

Experience on Smart Bus Operation in Taiwan



Baoruh Electronics Co., Ltd
Jih Yao Huang Vice President
WWW.BAORUH.COM

This is not an ADB material. The views expressed in this document are the views of the author/s and/or their organizations and do not necessarily reflect the views or policies of the Asian Development Bank, or its Board of Governors, or the governments they represent. ADB does not guarantee the accuracy and/or completeness of the material's contents, and accepts no responsibility for any direct or indirect consequence of their use or reliance, whether wholly or partially. Please feel free to contact the authors directly should you have queries.

Experience on Smart Bus Operation in Taiwan

- **The important achievement of APTS
(Advanced Public Transportation System)**
- Technology, products and solution of Smart bus in Taiwan
- Next-generation Smart-BUS service plan
- International Cooperation

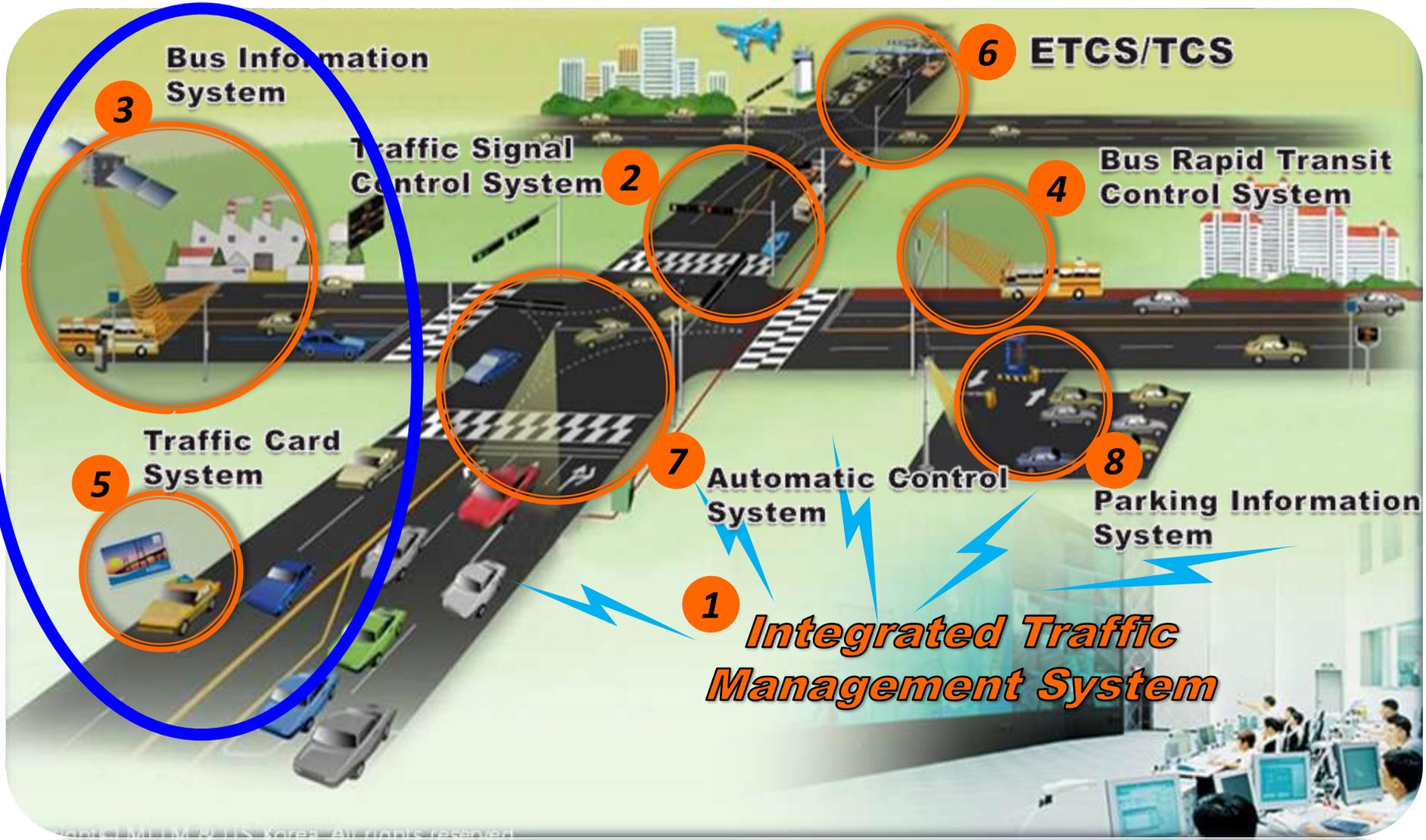
Profile : Taiwan

Indicators	Numbers
Area (Km ²)	36,193
Population ('000)	23,430
Population Density (p/Km²)	649.92
GDP('000), US\$(2015)	523,009,000
GDP per capita, US\$ (2015)	22,294
PC Penetration	88.4%
Internet Connectivity (4G)	84.8%
Mobile Phones (4G)	113.2%
Vehicle ownership(1000P)	910 (328car+582 motorcycle)
Road density(m/Km ²)	1,165
Intercity BUS Company	55(5300 buses)
City Bus company	22((10000 buses)
Total route number	8,000
Total Station number	130,000

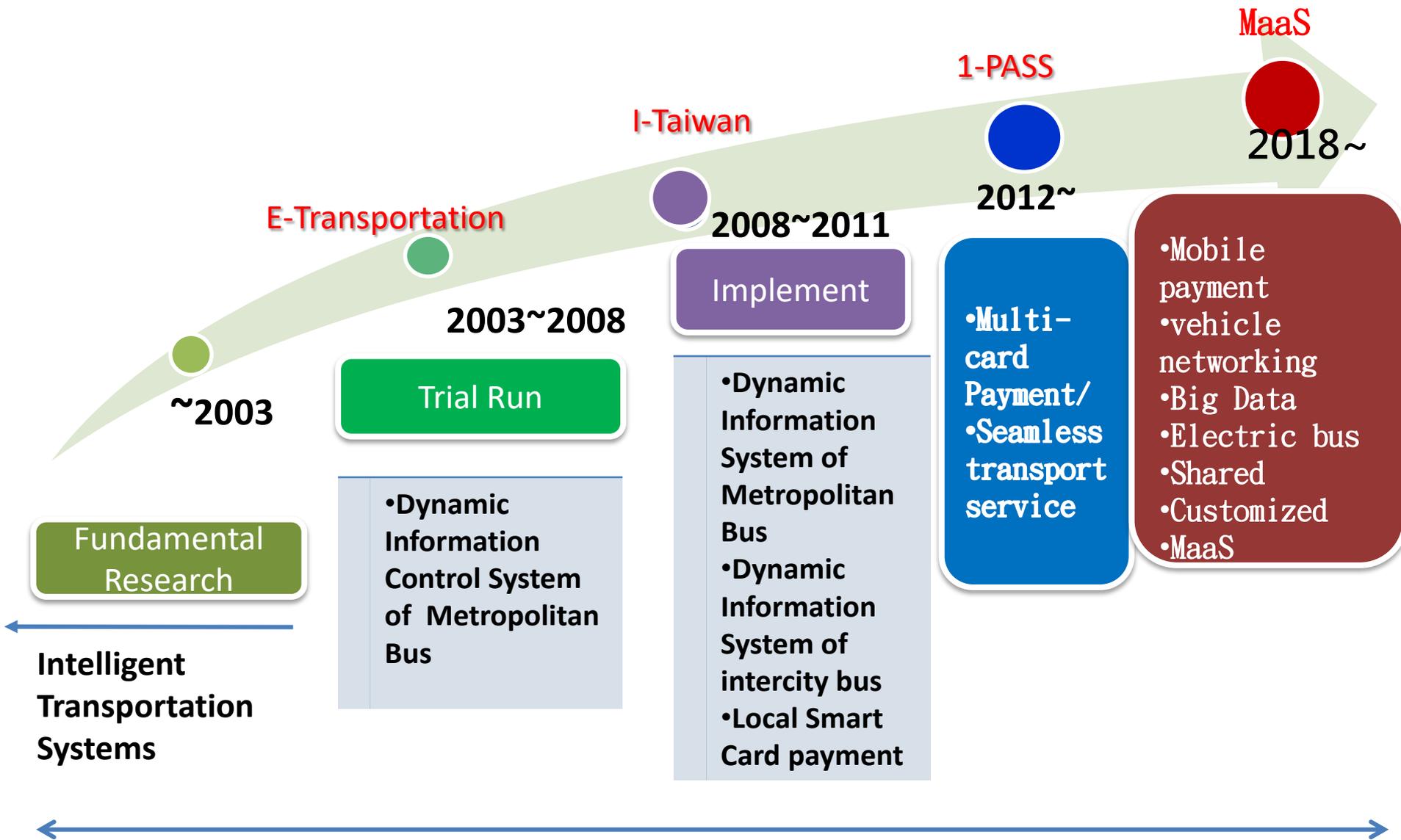


ITS Achievements in Taiwan

Smart BUS Operation Service



Taiwan's APTS Development Process



Noun definition

一、Mass transit :

It refers to public transportation with fixed routes (airlines), Fixed classes (airlines), fixed stations and fixed rates, and providing passenger transportation services. The public transport undertakings include: urban bus transportation industry, highway bus passenger transportation industry, railway transportation industry, mass transit system transportation industry, Ship transportation industry, passenger boat management industry and civil aviation transportation industry.

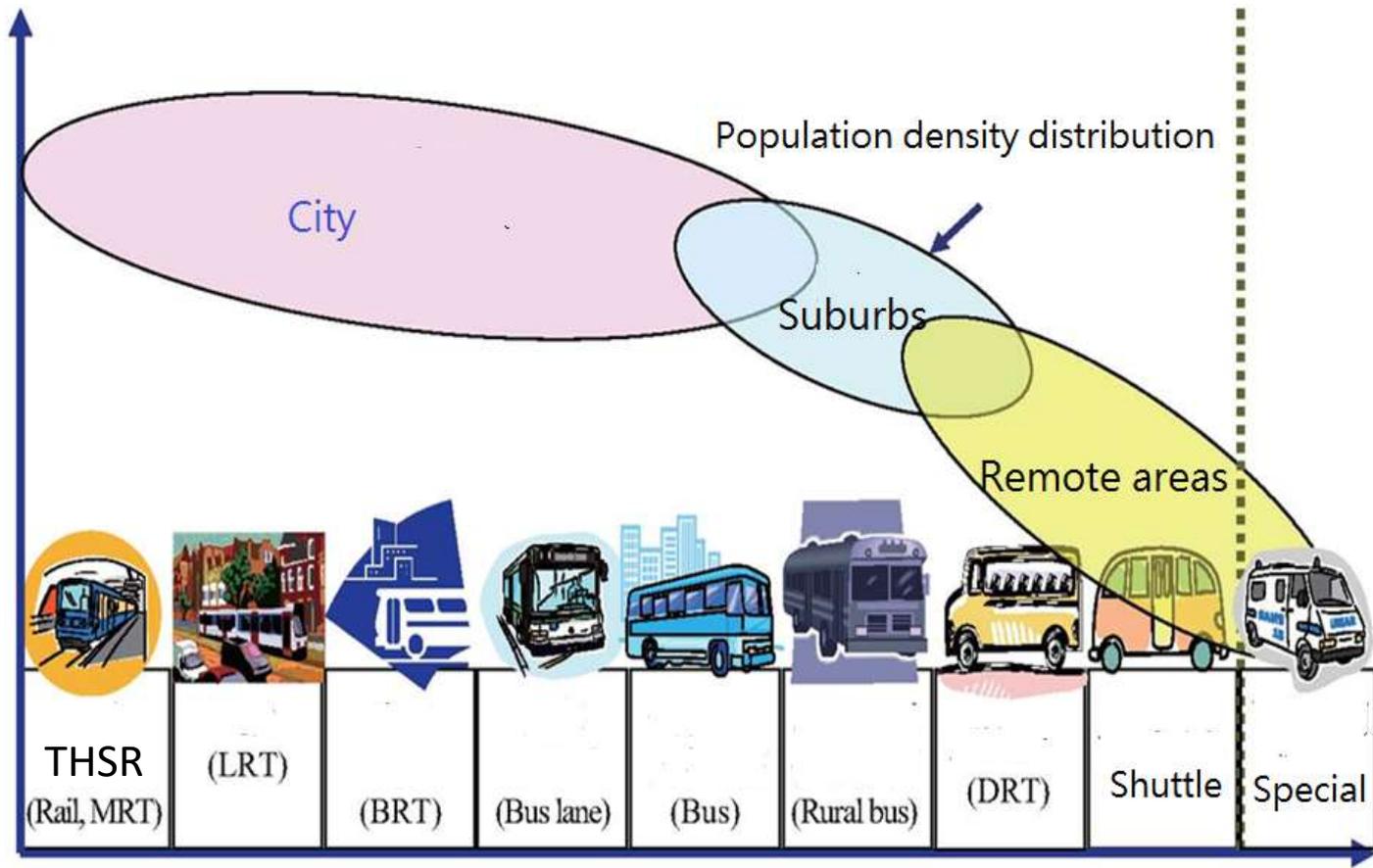
二、Public transportation :

Including Mass transit and Paratransit , including vice-mass transportation including: taxis, tour buses, minibus rental industry, and car sharing (including: car sharing, medium car sharing and taxi sharing), call-to-call Or Dial-A-Ride & Demand Respond Bus etc

三、This topic : Bus Transportation

(Metropolis/Suburb/Intercity)

Various kinds of transportation



Single fare/flat fare

Distance-based fare

Zone fare

Source : MOTC Taiwan

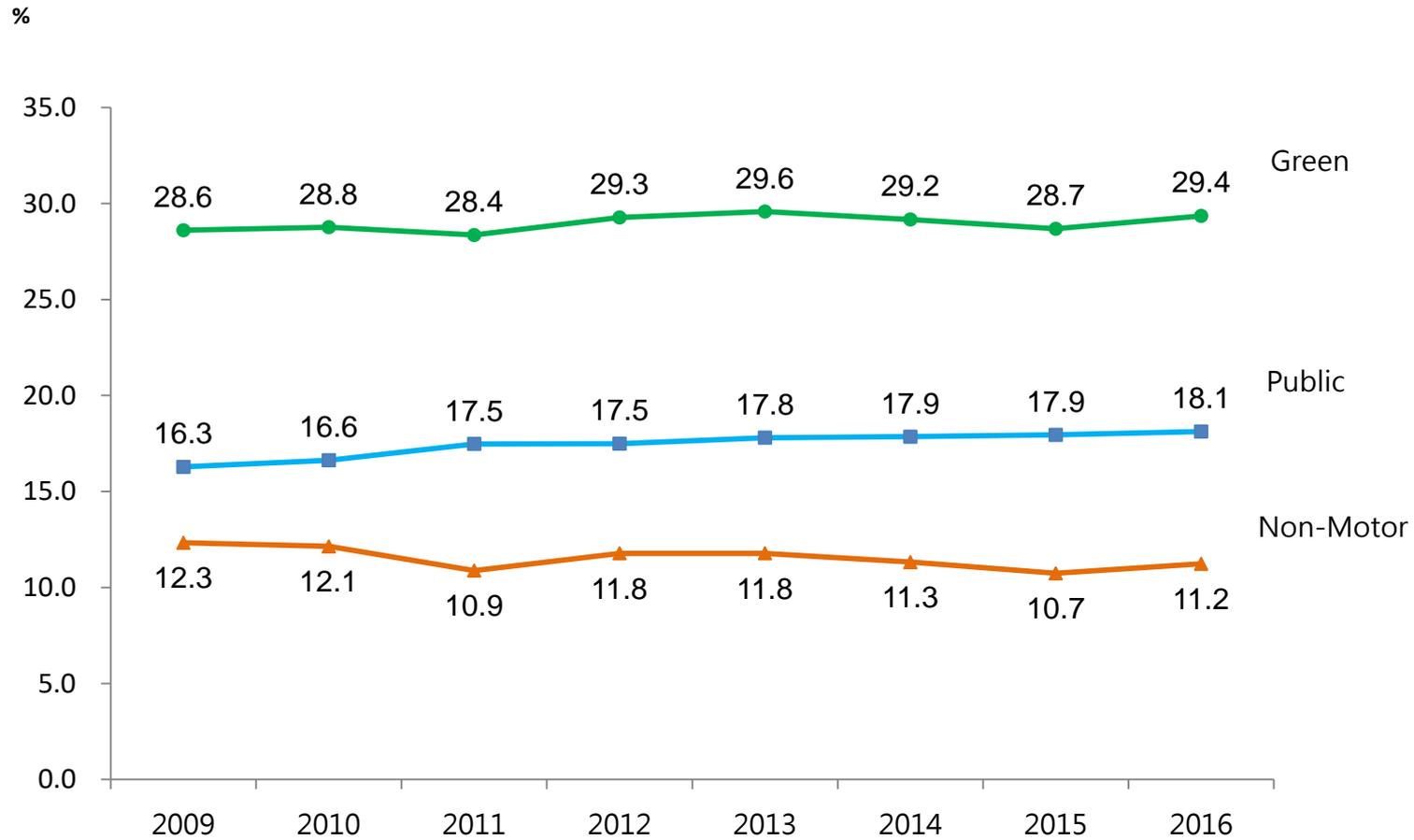
Public transport market share by city



Area	2009	2010	2011	2012	2013	2014	2015	2016
Taiwan	16.3	16.6	17.5	17.5	17.8	17.9	18.0	18.2
Taipei	39.5	43.4	43.5	42.5	42.6	41.3	41.5	42.8
N-city1	36.9	38.1	38.5	39.0	40.6	38.0	40.6	39.8
N-city2	29.0	29.8	31.8	31.0	32.7	33.2	33.6	33.8
N-city3	13.8	13.7	14.0	13.9	14.2	15.6	14.7	15.0
Taichung	9.1	9.2	9.9	10.5	10.8	11.9	12.3	12.2
N-city5	8.3	8.0	7.7	8.6	9.4	8.4	9.6	10.3
N-city6	8.4	8.6	9.6	9.5	9.8	9.0	8.5	10.0
Kaohsiung	9.1	8.0	8.7	8.8	8.7	9.4	9.1	9.3
N-city7	6.9	7.9	8.6	8.8	8.4	8.2	6.8	8.8
N-city8	6.7	7.0	7.0	8.3	8.2	8.6	8.7	8.3
Island1	5.0	6.9	8.7	8.6	7.4	7.5	7.0	7.0
S-city1	6.5	5.8	5.7	5.9	5.9	6.5	6.5	6.7
S-city2	5.2	5.8	6.4	6.4	6.4	5.8	5.2	6.2
E-city1	5.8	5.1	4.3	5.9	5.0	5.1	5.6	6.1
E-city2	6.2	5.4	6.1	6.3	6.7	6.6	6.0	6.1
M-city1	6.2	5.3	6.2	5.8	5.9	5.4	4.7	5.9
M-city2	6.0	4.9	5.3	5.5	4.9	5.7	6.5	5.5
M-city1	5.4	4.5	4.8	5.2	4.5	4.9	5.3	5.3
S-city3	5.3	5.7	5.6	5.6	5.8	6.2	6.0	5.2
S-city4	4.1	4.6	3.9	4.0	4.5	4.4	4.1	4.9
Island2	-	12.0	10.7	11.4	10.6	12.9	11.3	12.1
Island3	-	12.7	13.1	12.8	13.0	9.7	10.0	10.2

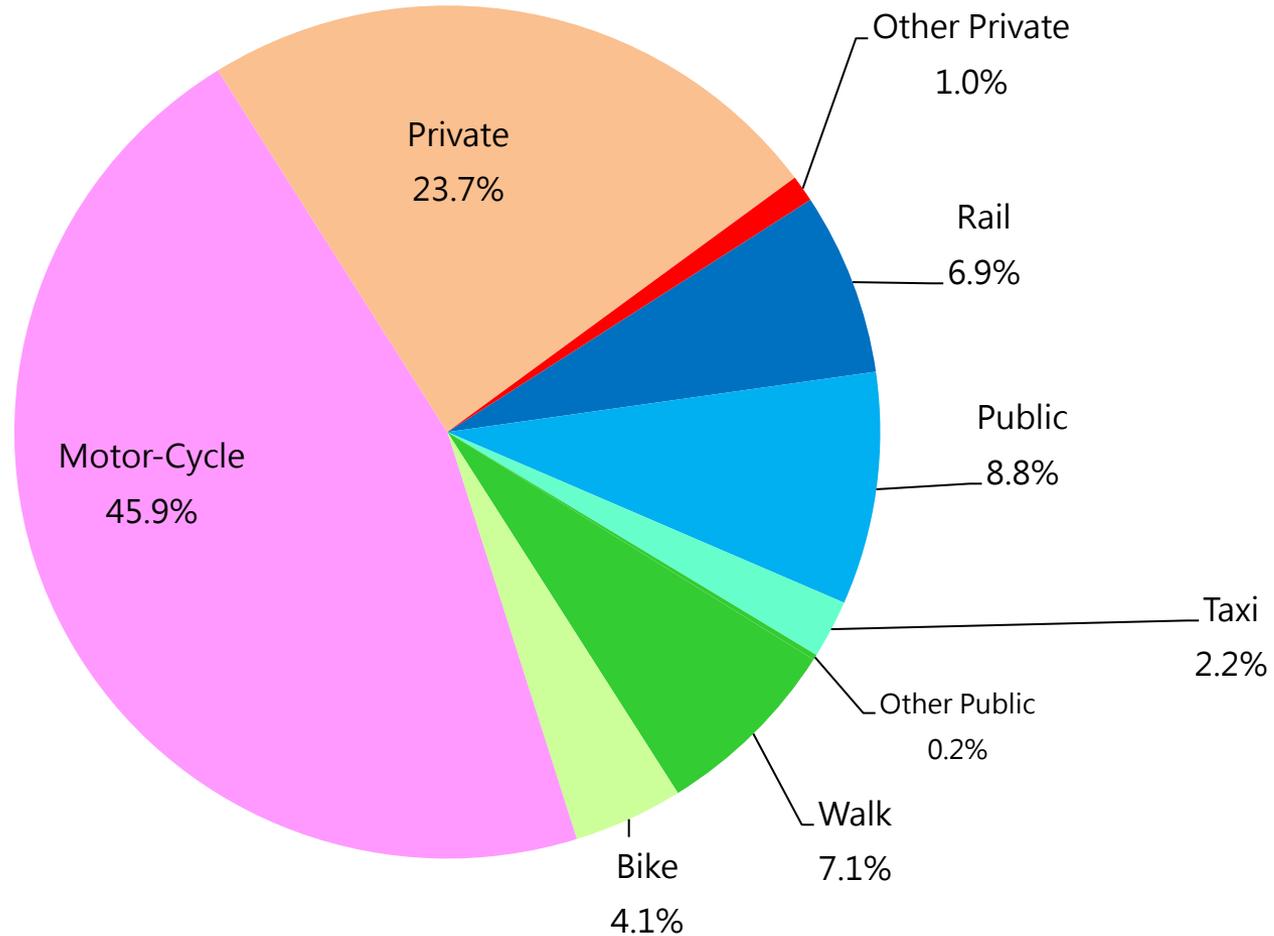
Source : MOTC Taiwan ,2017

Market share of green transport (public and non-motor vehicle)



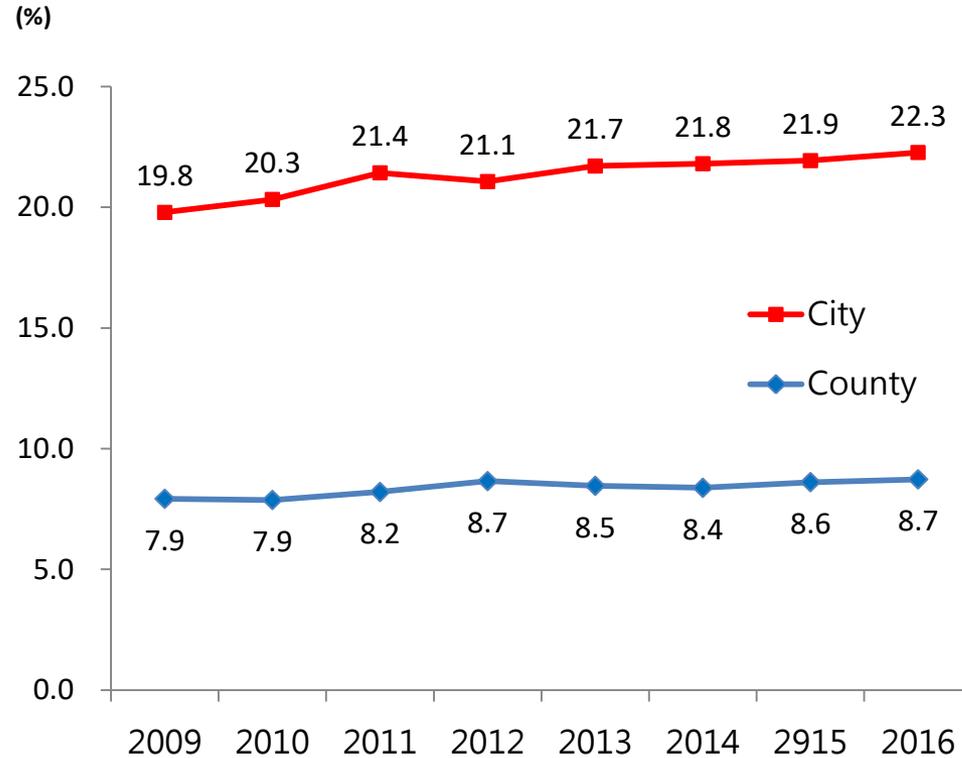
Source : MOTC Taiwan ,2017

Proportion of using the vehicle



Source : MOTC Taiwan ,2017

Market share of public transport by location



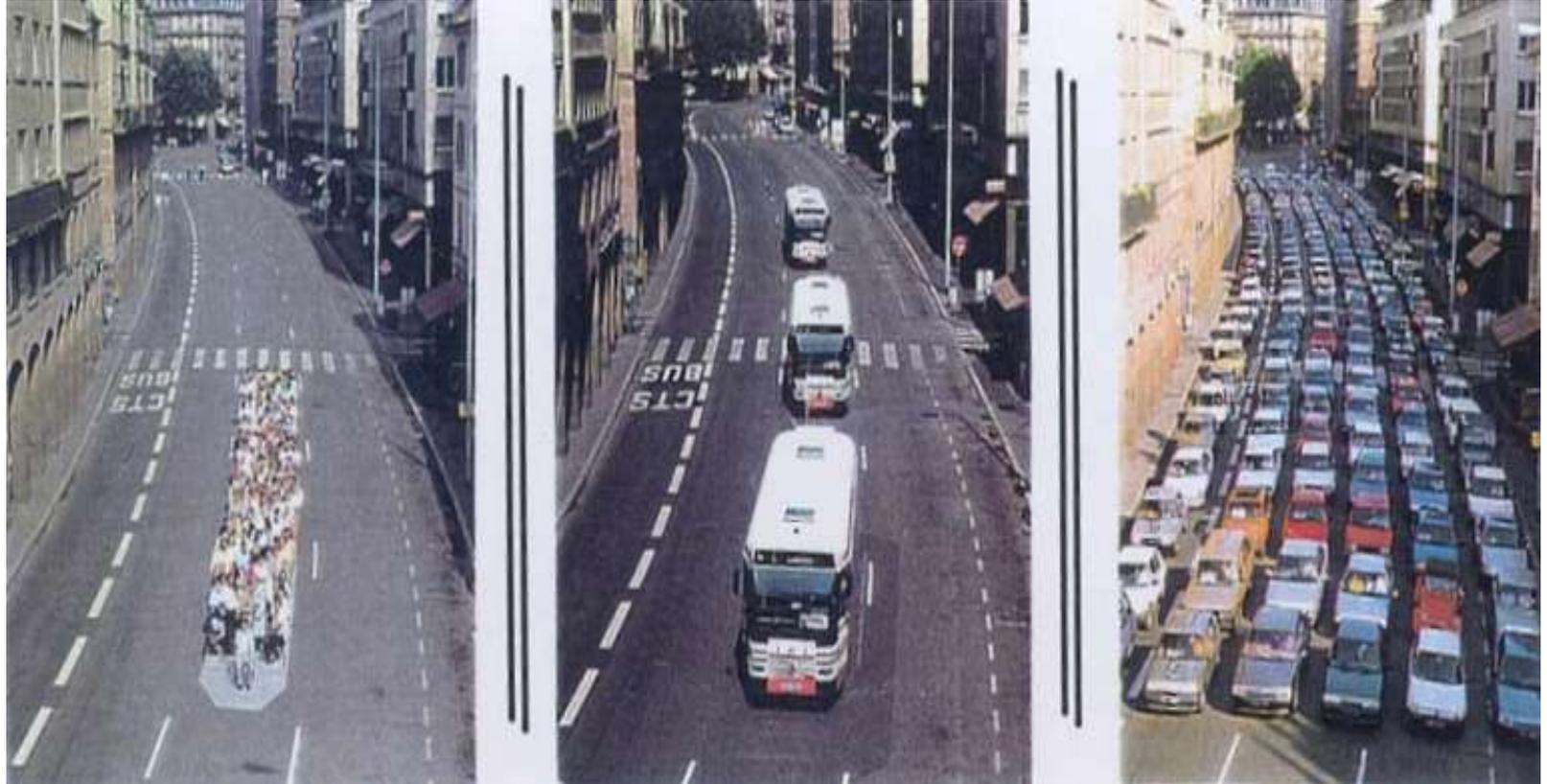
Source : MOTC Taiwan ,2017

Necessity of developing public transport system

1. The efficiency of road space use
2. Energy use efficiency
3. Environment protection (CO₂ emissions)

Necessity of developing public transport system

1. The efficiency of road space use



MRT

BUS

Private Car

Source: MOTC, Taiwan

Necessity of developing public transport system

2. Energy use efficiency

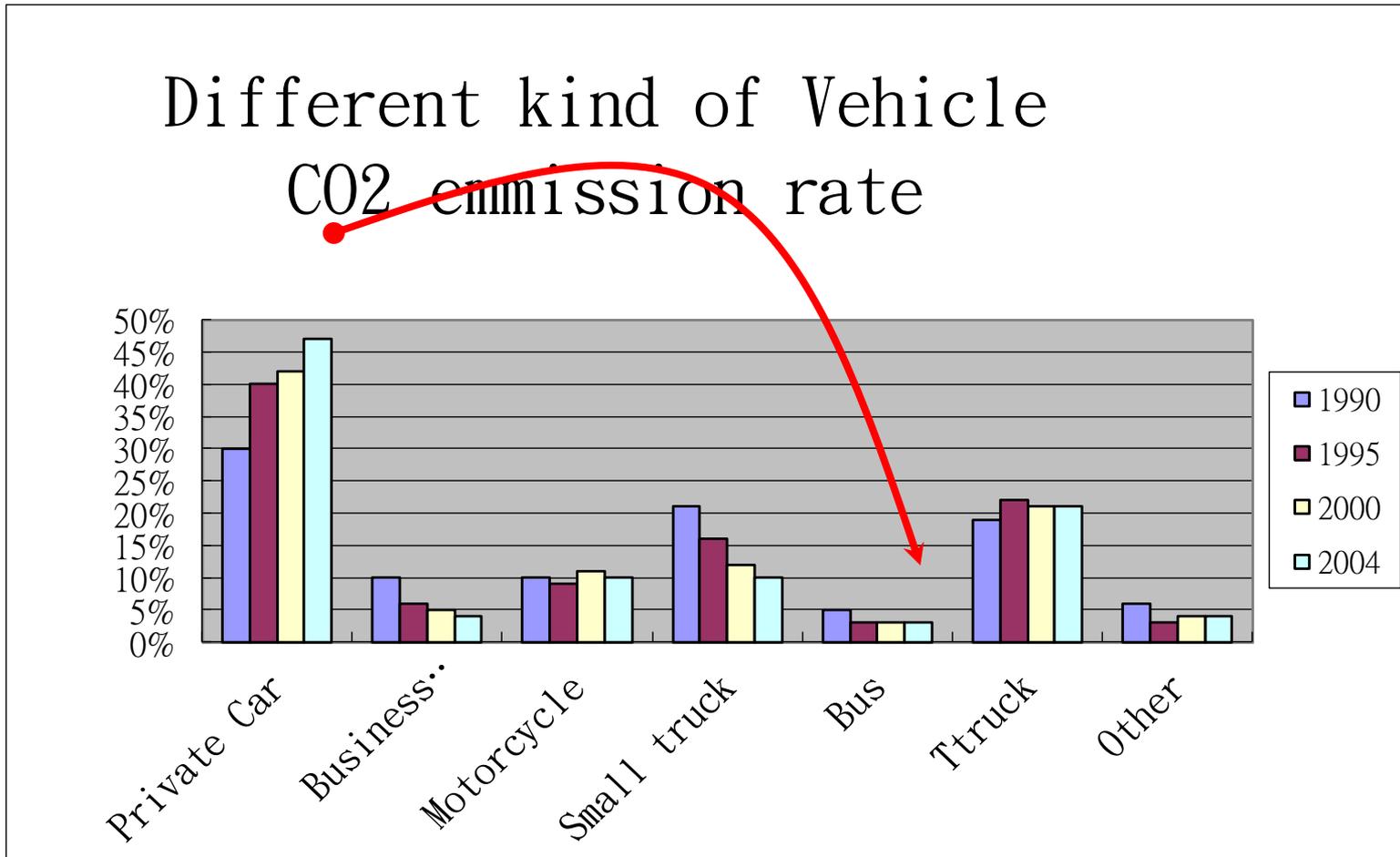
Public Transport and Private Transport Energy Efficiency Analysis Table

	Vehicle type	Fuel consumption (Km/liter)	Ride rate (Passengers/Trip)	liter/ per person- per KM	Mass Transport/ Private transport (Fuel Consumption)
Public Transport	BUS	3.3	22.89	0.0132	-
Private Transport	Private car	10.4	1.62	0.0594	1/4
	Motor cycle	27.3	1.15	0.0319	2/5

Source: MOTC, Taiwan

Necessity of developing public transport system

3. Environment protection (CO₂ emissions)



Source: MOTC, Taiwan

Experience on Smart Bus Operation in Taiwan

- The important achievement of APTS
(Advanced Public Transportation System)
- **Technology, products and solution of Smart bus
in Taiwan**
- Next-generation Smart-BUS service plan
- International Cooperation

Bus and Service in 1950 era

One driver ,one Ticket cutter / BUS



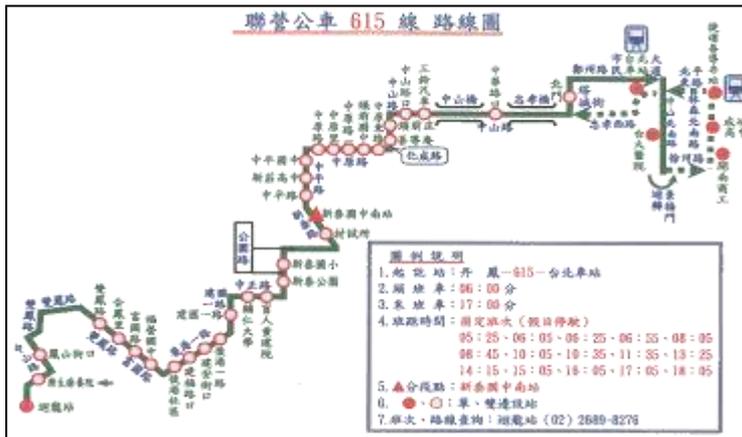
Traditional bus facilities (1980~2000)



Paper Ticket Issuer

Cash Box

Bus routes and stops information



On board commercial AD

Smart Bus Operation System

- Bus Information System(BIS)
- Bus Operation Management System (BMS)
- Advance devices and facilities

- Telematics
- Communication
- Web Service
- Control Center
- Smart Card
- SeamLess Service

- ✓ Information
- ✓ Time
- ✓ Payment
- ✓ Carrier



BIS/BMS Center



Web



Smart Phone, PDA



BUS Stop



LED Stop



LCD



BUS



OBU & Display



Route display

Smart Bus Management System



E-Plan Trip Planner



- 1. GIS Web Service
- 2. Trip Plan Algorithms
- 3. Schedule Arrangement
- 4. Tourism Information

- 5. Travel Time Prediction
- 6. Customization Info.
- 7. Multi-information
- 8. Smart Mobile Devices

- Friendly
- Sustainability
- Integrated Service



Total Solution for Smart Bus

Passenger



MOD



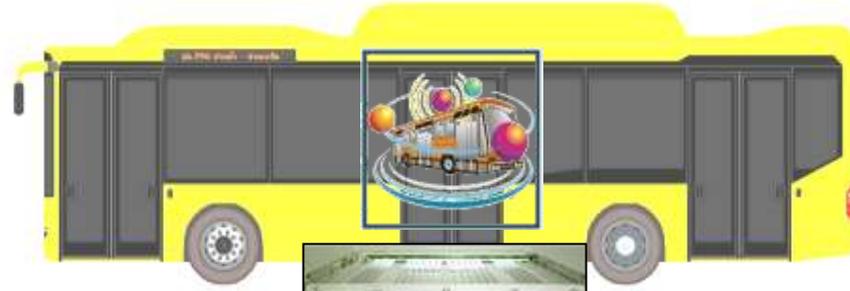
Interactive Information



E-Ticketing



Personalized Navigation



Integrated On Board Unit



CAN-BUS Interface/Adapter

Vehicle



LED Display



DVR



Digital Driving Recorders



GPS Receiver



RDS-TMC Receiver



Gyro Sensor

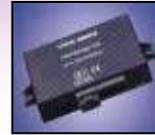
Driver



Integrated Driver Interface



Collision Alert



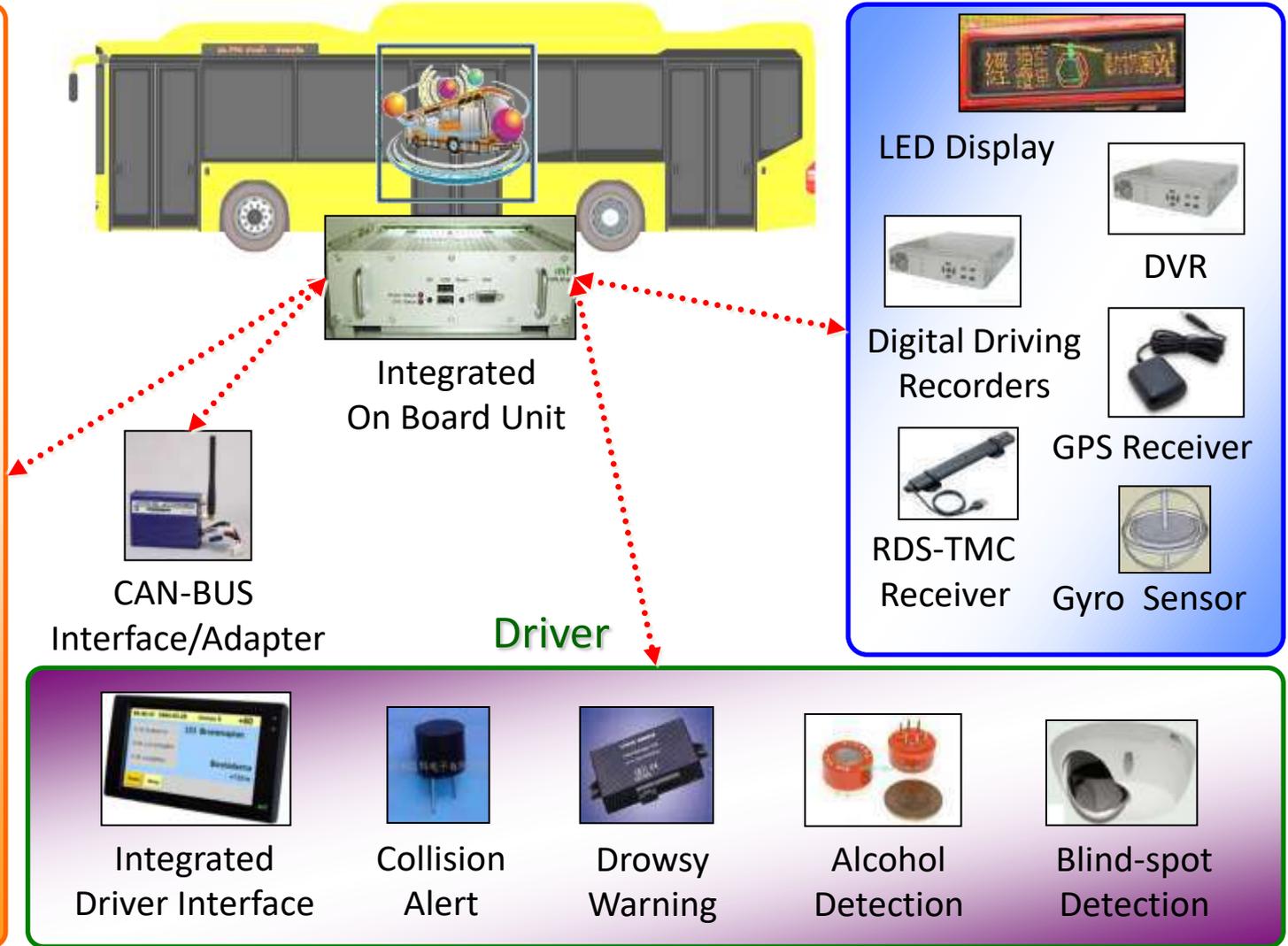
Drowsy Warning



Alcohol Detection



Blind-spot Detection



Vehicle Data Recorder



Vehicle monitor



Tachograph
analyze



API develop tools



BR 6828 Vehicle Data Recorder



GPS



4G



Time
management



Abnormal Fuel
Consumption
check



RPM
measurement



Temperature
monitor



Speed limit

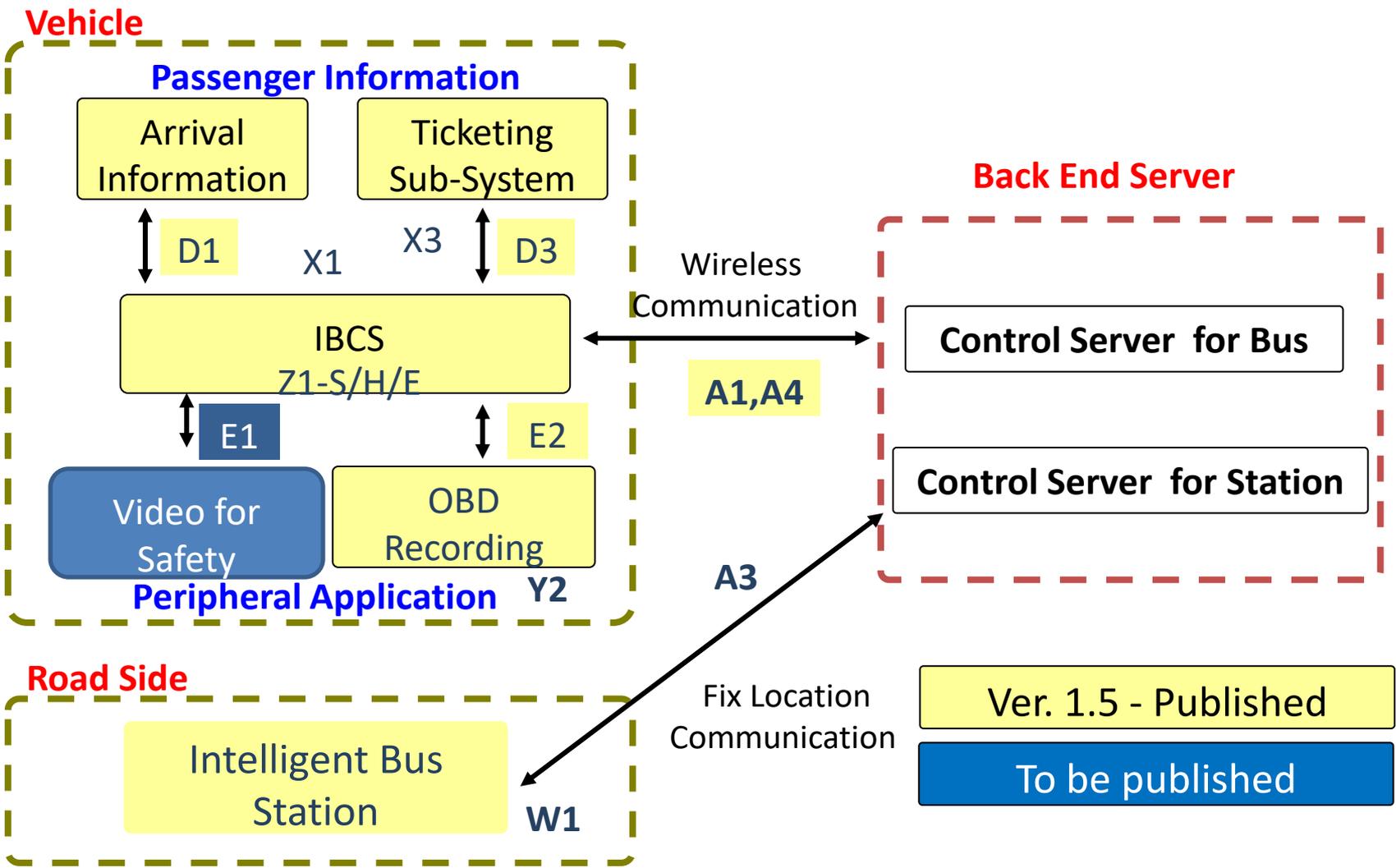


Speeder

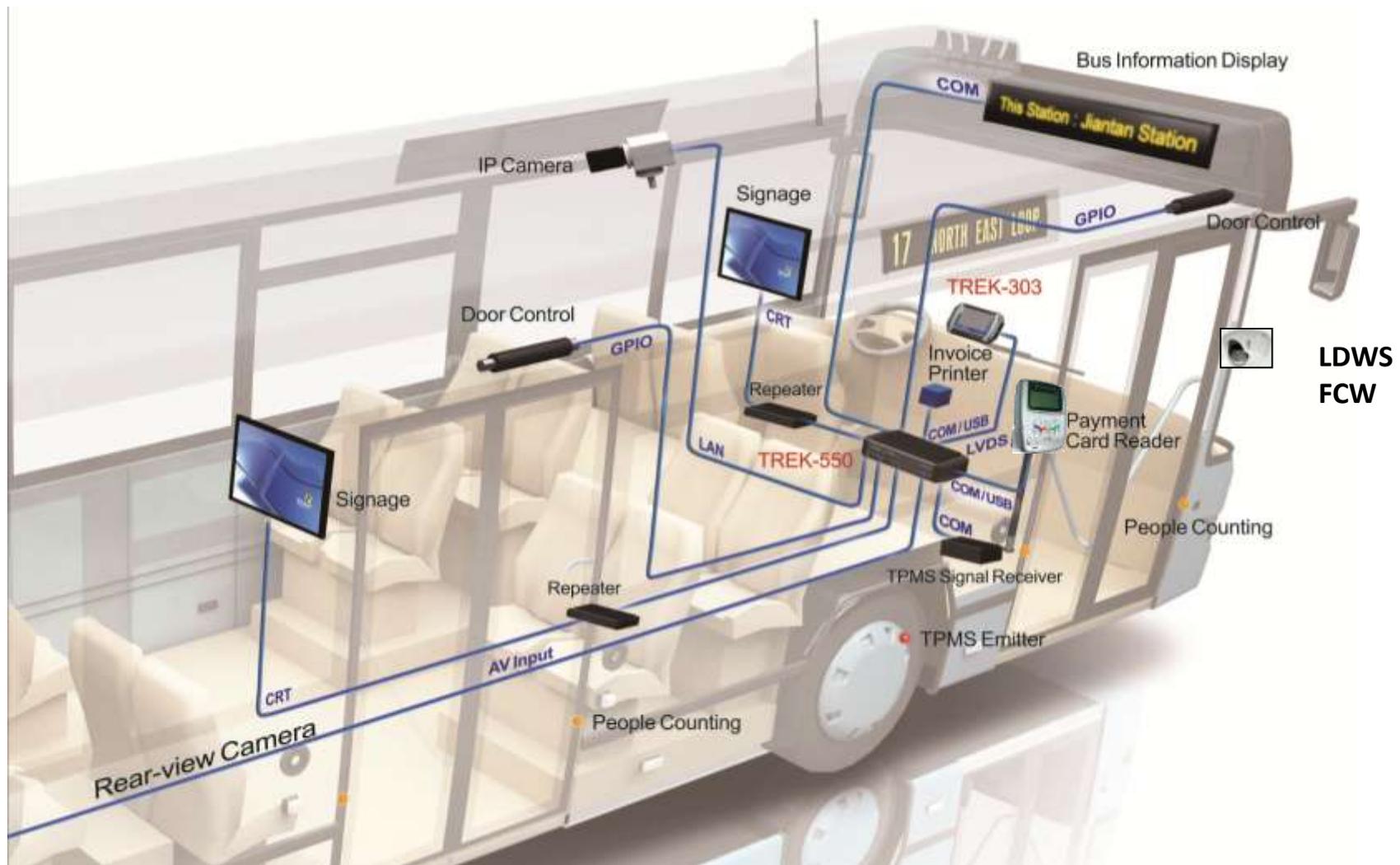


Video recorder

Smart Bus Sub-System Interface Standard



Smart Bus Facilities



Source: TTIA , 2012

Smart Bus Operation System) (2000~)



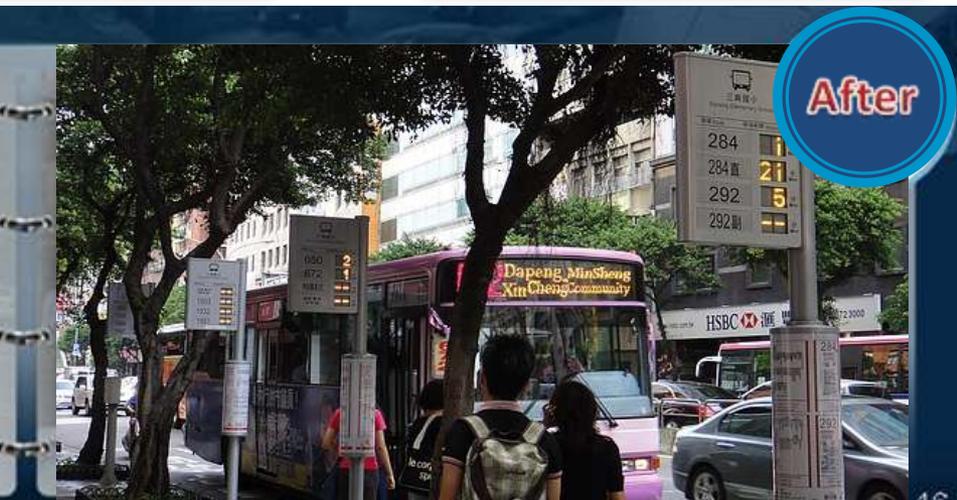
① Data Collection



② Data Processing



③ Information Supply



Before

After

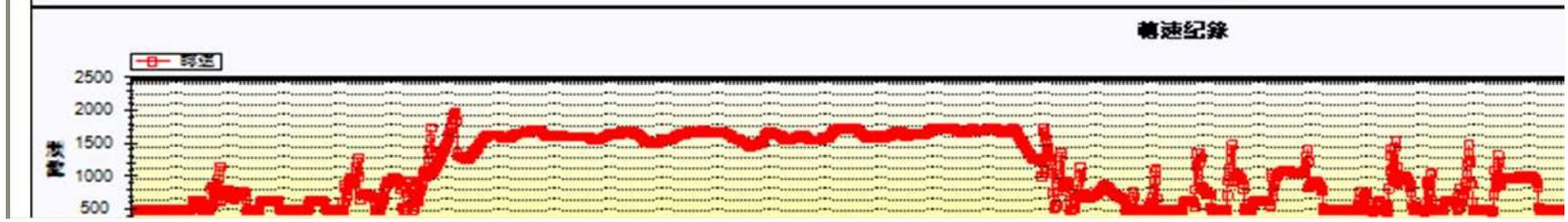
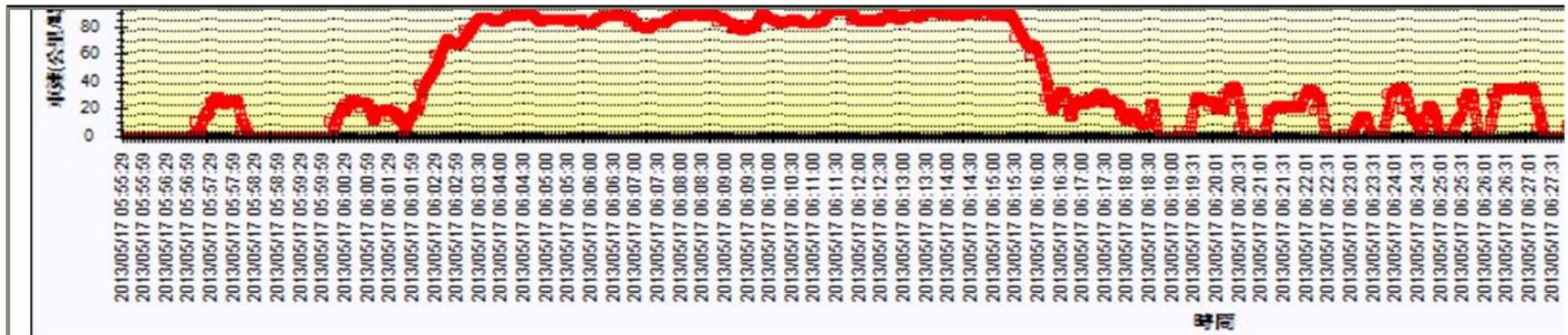
Smart Bus Operation System (2000~)



Smart Station



Driving records and behavior



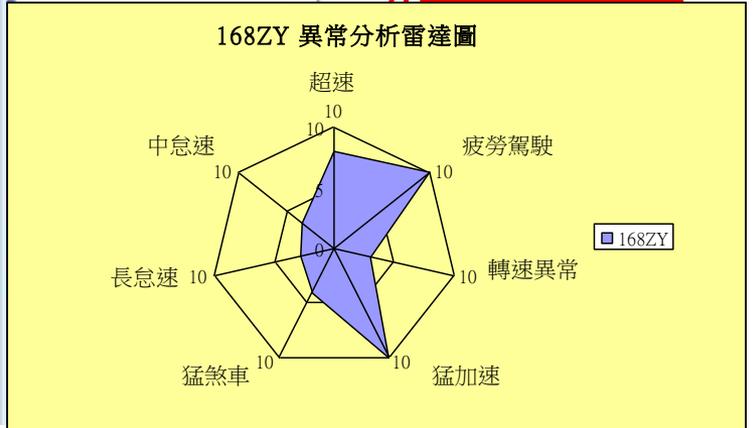
Driving Behavior Analysis System

The screenshot displays the main interface of the Driving Behavior Analysis System. It includes several key components:

- Driving status:** Located in the top-left panel, showing real-time data such as time (14:37:20), speed (10.1), and acceleration (-9.0).
- GPS Location:** A map in the center showing the vehicle's current location on a street grid.
- GPS status:** A panel below the driving status showing GPS coordinates (longitude: +120.3094, latitude: +22.6606) and direction (103.0).
- Vehicle status:** A list of sensor data on the left side, including speed, lights, engine speed, and door status.
- Video Recording:** A large window at the bottom showing a live video feed of the road ahead from the vehicle's perspective.

This interface shows the data analysis capabilities of the system. It consists of:

- Data Table:** A table with multiple columns containing recorded data points, with some rows highlighted in yellow.
- Line Graphs:** Several line graphs on the right side, each displaying different metrics over time, such as speed fluctuations or engine performance.



Radar chart of Driving behavior

Bus Information System

公路汽車客運動態資訊系統 - Windows Internet Explorer

http://web.taiwanbus.tw/eBUS/#

檔案(E) 編輯(E) 檢視(V) 我的最愛(A) 工具(T) 說明(H)

我的最愛 | Yahoo!奇摩 | 建議的網站 | 白訂連結 | 免費的 Hotmail | 網頁快訊圖庫

公路汽車客運動態資訊系統

動態監控 基本資料 營運管理 統計報表 系統管理 操作手冊 登出

歡迎! 2013-05-21 17:07:25

系統公告 動態時刻表查詢

核定班次數: 110

班次序 / 站序	1. 基隆火車站	2. 瑞光路	3. 臺北花市	4. 仁寶大樓	5. 治馨新村	6. 捷運劍南路站	駕駛	發車狀態稽核	歷史軌跡	到離站紀錄
第1班車	0600	0635	0640	0645	0650	0655				
679-FG	0600	0619	0621	0623	0626	0629	游明進	準點	查看	查看
第2班車	0605	0640	0645	0650	0655	0700				
687-FG	0605	0626	0628	0630	0632	0635	李後豐	準點	查看	查看
第3班車	0612	0647	0652	0657	0702	0707				
682-FG	0613	0631	0634	0635	0638	0642	劉旭凱	準點	查看	查看
第4班車	0620	0655	0700	0705	0710	0715				

BUS arrival rate of on time

- 86.87% (2009)
- 88.48% (2010)
- 91.69% (2011)
- 95.01% (2018)

Count of inquiry from passengers



Smart Card Ticketing System in Taiwan

2000~ 2010

Five cards ⇔ Five Devices ⇔
Five CPS ⇔ Five Settle system



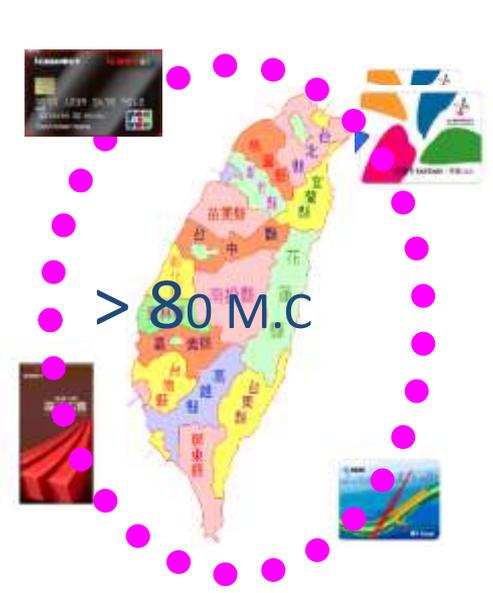
2011 ~2016

Four cards ⇔ One Device ⇔
One CPS ⇔ Four Settle system



2017 ~ Multi-Card/Multi-Payment(Smart phone.)

⇔ One Device ⇔
One CPS ⇔ Multi-Four Settle system



Smart Card Market Share in Taiwan

Smart Card Issuer	Volume of Circulation (10,000 Cards)	Transaction amount(2018.2) (0.1 Billion NT\$)	Deposit amount (~ 2018.2) (0.1 Billion NT\$)
EasyCard	6,290.93	45.35	62.22
iPASS	1,389.36	5.89	9.65
iCASH	1,732.62	9.81	11.20
Happycash	155.18	0.30	0.58

Source : Smart Card Issuers Taiwan ,2018

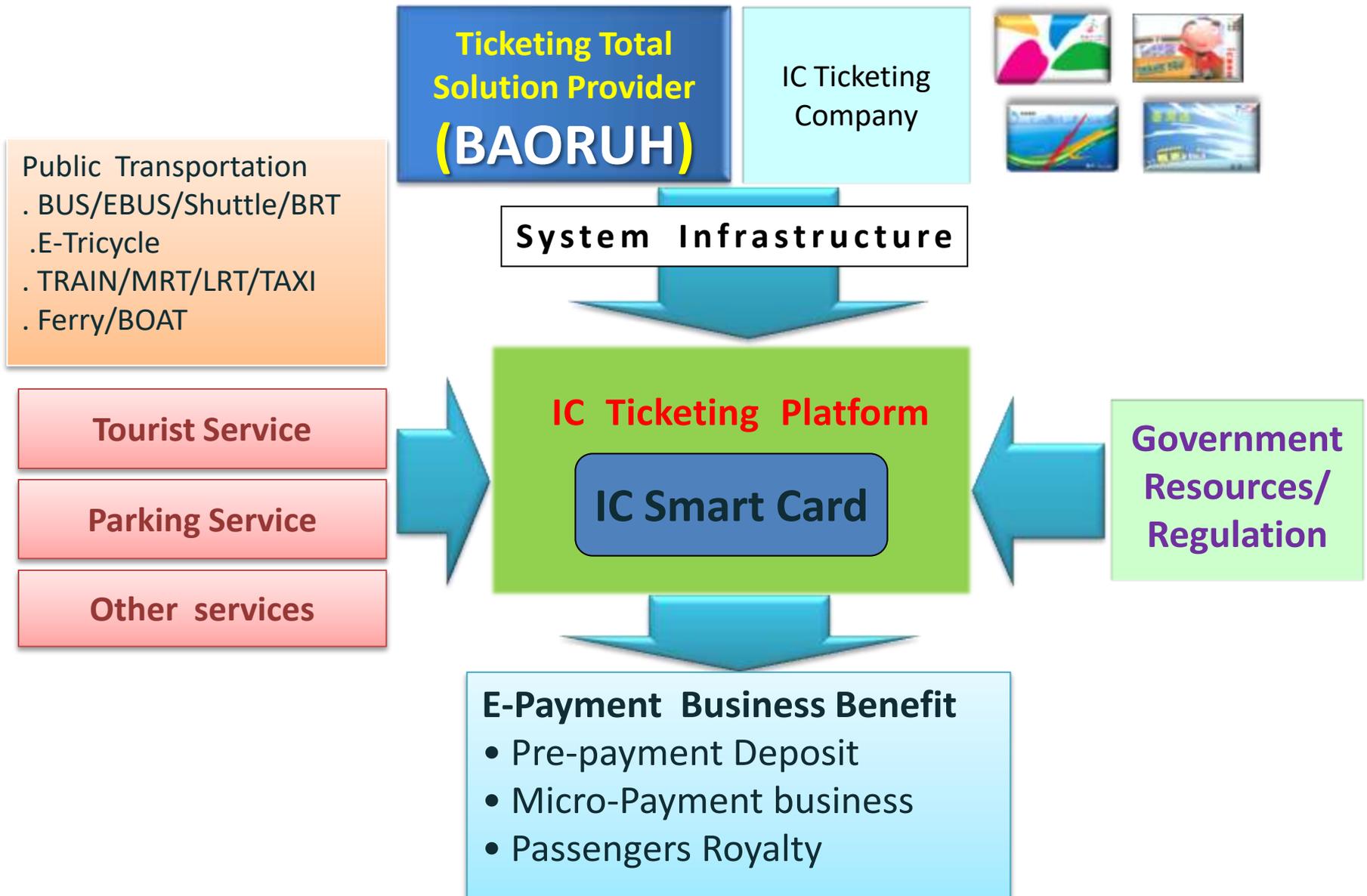
Circulation and Transactions of Easy Card

Unit: 1,000 times; NT\$1,000

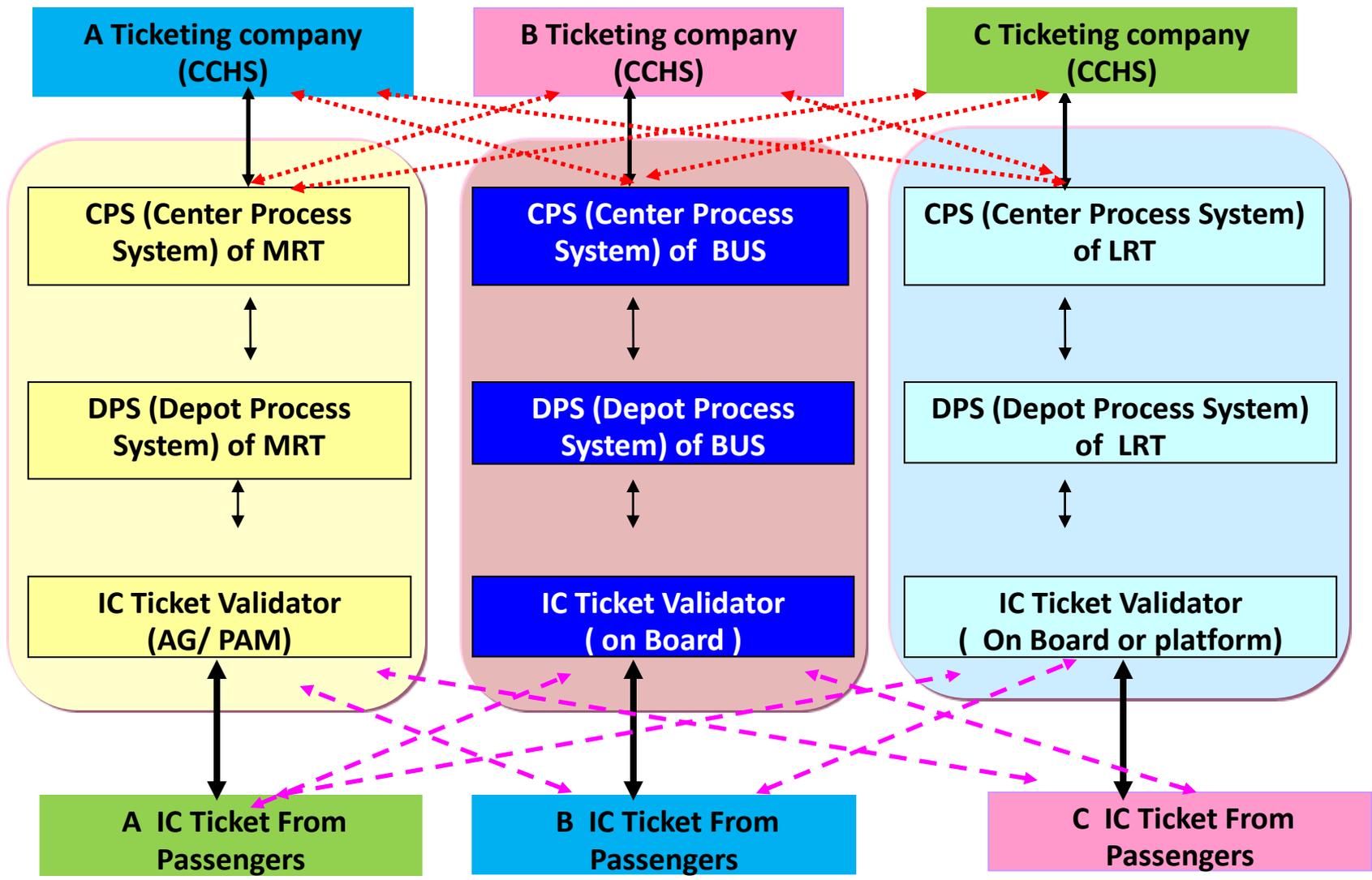
年(月) 別 Year (Month)	發卡量 (張) ① Volume of Circulation (Cards)	累計發卡量 (張) ② Accumulated Volume of Circulation (Cards)	交 易 量 ③		
			合 計 Total		公 Bus
			筆 數 Transaction	交易金額 Amount	筆 數 Transaction
96年 2007	3,044,054	11,587,294	956,856	15,086,757	580,192
97年 2008	3,504,473	15,091,767	1,039,549	16,359,516	627,235
98年 2009	2,772,033	17,863,800	1,086,808	16,928,972	657,447
99年 2010	5,388,330	23,252,130	1,168,564	18,407,821	693,455
100年 2011	5,761,262	29,013,392	1,245,603	20,148,060	709,606
101年 2012	6,927,211	35,940,603	1,297,858	21,469,830	722,966
102年 2013	7,132,263	43,072,866	1,340,270	22,372,072	731,085
103年 2014	6,811,117	49,883,983	1,385,186	23,403,296	728,801
104年 2015	7,634,788	57,518,771	1,397,949	24,077,558	702,442
105年 2016	6,989,611	64,508,382	1,404,334	24,230,988	698,723
106年 2017	7,931,646	72,440,028	1,360,139	23,135,017	682,828

Source : Smart Card Issuer Taiwan ,2018

Smart Card Ticketing Business



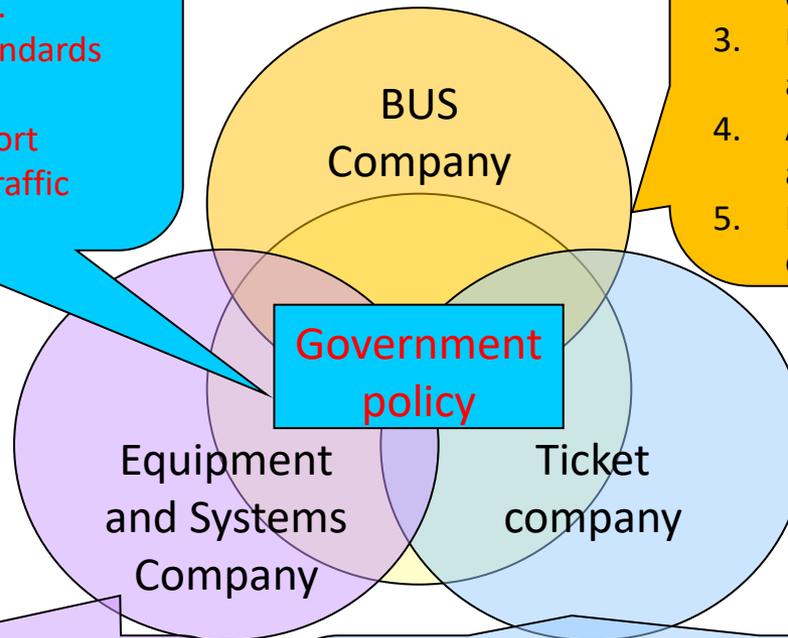
Multi-IC Card System and Data flow



Power and responsibility of the organization of e-payment systems

1. Provide electronic ticket construction, promotion policies and incentives.
2. Formulate relevant standards and processes.
3. Promote public transport policies and increase traffic volume.

1. Cooperate with government policies and their own operational strategies.
2. Assist in the construction of an electronic ticket system.
3. Use and transport related equipment and systems.
4. Additional electronic ticket consumer access.
5. Increase the source and service items of different card issuers.



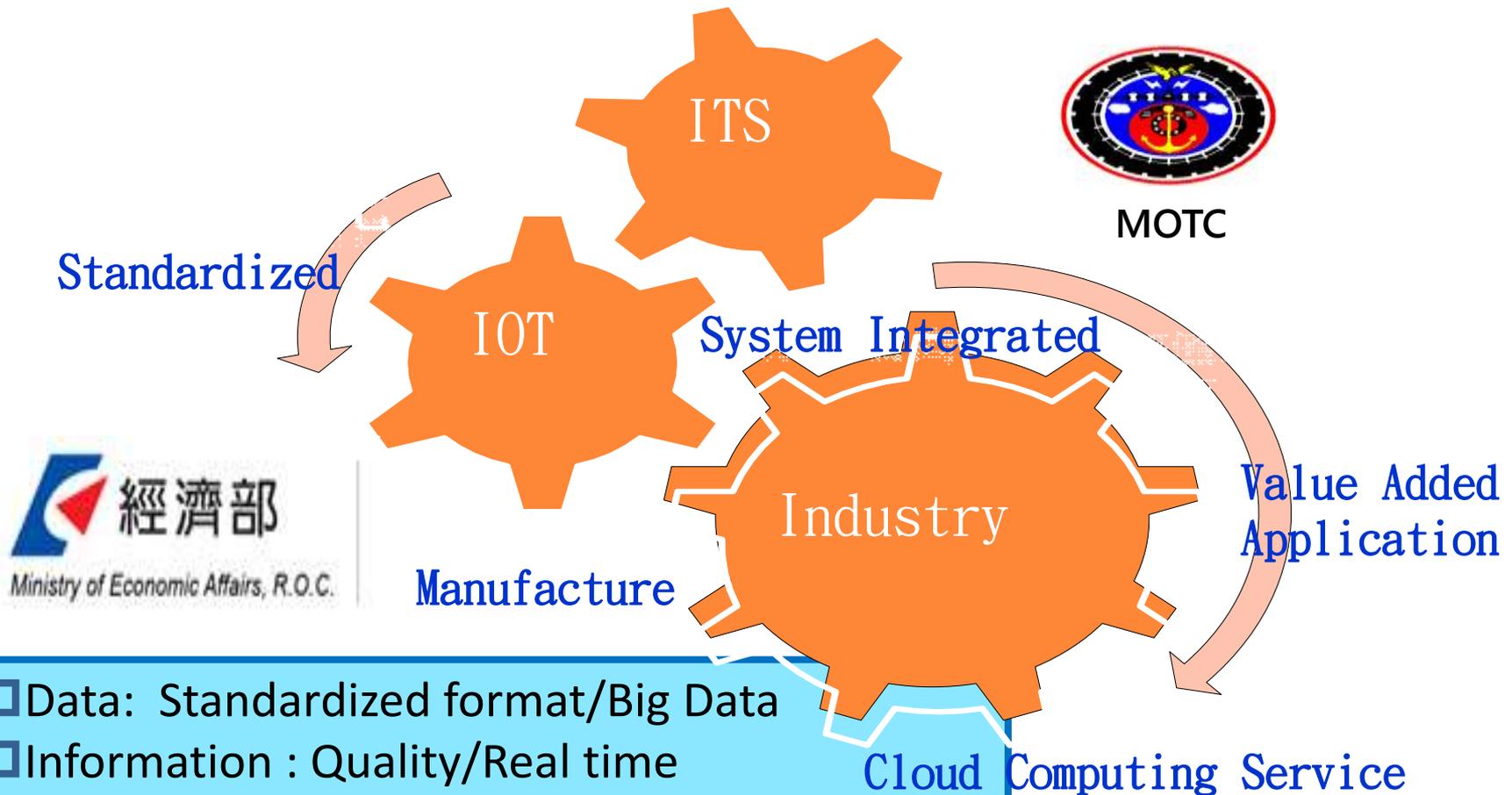
1. Responsible for the construction of passenger ticketing system.
2. Integrate relevant trading systems for passenger transport operators, access providers and ticketing operators.
3. Ensure the normal operation of equipment, systems and transactions

1. Cooperate with government policies and their own operational strategies.
2. Increase the electronic ticket consumer access.
3. Assist in the construction of an electronic ticketing system.
4. Assist operators and governments in establishing third-party ticket transaction authentication and reporting functions.
5. Ensuring the transaction rights between cardholders and the passenger transport industry.

Experience on Smart Bus Operation in Taiwan

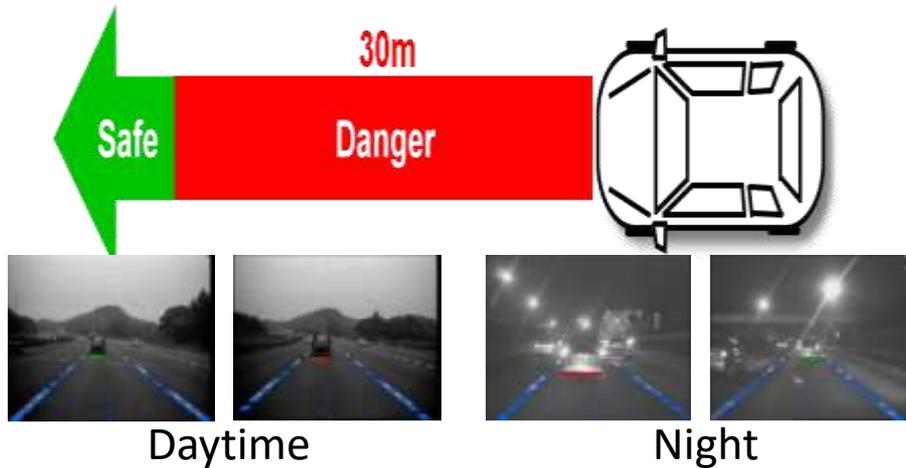
- The important achievement of APTS
(Advanced Public Transportation System)
- Technology, products and solution of Smart bus in Taiwan
- **Next-generation Smart-BUS service plan**
- International Cooperation

Future Plan of Smart BUS in Taiwan

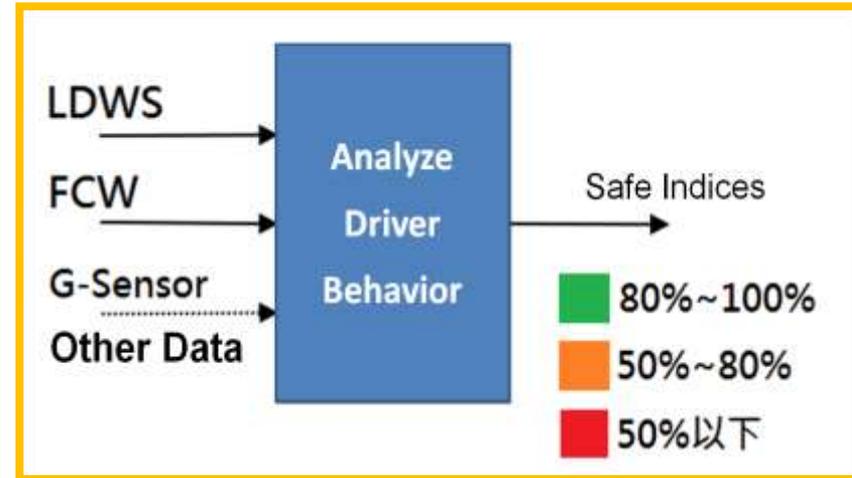


- ❑ Data: Standardized format/Big Data
- ❑ Information : Quality/Real time
- ❑ Device : Standardized
- ❑ System: Integrated/Enhanced/Cloud Computing
- ❑ Application : Domain Knowledge/Open Data
- ❑ Service : Cloud Computing / Seamless

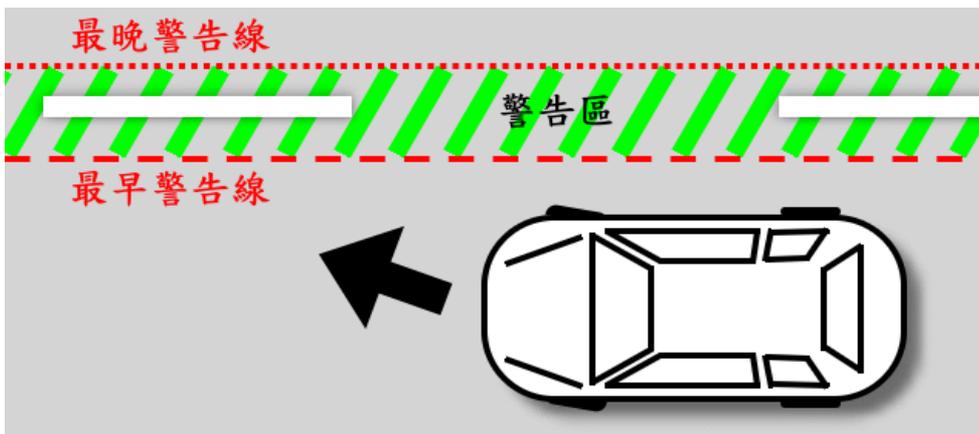
Advanced Driver Assistance Systems (ADAS)



Front Collision Warning System



Real Time Driver Behavior Analyst



Land Departure Warning System (LDWS)

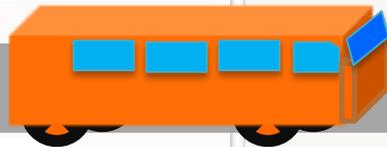


Accident prevention and rescue system

Before
(Warming)

Happening
(E-Call)

Playback



Integrated Smart Bus of On Board Solution



Integrated Smart Bus of Information and Management Solution

台北中港中經
Rout LED Display

Bus
中港新城
Arriving Information

GPS

4G

WiFi

IC Card validator

On Board

Bus Information Control Center

4G

WiFi

Cloud Computing

IC Ticket

ATVM

Station/ Bus Stop

ERP or MIS

Salary

Maintenance

Finance

Auditing

Management



**Taiwan will Build EV-BUS
Transportation System by
2030
(15,000 Buses)**

EV industry Development Strategies

Taiwan Government released EV Development Action Plans in 2010 to speed up the development of EV industry.



Taiwan Driverless Cars Testing Sites



Taoyuan
Agriculture Expo/
Hutoushan
innovation base

Shilin Technology Park

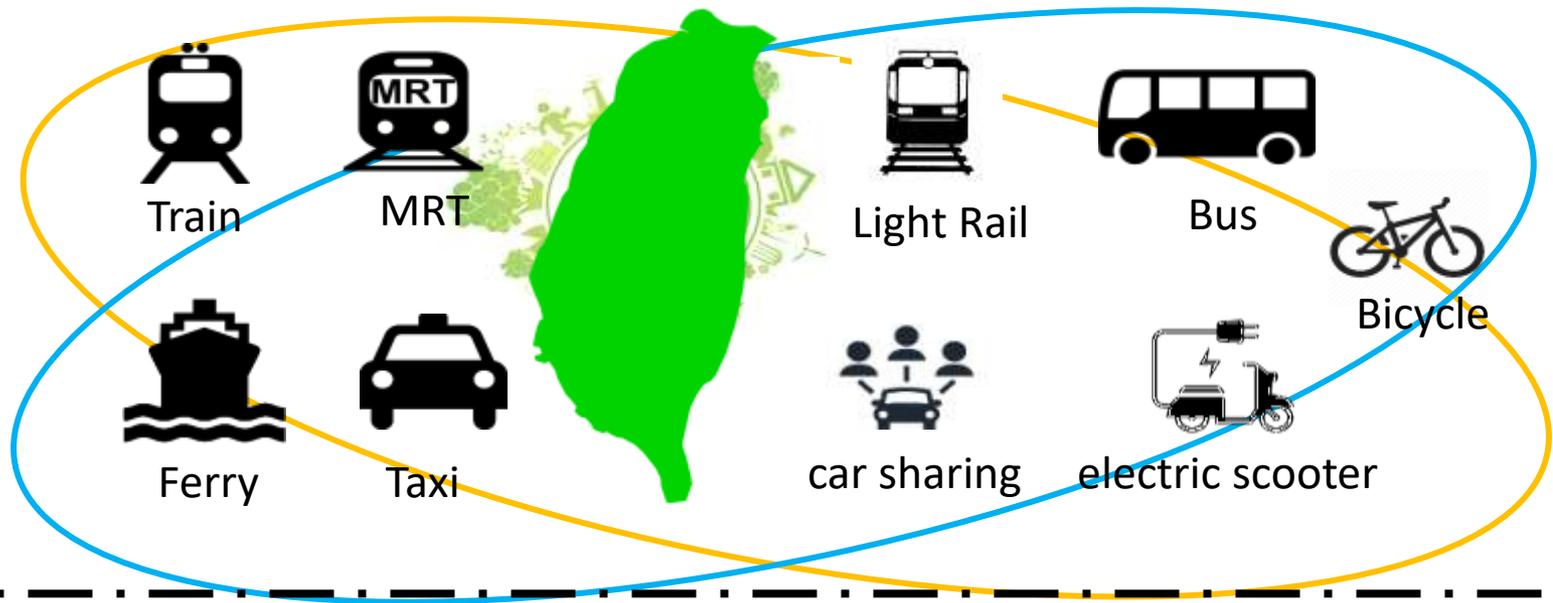
Taichung Gateway

Shalun Green Energy
Science City

Hamasing The Pier-2
Art Center



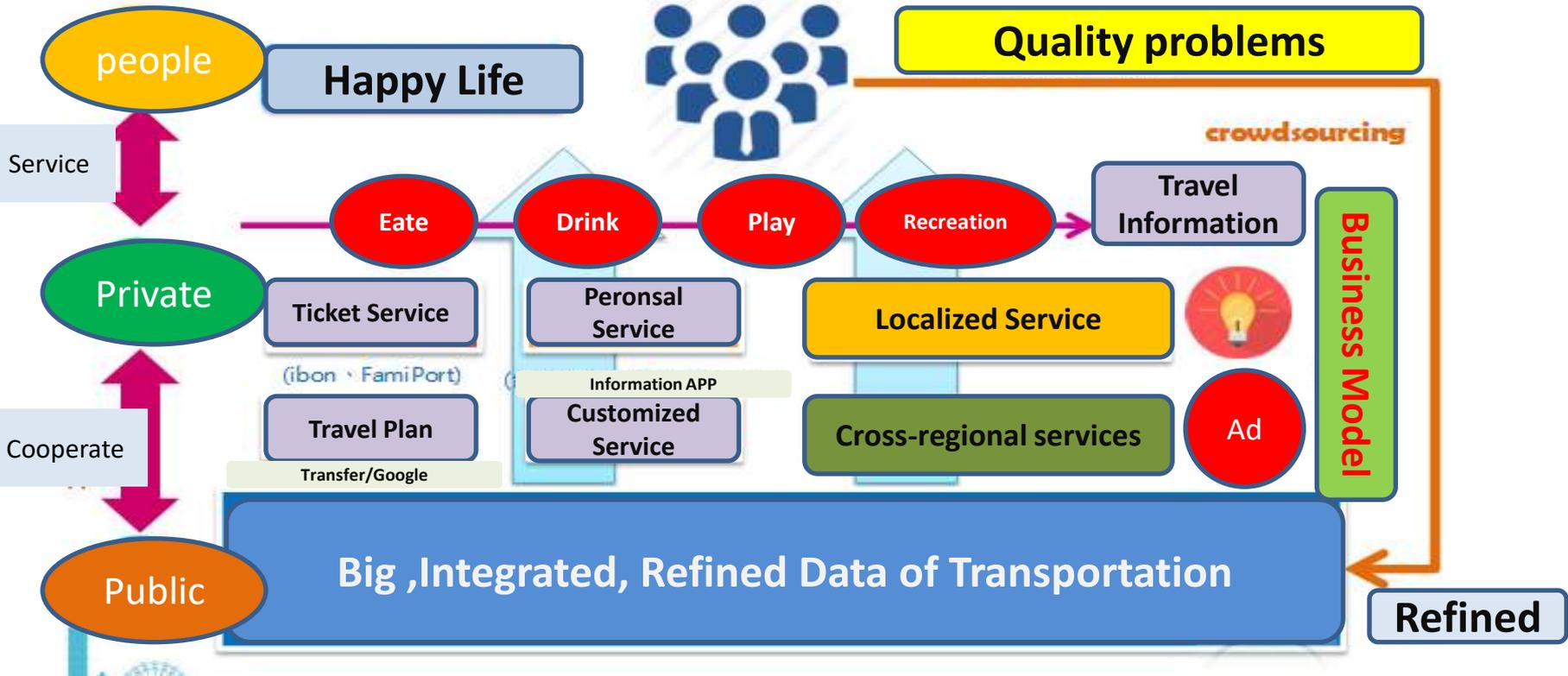
Taiwan MaaS Plan (Mobility as a Service)



MaaS (Mobility as a Service)

Smart Transport for Smart City and Easy Life

PPP Service Model



Experience on Smart Bus Operation in Taiwan

- The important achievement of APTS
(Advanced Public Transportation System)
- Technology, products and solution of Smart bus in Taiwan
- Next-generation Smart-BUS service plan
- **International Cooperation**

Taiwan : Hub in Asia-Pacific

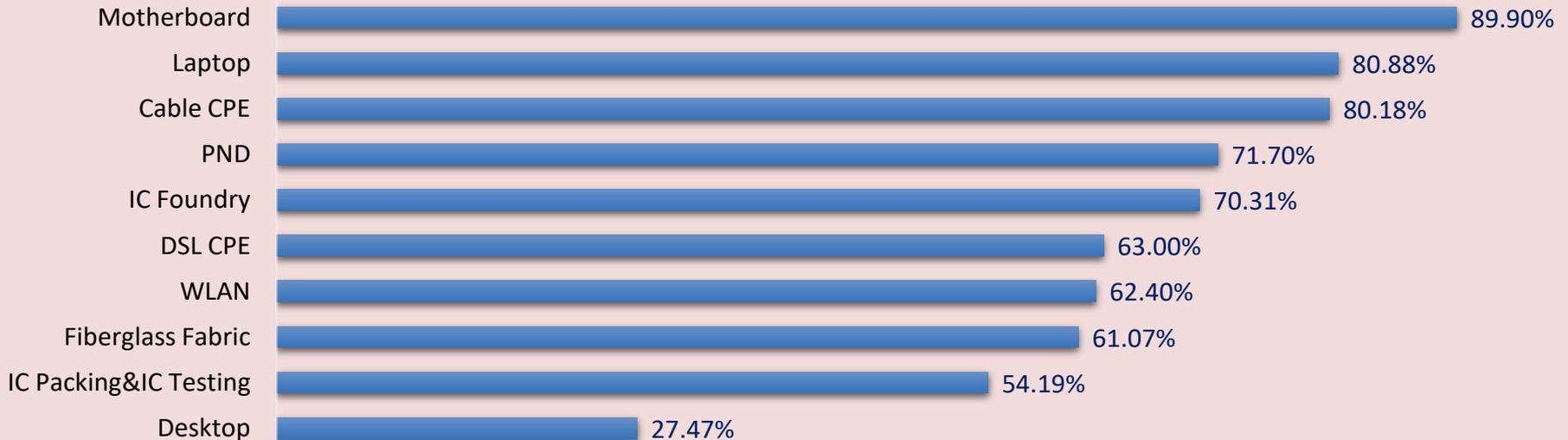
Geographically, Taiwan is located at the heart of the Asia-Pacific region, which puts it in an advantageous position to make use of global production resources and marketplace.

Taiwan Industry provides quality products and services, which enable the development of international brands. Taiwan also has easy access to Asia's production resources, which makes rapid achievement of mass production possible. With it's a superior innovation and R&D base, Taiwan's abundant production experience, capability to commercialize innovative products rapidly and its global deployment, Taiwan become a Hub of Hi-Tech products & Services in the Asia-Pacific Region.

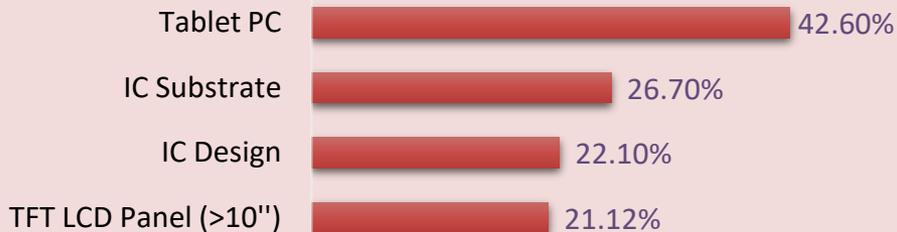


Taiwan has Competitive Advantage in ICT Products

No.1



No.2



No.3



Conclusion



- Production
- Product
- Solution
- Service

Global Partners

Policy/Standard/Field Trial
Cloud Computing



- Domain Knowledge
- Embedded/Tech./Module...
- Prototype
- System and Integration

Thank you for kind attention



JY@BAORUH.COM.TW
Baoruh Electronics Co., Ltd
Jih Yao Huang Vice President
+886-7-3472000
WWW.BAORUH.COM