

THI's BRT and APTS Developments



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Outline of Topics

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Conclusions

What is BRT? - Think rail, use buses

◆ **Bus Rapid Transit (BRT) is a flexible, high performance rapid transit mode that uses a variety of innovative system designs, technologies, controls and management to achieve following main objectives :**

➤ **Reducing travel times**

- Running way travel time
- Station dwell time
- Wait time ∨ transfer time

➤ **Enhancing the travel experience**

- Accessibility
- Passenger comfort
- Passenger safety and security

➤ **Making service more reliable**

- Running way reliability
- Station dwell reliability
- Approaching time reliability

➤ **Making systems more efficient**

- High capacity
- Enhanced system management

Major Elements of BRT

Lane priority



BRT Objectives

- Reducing travel times
- Making service more reliable
- Enhancing the travel experience
- Making systems more efficient

Fare collection



Vehicle design



Station design



ITS (APTS)

Major Elements of BRT

◆ Lane priority

- Curbside
- Median
- Contraflow
- Elevated

Las Vegas, USA



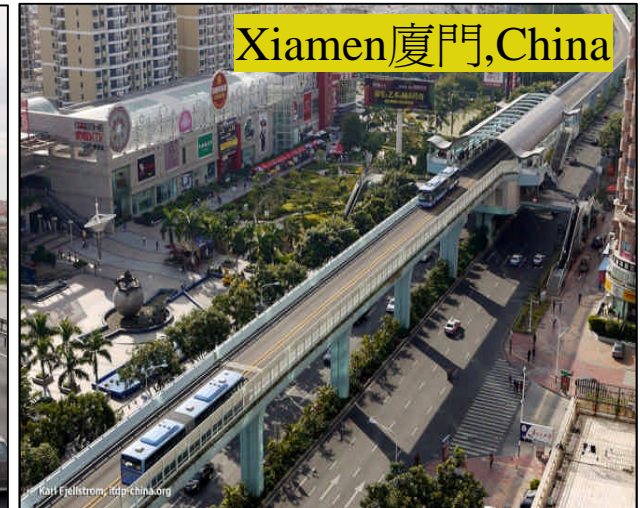
Lyon, France



Istanbul, Turkey



Xiamen 廈門, China



Major Elements of BRT

◆ Vehicle design

- Stylish vehicles
- High passenger capacity
- Easy to board and alight
- Environmentally compatible
- Cleaner propulsion power(diesel fuel/hybrid electric-diesel/compressed natural gas ...)



Major Elements of BRT

◆ Station design

- Attractive and safe
- Enhanced lighting
- Public artwork
- Level boarding/alighting
- Solar power



Major Elements of BRT

◆ Fare Collection

- Station-based electronic fare payment
- Vehicle-based electronic fare payment



Major Elements of BRT

◆ ITS/APTS

- Transit signal priority(TSP)
- Real-time passenger information system
 - at Station/Stop
 - on/for Person
 - on Vehicle
- Automated vehicle location(AVL)
- Safety and security system
- Vehicle guidance and control(Optical/curb guidance)

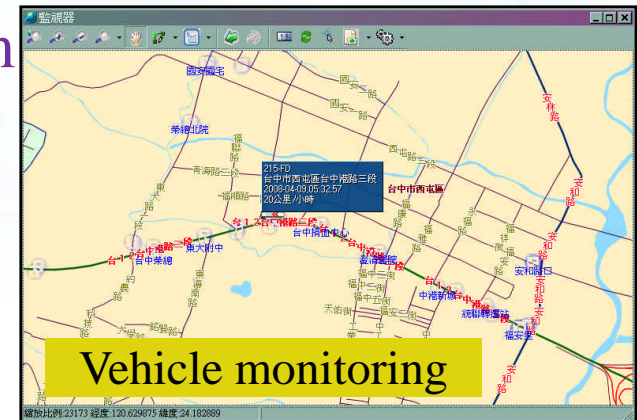


Major Elements of BRT

◆ ITS/APTS (cont.)

➤ Advanced Operations Management System

- Automated scheduling/dispatch system
- Advanced communication system
- Vehicle mechanical monitoring
- Driver information system



Monitor

中斷連線 顯示地圖 地圖管理 返回資料管理 [F12] 幫助

車輪編號

車牌ID	日期時間	位置
106-FC	2008/4/9 上午...	龍井
157-F...	2008/4/9 上午...	台中市東區
161-FC	2008/4/9 上午...	龍井
147-F...	2008/4/9 上午...	台中市東區
156-F...	2008/4/9 上午...	台中市東區
FP-600	2008/4/9 上午...	烏日
FP-606	2008/4/9 上午...	烏日
FP-436	2008/4/9 上午...	烏日

事件清單 (按時間)

車牌ID	日期時間	位置	R/un
106-FC	2008/4/9 上午...	台中市西...	
068-FC	2008/4/9 上午...	大雅中清路	9
163-FC	2008/4/9 上午...	大雅	9
FP-600	2008/4/9 上午...	烏日	33
157-FC-2	2008/4/9 上午...	台中市...	41
100-FC	2008/4/9 上午...	台中市西...	
167-FC	2008/4/9 上午...	台中市北...	15

Event alarm and statistics

車輪編號

車牌ID	日期時間	位置	數量
163-FC	2008/4/9 上午...	台中市北...	1
163-FC	2008/4/9 上午...	台中市北...	1
150-FC	2008/4/9 上午...	台中市東區	1
163-FC	2008/4/9 上午...	大雅中清路	1
163-FC	2008/4/9 上午...	大雅中清...	1
163-FC	2008/4/9 上午...	大雅中清...	1

Fleet schedule and variance analysis

1

BRT and APTS



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THI's Case Study

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Conclusions

ITS/APTS Planning for Taichung BRT

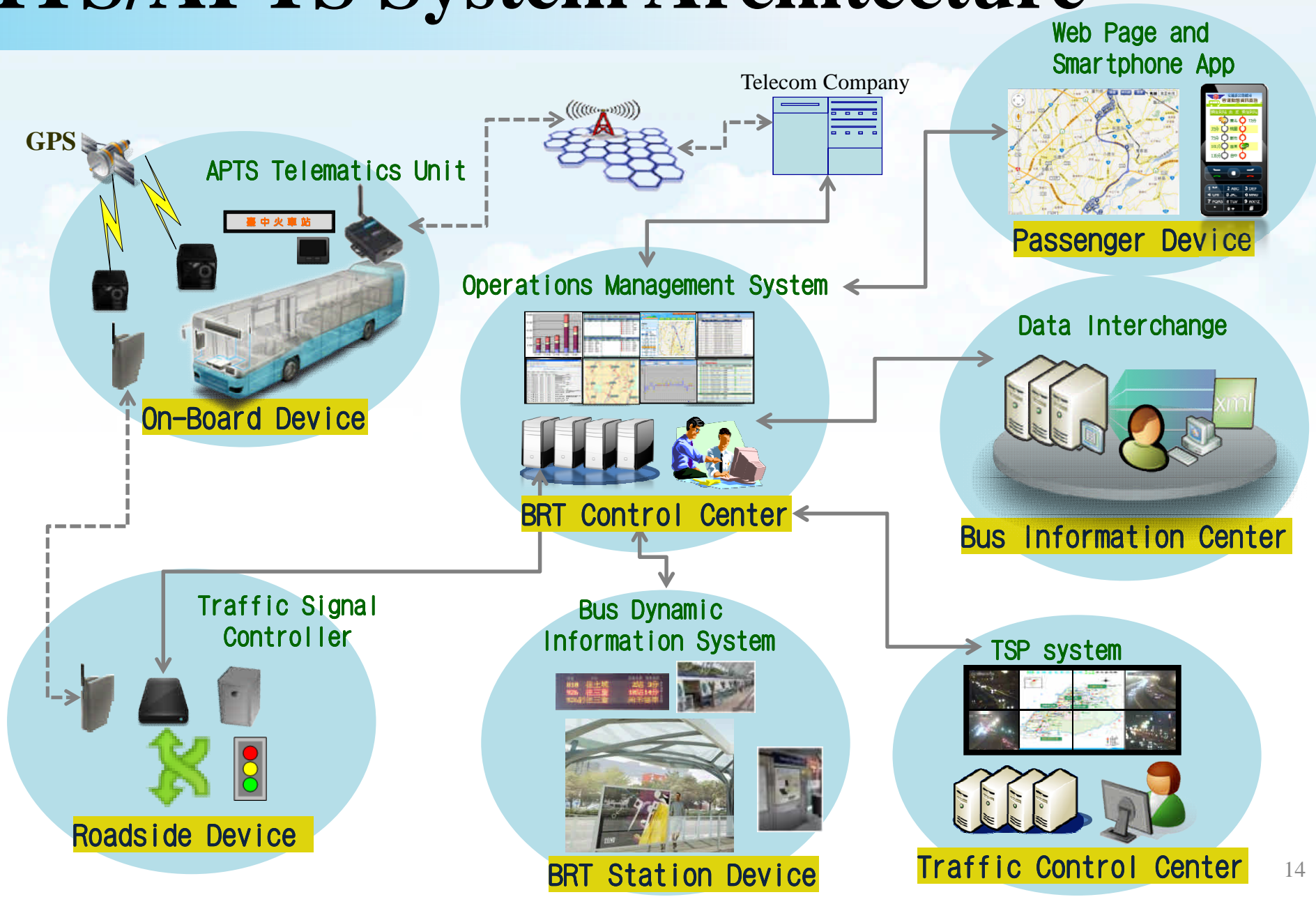
Goals

- To improve precise departure/arrival times
- To stabilize the scheduled headways
- To enhance the vehicle speed
- To make operational and customer services more intelligent and reliable

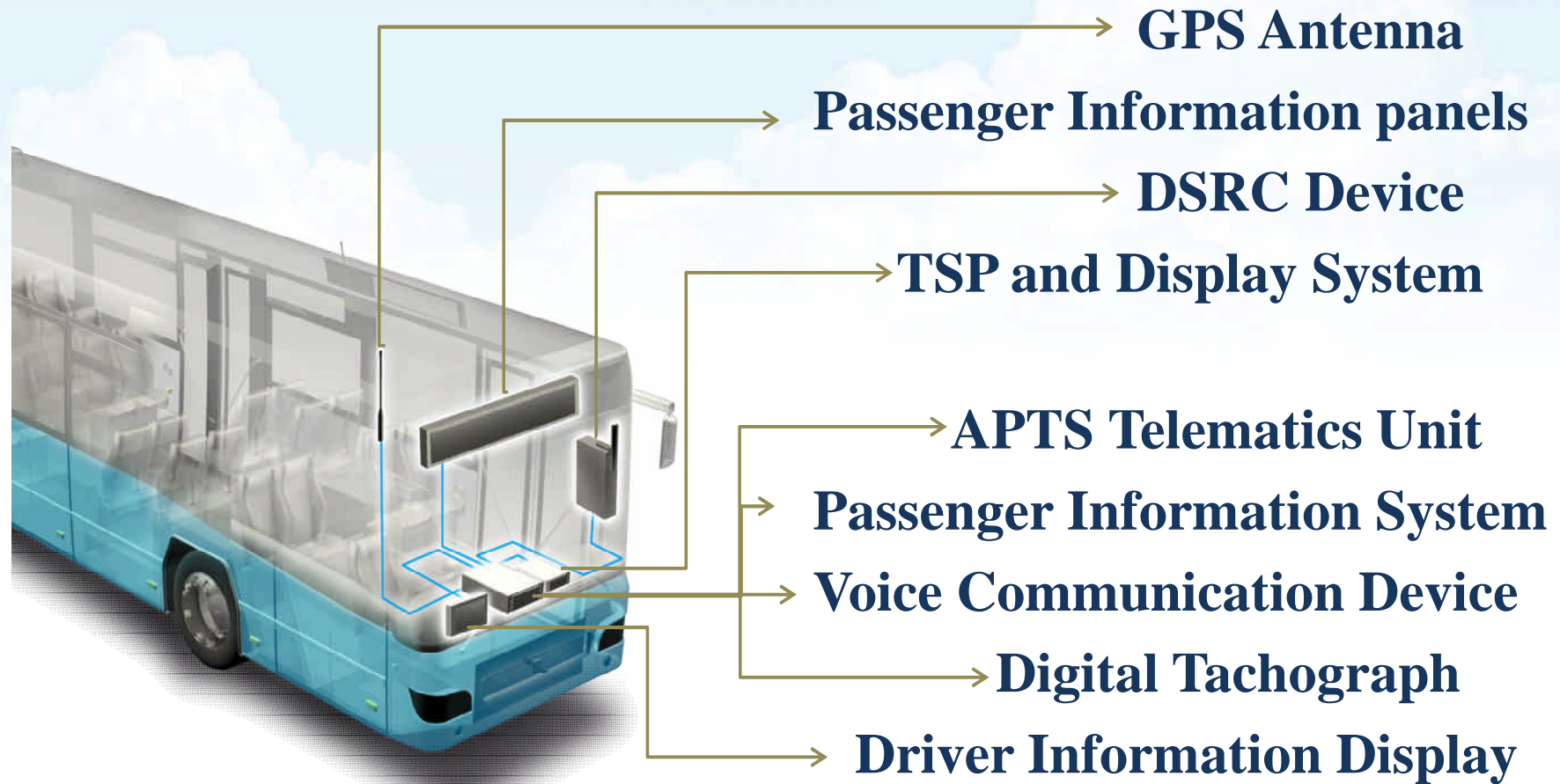
Strategies

- Driver information system
- Transit signal priority(TSP)
- Passenger information system
- Advanced operations management system

ITS/APTS System Architecture



Vehicle On-Board Devices



Note: Transit Signal Priority(TSP)

Driver Information System(1/2)

- ◆ **Traffic signal green-phase remaining time display**
 - To provide the remaining time of downstream intersection green light for drivers
 - Data transmission method
 - The intersection IPC calculates the green-phase remaining time of traffic signal, then transmit this data to on-board display via DSRC devices



Driver Information System(2/2)

◆ The BRT headways display

- To assist drivers in keeping a scheduled headway
- To show the headway in the numbers of stations away from on the display to continuously monitor the BRT in front and behind

◆ Station departure time countdown display

- For the effective control of the BRT traveling in a green-phase bandwidth, each station departure time countdown information will be displayed to remind drivers of the departure time



Roadside Devices

◆ Roadside DSRC device

- To receive TSP request
- To broadcast the green-phase remaining time

◆ IPC (Industrial Personal Computer)

- To receive TSP messages from different vehicle's on-board DSRC devices
- To estimate the proper signal phase and timing, then send these messages to traffic signal controller

◆ Traffic Signal Controller

- To receive IPC priority messages and perform TSP strategies

Design of Transit Signal Priority(1/2)

Purposes

- To minimize the vehicle stops and delays at intersections of network

Strategies

before
driving

- To plan the optimal BRT schedule
- To plan the optimal Signal Pretimed plan

during
driving

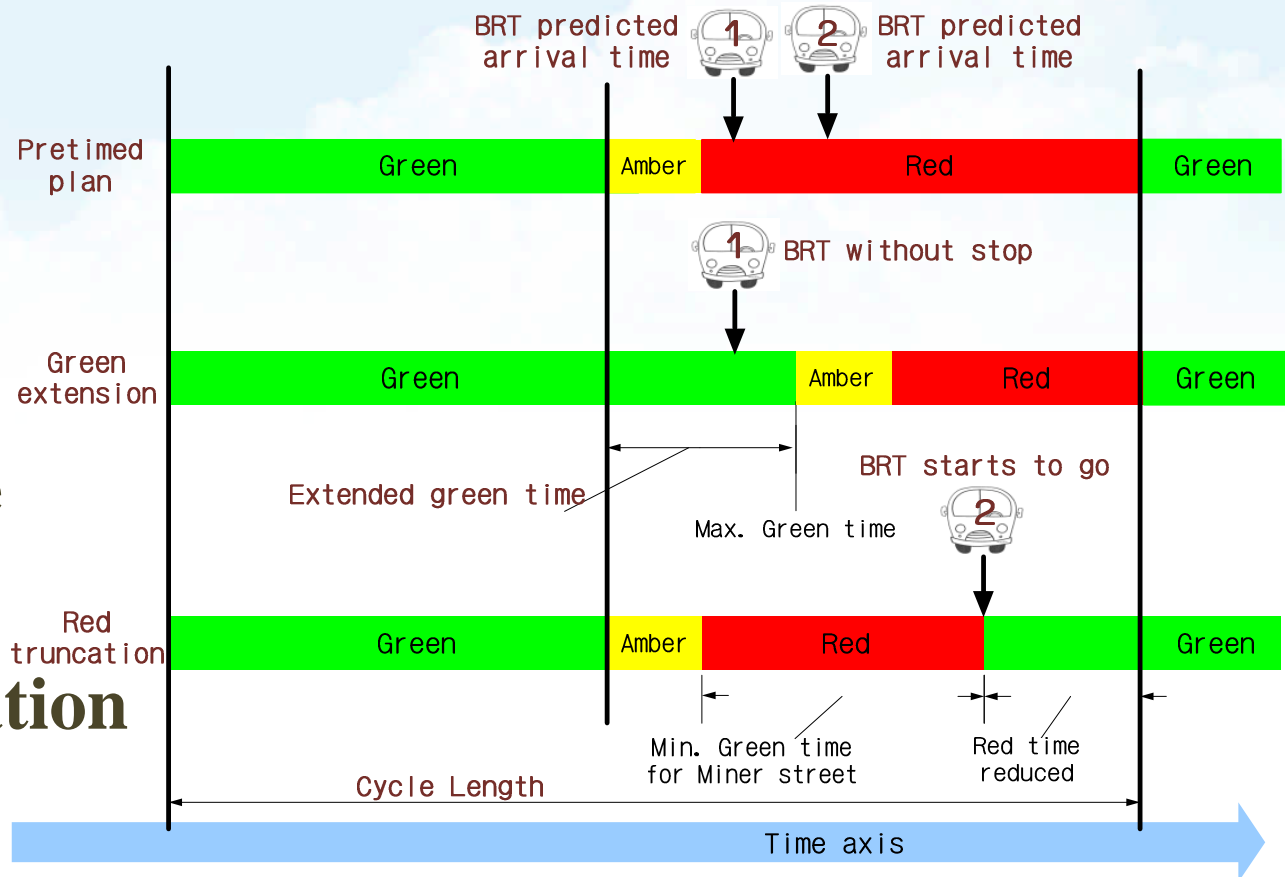
- To stabilize the vehicle speed
- To have priority to pass through intersections when BRT delay

delay

Design of Transit Signal Priority(2/2)

◆ Signal Pretimed Plan for TSP

- Speed
- Station dwell time
- Headway
- Signal cycle length
- Station location



Station ITS/APTS Devices

◆ Real-Time Passenger Information System

- LED information panels (TTIA v1.5 Standards)
- Dynamic transit information display
- The content of display is set and transmitted by the BRT Control Center

Real-time passenger information



◆ Security Surveillance System

- CCTV network outside/inside of station
- Emergency button and intercom

Dynamic transit information



◆ A Fiber Optic Network Link to Center

◆ Other Systems

- Power system, lighting system, platform gate system, electronic fare collection system...

Operations Management System(1/6)

Advanced Operations
Management System

Data Processing

Operations Management

Monitoring Management

Information Publishing

Data Interchange

Operations Management System(2/6)

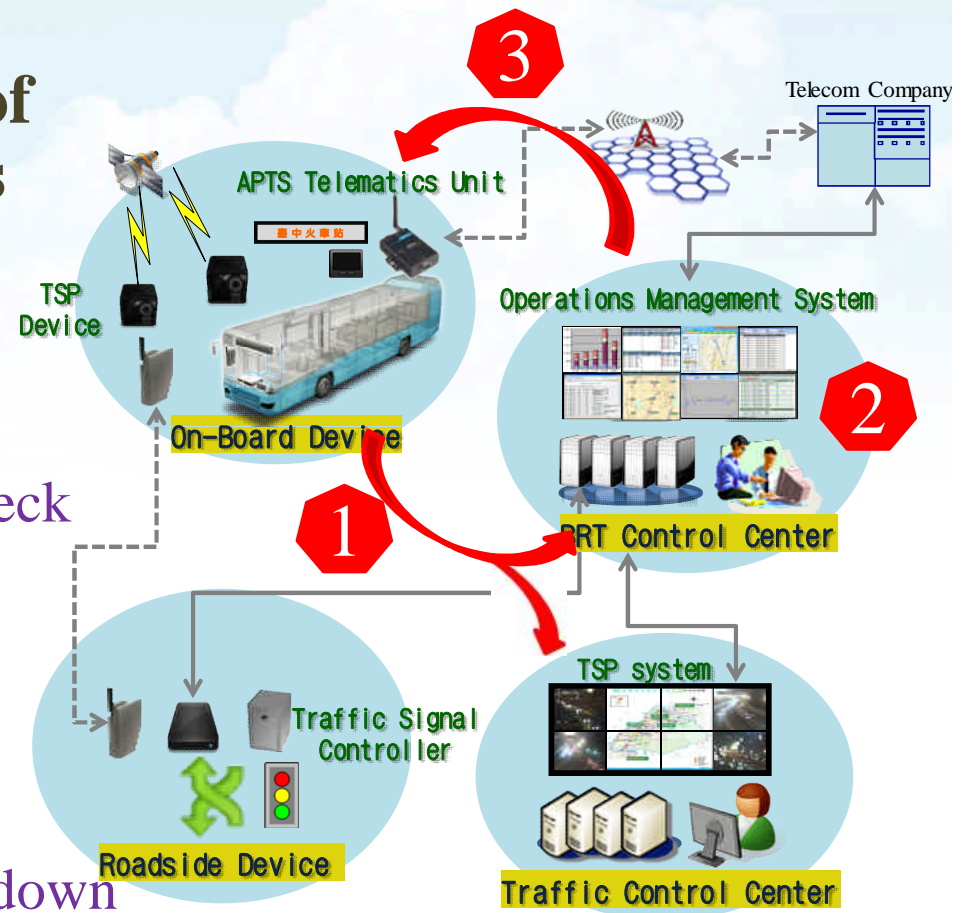
◆ Data Processing

1 Transmit dynamic data of on-board units to centers

2 Logic analysis and computation of data

- Estimated arrival time
- Scheduled departure time check
- Driving record analysis
- Alert message processing
- Vehicle location
- BRT headways
- Station departure time countdown

3 Transmit analysis results to on-board units and display



Operations Management System(3/6)

◆ Operations Management

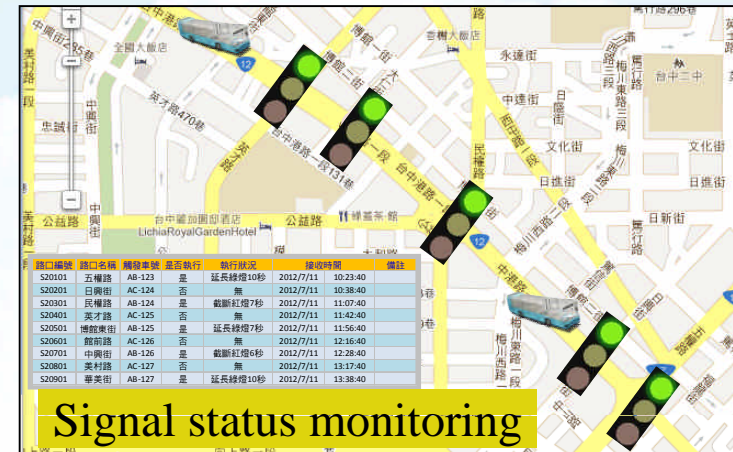
- **Basic data management**
 - Bus garage/yard management
 - On-board units setting
 - Routes and stations setting
- **Fleet management**
 - Vehicle basic information
 - Fleet Allocations
 - Attendance
- **Bus driver management**
 - Driver basic information
 - Working hours
 - Attendance
- **Operational data analysis**
 - Driving conditions check
 - Driver behavior audit
 - Equipment failure statistics
- **Scheduling and dispatch management**
 - Bus Scheduling
 - Driver Scheduling
 - Emergency Dispatch

Operations Management System(4/6)

◆ Monitoring Management

➤ Signal status monitoring

- GIS-based monitoring
 - Real-time status of signal
 - BRT location



- Monitoring tables

➤ Facility monitoring and maintenance

- On-board devices
- Station devices
- Roadside devices
- Center facilities

設備名稱	服務名稱	設備IP	設備狀態	設備名稱	服務名稱	設備IP	設備狀態	設備名稱	服務名稱	設備IP	設備狀態
WEB	PING	123.12.1.1	✓	AP	PING	123.12.1.2	✓	DB	PING	123.12.1.3	✓
MAN	PING	123.12.1.4	✓	WEB	WEB	123.12.1.1	✗	AP	UDP	123.12.1.2	✓
								DB	SQL	123.12.1.3	✓

序號	報修時間	車牌號碼	報修品項	狀態	明細
1	2009/11/10 上午 09:35:11	168-DC	車樑	尚未處理	詳細資料
2	2009/11/10 上午 05:46:27	554-AJ	行車記錄器	尚未處理	詳細資料
3	2009/11/9 上午 08:09:43	968-BC	LED顯示器	駐點人員進件	詳細資料
4					詳細資料
5					詳細資料

設備名稱	硬體名稱	使用率
WEB	磁碟C:	12%
AP	磁碟C:	23%
DB	CPU	2%
DB	記憶體	33%
DB	磁碟C:	34%

Maintenance management

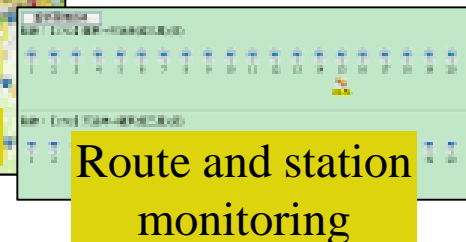
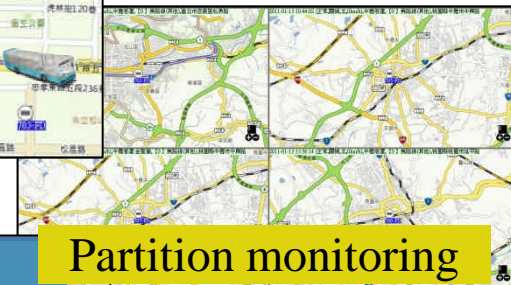
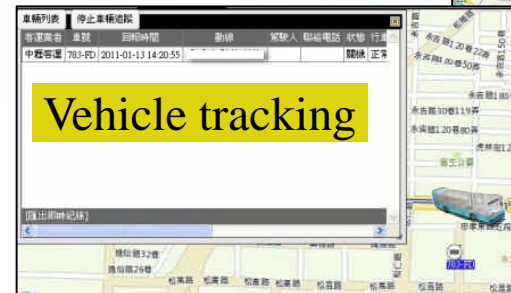
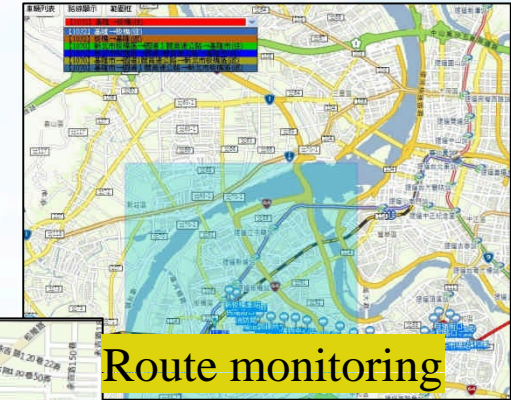
Monitoring management

Operations Management System(5/6)

◆ Monitoring Management(cont.)

➤ Vehicle monitoring and control

- Monitoring tables
- Region/division monitoring
- Partition monitoring
- Route monitoring
- Vehicle tracking
- Events notification and monitoring
- Historical data monitoring
- Dwell time monitoring
- Headways monitoring



Operations Management System(6/6)

◆ Information Publishing

➤ Web service

- BRT real-time information
- BRT arrival time of each station

➤ Passenger information panels

- BRT arrival time

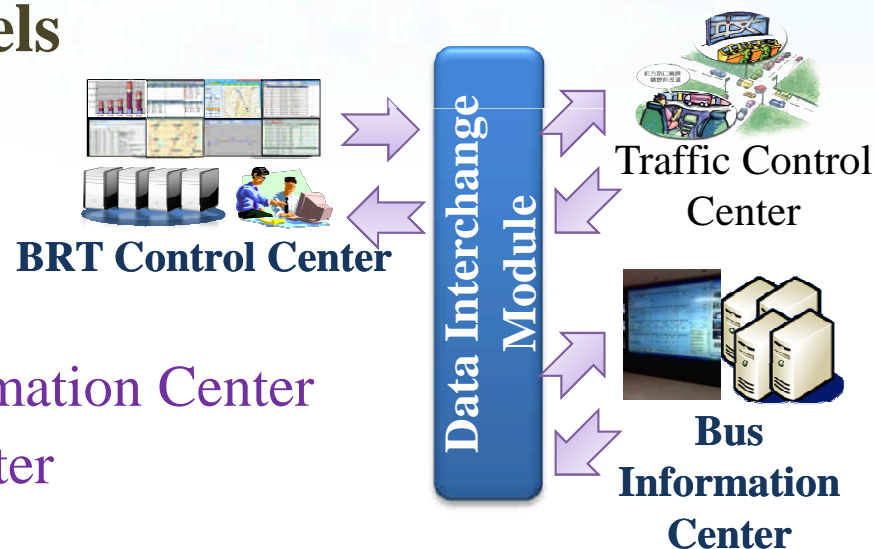
◆ Data Interchange

➤ To transmit data

- BRT dynamic data to Bus Information Center
- TSP data to Traffic Control Center

➤ To receive data

- Dynamic bus/rail information from Bus Information Center
- The processing information of TSP and real-time status of signal from Traffic Control Center



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Conclusions



Conclusions

- ◆ **There is no single BRT system prescription, especially in the application of ITS technologies .**
- ◆ **A good signal pretimed plan will reduce the most of stop delays.**
- ◆ **TSP system should be integrated with Traffic Control Center and TRB Control Center.**
- ◆ **BRT real-time passenger information should be incorporated into Traffic Information Center in Taiwan.**
- ◆ **The practical processes of BRT operations are even more important than physical devices.**

Thank You for Your Attention!

For more information

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