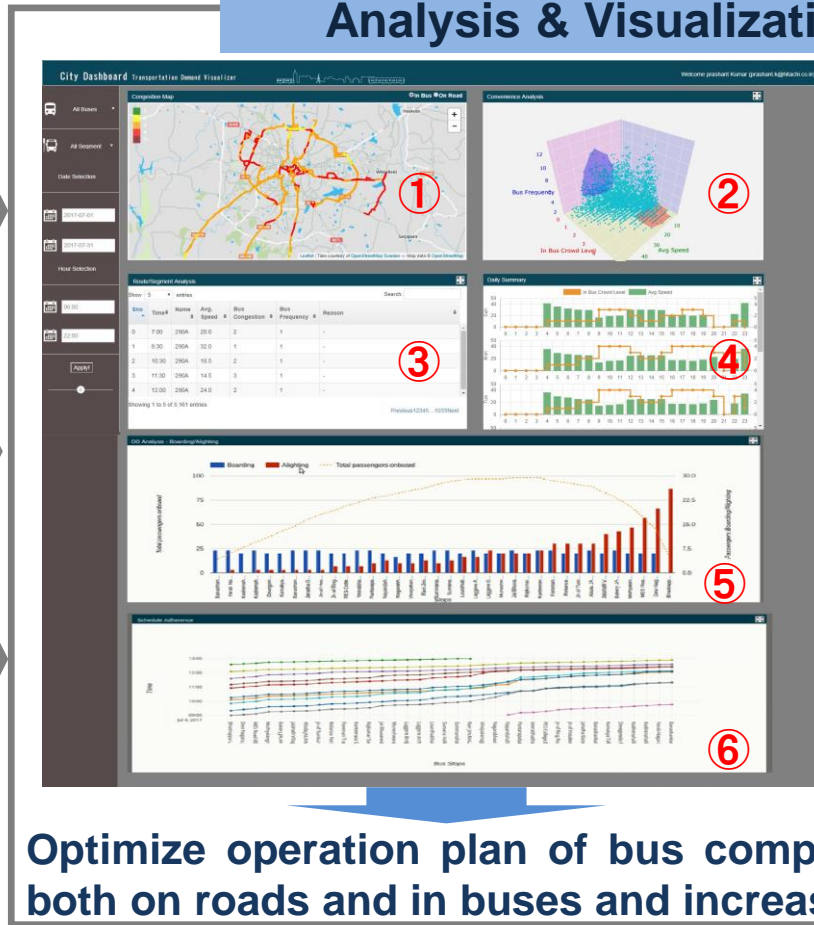
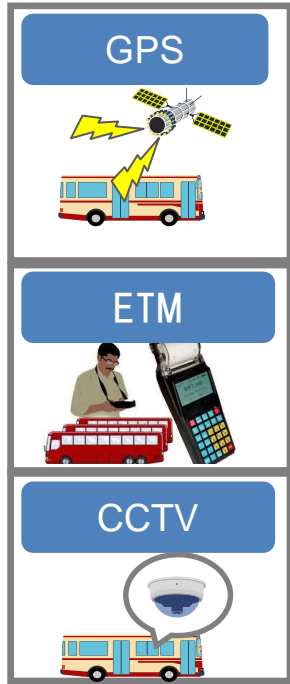


IoT Data Sources

SENSING



## Analysis & Visualization of Bus Operation



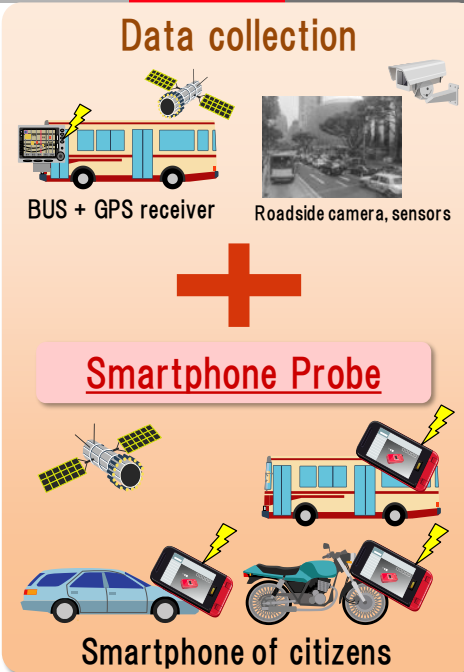
- ① Map based On-road/In-bus congestion visualization
- ② Grouping & picking-up inefficient bus operation
- ③ Analyzing what causes the inefficiency
- ④ Visualizing the congestion data of each time slot & day of the week
- ⑤ Visualizing load pattern & boarding/alighting across stops a route
- ⑥ Analyzing bus bunching, delays due to traffic and bus frequency

**Optimize operation plan of bus companies in order to solve congestion both on roads and in buses and increase occupancy.**

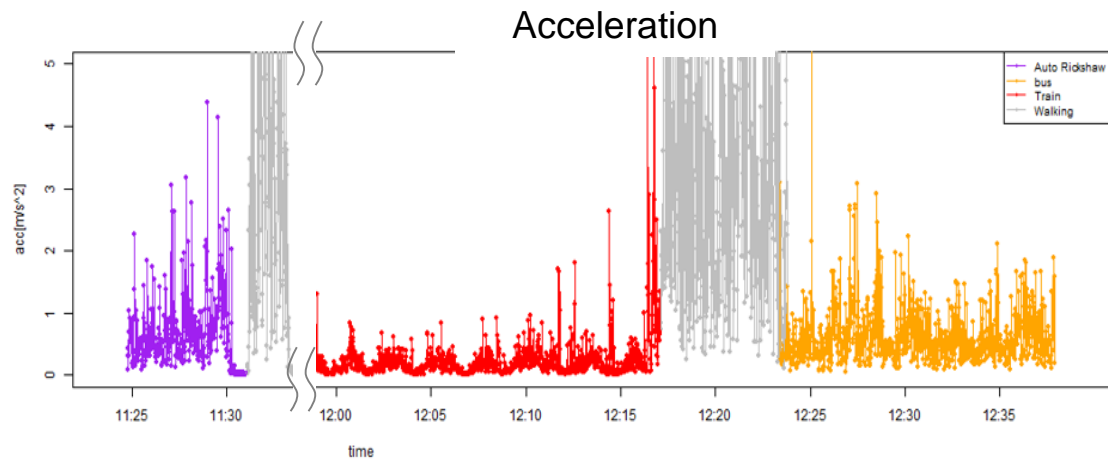
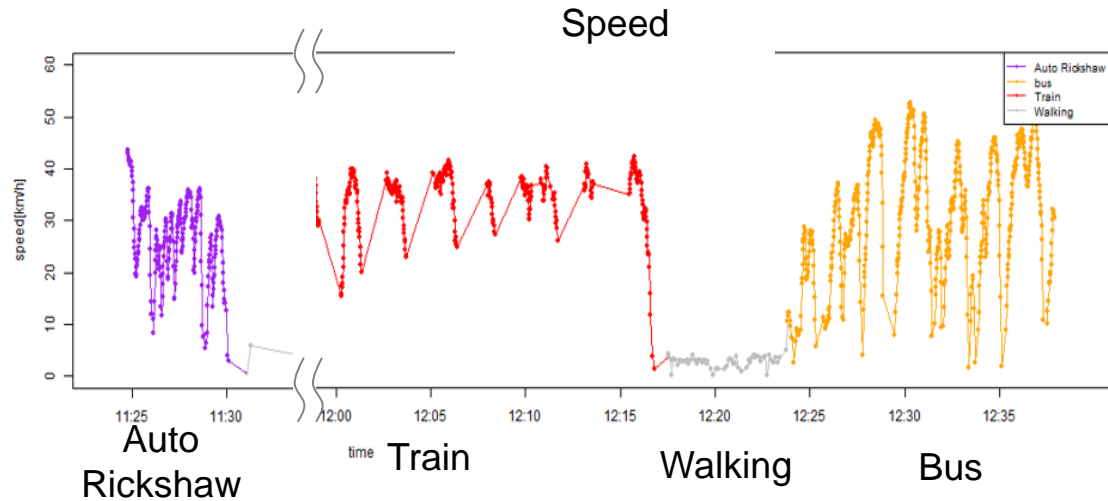
### Benefit

Bus company	<b>Identify problem area</b> from operation data analysis, <b>Identify missed opportunity</b> with areas of high demand, <b>cost reduction</b> by reducing low occupancy services bus operation,
Citizen	<b>Better usability</b> of public transportation with less in-bus congestion, and improved service.

# 3-2. Public Transport Optimization- Analyze



Machine learning based automatic classification of trips and modes of travel to extract city Origin-Destination (OD) patterns



Speed / Acceleration Log

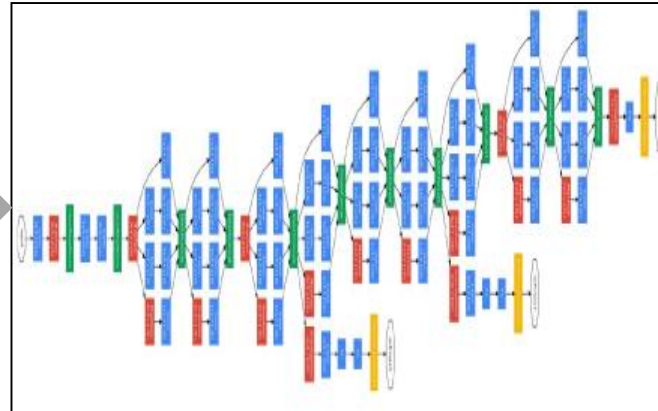


Passenger density analysis with deep learning to analyze spatio-temporal ridership

Input image



Trained CNN for Classification



Results Computed on Server

L1: Empty or few passenger  
L2: Few occupied seats  
L3: Few standing  
L4: Fully occupied, standing  
L5: Heavily crowded

## ❑ Solution:

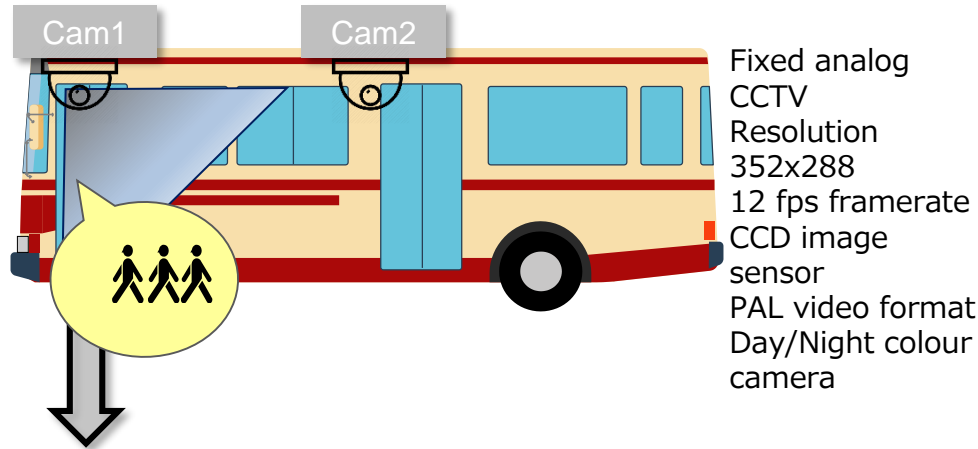
- Train an Image Classification CNN to classify input image to one of 5 levels
- Resultant density level is useful for planning, optimization of routes

## ❑ Evaluation:

- **Accuracy** - We achieved on an average **80% and above** on real world city bus services videos

# 3-4. Public Transport Optimization- Passenger counting **HITACHI** inspire the Next

To detect and count passenger in-flow and out-flow i.e., boarding, alighting at each stop.



**Accuracy range 75~90% tested over 90+ videos**

**Typical test scenarios considered are:**

*Day & night time cases*

*Single/multiple boarding alighting*

*Includes reflection, shadow, occlusion ...*

Idea: Light weight algorithm

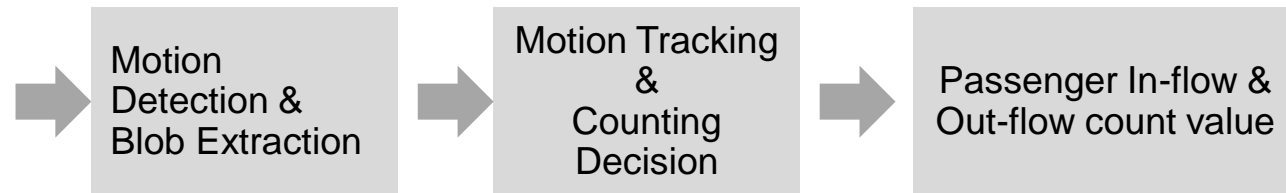
Deploy on OBU (i.e., on-board unit in bus)

- ❑ Solution: To detect and count passenger in-flow and out-flow i.e., boarding and alighting at each bus stop. Portion of image focused at door will be analysed.

Input image



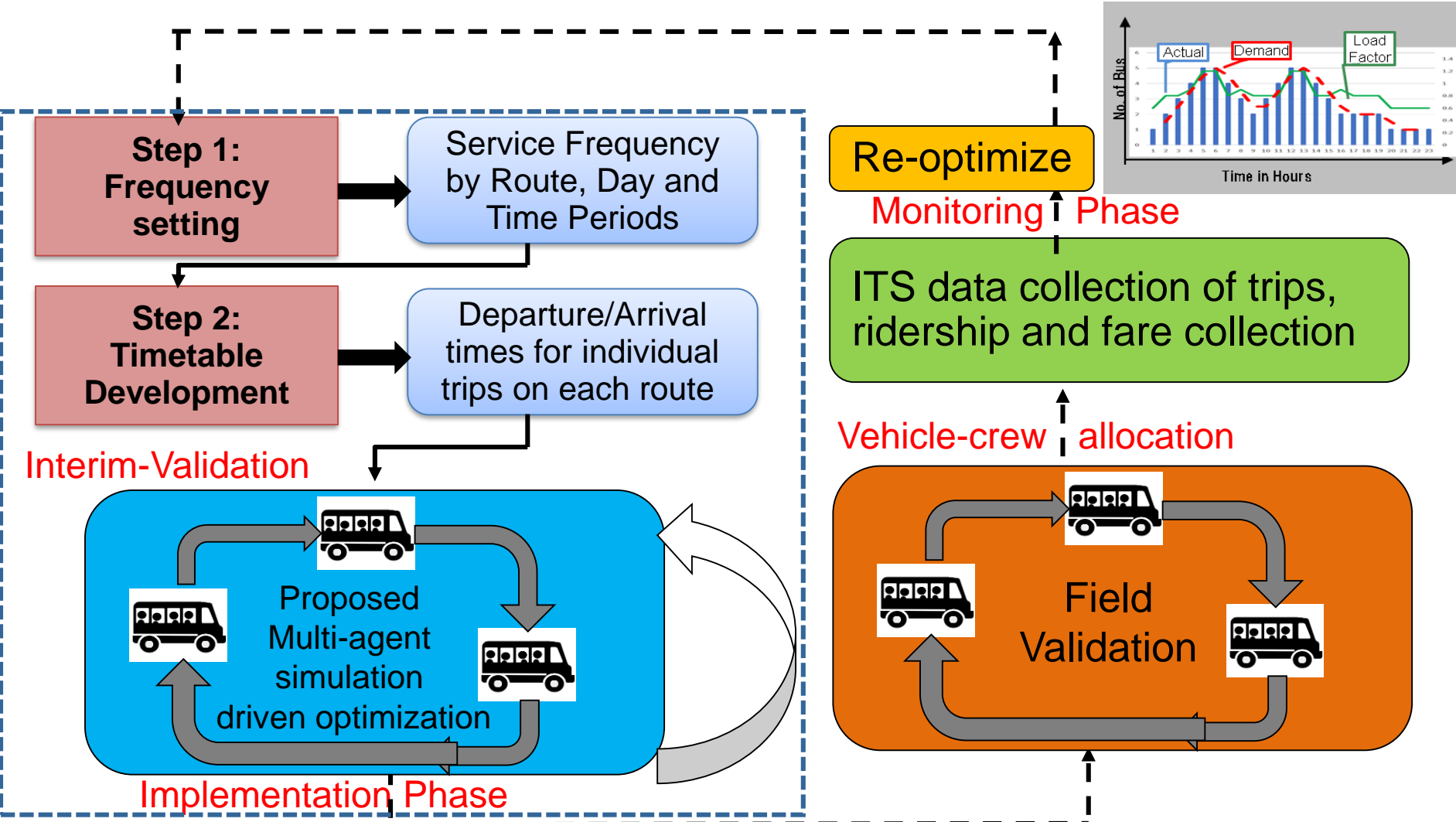
Computer Vision based passenger count measurement





# 3-5. Public Transport Optimization- Bus Scheduling

Simulation driven schedule optimization for interim validation of timetables



# 4-1. Video Analytics for City Traffic Control

Enable to measure traffic volume with multiple vehicle types and to detect traffic violation/accident accurately. Contribute to understand traffic events

## Measurement & Collection

### ① Multiple vehicle type classification



Four Wheelers



Three Wheelers



Two Wheelers



Light Motor Vehicles



Trucks/Buses



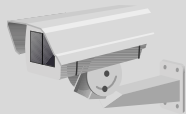
Collect data with multiple types of vehicles

Traffic volume

Traffic violation

Traffic accident

### ② Traffic violation/accident detection

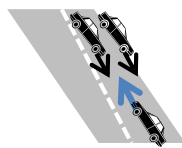


CCTV

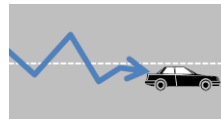
Collision



Wrong way



Dangerous driving



## Solution

### Real-time operation

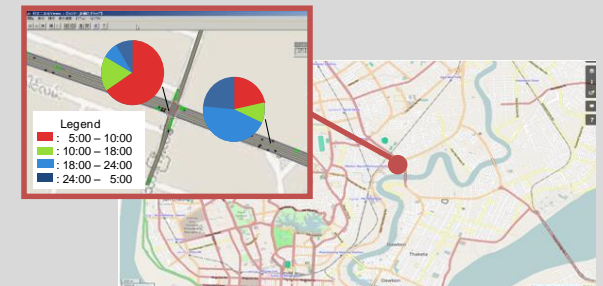
- ✓ Prompt response for traffic event
- ✓ Efficient regulation

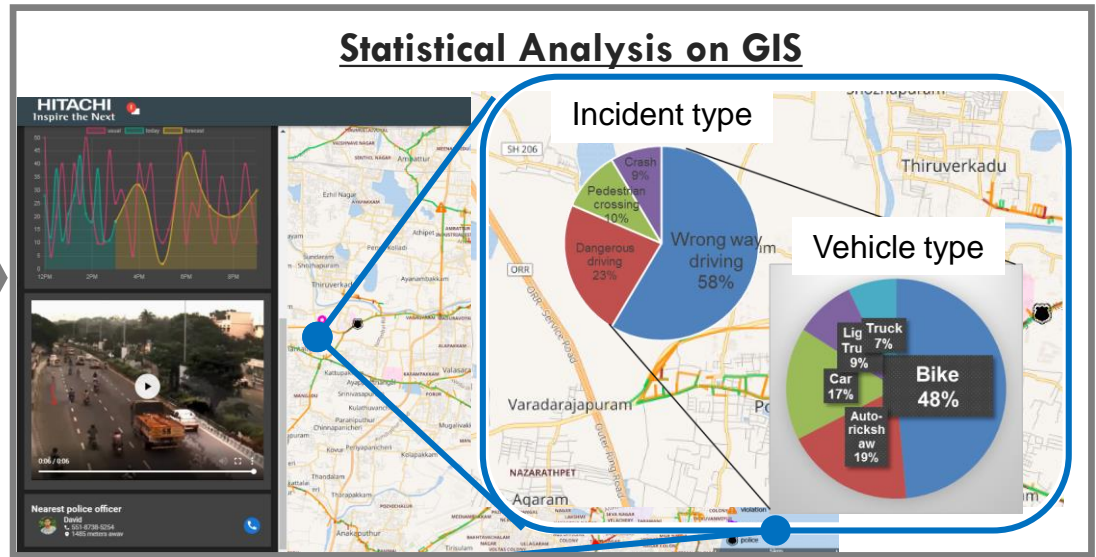
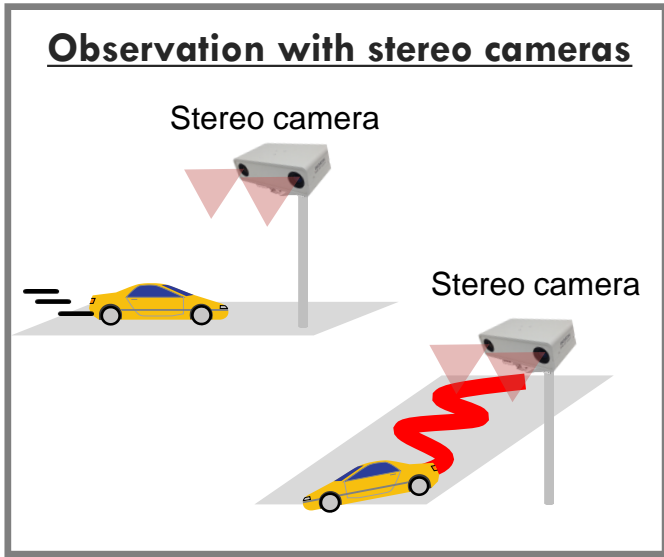
**\*\* Caution \*\***  
Traffic Accident occurred at 10 km ahead. Be careful.



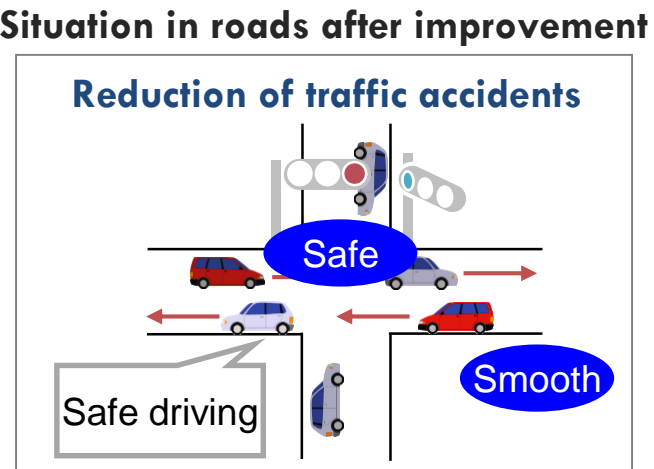
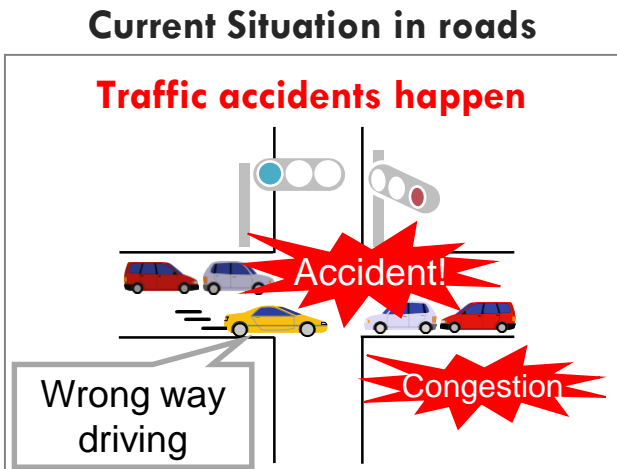
### Data analysis

- ✓ Find areas violation/accident frequently happen
- ✓ Traffic simulation





Current situation found from data : Motorbike drivers are likely to drive wrong way.

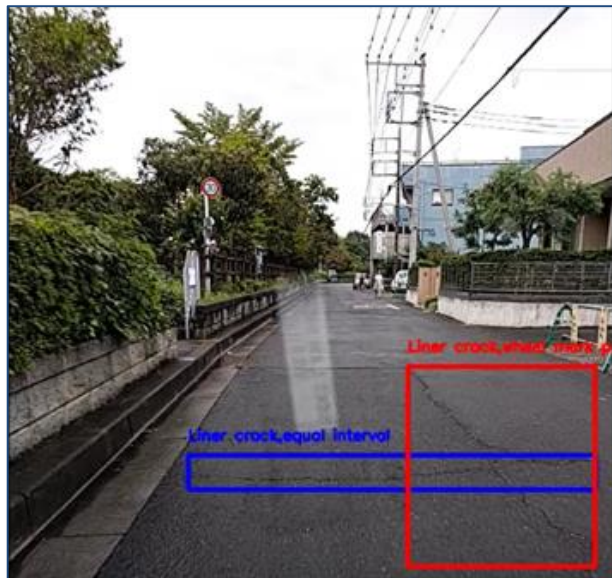


# 4-3. Video Analytics for Road Surface Damage Detection

## Analysis and Planning of Road safety monitoring with sensors and video data

- Automatic recognition of different types of cracks such as linear cracks, longitudinal cracks, alligator cracks, blur white lines, etc.
- Images are frame grabs taken from inside of vehicle, with on-board camera unit.
- Deep Learning algorithms for identifying different types of cracks, from dataset from different cities of Japan.

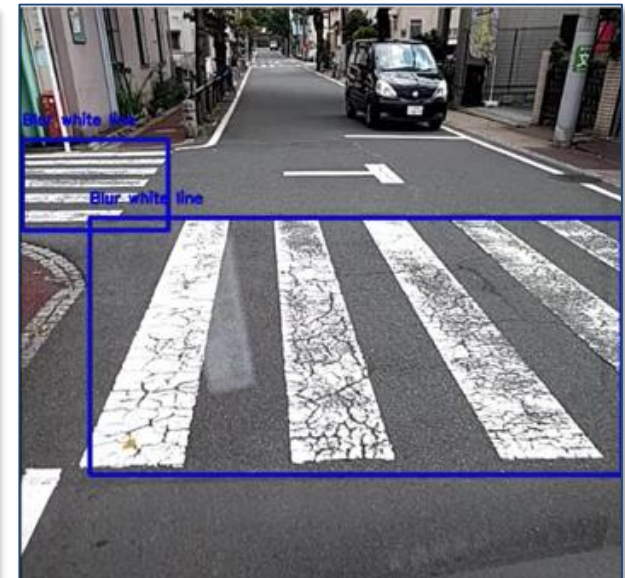
**IEEE BIG DATA CUP CHALLENGE** Hitachi India team has an accuracy of 60%



Linear Cracks



Alligator Cracks



Blur white lines

- Hitachi's technologies for smart, sustainable urban transportation including visualization and optimization are introduced.
- City traffic and road video analytics to monitor passenger flow in vehicles and on-road incident analysis.
- Through collaboration and proof of concept (PoC) opportunities we hope to expand research and development activities in urban transport for ASEAN region.

**HITACHI**  
Inspire the Next 