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How advanced public transport management systems play a role in EV bus operation: efficient operation, safe driving and zero emissions

16 - 17 MAY 2024

BUS FLEET ELECTRIFICATION:

INSIGHTS FROM GLOBAL PUBLIC TRANSPORT INNOVATORS

ORGANIZED BY

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ALL ABOUT BUS, COACH AND PEOPLE

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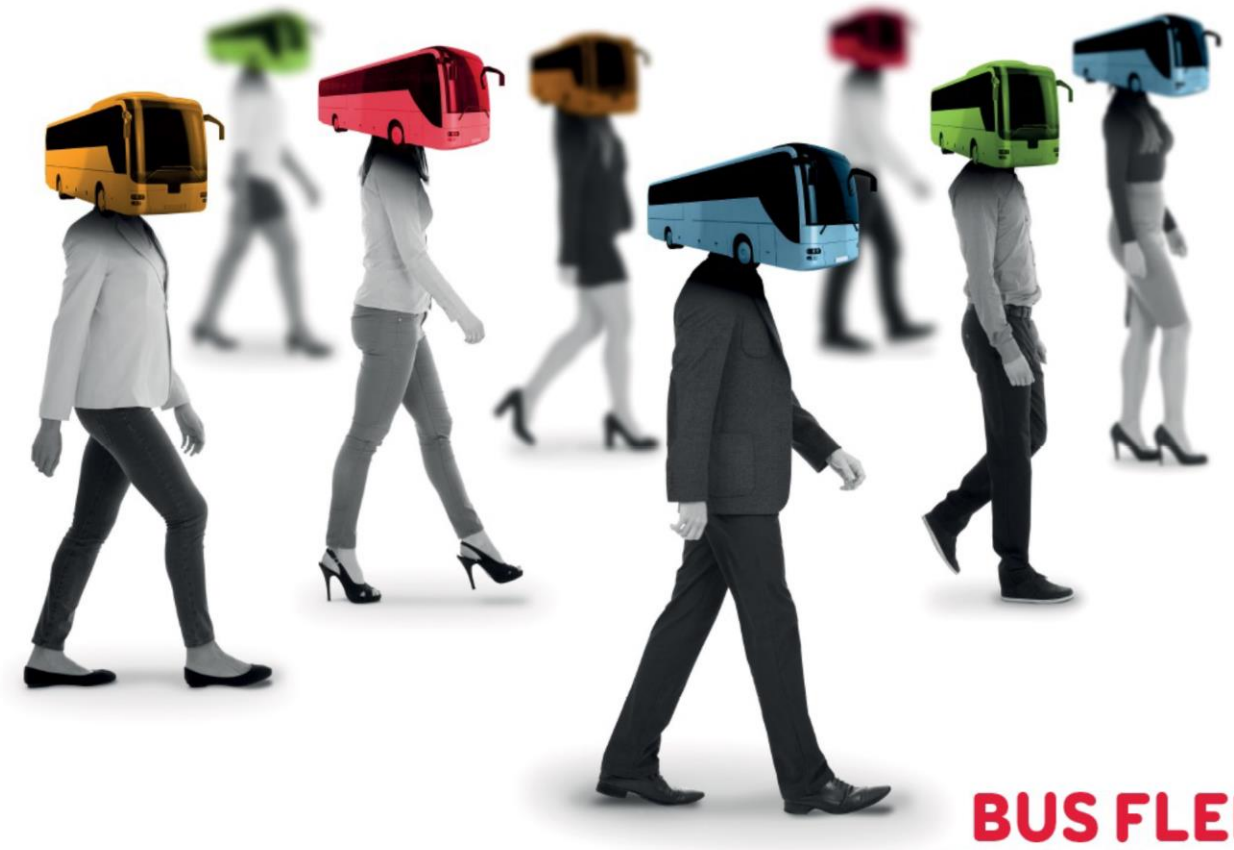

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17 May 2024

Session 01

Background Analysis

The Growing Data of EV Bus Globally

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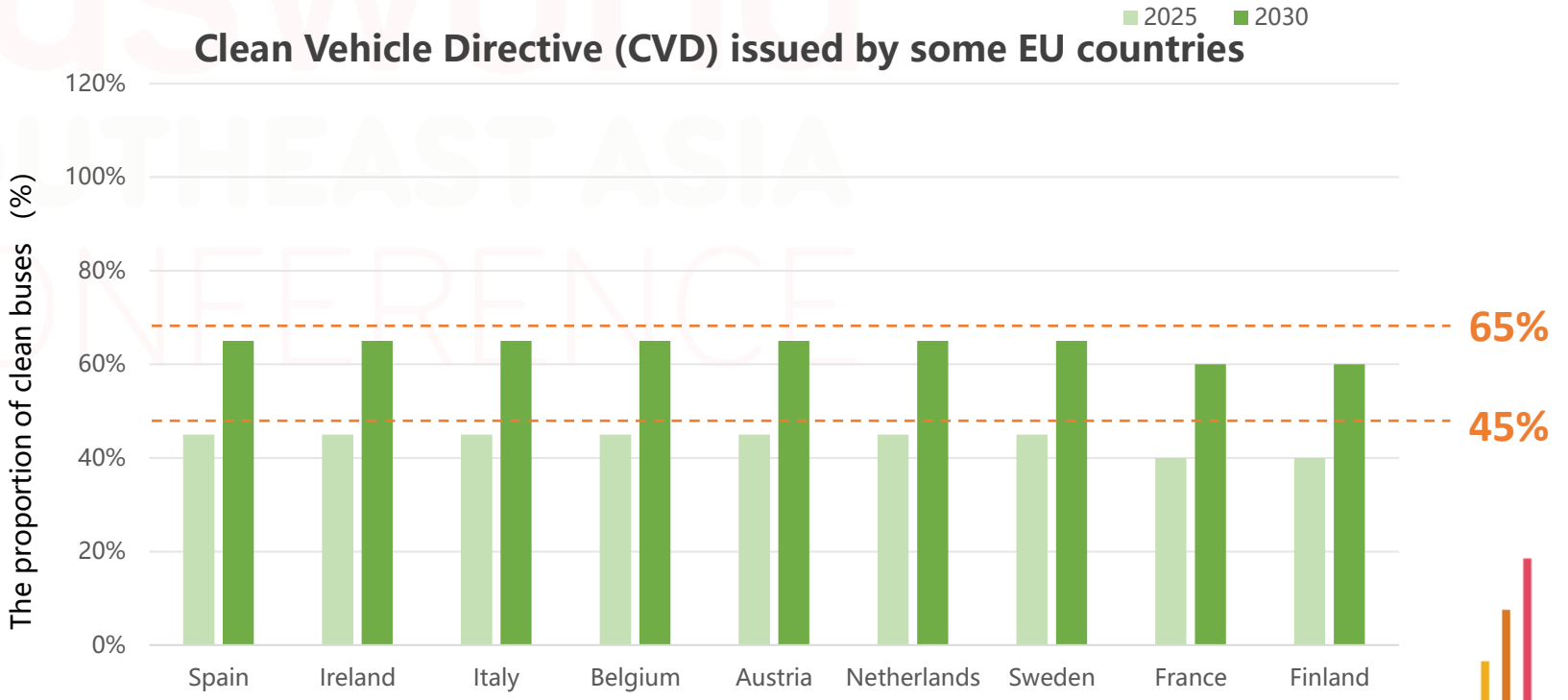
- EU countries plans to increase numbers of clean buses to 45% in market, within of which 50% will be 0-emission buses
- Some of Asia and American countries have published the EV bus planning

Qatar 2030 EV Plan

EU CO_2 Emission Regulation



The Growing Data of EV Bus in China

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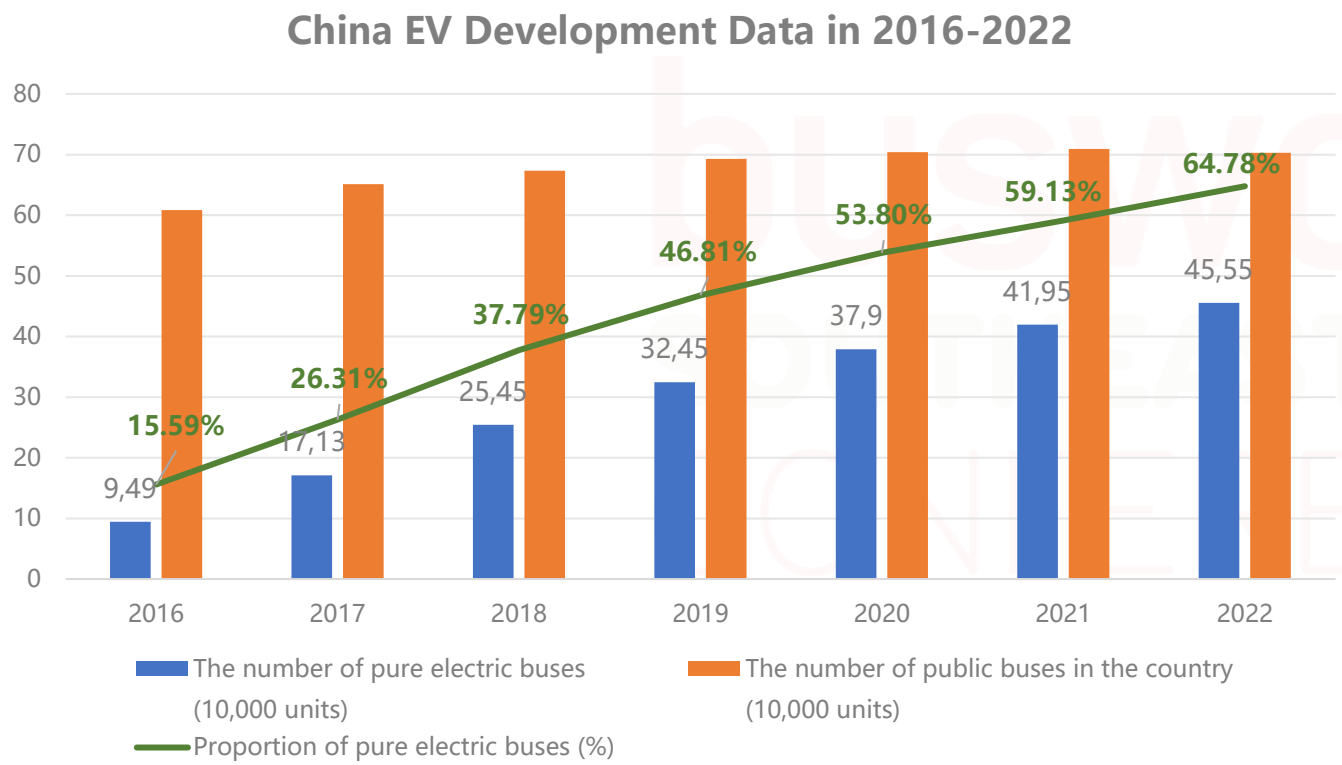

2016-2022

Total EV

949 000->4 555 000

Ratio**15.59%-64.78%**

Route Numbers: 6 0500

Route Distance>10 Million KM

Total Loading>**500 Billon Passengers**

CO^2 Emission Decrease by 54 Million Tons

What affects EV bus operation?

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Battery Charging &Operation Plan

Decrease Vehicle Emission

Quick Response for Emergency Events

Driver Dangerous Behavior Monitoring

Intelligent Schedule Planning Based on Passenger Counting Data

Provide Comfortable Trip Experience

The advanced public transportation management system can help electric buses:

efficient operation, safe driving and zero emission

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Session 02

Industry development

Smart Charging Solution Helps with Vehicle Charging and Operational Planning

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There are many factors affecting energy consumption

Vehicle rated battery capacity, operating environment temperature, etc; will have an impact on vehicle power consumption.
The charging solutions should be considered for different operation mode and seasons, etc.

Vehicle running with balancing battery

Improper management of remaining battery may cause the battery pack to discharge or charge, thus affecting the performance of the battery pack energy and lifespan.

Charging facilities are not used during the daytime

Electric buses mostly run on the routes during the day and at night the charging is unified and centralized during the day. The charging piles are located in most places during the day. In idle state, utilization rate is extremely low.

Smart Charging Solution for Optimization of Operation Planning

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Vehicle Battery SOC Monitoring

Real-time monitoring of vehicle power status, based on mileage and speed Analyze optimal vehicle charging time

Charging Resource Monitoring

Real-time detection of the location and availability of charging piles, timely analysis of the most reasonable charging piles based on vehicle operation conditions, saving time on searching for charging piles. Approximate vehicle energy consumption

Vehicle Operation Data

Vehicle Timetable | Driver Rotation Plan | Charging Plie Data ...

Charging + Operation Plan

- Passenger Loading Rate
- Vehicle Empty Rate
- Operation Efficiency
- Operation Cost

Global Carbon Emission Reaches to a Highest Level, ¼ Coming from Transportation

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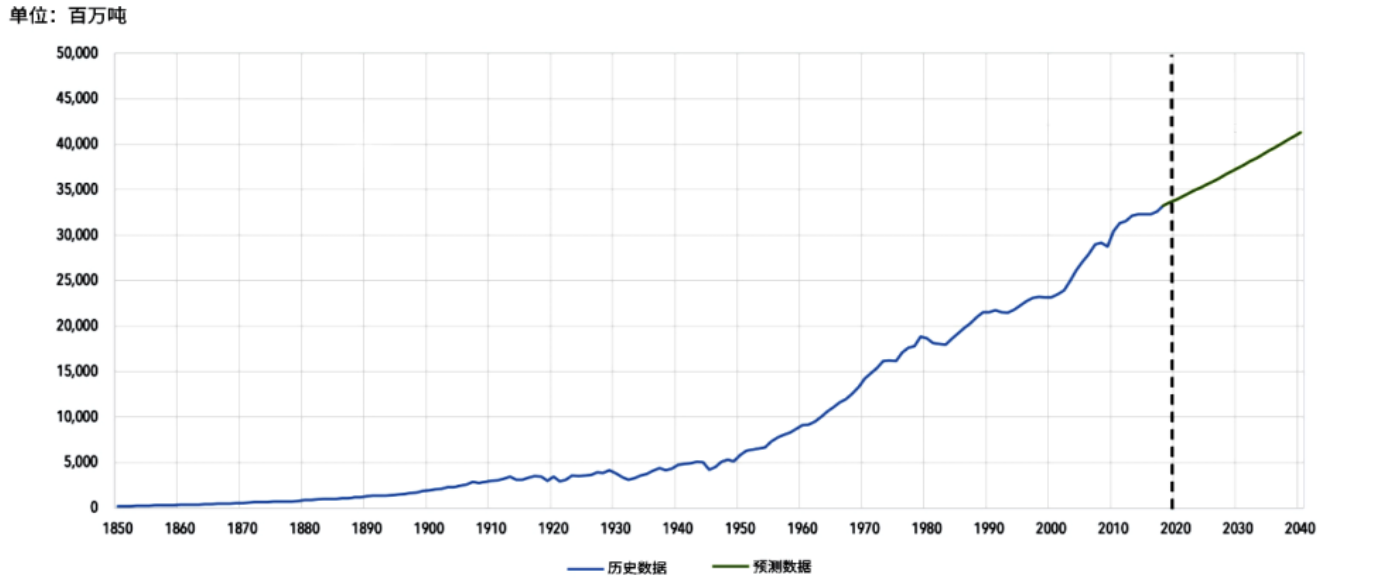
Serious Environmental Pollution and High Carbon Emissions

The popularity of new energy vehicles has driven global road fuel consumption Oil demand peaks in 2027, road traffic carbon emissions It will reach its peak in 2029

The International Energy Agency (IEA) points out that global carbon emissions has reached to **37.4 billion** tons in 2023, which is increased by 1.1% compared with 2022. Within which there are **25%** of carbon emissions are coming from the transportation.

Trends of global carbon emissions from 1850 to 2040



图源：CENTER FOR CLIMATE AND ENERGY SOLUTIONS

Vehicle Energy Consumption Management, Targeting to Zero Emission

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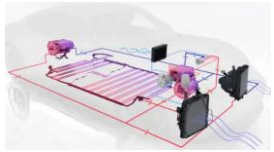
Temperature

When the ambient temperature drops to -27°C, operating energy consumption increases 47.1%; when the ambient temperature rises to 35°C, the operating capacity consumption increased by 9%.



Manage the AC temperature smartly

Increase the utilization rate the of vehicle energy for less wasting

Driving Behavior

Behaviors such as sudden acceleration, sudden braking, and high-speed driving will increase energy consumption, resulting in higher power consumption per 100 kilometers

Limit the speed of vehicles,

Reduce poor driving behavior

Charging

Real-time monitoring of the operation and status of charging piles and vehicle charging information, timely notification of vehicle charging, reduce power loss

Battery

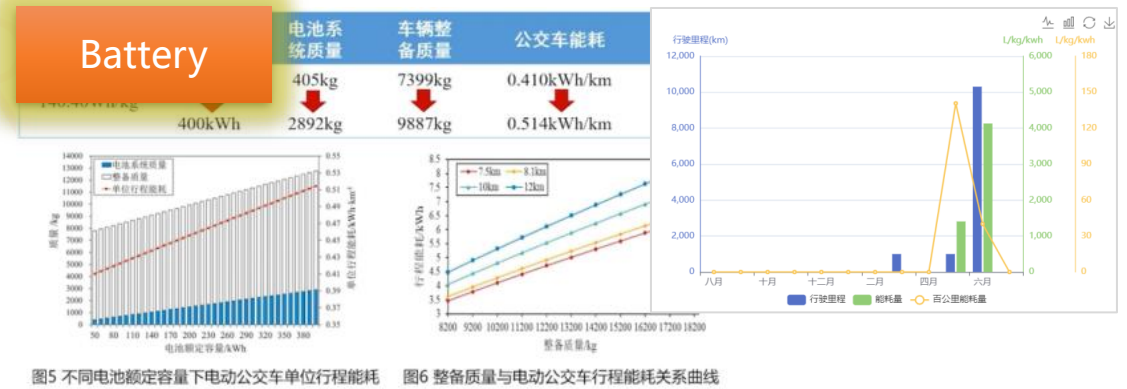


图5 不同电池额定容量下电动公交车单位行程能耗　图6 整备质量与电动公交车行程能耗关系曲线

The rated battery capacity affects the weight of the bus body, which in turn affects the energy consumption of the bus. Through the analysis of battery and vehicle energy consumption data, it provides data support for subsequent car purchase or battery replacement

Intelligent Scheduling and Dispatching to Reduce Abnormal Passenger Flow

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Buses are crowded in rush hours

The number of vehicles schedule does not match the actual passenger flow, which is extremely easy to cause fewer vehicles and crowded passenger flow during peak periods.

The problem of low vehicle occupancy rate during off-peak periods will cause the wasting of resources.

Many people waiting for the buses in stops

Due to special holidays or weather conditions, etc., the passenger flow in bus stop may change.

Several buses approaching to same bus stop at same time

The vehicle schedule is unreasonable, and the system operator is hard to dispatch, it will cause the congestion of buses approaching to the same bus at the same time.

Intelligent Scheduling Solution Solves Abnormal Passenger Flow Problem

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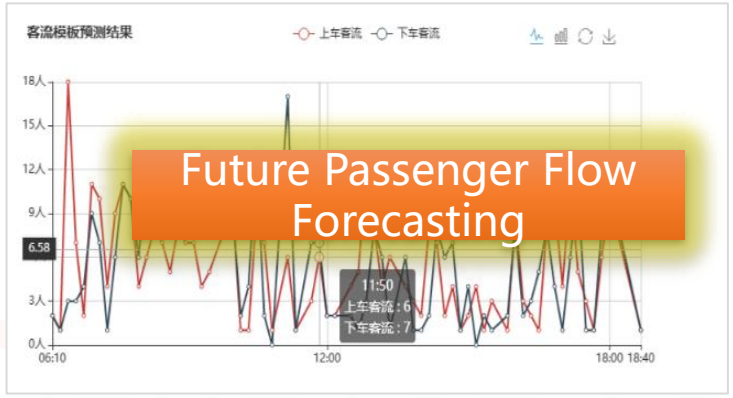
Historical Passenger Flow Historical Turnover Rate

Prediction Algorithm

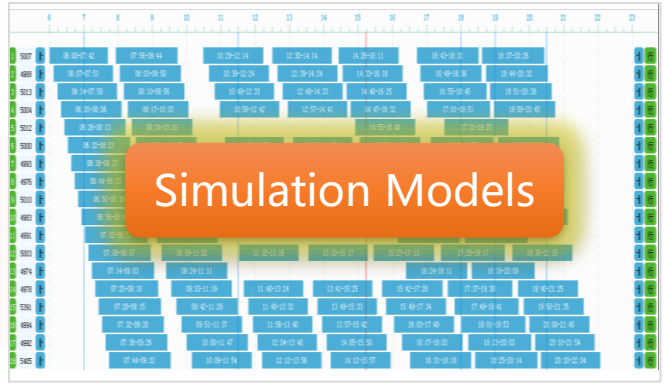
Min Rest Time for a Trop

Trip Frequency



Future Passenger Flow Forecasting

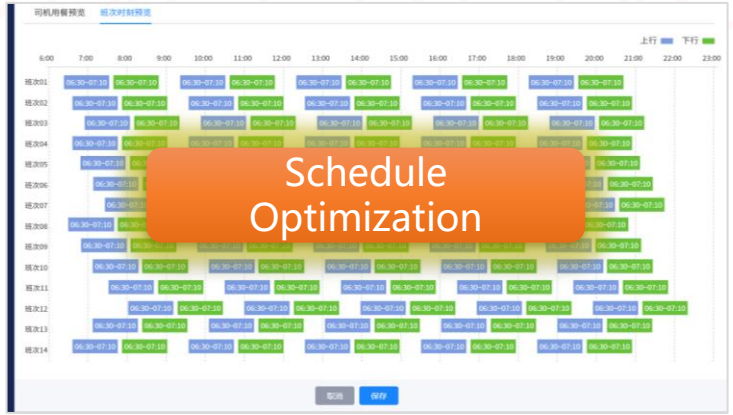
Passenger flow data forecast for specific dates and weather conditions in the future



Simulation Models

Simulation plan for optimal vehicle departure interval

Peak Full Threshold Charging Plan Charging Plan Maximum Departure Interval Driver's Break Time Departure Time-table Min No. of Buses



Schedule Optimization

Requirement 1: rush hours, or special holidays/weather etc.
>increase trip frequency to meet high passenger flows;
Requirement 2: off-peak hour or special weather etc.
>decrease trip frequency to meet low passenger flows.

Generate a schedule that satisfies the minimum number of vehicles and the maximum full load rate

Unexpected Events Disrupt Bus Operation

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Vehicle gets fire or breaks down

Abnormal passenger flow

Driver is late to work or ask for leave

Traffic jam

Poor weather....

- **Unexpected emergency events disrupt bus operation**
- Using of **dynamic scheduling** algorithm for quick generation of travelling plan

Fleet Tracking and Video Surveillance for Operation Management

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Accidents during bus operation

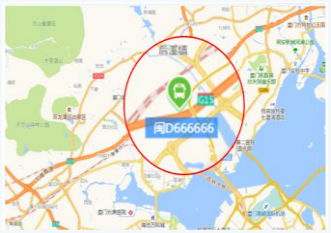
GPS

GIS

4G/5G

Behavior Analysis Algorithm

CCTV Cameras



Real-time Tracking

Track Playback

CAN-bus Monitoring

Video Surveillance

Intelligent Dispatching for More Efficient Operation

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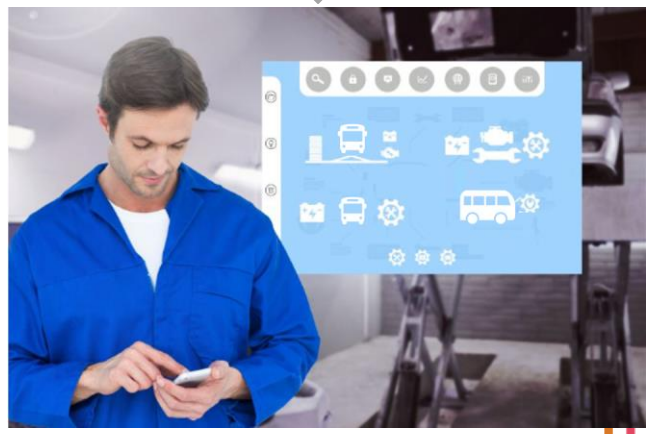
Event Model

- Vehicle Status
- Passenger Flow
- Driver
- Traffic Status
- Weather
- ...

GPS | GIS | 4G/5G | AI algorithm

Event model based on various scenarios for **Automatic Dispatching**

Bus faulty diagnose & alarm data



Vehicle repair and maintenance

Mobile App for **Dispatching**

Driver’s Behavior Causes Most of Accidents

Frequent traffic accidents

Poor driving Behavior

According to data of World Health Organization, the traffic accidents cause nearly 1.3 million people died and about **50 million** injured in the past few years, averaging every 24 seconds there is a person **died in traffic collision.**

According to current trends, the traffic accidents may cause about more than 13 million deaths in the next ten years and 500 million injuries.

According to the CIDAS (China Traffic Accident In-depth Investigation) database, in 2011 to 2021, there are 5,664 accidents causing by **drivers. The proportion of such accident is about 81.5%.**

DMS&ADAS and BSD for Driving Behavior Monitoring

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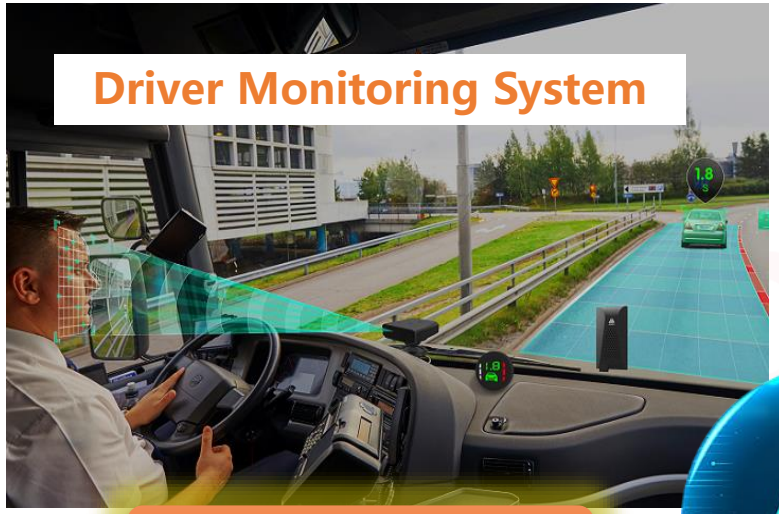
Driver Monitoring System



Advanced Driving Assistance System

Face recognition algorithm

- Make Phone Call
- Eye Closed
- Fatigue Driving
- Smoking

Computer Vision Algorithms

- Forward Collision
- Harsh Braking
- Harsh Turn
- Lane Deviation

Radar+Video with AI for Zero-blind Driving

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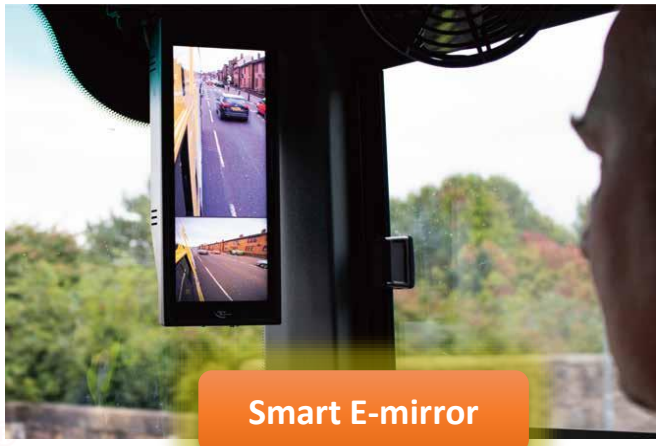
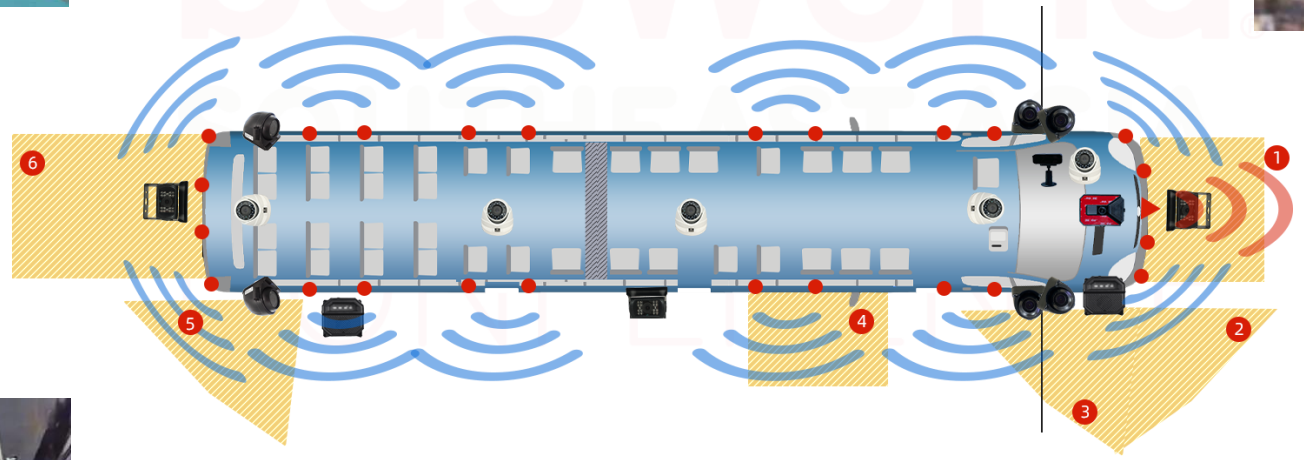
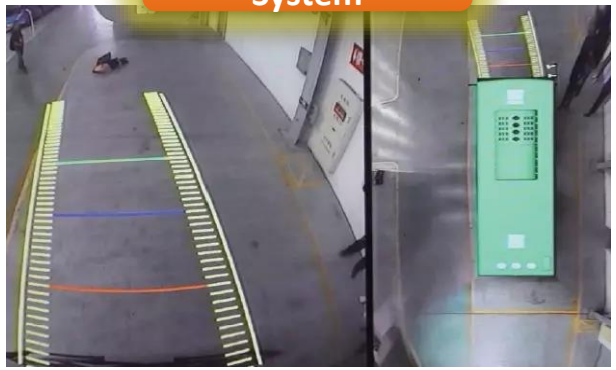
Blind Spot Detection



Smart E-mirror



360° Bird View System



Radar+sound+light alarm

APTMS Provides More Comfortable Trip

Summer: Too Much Hot

Winter: Too Cold in Bus

Temperature control

Enjoyable the temperature is the key of good service.

➢ Turn on heating or cooling remotely in advance so that the bus is ready for passengers once operation starts

➢ Preset AC for heating provides comfortable temperature without consuming the battery

Rime Traveler Information For Better Experience

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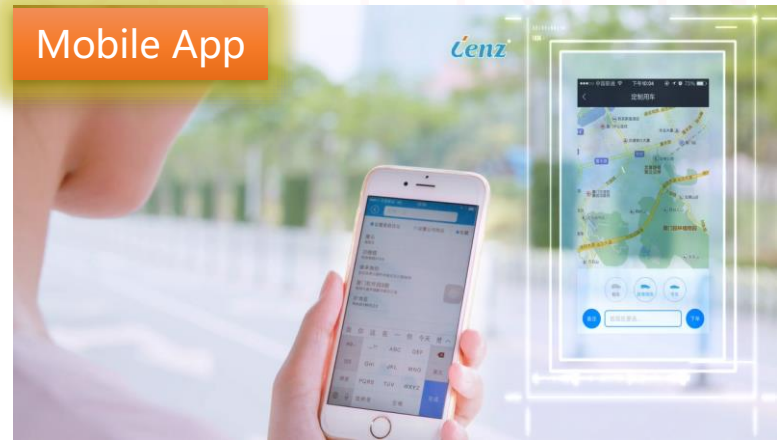
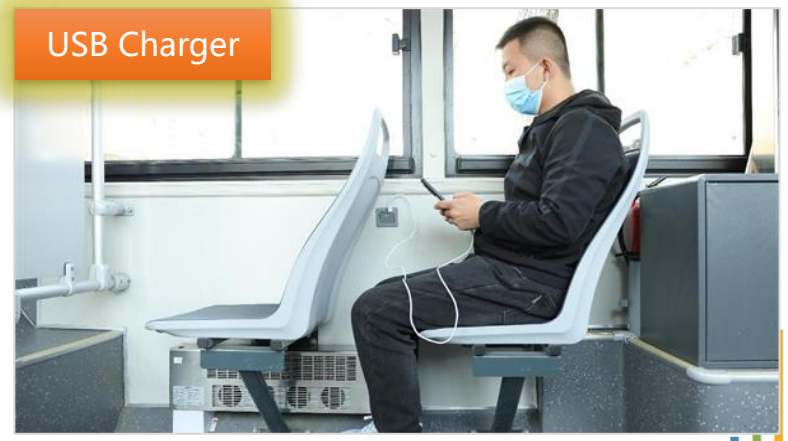
PID

Mobile App



USB Charger



CAN-Bus Data is Very Important in Bus Operation

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- Vehicle Data
- Speed
- Driver Motor
- SOC
- Engine Data
- Faulty Data
- Extreme Value
- AC Temperature
- Voltage & Temperature of Rechargeable Storage Device
- …

CAN-Bus Data

Predictive maintenance
Driver behavior monitoring
Service improvement
Operation cost management
…

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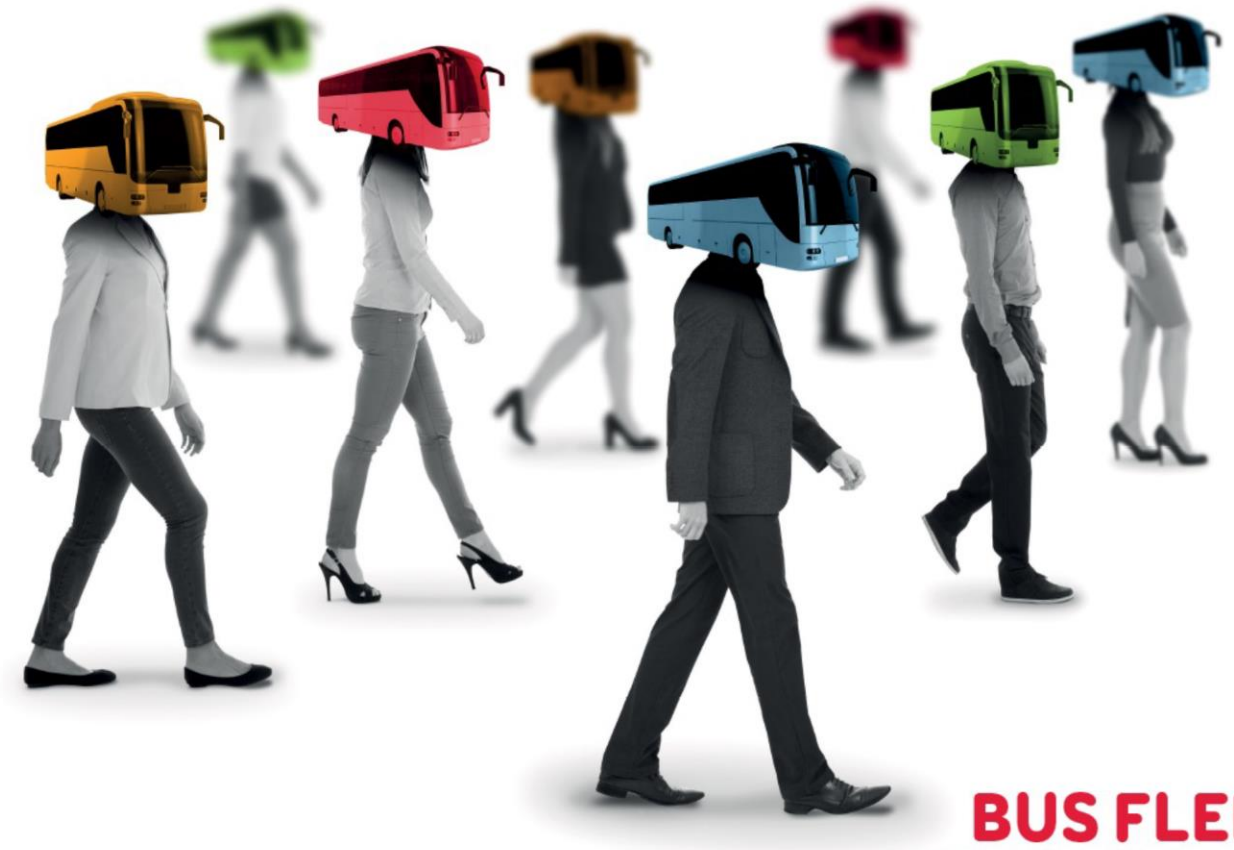

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Session 03

About Lenz

About Xiamen Lenz

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Xiamen Lenz Communication Co.,Ltd (Stock ID: 430491) founded in 2006, and was successfully listed in New OTC Market of Beijing in 2014. Relaying on AI, 4G/5G, Mass, Data Base and Transport Engine, Lenz is focus on the independent research and development of the solutions for public transportation, telematics and smart sanitation, which have been deployed in more than 400 cities in 30+ countries. Owning 200+employees, there about 100 RD engineers in the company. The office area is 4000 ㎡, and production center area is 4000 ㎡.

Our Projects: 40+Countries，400+Cities

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Our Projects

Thailand Public Bus
Malaysia Public Bus
Kuwait Public Bus
Pakistan BRT
Ecuador BRT
Gabon Public Bus

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