

The background features a futuristic, semi-transparent rendering of a freeway system. On the left, a control center with a large screen and people is visible. In the foreground, a car is shown with a glowing yellow beam of light or data being transmitted to it. The overall scene is set against a bright, hazy sky and a distant cityscape.

CECI's intelligent freeway systems.

Freeway & Expressway Traffic Management System

CECI



CECI Engineering
Consultants, Inc., Taiwan

CECI



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November 6, 2012

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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

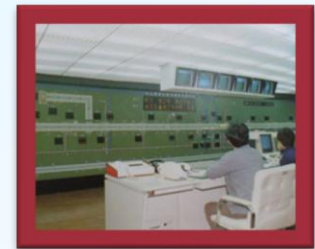
- ◆ Line → Network
- ◆ Control → Management
- ◆ Static → Dynamic



System Development

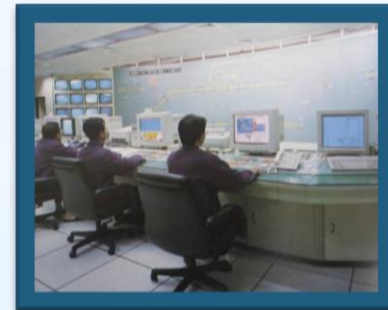
□ 1980~

- ◆ 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~

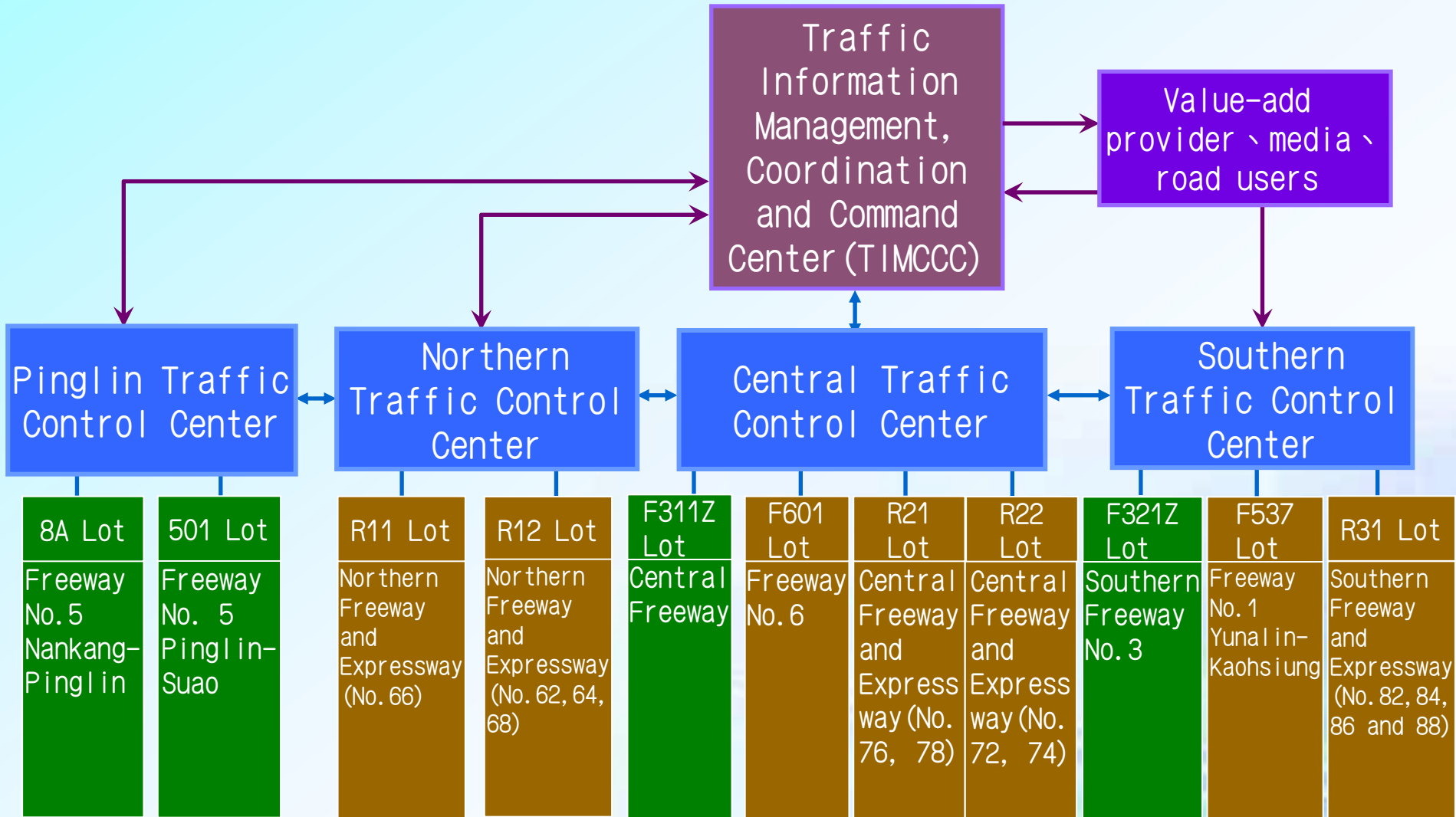
- ◆ Integrated Highway and Expressway Network Traffic Management System

□ 2010~

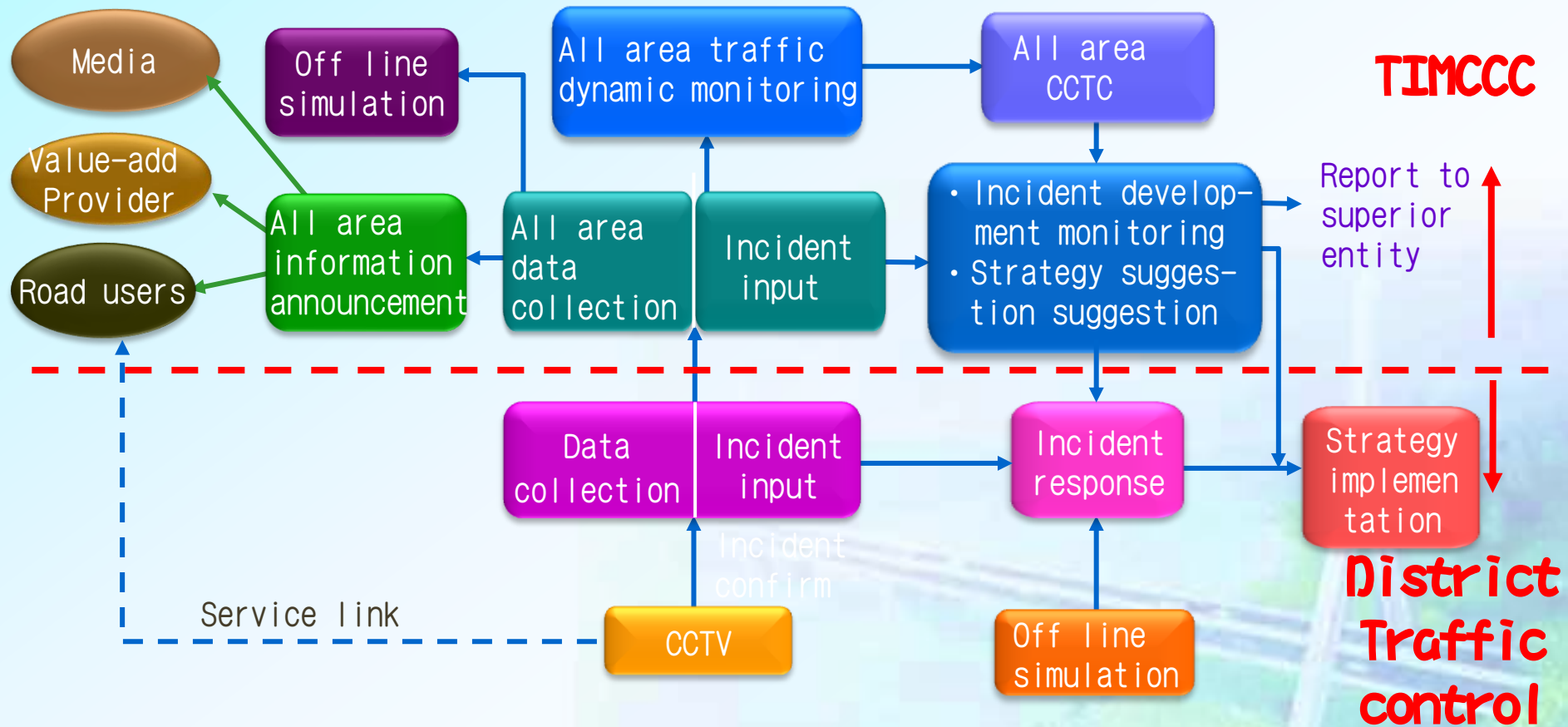
- ◆ Freeway No.5 Traffic Control system Upgrade and Improvement



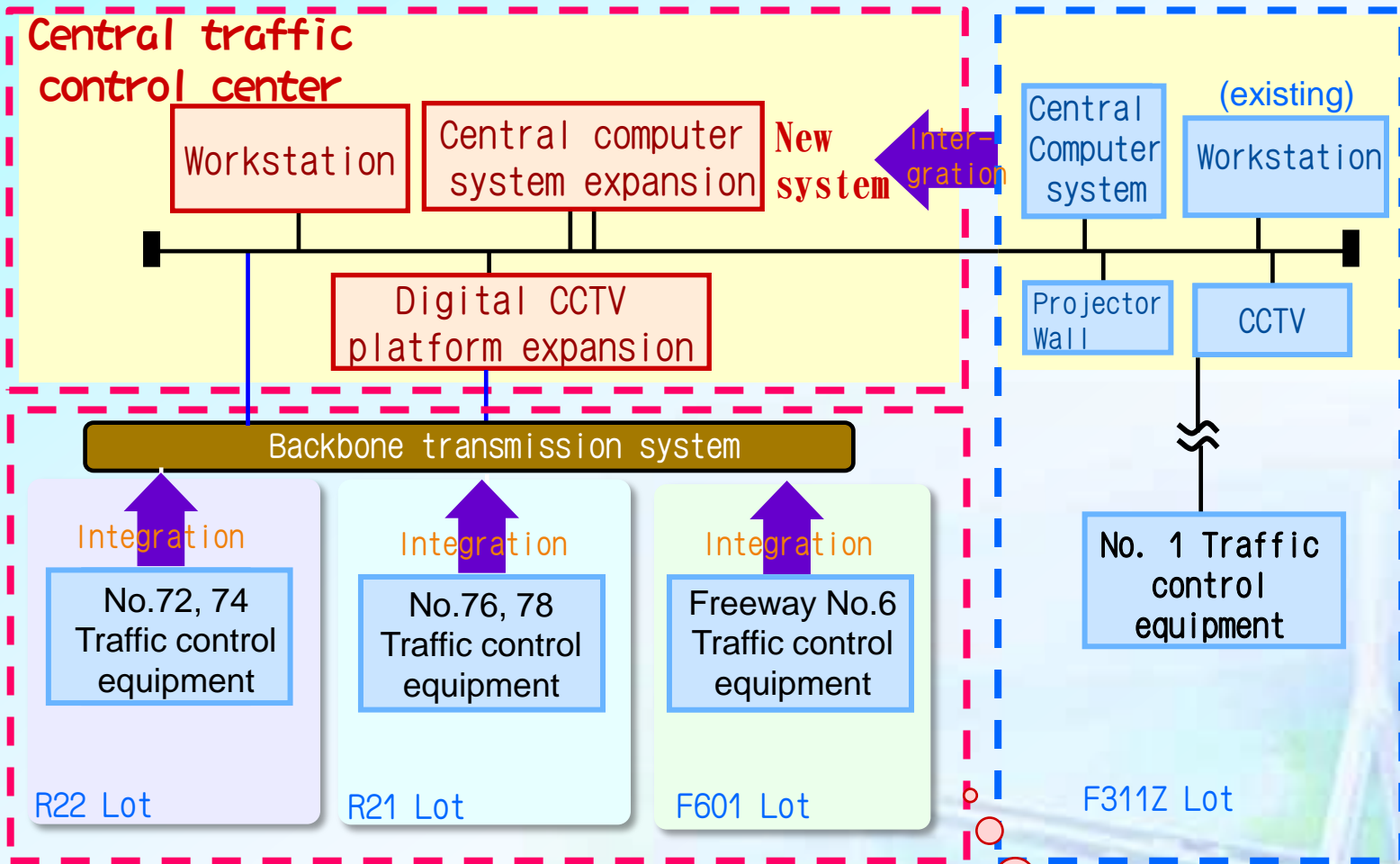
TIMCCC Architecture



TIMCCC Architecture

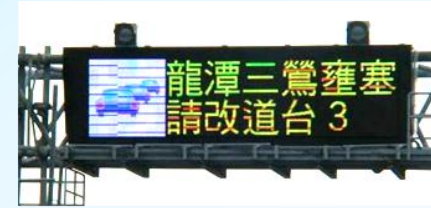


System Integration



Integration of under construction and existing system

Advance Traffic Management



- Route guidance control
- Metro area network management
- Route guide information
- Network information 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

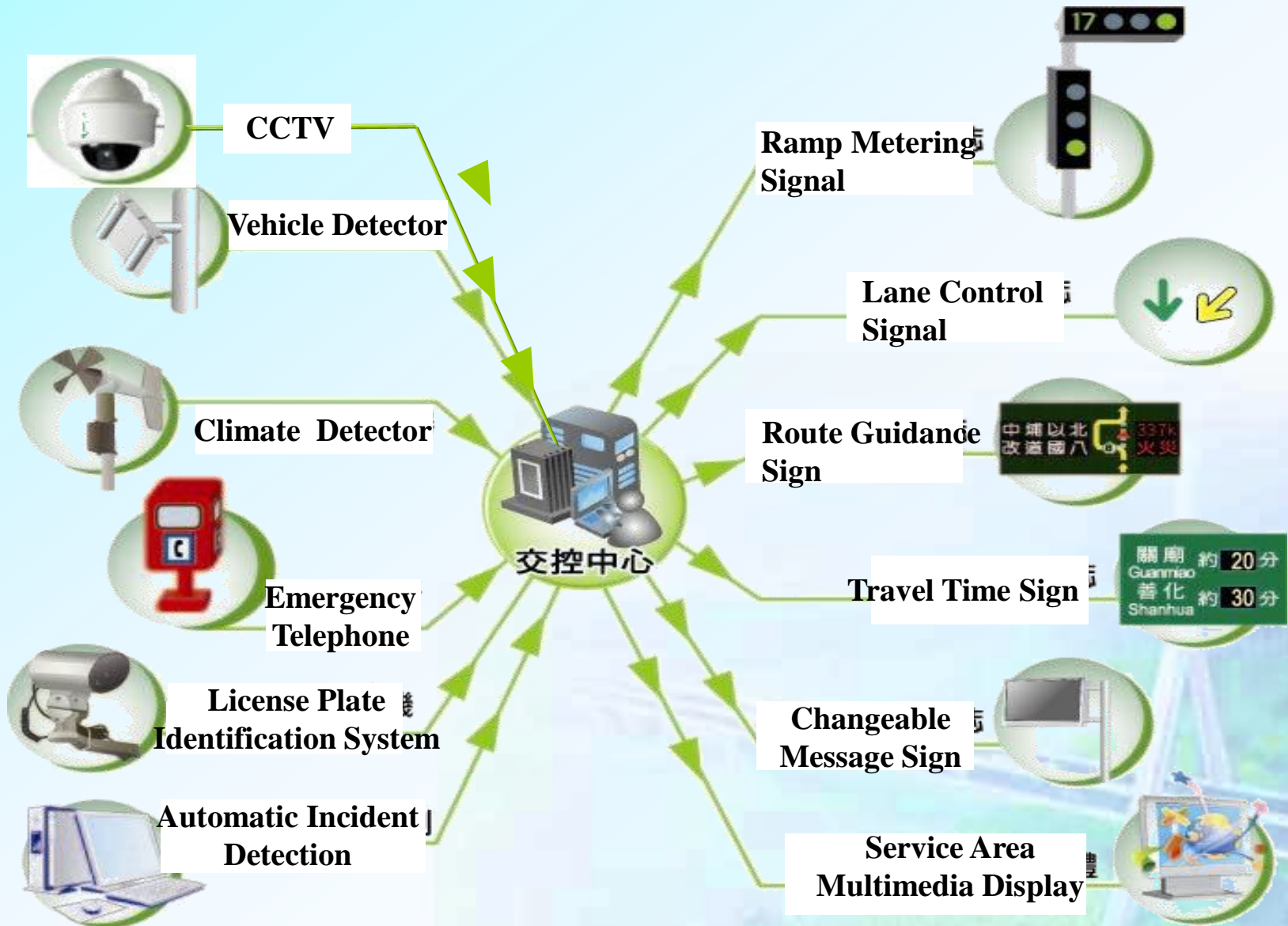
- Tunnel control
- Recurrent congestion management
- RMS
- Open shoulder line dynamically



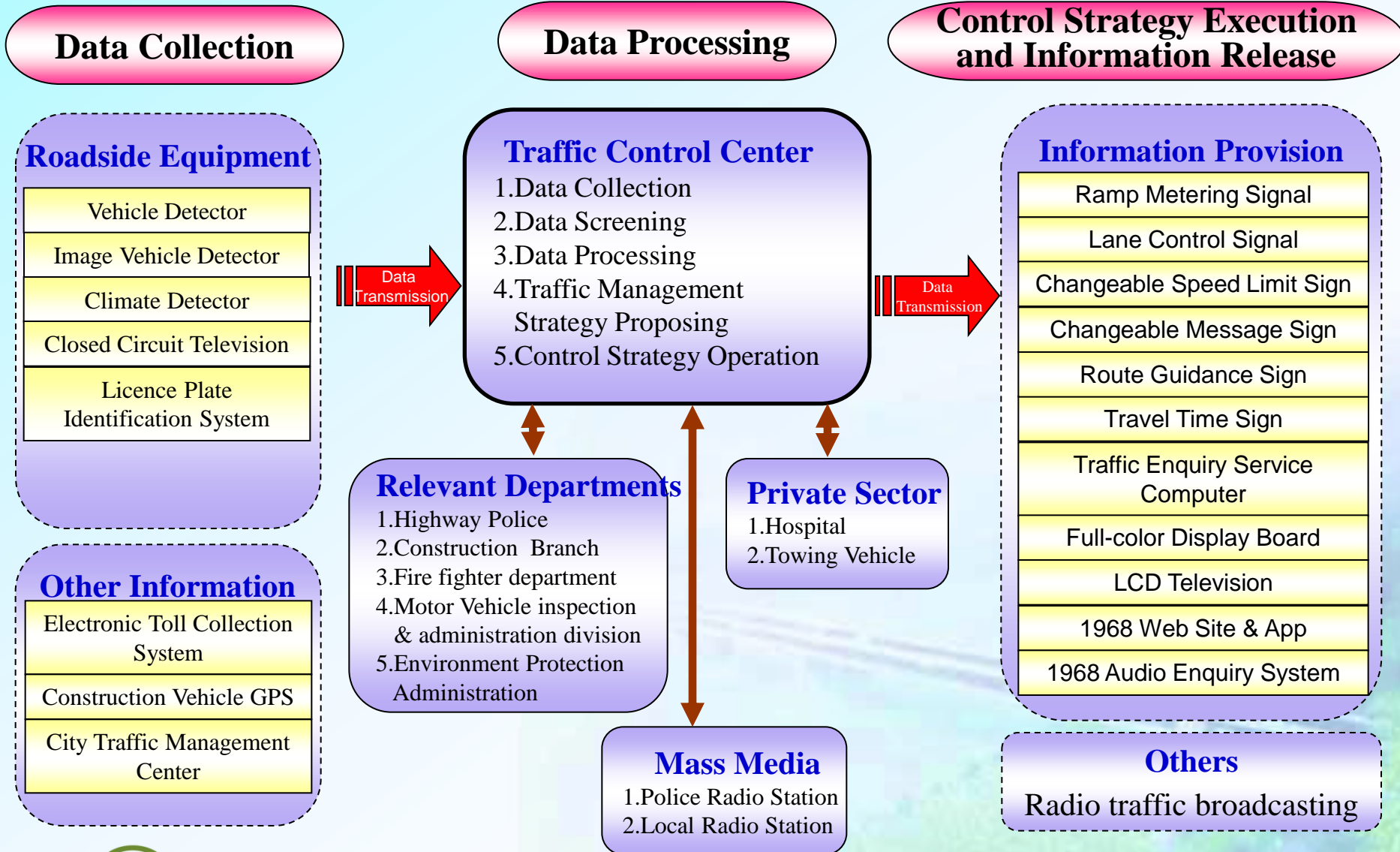
II. Organization and System Framework

- ◆ **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

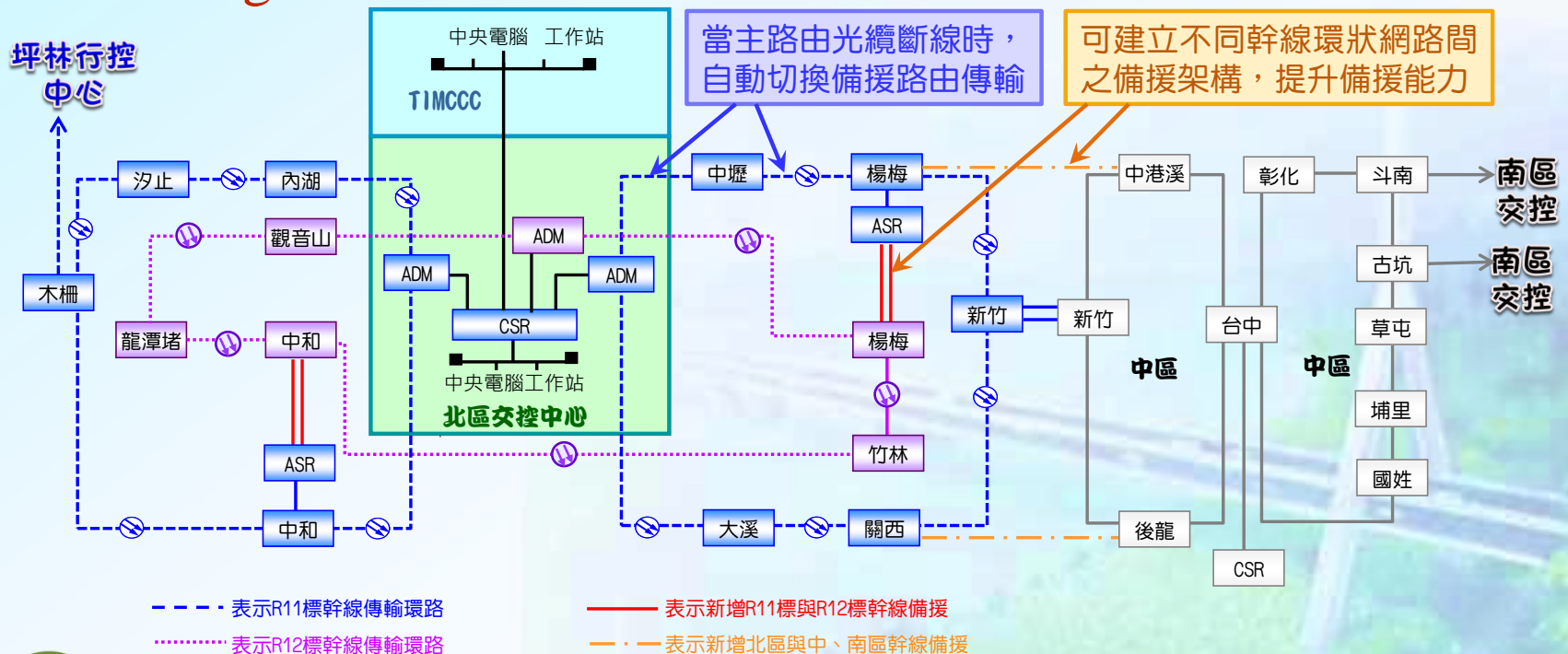
□ Local Communication

- ◆ 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

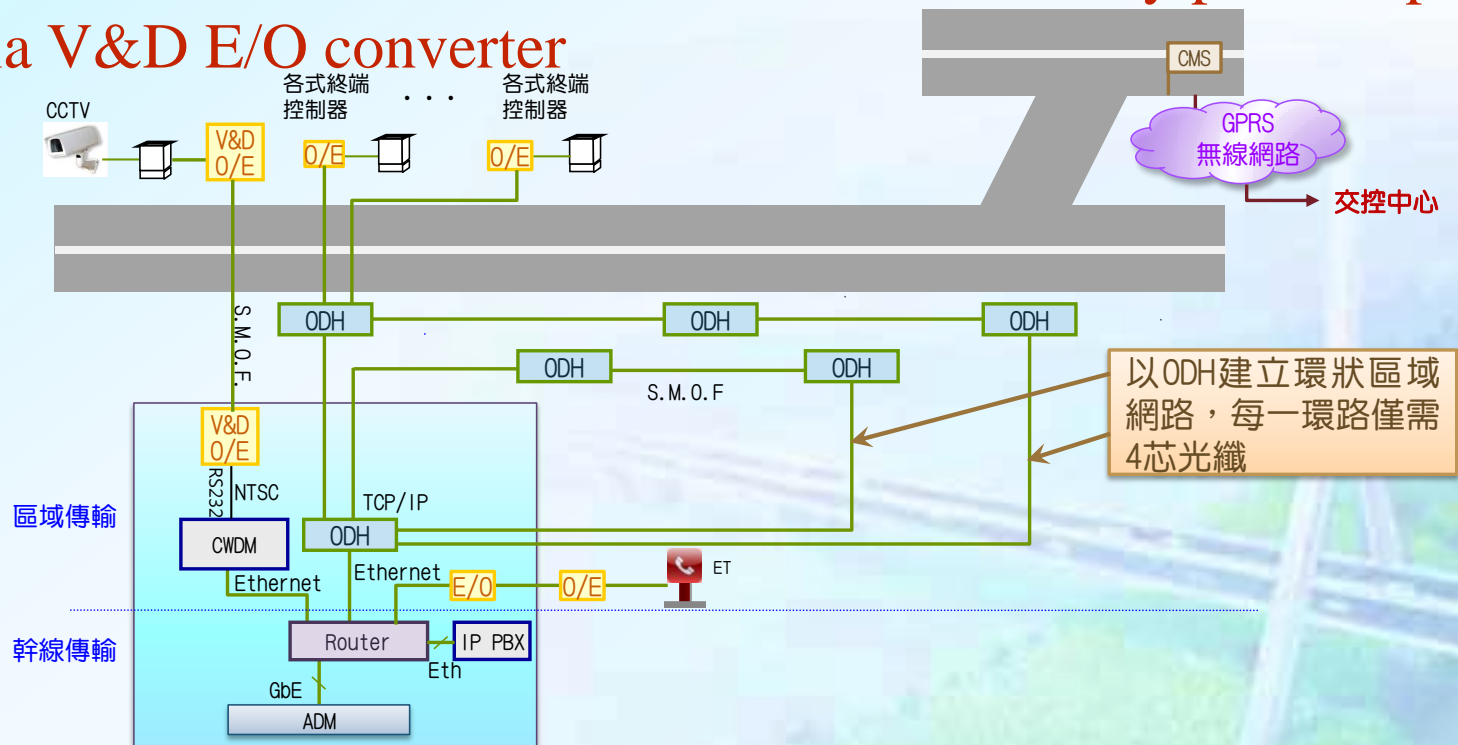
- ◆ SDH network has multiplex shared protection function. When any of link is disconnected, the network will be automatically switched to redundant link.
- ◆ With redundancy, high switch efficient and bandwidth management



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



以ODH建立環狀區域網路，每一環路僅需4芯光纖

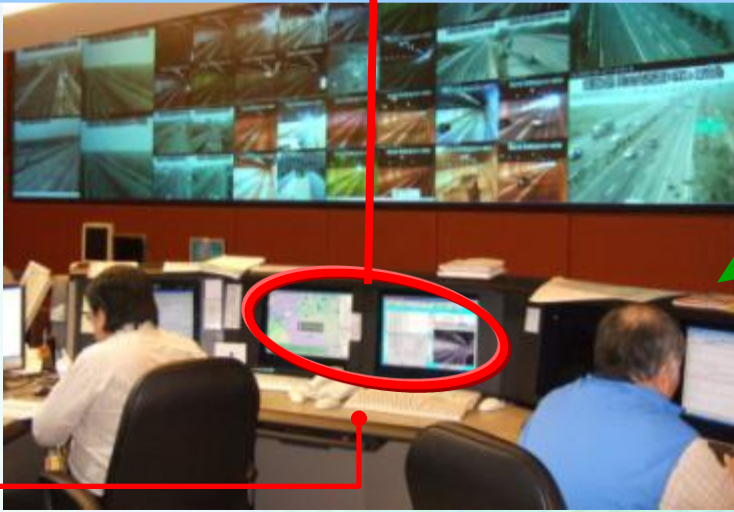
System Automation

Monitoring from Fully Integrated Workstation

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



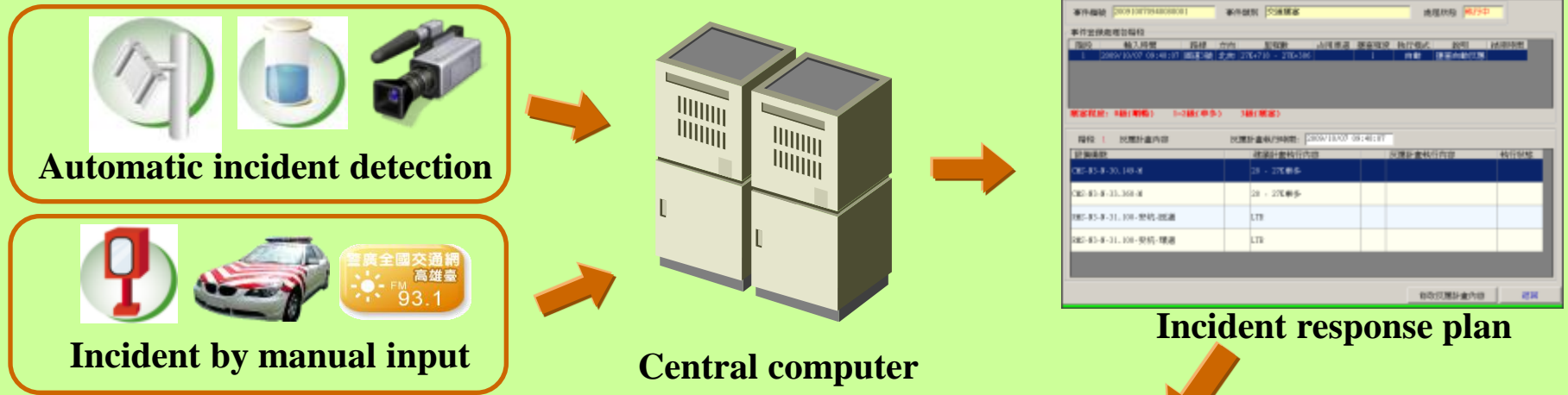
Report and dispatching of traffic incidents



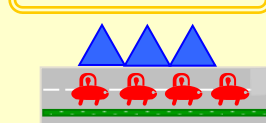
Integrated monitoring, management and maintenance

System Automation

Automatic incident response



Vehicle Detector



CMS

CMS



RGS

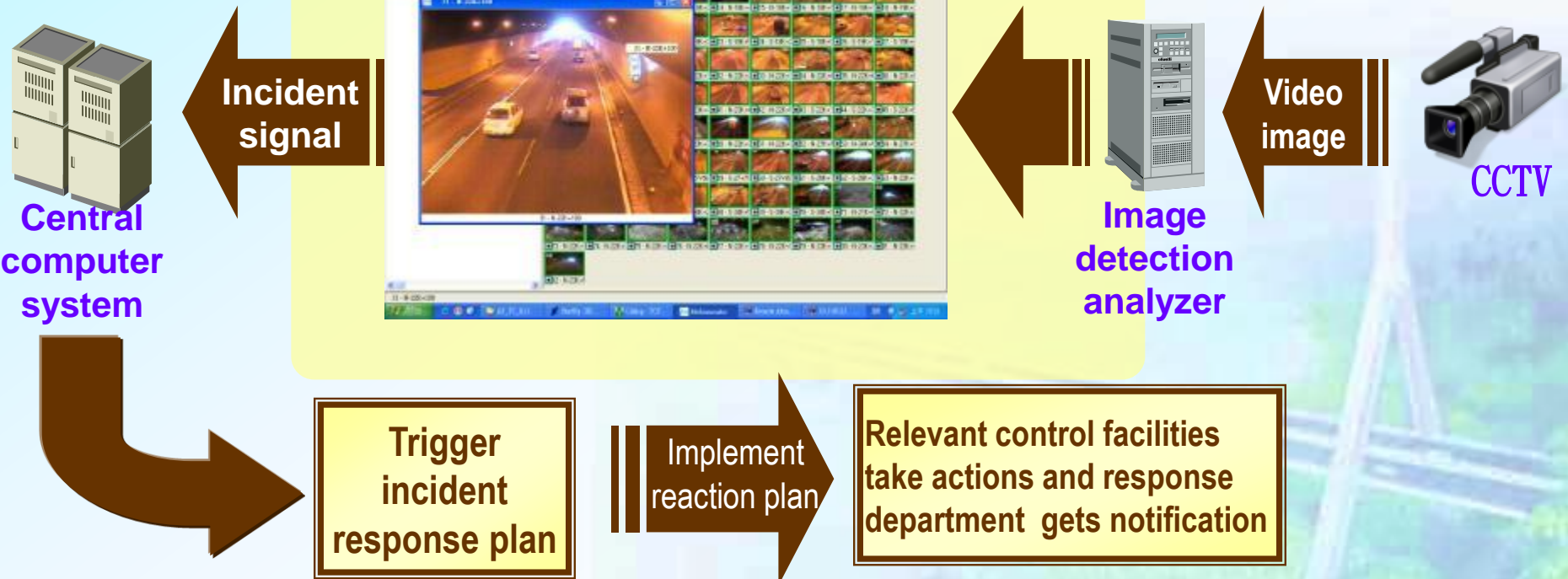


System Automation

Automatic Image incident detection

Detecting fire smoke, wrong-way driving, stopped, debris, pedestrian, congestion,...

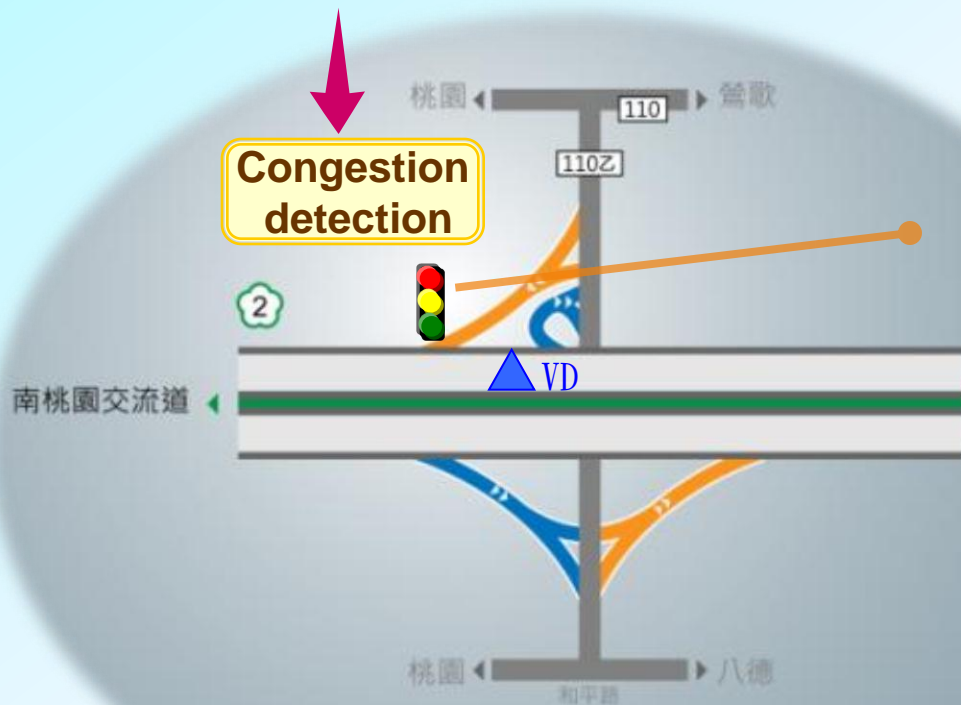
Using image technology to monitor tunnel safety seamlessly



System Automation

- ❑ Automatic traffic-responsive ramp metering model

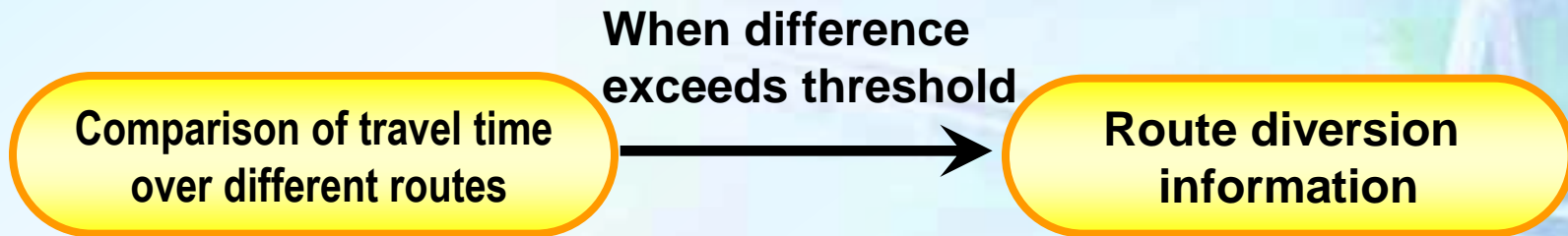
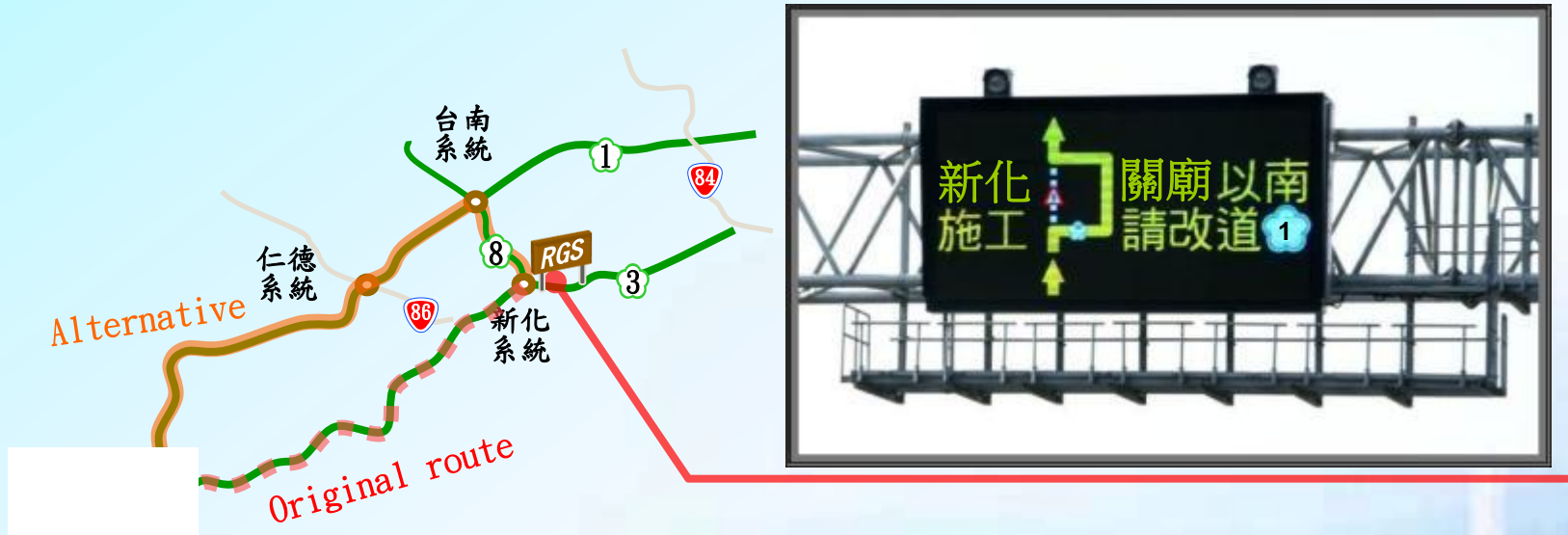
**Automatic
traffic-responsive
model**



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

System Automation

- Route guidance information before major system interchange



System Automation

Metropolitan area network information



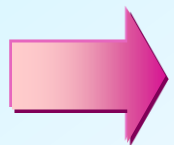
If travel speed below threshold

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.

施工通報系統

新增施工 審核 施工清單 查詢 施工現況 通行碼 報表 設定 使用者 密碼 操作手冊 登出

審核 → 清單

通報單內容	路段管制情形	注意配合事項	承商聯絡方式	修改
通報單號 2_8147 工程/工作名稱 國道一號新營至永康段雙匝道八號一狀旁作業工作(98) 施工項目 國道一號拓寬工程 預定施工時間 2009-04-28 08:00:00 + 2009-04-28 17:00:00	施工路段/方向 國道1號 雙向 281K~320K 施工位置 外側路肩 交通管制情形 移動性施工 不影响交通	用路人注意 用路無阻 交控中心配合事項 透過電台廣播宣導 透過CMS顯示資訊 警管方配合事項 加強巡邏	承商聯絡方式 日新建設 【公司電話】 (0)06-6370948 (黃) 黃 【公司傳真】 06-6353973 【現場人員(-)] 王睿齊 0910679340 工商稅承辦人 新營工務段 郭啟水 06-6563724分機3212	
通報單號 2_8148 工程/工作名稱 國道一號新營至永康段雙匝道八號一狀旁作業工作(98) 施工項目 國道八號拓寬工程 預定施工時間	施工路段/方向 國道1號 雙向 0K~15.51K 施工位置 外側路肩 交通管制情形 移動性施工 不影响交通	用路人注意 用路無阻 交控中心配合事項 透過電台廣播宣導 透過CMS顯示資訊 警管方配合事項 加強巡邏	承商聯絡方式 日新建設 【公司電話】 (0)06-6370948 (黃) 黃 【公司傳真】 06-6353973 【現場人員(-)] 王睿齊 0910679340 工商稅承辦人 新營工務段	

反應計畫 **反應項目** **編號** **內容** **新增** **刪除** **修改**

建議反應 GPS CMS-F80-E-000510 前方內1車道移動施工

事件內容

前方內1車道
移動施工

列印 執行 關閉 選擇建議反應

System Automation

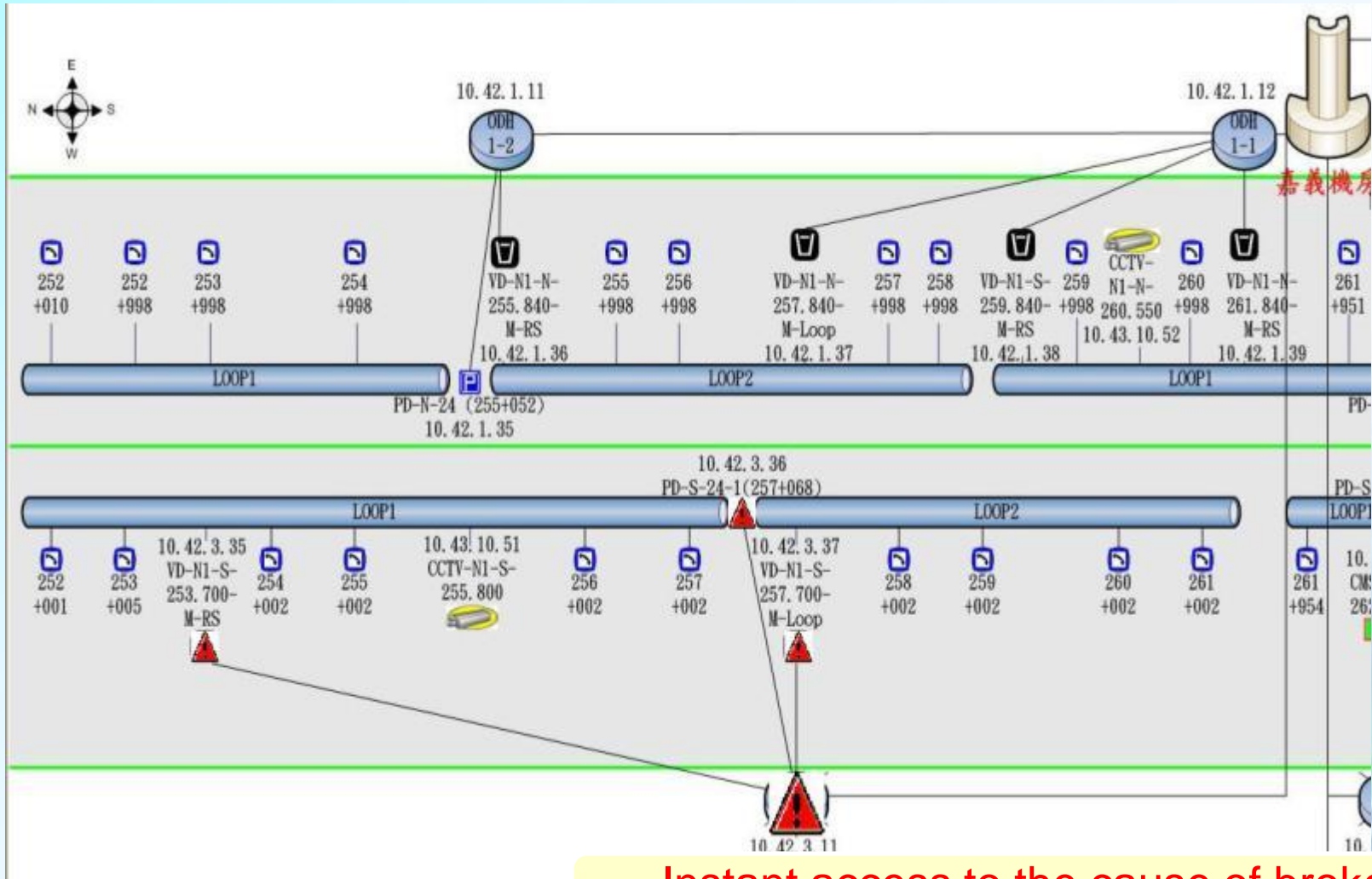
- Information exchange with city traffic control system



Realtime collection of local CCTV, CMS, VD information

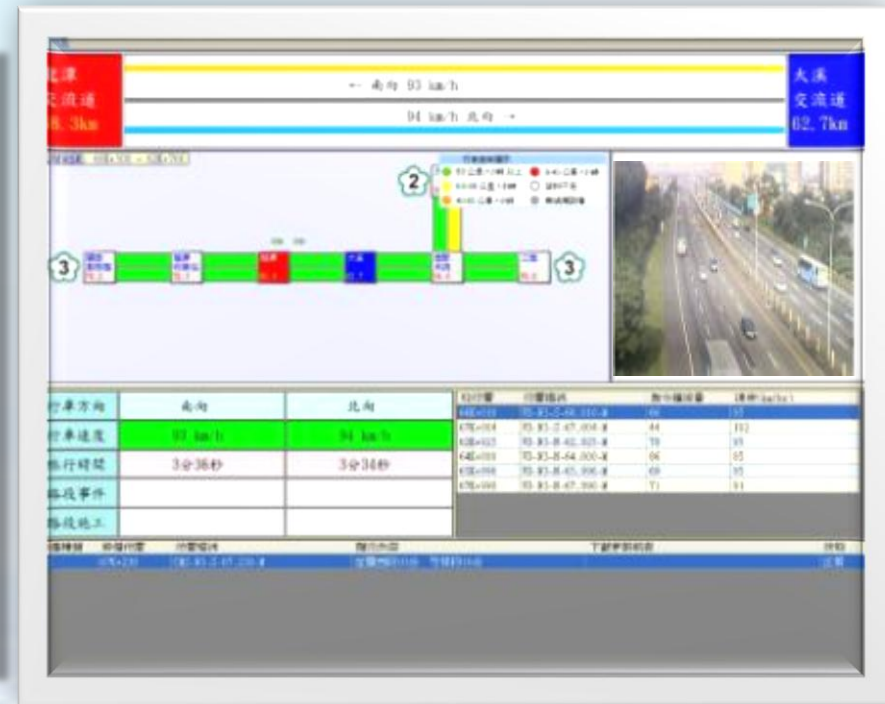
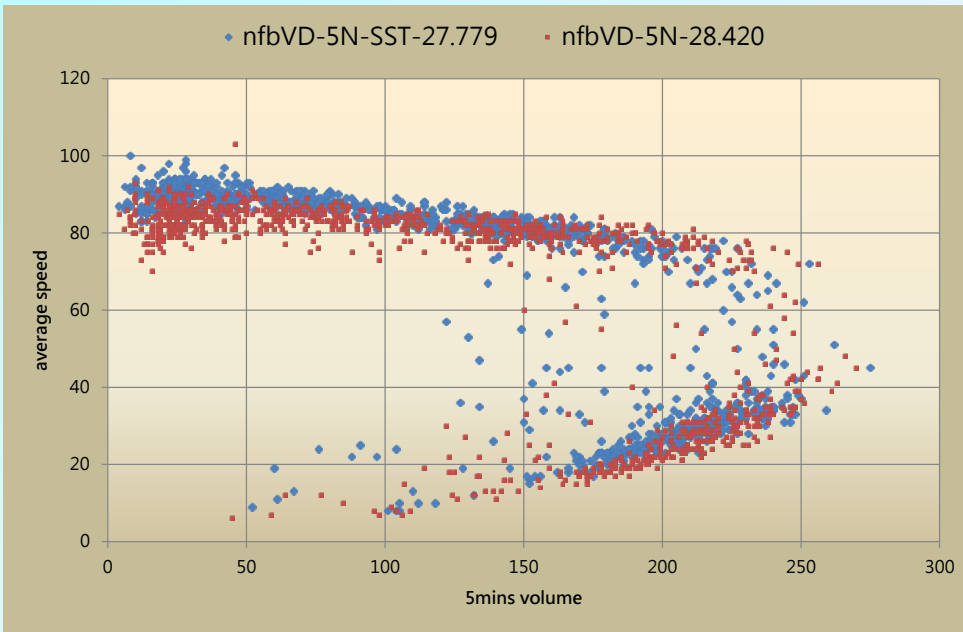
System Automation

Automatic theft detection alert



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



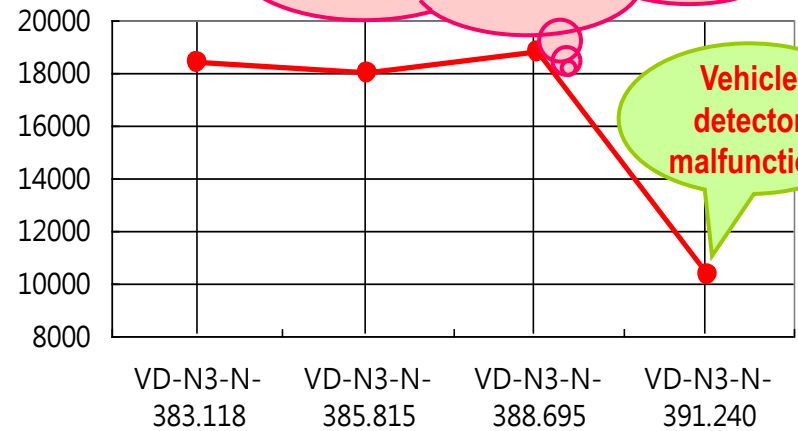
時間	車牌號碼(欄1)	車牌號碼(欄2)	車牌號碼(欄3)	車牌號碼(欄4)	
2010-11-19 14:00:00	721ZN	2010-11-19 13:59:59	8165NL	2010-11-19 13:59:57	9860FG
2010-11-19 13:59:58	C30300	2010-11-19 13:59:56	150SC	2010-11-19 13:59:55	4881XV
2010-11-19 13:59:54	18179U	2010-11-19 13:59:51	403FE	2010-11-19 13:59:51	SC6950
2010-11-19 13:59:50	5075KA	2010-11-19 13:59:49	DT521	2010-11-19 13:59:47	MH5908
2010-11-19 13:59:44	3289HU	2010-11-19 13:59:43	6416HS	2010-11-19 13:59:42	R03288
2010-11-19 13:59:39	072MK	2010-11-19 13:59:37	7M6952	2010-11-19 13:59:33	295438
2010-11-19 13:59:31	1035QG	2010-11-19 13:59:30	1119P	2010-11-19 13:59:30	2863LF
2010-11-19 13:59:30	1301LJ	2010-11-19 13:59:27	8108HU	2010-11-19 13:59:25	6707VWQ
2010-11-19 13:59:24	UM1729	2010-11-19 13:59:23	1322G	2010-11-19 13:59:21	1722N2
2010-11-19 13:59:14	8581LW	2010-11-19 13:59:13	9725UB	2010-11-19 13:59:11	KF916
2010-11-19 13:59:11	1180HB	2010-11-19 13:59:10	0607UC	2010-11-19 13:59:09	9860FU
2010-11-19 13:59:07	563252	2010-11-19 13:59:05	522HS	2010-11-19 13:59:03	W79126
2010-11-19 13:59:02	1486LV	2010-11-19 13:59:01	483KM	2010-11-19 13:59:51	U31187
2010-11-19 13:59:51	1180VM	2010-11-19 13:59:50	7775LV	2010-11-19 13:59:48	HC0860
2010-11-19 13:59:47	5M0727	2010-11-19 13:59:45	8181LT	2010-11-19 13:59:44	T8038
2010-11-19 13:59:42	U39909	2010-11-19 13:59:42	9719LZ	2010-11-19 13:59:40	G0333
2010-11-19 13:59:40	9M7329	2010-11-19 13:59:39	C87527	2010-11-19 13:59:36	5566QD
2010-11-19 13:59:35	JH492	2010-11-19 13:59:31	YR2250	2010-11-19 13:59:31	240JF
2010-11-19 13:59:29	1585LZ	2010-11-19 13:59:26	7408LY	2010-11-19 13:59:26	392LF
2010-11-19 13:59:24	2069VN	2010-11-19 13:59:23	1175VN	2010-11-19 13:59:23	117HP
2010-11-19 13:59:22	054106	2010-11-19 13:59:21	160TL	2010-11-19 13:59:18	7983LL
2010-11-19 13:59:16	3979K	2010-11-19 13:59:15	2985UG	2010-11-19 13:59:12	D77501
2010-11-19 13:59:11	N739D1	2010-11-19 13:59:09	US442	2010-11-19 13:59:02	2A2941
2010-11-19 13:59:00	8038JB	2010-11-19 13:57:59	LJ7212	2010-11-19 13:57:57	BC6768
2010-11-19 13:57:54	3C3218	2010-11-19 13:57:54	1595TL	2010-11-19 13:57:53	DV7899
2010-11-19 13:57:53	YC7293	2010-11-19 13:57:52	CB7646	2010-11-19 13:57:49	9797JK
2010-11-19 13:57:47	1509L7	2010-11-19 13:57:46	0309L7	2010-11-19 13:57:46	0309L7

Facility Maintenance and Management

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

設備種類	設備位置	車輛數量 / 設備數量	確錄數量	故障異常數量	妥善率
車輛偵測器	國道一號	190 / 200	10	0	95%
	國道三號	120 / 180	12	2	90%
測試可變標誌	國道一號	19 / 20	10	0	95%
	國道三號	12 / 18	16	2	90%
閉路電視	國道一號	19 / 20	17	2	90%
	國道三號	19 / 20	17	2	90%

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



Same time VD data comparison



Same interchange VD data comparison

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

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

未來日旅行時間查詢

時段: 固定時段 連續時段

起始日: 99 年 1 月 1 日 17 時

迄止日: 99 年 1 月 7 日

路段: 國道1號

99年1月5日17時路段旅行時間資料

年	月	日	路段名稱	旅行時間	旅行時間(施工事件)
99	1	1	基隆端 - 基隆	1分23秒	1分47秒
99	1	2	基隆 - 八堵	1分4秒	1分13秒
99	1	3	八堵 - 五堵	3分32秒	4分10秒
99	1	4	五堵 - 汐止收費站	2分41秒	3分18秒
99	1	5	汐止收費站 - 汐止	52秒	1分1秒
99	1	6	汐止 - 汐止系統	49秒	57秒
99	1	7	汐止系統 - 汐五汐止端	56秒	1分4秒
			汐五汐止端 - 東湖	2分12秒	2分38秒
			東湖 - 內湖	1分47秒	2分14秒

繪製長條圖 詳細資訊 查詢 結束

30分鐘後旅行時間即時監視

查詢條件

國道編號: 國道1號 方向: 南向 旅行起點: 基隆端 旅行終點: 高雄端

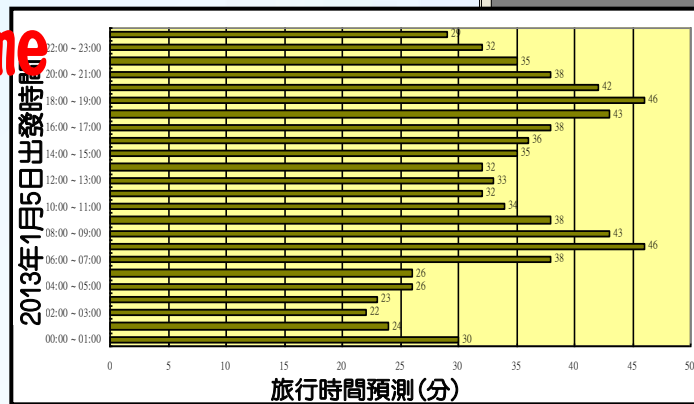
未來旅行時間:

預測2010/01/30 10:15的旅行時間(單位:分鐘)

	基隆端	基隆交流道	八堵交流道	五堵交流道	汐止交流道	汐止系統交流道	汐五高架汐止端	東湖交流道	內湖交流道
基隆端		2	5	11	17	19	21	24	26
基隆交流道			3	9	15	17	19	22	24
八堵交流道				6	12	14	16	19	21
五堵交流道					6	8	10	13	15
汐止交流道						2	4	7	9
汐止系統交流道							2	5	7
汐五高架汐止端								3	5
東湖交流道									2
內湖交流道									
圓山交流道									
台北交流道									

結束

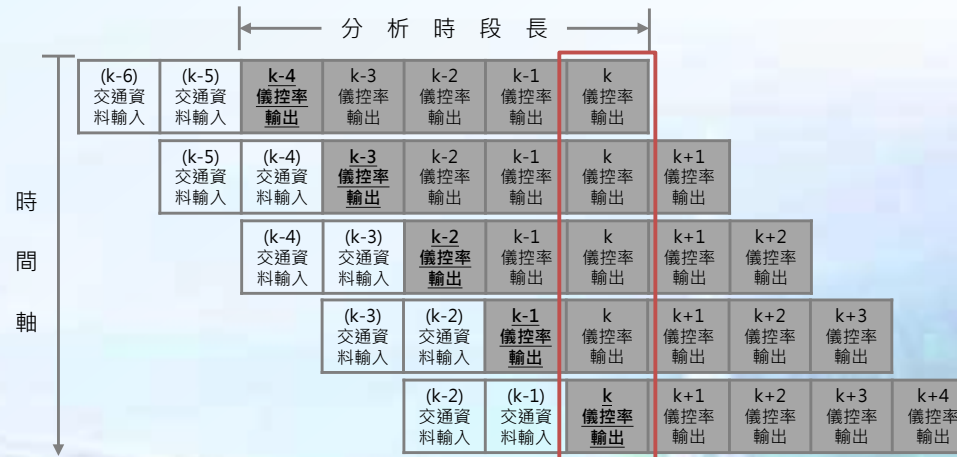
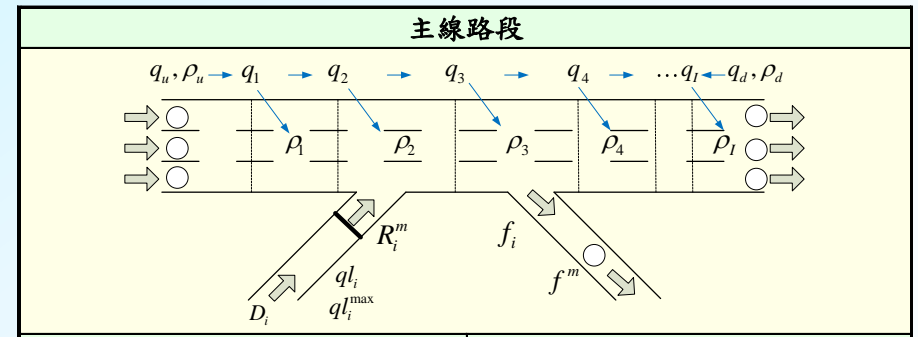
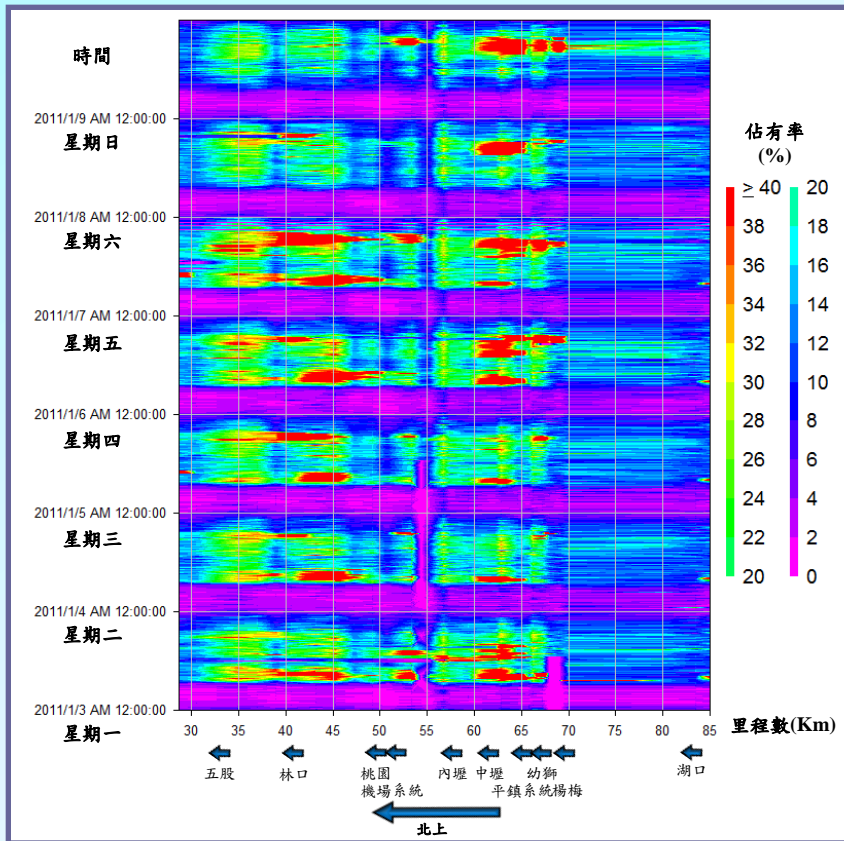
Travelling time Prediction



Integration RMS Strategy

□ Integrated RMS range

□ The goal is max. throughput



k時段實際執行之儀控率
採上述各分析時段儀控率之加權平均數

Goal Formula

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

MCTM: Modified Cell Transmission model



Thank you