CECI's intelligent freeway systems.

Freeway & Expressway Traffic Management System

CECI Engineering Consultants, Inc., Taiwan

November 6, 2012

Contents

Ⅰ. Transportation Network

Ⅱ. Organization and System Framework

Ⅲ. Information Services for Road Users

Ⅳ. Future Prospects

Ⅰ. Transportation Network

- Freeway Network
- System Development
- TIMCC Architecture
- System Integration
- Advance Traffic Management

Freeway Network

- Taiwan western freeway and expressway had been completed and formed a network

- Development of traffic management technology
  - Line → Network
  - Control → Management
  - Static → Dynamic

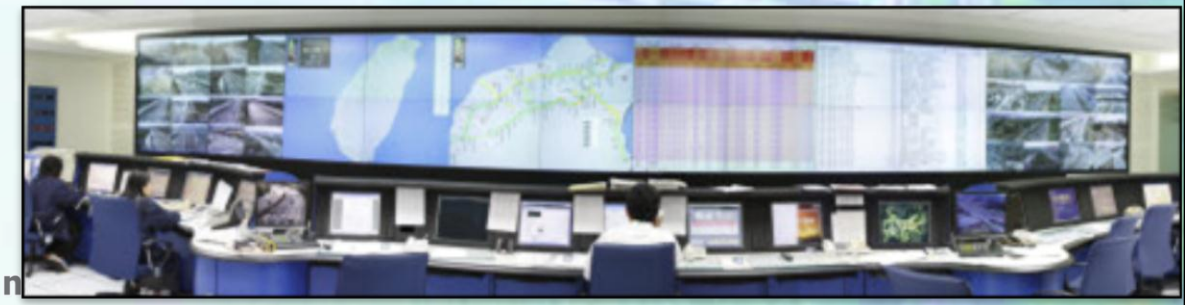
System Development

- 1980~
  - Freeway No.1 Keelung-Yangmei Traffic Control System
  - Northern Second Freeway Traffic Control System

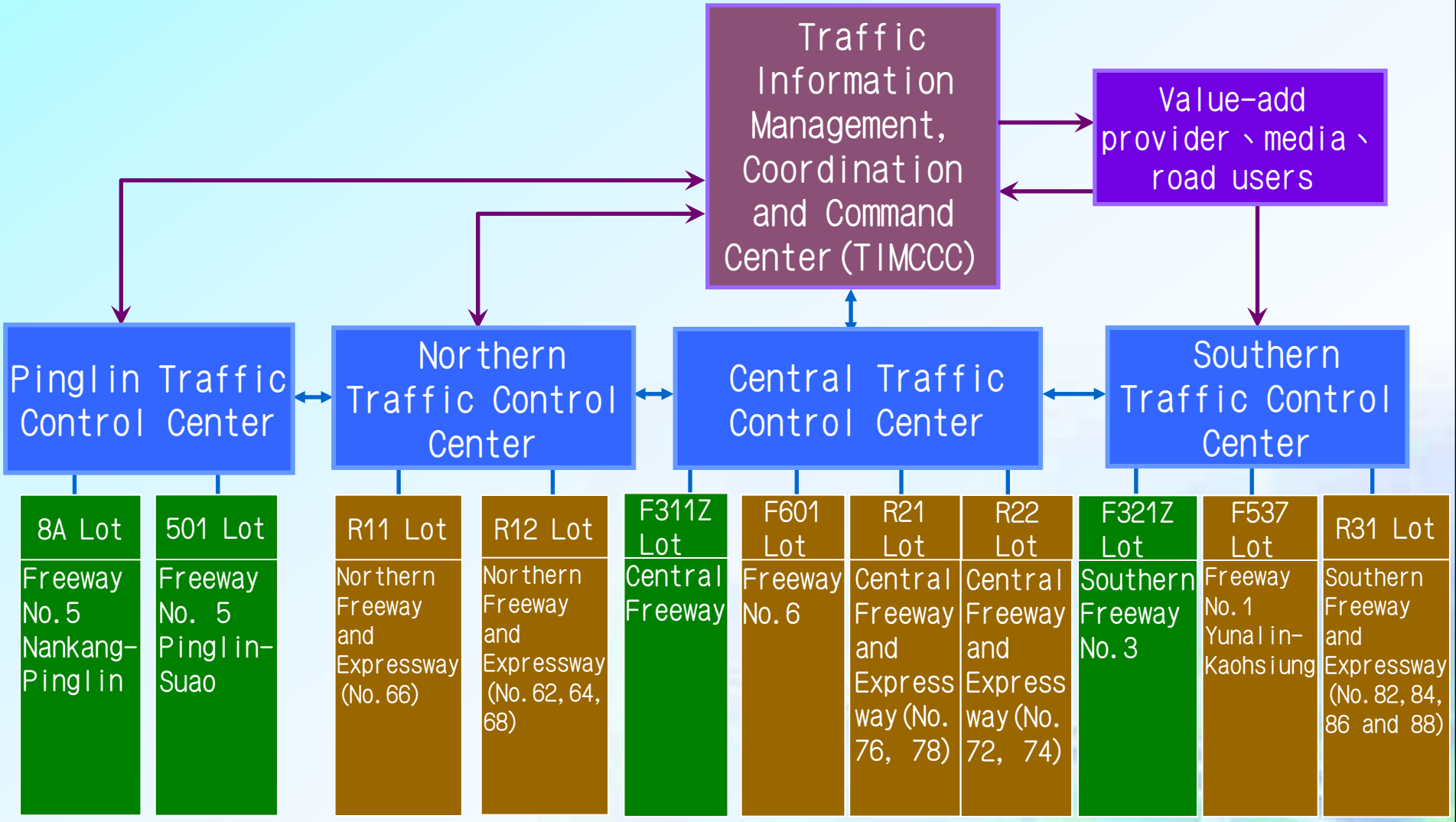
- 1990~
  - Freeway No.3 Traffic Control System
  - Freeway No.5 Traffic Control System

- 2000~
  - Integrated Highway and Expressway Network Traffic Management System

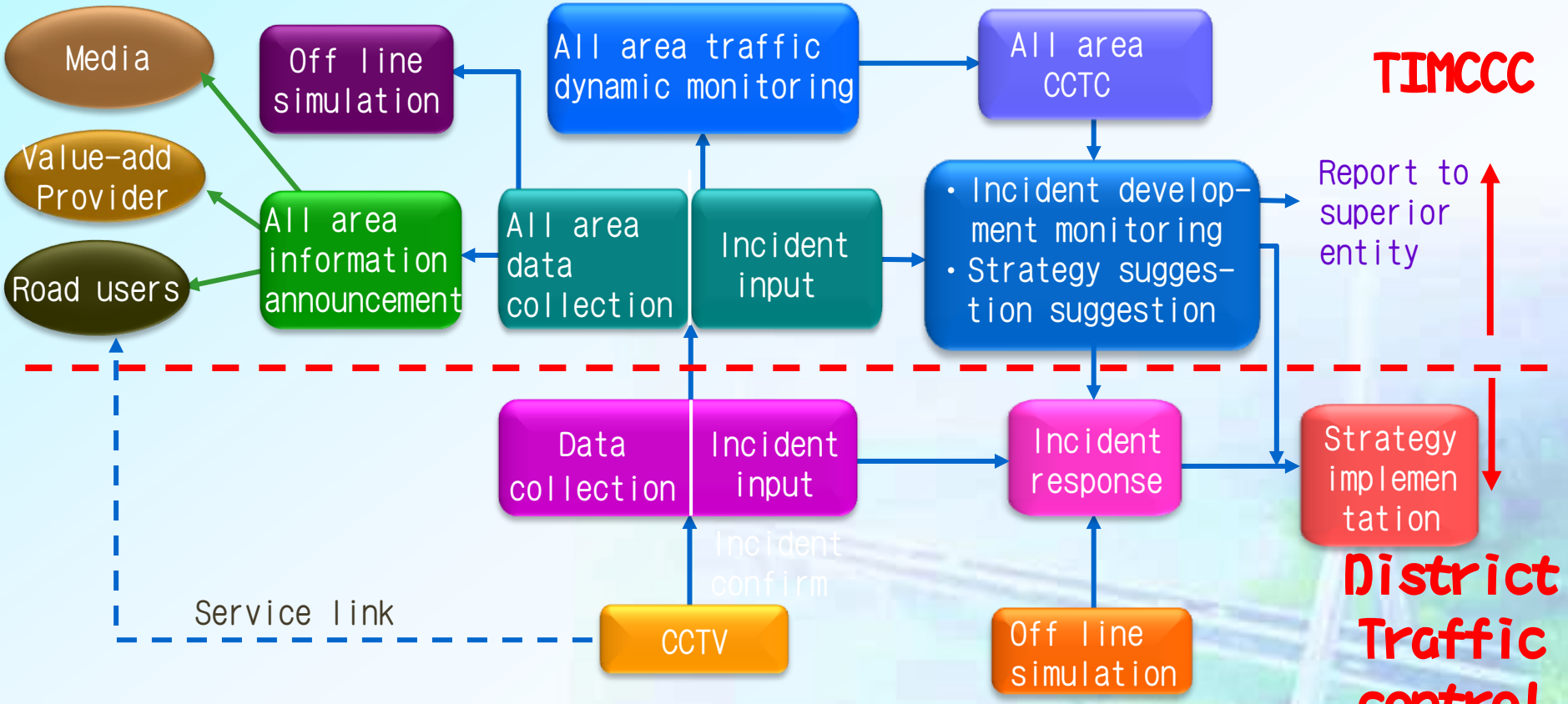
- 2010~
  - Freeway No.5 Traffic Control system Upgrade and Improvement



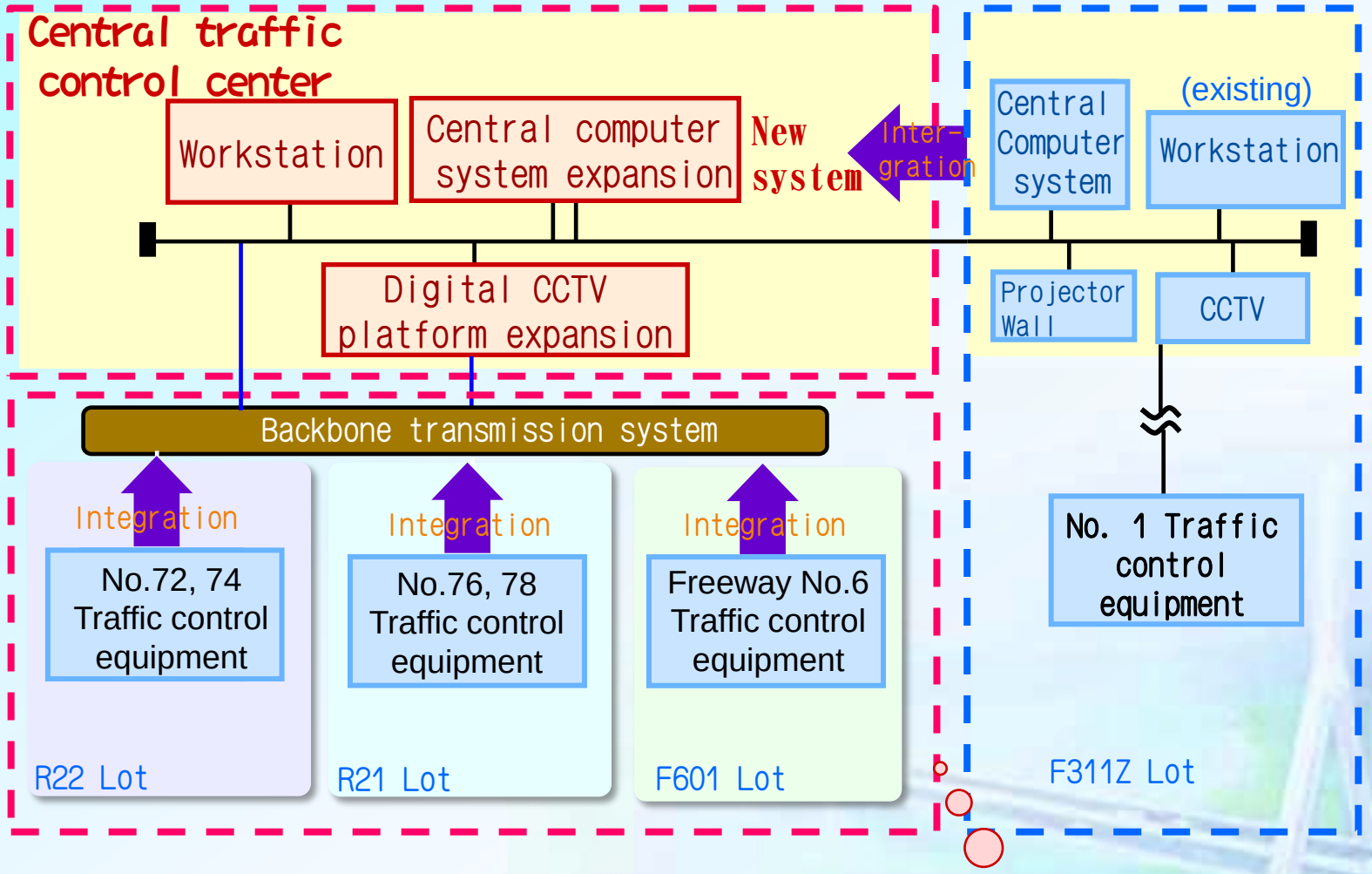
TIMCCC Architecture



TIMCCC Architecture

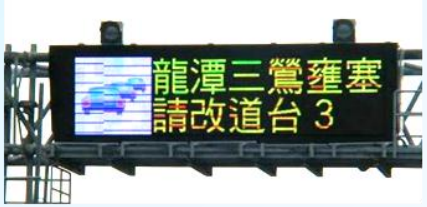


System Integration



Integration of under construction and existing system

Advance Traffic Management



- Route guidance control
- Metro area network management
- Route guide information
- Network informa-tion comparison

Network management

- Road condition detection and monitoring
- cross road control

Main line traffic condition

Traffic Management System

Road users information

- Advance traveler information provide system

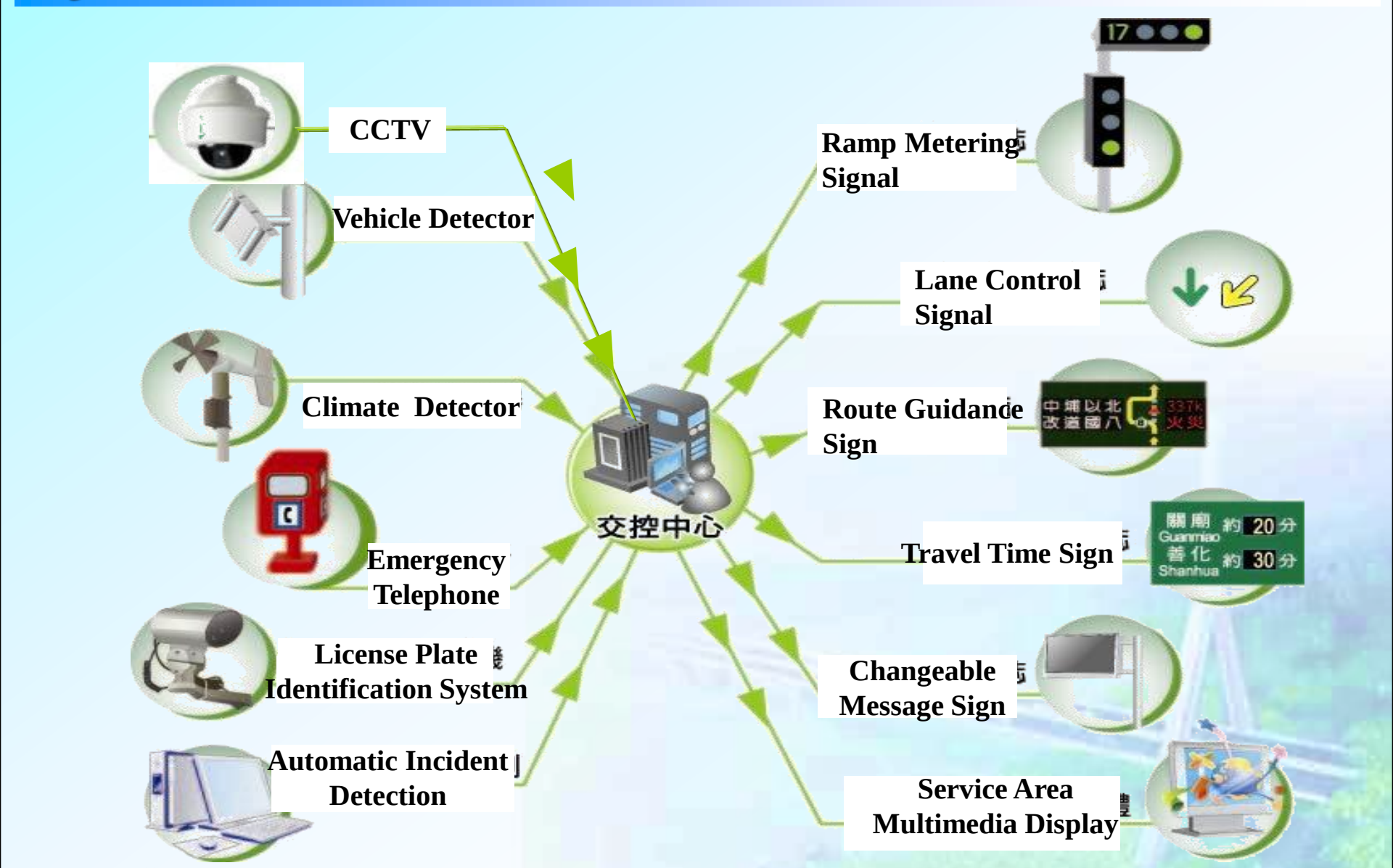
Network incident management

- Tunnel control
- Recurrent congestion management
- RMS
- Open shoulder line dynamically

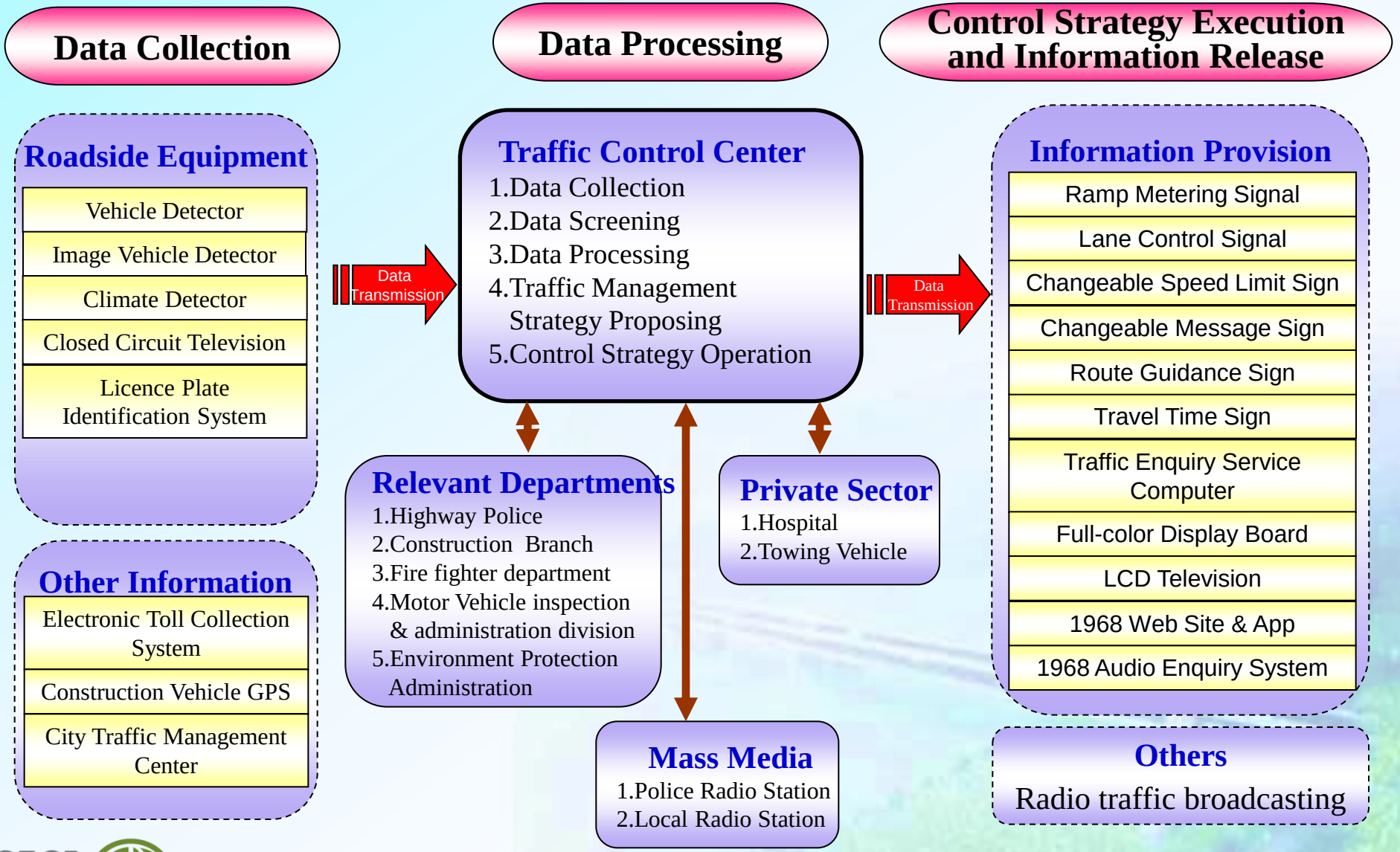
Ⅱ. Organization and System Framework

- System Framework
- Communication Network
- System Automation
- System Operation
- Facility Maintenance and Management

System Framework



System Framework



Communication Network

Backbone Communication

- Communication between carrier stations
- Bandwidth requirement, long distance transmission, redundant protection, interface: E1/E3/T1/T3、STM-1/4/16、10/100/1000 Base-Tx、GbE
- ITU-T standard, applied ADM (Add Drop Multiplexer) equipment to build Self-Healing Ring with 10Gbps bandwidth

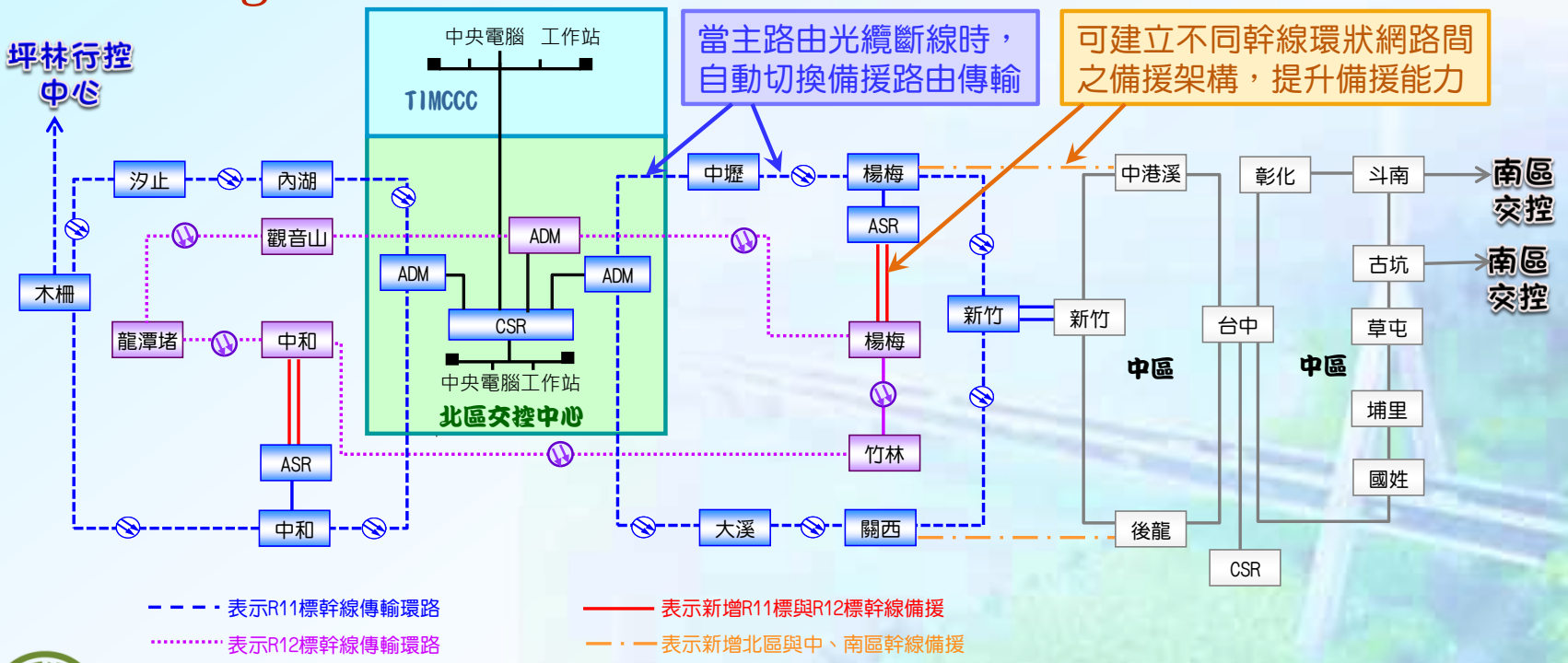
Local Communication

- Communication between carrier station and road site units
- Bandwidth requirement, long distance transmission, redundant protection, reducing number of fiber cores, IP and remote management
- Applied ODH to build a local ring with 100Mbps bandwidth

Communication Network

Backbone Communication

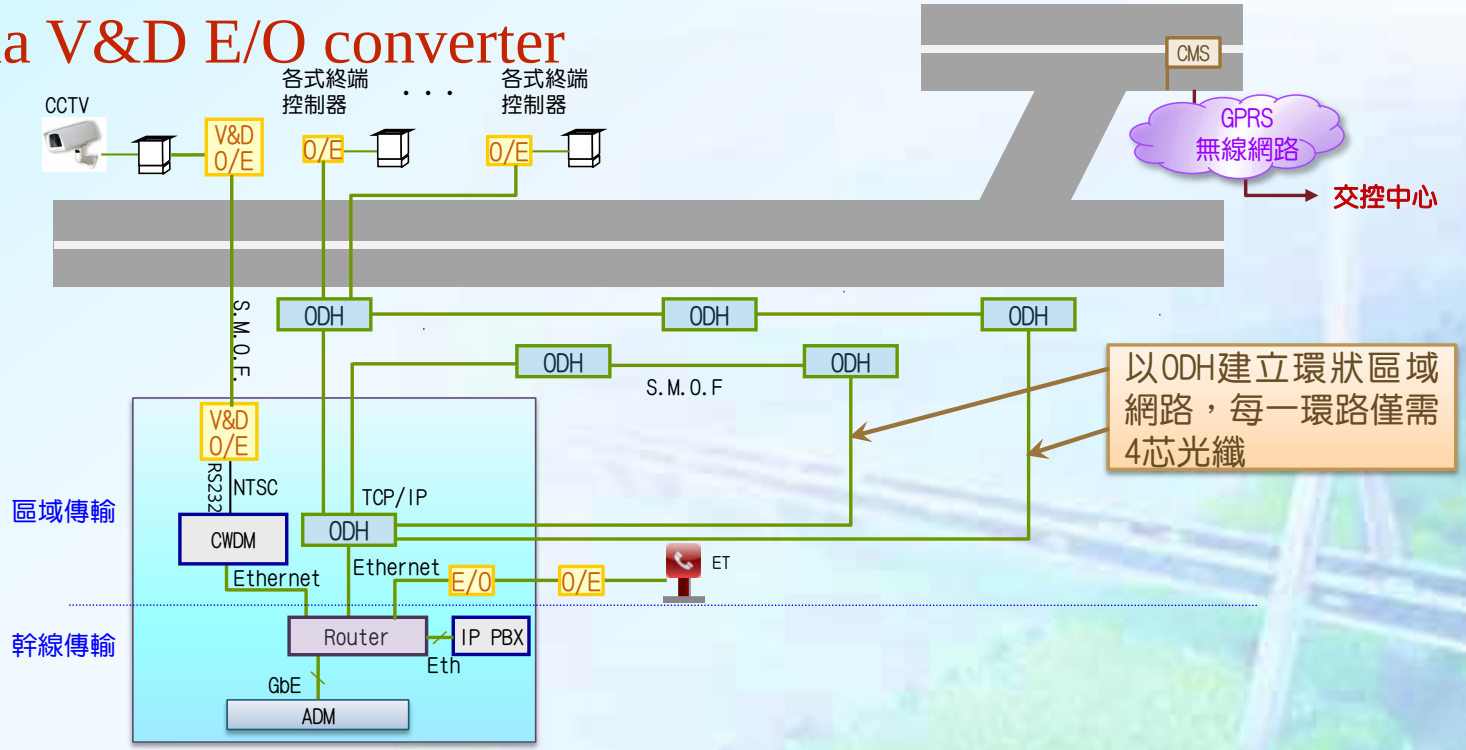
- SDH network has multiplex shared protection function. When any of link is disconnected, the network will be automatically switched to redundant link.
- With redundancy, high switch efficient and bandwidth management



Communication Network

❑ Local Communication

- ◆ ODH collects signals of all road site equipment which is with redundant protection and our door environment protection function
- ◆ CCTVs connect to CWDM of carrier station by point to point via V&D E/O converter

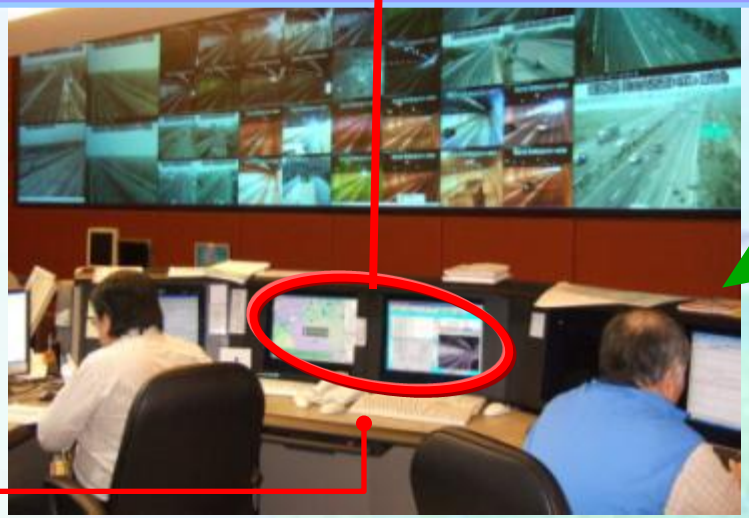


System Automation

❑ Monitoring from Fully Integrated Workstation

- **Integration of traffic monitoring, incident management and strategy download**
- **Monitoring and control of all facilities**

Report and dispatching of traffic incidents



Integrated monitoring, management and maintenance

System Automation

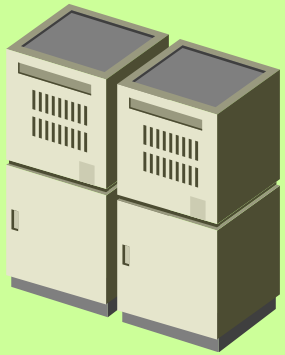
❑ Automatic incident response



Automatic incident detection

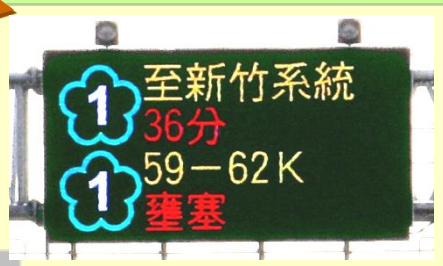


Incident by manual input



Central computer

Incident response plan

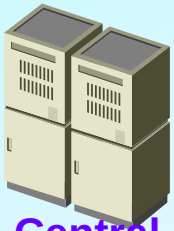


System Automation

❑ Automatic Image incident detection

Using image technology to monitor tunnel safety seamlessly

Detecting fire smoke, wrong-way driving, stopped, debiris, pedestrian, congestion,…



Central computer system

Incident signal

Image detection analyzer

Video image

CCTV

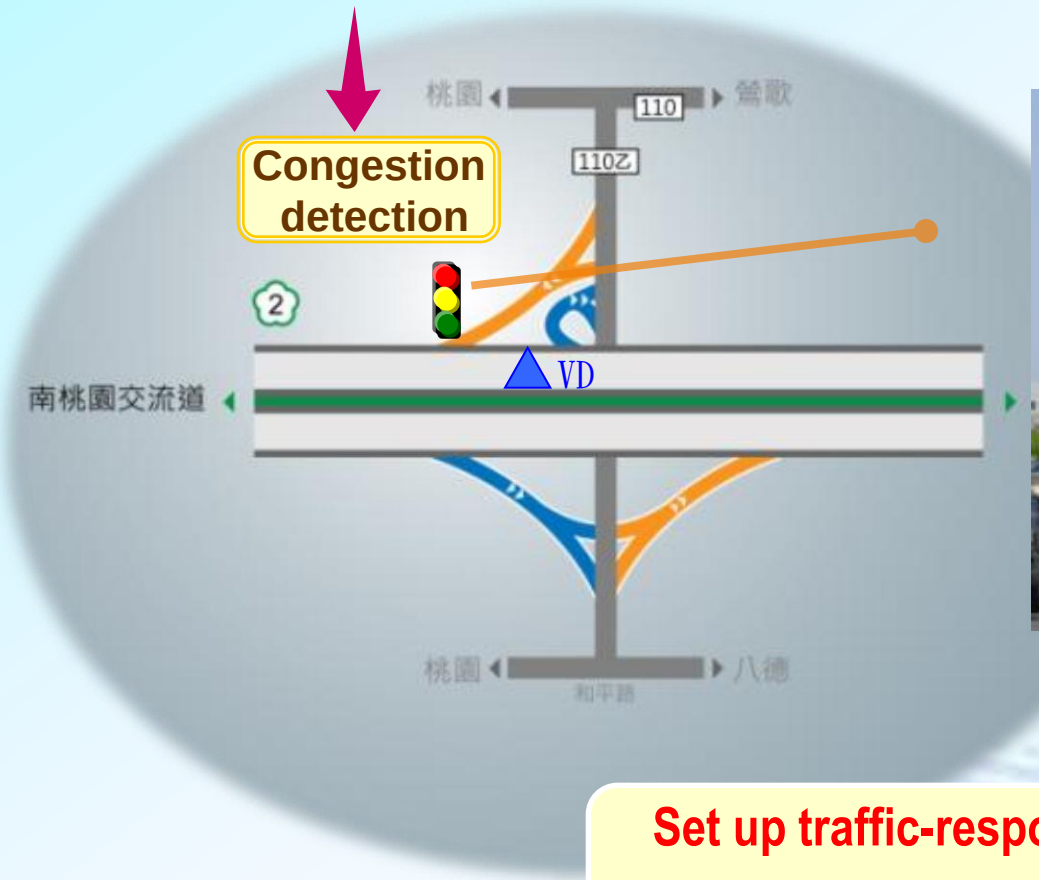
Trigger incident response plan

Implement reaction plan

Relevant control facilities take actions and response department gets notification

System Automation

- Automatic traffic-responsive ramp metering model

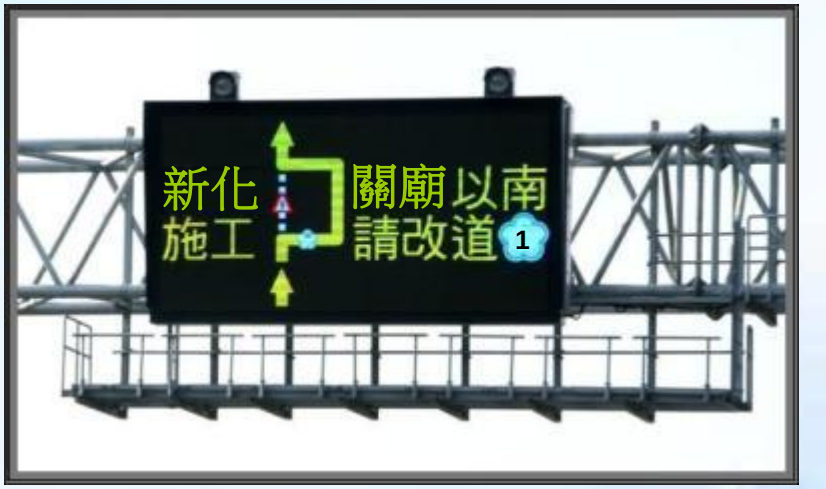


Automatic traffic-responsive model

Set up traffic-responsive signal timing plans for optimal use of roadway capacity

System Automation

- Route guidance information before major system interchange



Comparison of travel time over different routes

When difference exceeds threshold

Route diversion information

System Automation

- Metropolitan area network information

If travel speed below threshold → Renew metropolitan network information

System Automation

❑ Realtime travel time information

- VD information
- AVI information
- ETC information
- Historical traffic database

System Automation

- CMS information update automatically for moving construction

Given moving construction message from GPS locating, the traffic control system can download or remove the construction message from CMS automatically.

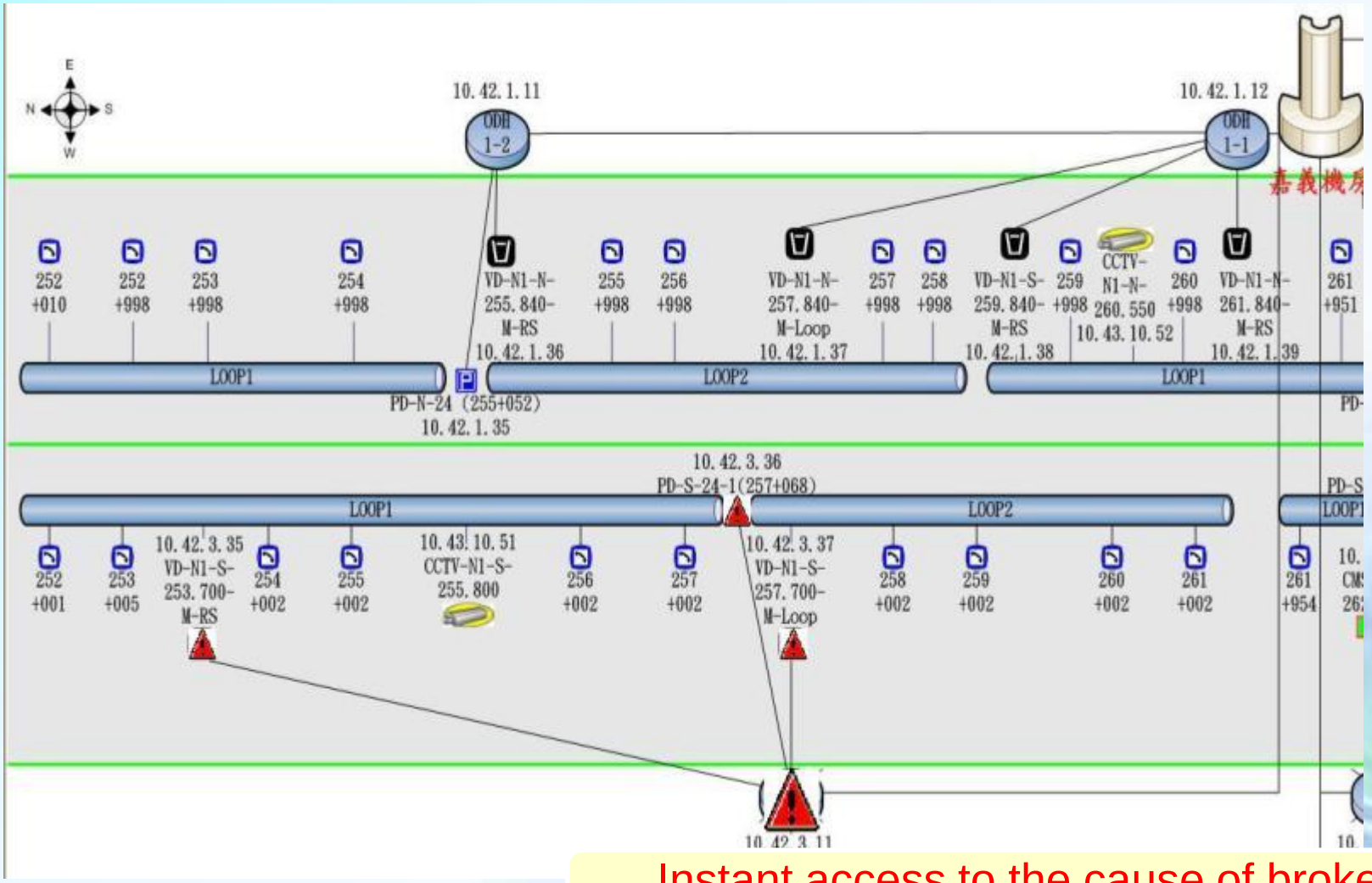
System Automation

- Information exchange with city traffic control system

Realtime collection of local CCTV, CMS, VD information

System Automation

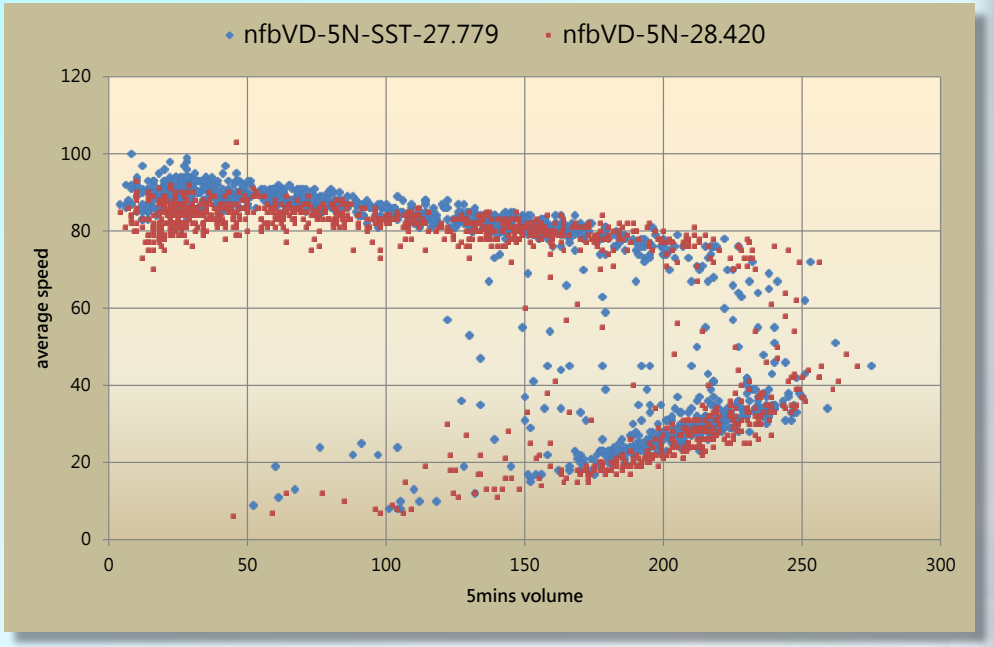
- Automatic theft detection alert

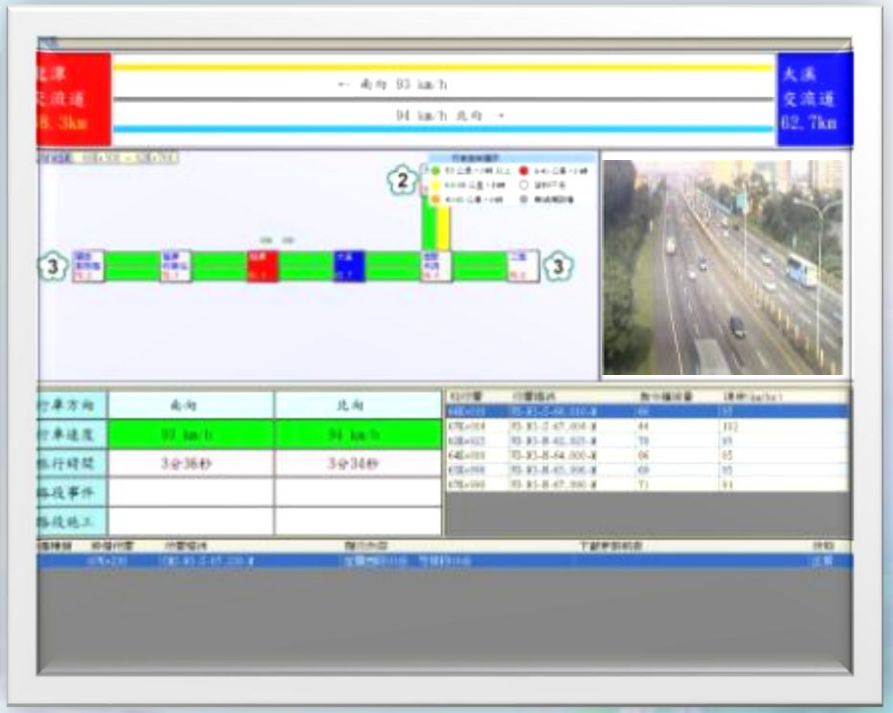


Instant access to the cause of broken cable to reduce potential cable theft

System Automation

- Vehicle Detectors - obtain data of current traffic volume and speed





Provide statistics for freeway flow data, feature summary and comparison, and display realtime traffic speed and volume of roadway segment.

System Operation

- CCTV non-stop video recording - to identify cause of incidents and management process

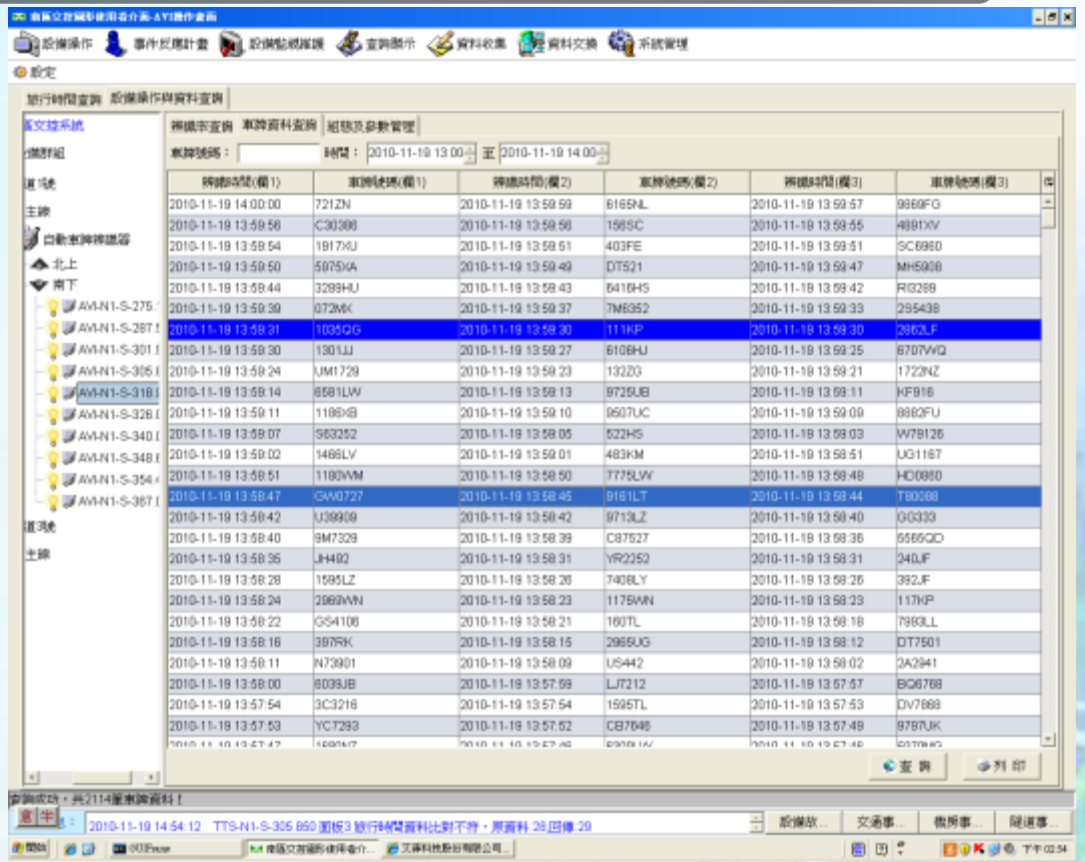
Real-time traffic video monitoring

Historical video reviewing

System Operation

- Automatic Vehicle Identification (AVI) - to acquire actual travel time

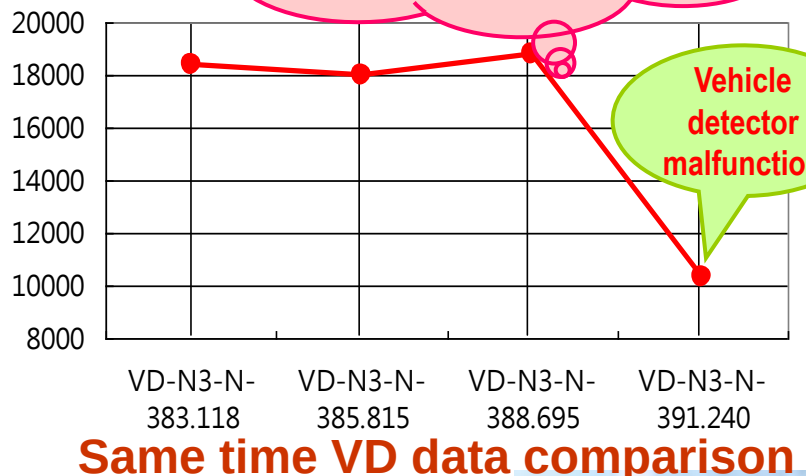
Provide roadway travel time and O-D information



Facility Maintenance and Management

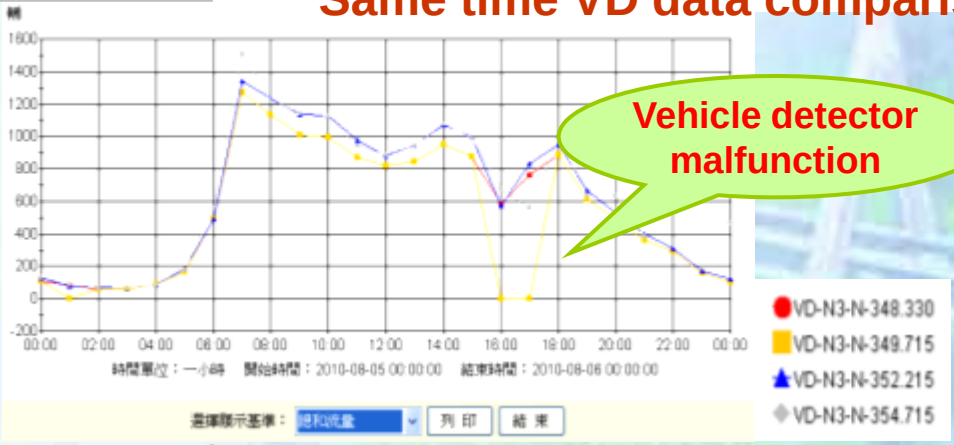
- To establish a monitoring and maintenance management system for all facilities

To find malfunction facilities proactively by using VD's traffic volume conservation & traffic characteristic curve reviewing table



Same time VD data comparison

To establish a facility monitoring and maintenance mechanism for quick report and maintenance



Same interchange VD data comparison

Ⅲ.Roaduser Information Services

- **Pre-trip information services**
- **En-route information broadcast**
- **Personal devices**

En-route information broadcast

Function upgrade

New CMS uses LED full-color display which enables flexible contents and better effects

Installation location

Before interchange on-ramp and off-ramp, tunnel entry, toll station and accident hot spots

Application

Release travel time estimation, message of congestion, major accidents or incidents, and traffic safety education

En-route information broadcast

- Release realtime travel time estimation through CMS and TTS

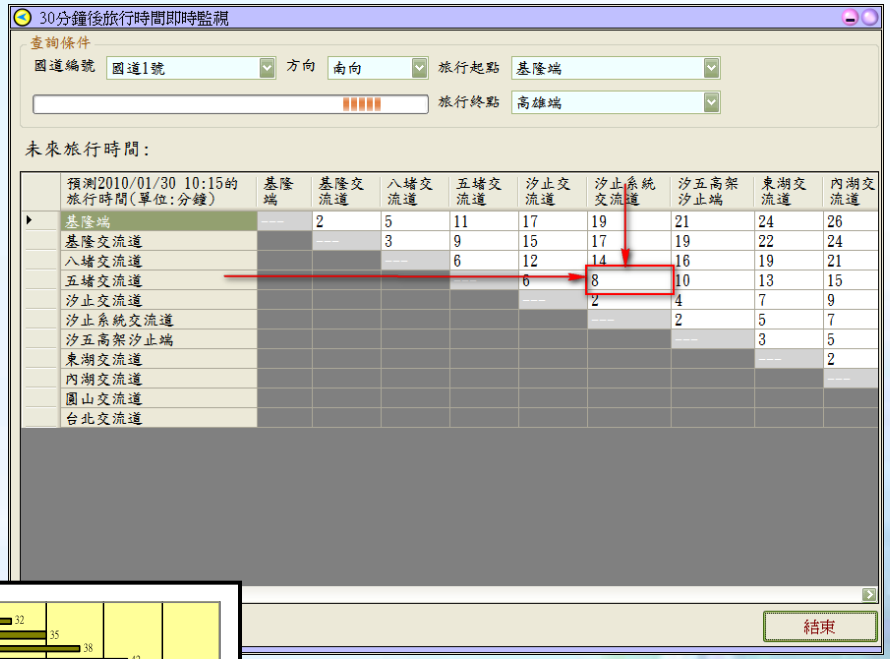
Personal devices

- Multiple information devices：cell-phone APP, navigator, internet, 1968 telephone inquiry, radio broadcast

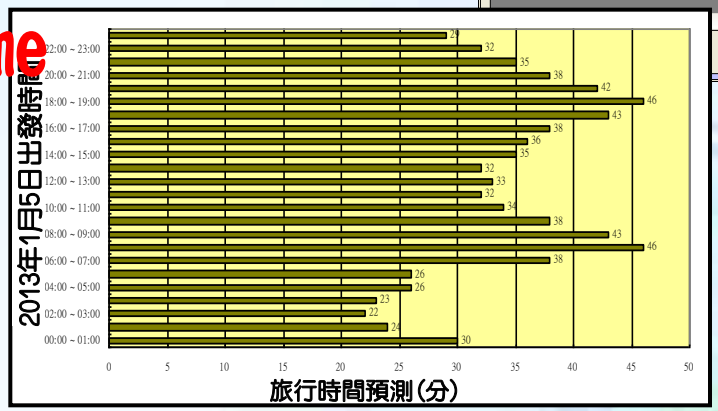
Ⅳ. Future Prospects

- **Travelling Time Prediction**
- **Integrated RMS Strategy**

Travelling Time Prediction

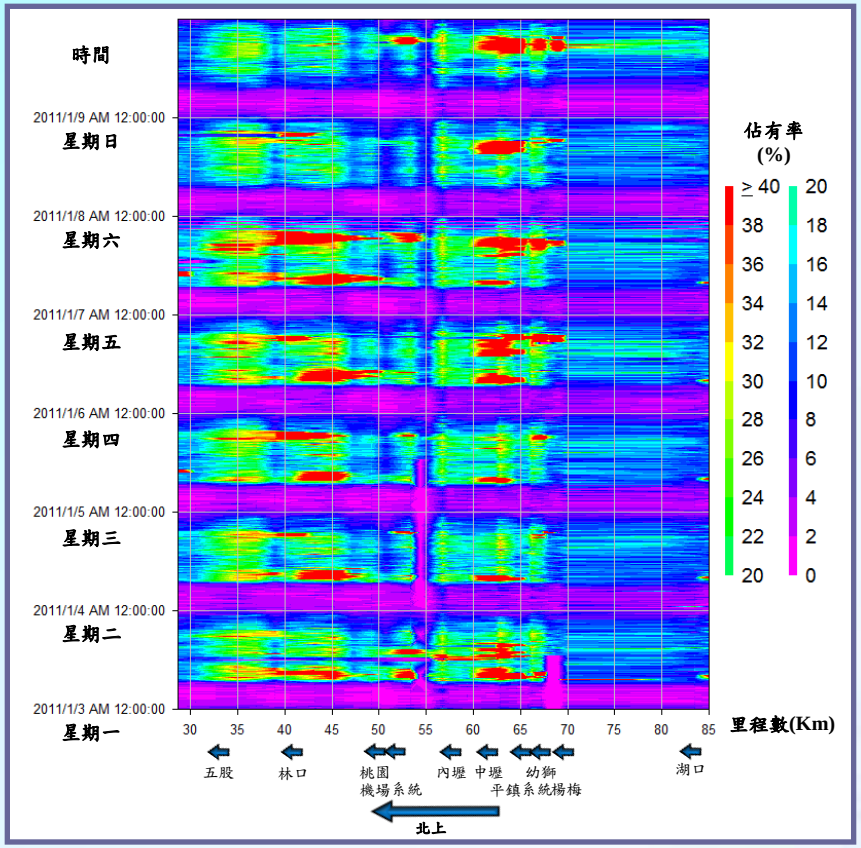


Travelling time Prediction

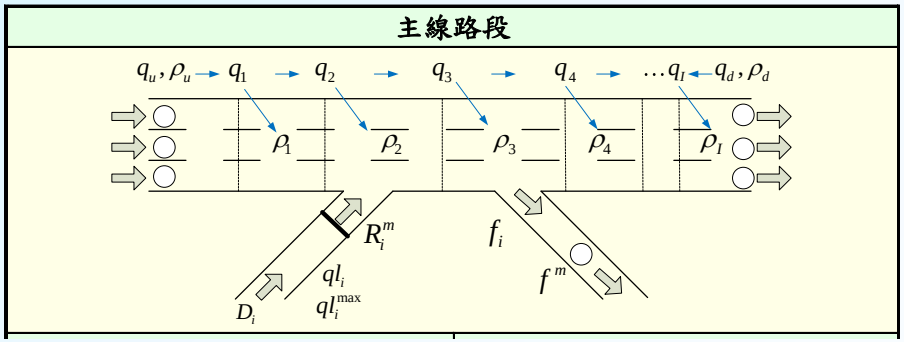


Integration RMS Strategy

❑Integrated RMS range



❑The goal is max. throughput



Goal Formula

$$Max \sum_{k=1}^{K} \left\{ q_I(k) + \sum_{i=1}^{I} f_i(k) - a_f \sum_i [R_i{}^m(k) - R_i{}^m(k-1)]^2 \right\} \times T - a_w \sum_i \varphi [ql_i(k)]^2$$

MCTM：Modified Cell Transmission model


Thank you