行政院及所屬各機關出國報告書

（出國類別：出席國際會議）

參加2003年美國運輸學會第82屆年會報告

服務機關：交通部運輸研究所

出國人職稱：綜合技術組組長

姓名：陳一昌

出國地區：美國

出國期間：92年1月10日至92年1月19日

報告日期：92年4月7日

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出國計畫主辦機關/聯絡人/電話：

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出國類別：□1.考察□2.進修□3.研究□4.實習☑5.其他(出席國際會議)

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分類號/目：HO／綜合類（交通類）　　HO／綜合類（交通類）

關 鍵 詞：智慧型運輸系統，Intelligent Transportation Systems，Transportation Research Board，Houston TranStar

內容摘要：

本次出國行程自92年1月10日至同年1月19日，為期10天，主要目的在參加第八十二屆美國運輸學會年會，會後並順道參訪德州休斯頓Houston TranStar交控及緊急危難中心。

出席年會期間除參加美國運輸學會年會多場研討會並於Poster Session協助展示說明與台灣大學周家蓓教授及陳怡先博士候選人共同發表的論文「Integrated System for Weight-in-Motion, Automatic Vehicle Identification, and Electronic Toll Collection into Commercial Vehicle Operation」外，同時亦參加北美華人運輸協會(NACOTA)年會並報告「台灣智慧型運輸系統發展之回顧~2002年」。

會後參訪德州Houston TranStar，除由毛啓明局長(Andrew C. Mao)導引參觀高速公路相關交通管理設施外，亦經由實地參訪TranStar，了解由Harris County, City of Houston, Metropolitan Transit Authority及Texas Department of Transportation所共同組成的Greater Houston Transportation and Emergency management Center運作情形。

本文電子檔已上傳至出國報告資訊網

摘要

交通部運輸研究所是國內負責運輸領域相關議題的主要政府研究單位之一，為充分了解國外相關議題的近期研究成果與最新研究發展趨勢並參與各項運輸學術研究之互動，每年均於奉准後編列預算指派同仁參與此一盛會；本年度由綜合技術組陳一昌組長代表與會，以了解智慧型運輸系統在運輸領域的最新研究議題與發展情況，並於 Poster Session 中作與台灣大學周家蓓教授及陳怡先博士候選人所共同提出論文「Integrated System for Weight-in-Motion, Automatic Vehicle Identification, and Electronic Toll Collection into Commercial Vehicle Operation」之現場展示與說明。此外由於北美華人運輸學會(NACOTA)循例於 TRB 年會前亦召開其年會，並事先來函邀請本所參加 TRB 年會之同仁能就便參加該會之討論並作報告，故亦至該會報告國內智慧型運輸系統於 2002 年發展之回顧，以協助旅美學人了解國內相關之發展情形。

另外由於欲了解智慧型運輸系統之實際運作情況，亦安排於 TRB 年會後，至德州休斯頓地區參訪運作績效出名的 Houston TranStar，除拜訪毛啟明局長(Andrew C. Mao)外，主要經由實地參訪，了解由 Harris County, City of Houston, Metropolitan Transit Authority 及 Texas Department of Transportation 所共同組成的 Greater Houston Transportation and Emergency management Center 運作情形。

TRB 為美國政府運輸部門所強力支持的學術研究團體，公私部門均提供相當之財務以支持學會之運作；學會每年之年會均會吸引國內外數以千計的運輸領域產、官、學、研單位人員與會，共同交換研究心得與啟發新的觀念與思維；惟國內似乎尚未見到受政府部門如此信賴且支持之研究單位。

近年來國外參與 NACOTA 年會者多來自大陸，大陸人士對該學會的影響力亦日漸加強。為避免海外學人對台灣發展情形有所脫鉤，國內奉派參加 TRB 年會人員，宜撥出時間參加北美華人運輸學會的活動，並提供國內發展情形的報告，將有助於與對岸及美方學人之良性交流與互動。

Houston TranStar 結合四個政府單位合署辦公，共同解決大休斯頓地區的交通控制與危難處理機制；各單位間的協調運作極為良好，各項行政資源亦能作最有效的運用，為美國一個相當卓越的運作典範。國內各級政府之交控單位間若欲改善彼此之間的協調合作關係，以有效整合區域交通之管理，似乎可以有所借鏡。

目錄

一、 前言

美國運輸學會(Transportation Research Board, TRB)是國家研究會(National Research Council)下的一個私人非營利機構，為國家科學學院(National Academy of Science)及國家工程學院(National Academy of Engineering)的主要運作單位；美國運輸學會成立於1974年，其前身分別為1920年成立的National Advisory Board on Highway Research及1925年改制的Highway Research Board。運輸學會的任務是藉由互動及進行研究，以促進運輸界之創新與進步並鼓勵研究結果的實施。TRB經由其技術委員會及工作小組的推動，強調各種運具及運輸相關事項，出版並釋出研究報告與同儕審查研究發現的各種技術論文；同時負責管理下列二項合約研究計畫：(1)由州運輸部門支持的National Cooperative Highway Research Program (NCHRP)及(2)由聯邦大眾運輸局(Federal Transit Administration)所支持的Transit Cooperative Research Program (TCRP)。此外TRB亦接受政府所委託，進行Long-Term Pavement Performance (LTTP)及Innovations Deserving Exploratory Analysis (IDEA)等計畫。

學會之經常活動分為下列五個部門

- Division A - Technical Activities 技術活動
- Division B - Studies and Information Services 研究及資訊服務
- Division C - Administration and Finance 管理及財務
- Division D - Cooperative Research Programs 合作研究計畫
- Division E - Special Programs 特別計畫

有超過4500位的運輸專業人士參與，作為TRB的志工，提供於約460個不同的委員會、工作小組以及審查小組等單位的服務，以推動學會之工作。學會除了在美國國會及政府單位要求下，主導運輸政策的特別研究以及維運網路上的運輸研究資訊外，並且負責舉辦每年吸引高達8000位美國國內外運輸專業人士參加的年會。本次奉派參加之年會即為第82屆年會，仍依慣例於嚴冬旅遊淡季的一月中舉辦；由於有將近2400篇的論文發表，會議地點一如往例，分別於Marriott Wardman Park Hotel (2660 Woodley Road，如照片一)、Omni Shoreham Hotel (2500 Calvert Street)以及Hilton Washington Hotel (1919 Connecticut Avenue)三處舉行，接駁巴士則於一月十二日(星期日)至一月十六日期間的前四日，自每日早上6時30分起至晚上11時止，以20分鐘間距循環行駛於三處會場(最後一日至下午二時三十分)，提供與會人員方便的遊走參與於各個會場的相關關注議題場次中。

照片一、會場之一 Marriott Wardman Park Hotel

交通部運輸研究所是國內負責運輸領域相關議題的主要政府研究單位之一，為充分了解國外相關議題的近期研究成果與最新研究發展趨勢並參與各項運輸學術研究之互動，每年均於奉准後編列預算由運輸計畫、工程、安全、管理、資訊及綜合技術等六個不同研究領域的組輪流指派一位同仁參與此一盛會；本年度輪由綜合技術組指派代表與會，以了解智慧型運輸系統在運輸領域的最新研究議題與發展情況。

二、行程概要

由於北美華人運輸學會循例於 TRB 年會前，於 TRB 學會會場召開其年會，並事先來函邀請本所參加 TRB 年會之同仁亦就便參加該會之討論並作報告，故需提前一天至華府以便與會；此外由於欲了解智慧型運輸系統之實際運作情況，亦安排於 TRB 年會後，至德州休斯頓地區參訪運作績效出名的 Houston TranStar.，全部行程安排如下：

92/01/11 (SAT) 搭乘 AA2418 LAX-DFW 至達拉斯轉乘 AA1566 DFW-DCA 至華盛頓
92/01/12(SUN) 參加 NACOTA(北美華人運輸學會)年會，並赴 TRB 年會報到。
92/01/13(MON) 參加 TRB 年會各場次研討會
92/01/14(TUE) 參加 TRB 年會各場次研討會
92/01/15(WED) 參加 TRB 年會各場次研討會
92/01/16(THR) 搭乘 AA1213 DCA-DFW 至達拉斯
92/01/17(FRI) 搭乘 CO2019 DFW-IAH 至休斯頓參訪 Houston TranStar
92/01/18(SAT) 搭車由休斯頓回達拉斯

附錄一為本次於 NACOTA 年會上所報告的論文(台灣 ITS 發展之回顧~2002)之簡報資料。

三、 年會主要內容及特色

本次年會共接受有約 2400 篇的論文，分別於三處會場的超過 500 個會場中舉行；其中有 115 場次又特別為年會主辦單位標示了屬於本次會議的四大特色議題(Spotlight Sessions)，即：(1)保安~一年後(Security: One Year Later(2)壅塞~未來將如何承受？(Congestion: What Does the Future Hold?)(3)改善安全的新工具(New Tools for Improving Safety)(4)再授權之路(The Route to Reauthorization)。顯然美國於經歷 2002 年 9 月 11 日的恐怖攻擊後，對於運輸業如何因應緊急危難處理的特別關注，因此對於運輸安全及保全(Safety and Security)方面檢討的議題特別的多。

若依運輸研究領域來分，則其領域別及舉辦研討會之地點分別為：

(1) 運輸系統規劃與行政(Transportation Systems Planning and Administration)，其中 Management and Administration, Finance, Planning, Public Transportation, Environment, Data 等在 Hilton 舉行，而 Intercity Rail, Aviation, Water Transportation, Freight Transportation 則在 Shorehan 舉辦。

(2) 設計與施工(Design and Construction)分別於 Marriot 及 Shorehan 舉行。

(3) 營運、安全與維護(Operation, Safety and Maintenance)於 Marriot 及 Hilton 舉行。

(4) 法律資源(Legal Resources)中，公路法於 Marriot，捷運法於 Hilton 舉行。

此外，由於發表論文實在很多，不能均能容納於各場次中宣讀，故本次年會中亦安排多場的海報會議(Poster Session)部分，由獲選論文之作者將其論文重點，以海報方式張貼於規定地點，並於年會安排的特定時段於張貼地點親自解說，以與聽眾達成面對面的溝通；因為聽眾可以直接與作者作充分的討論與雙向交流，因此互動效果極為良好，據悉將為年會日後可能逐漸增多辦理的方式。本次年會本人與台大周家蓓教授及陳怡先博士候選人所共同提出之論文「Integrated System for Weight-in-Motion, Automatic Vehicle Identification, and Electronic Toll Collection into Commercial Vehicle Operation」即被列於一月十四日上午(9:00-noon)在 Marriott 的 Exhibit Hall C 中屬於大會主題(spotlight)的 Poster Session 中發表，詳細論文內容如附附錄二所示。

3.1 年會展覽

TRB 的展覽，一向即甚為壯觀與多樣化，此次的展覽亦不例外。能夠參展之單位必須為 TRB 的贊助者或資助會員(欲成為資助會員，最少之資助金額自 15,000 美元起跳)。此次參展者除 Caliper Corporation、3M 等私部門外，絕大部分為政府公部門，包括：

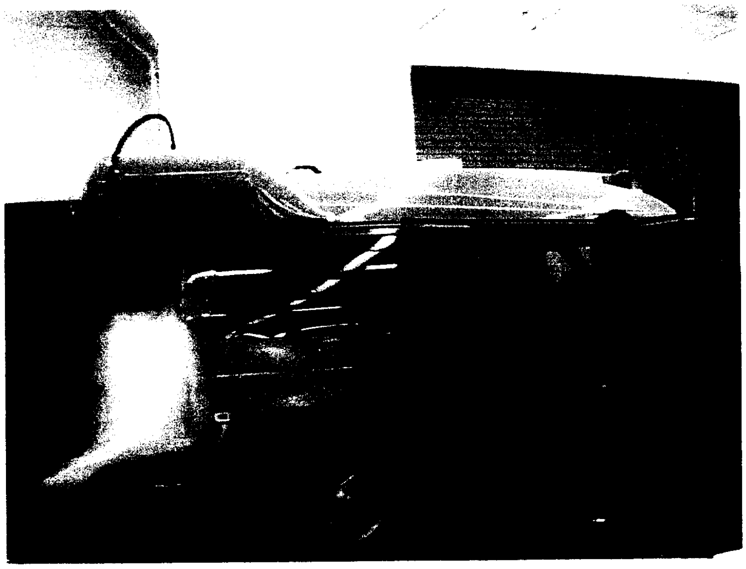
- **American Association of State Highway and Transportation Officials (AASHTO)**
- **American Public Transportation Association**
- **Bureau of Transportation Statistics**
- **Environment Protection Agency Smart Growth Network**
- **Federal Highway Administration (FHWA)**
  - Asphalt Pavement Program
  - Center for Advanced Infrastructure and Transportation
  - Center Artery
  - Concrete Pavement Technology Program
  - Construction and Systems Preservation
  - Federal Highway Administration Resource Centers
  - Federal Lands Highway Program
  - Garrett A. Morgan Technology and Transportation Futures Program
  - Geotechnical Engineering
  - High-Performance Concrete Bridges
  - High-Performance Steel for Bridges
  - Highway Innovative Technology Evaluation Center
  - Highway Safety Information System
  - Hydraulics
  - Information: FHWA Exhibits
  - Infrastructure Research and Technology
  - Interactive Highway Safety Design Model
  - Local Technical Assistance Program
  - Long-Term Pavement Performance Program
  - McTrans (the Center for Microcomputers in Transportation)
  - National Highway Institute
  - Nationwide Differential Global Positioning System
  - Office of Asset Management
  - Office of Highway Policy Information
  - Office of Infrastructure
  - Office of International Programs
  - Office of Operations and Intelligent Transportation Systems
  - Office of Safety
    - ✓ Intersection safety
    - ✓ Pedestrian Safety

- ✓ Safety Vital Few Program
- ➢ Organization for Economic Co-operation and Developments Road Transport Research Program
- ➢ Pavement Smoothness
- ➢ PC-TRANS
- ➢ PIARC-World Road Association
- ➢ Planning and Environment
  - ✓ Access management
  - ✓ Congestion Mitigation and Air Quality Improvement program
  - ✓ Intermodal and Statewide Programs Data van
  - ✓ 'It All Adds Up to Cleaner Air' Pubic Education Initiative
  - ✓ Livable Communities
  - ✓ National Scenic Byways Program
  - ✓ Office of Real Estate Services
  - ✓ Transportation Enhancement Program
- ➢ Preventive Maintenance
- ➢ Recycled Materials Resource Center
- ➢ Research, Development, and Technology Strategic Communicat
- ➢ Research Partners
- ➢ Small Business Innovation Research
- ➢ Technology Implementation Group
- ➢ Travel Model Improvement Program
- ➢ Universities and Grants Programs
- ➢ Wood in transportation Program
- ➢ Woodrow Wilson Bridge Project

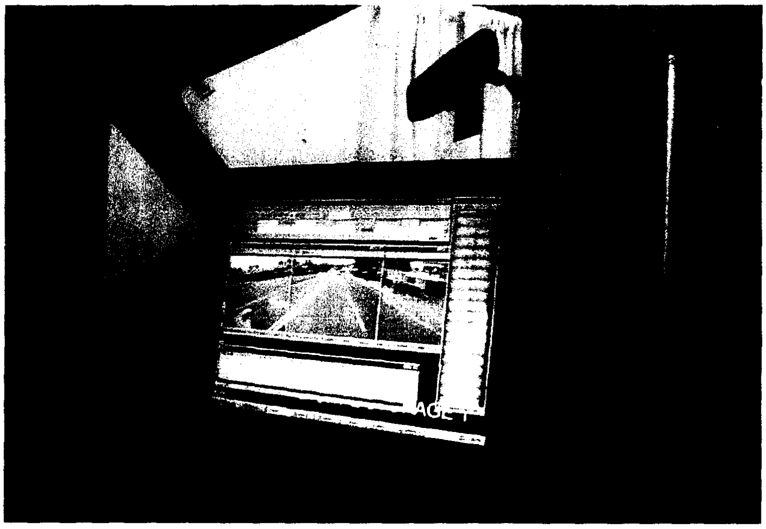
- ◆ **Federal Motor Carrier Safety Administration**
- ◆ **Federal Railroad Administration**
- ◆ **Federal Transit Administration**
- ◆ **Maritime Administration**
- ◆ **Maryland State Highway Administration**
- ◆ **National Aeronautics and Space Administration (NASA)**
- ◆ **National Asphalt Pavement Association**
- ◆ **National Highway Traffic Safety Administration**
- ◆ **Transportation Research Board**
  - ➢ Affiliates and Publications
  - ➢ Innovations Deserving Exploratory Analysis (IDEA) Programs
  - ➢ Information Services (TRIS and RiP Database)
- ◆ **US Army Corps of Engineers**
- ◆ **US Coast Guard Marine Transportation System**
- ◆ **US Department of Agriculture**
- ◆ **Volpe National Transportation System Center**
- ◆ **American Public Transportation Association**
- ◆ **Federal Transit Administration**

- **National Household Travel Survey**
- **Transportation Research Information Services**

藉由參觀各個參展單位的攤位以及收集其所提供的書面資料，可以充分了解美國政府運輸部門最新之研究成果與未來研究領域走向，對於國內研究單位欲與國際同步或接軌時之一手資訊獲得極為重要。以鋪面工程為例，在聯邦公路總署的研究計劃所展示的即有：Asphalt Pavement Program、Concrete Pavement Technology Program、Long-Term Pavement Performance Program、Office of Asset Management、Pavement Smoothness、Preventive Maintenance、Recycled Materials Resource Center 等，可以全盤了解美國近年來對於鋪面方面所關注的議題及研究結果。照片二、三為現場所展示的路面評審儀 ARAN。



照片二、ARAN 外觀



照片三、ARAN 內裝有路況顯示設備

3.2 911 恐怖攻擊後之相關議題

本次大會特別提出有關 911 事件後安全與保安方面的討論會(Workshop)，部分的主要議題為：

1. Traffic Incident Management 交通事故管理
2. Using Simulation to Evaluate Impacts of Airport Security 運用模擬法評估機場保安之衝擊
3. Transportation Security Research: Establishing a National Priority 運輸保安研究：建立國家優先性
4. Glare and Nighttime Roadway Visibility 炫目及夜間道 路的可視度
5. Reaching 100 Percent: Achieving Higher Sear Belt Use Rates 到達百分之一百的安全帶使用率
6. What is Safety Culture and How Can It Be Improved? 如何改進安全文化
7. Intersection Crossroads to Safer Driving? 路口行車安全
8. Railroad Safety, Derailment Prevention, and Risk Assessment 鐵路安全、預防出軌與危機評估
9. Transportation Finance 運輸財源

3.3 學術委員會活動

學會所屬的各個學術委員會亦於年會期間同時舉辦其各自獨立的委員會議(Committee Meetings)，除了該學術委員會的委員得以參加外，與會人員亦可以蒞場旁聽，以了解該委員會一年來的主要活動以及未來一年擬進行研究的方向。學會下之各種委員會數量極多，幾乎重要或有趣的運輸議題都成立了相對的學術委員會加以主導，主要技術活動(Technical Activities)分為下列諸端：

Group 1:運輸系統規劃與行政(Transportation Systems Planning and Administration)

- Section A 管理與行政(Management and Administration)
- Section B 複合運具運輸(Multimodal Freight Transportation)
- Section C 運輸預測、資料、經濟(Transportation Forecasting. Data, and Economics)
- Section D 運輸系統規劃(Transportation Systems Planning)
- Section E 公共運輸(Public Transportation)
- Section F 環境事務(Environmental Concerns)
- Section G 航空(Aviation)

Group 2：運輸設施之設計與施工(Design and Construction of Transportation)

- Section A 一般設計(General Design)
- Section B 鋪面管理(Pavement Management)
- Section C 結構物(Structures)
- Section D 瀝青(Bituminous)
- Section E 混凝土(Concrete)
- Section F 施工(Construction)
- Section G 地工材料(Geomaterials)
- Section H 土壤力學(Soil Mechanics)
- Section I 地質與土壤特性(Geology and Properties of Earth Materials)
- Section J 軌道系統(Railway Systems)

Group 3：運輸設施之營運、安全與維護(Safety, and Maintenance of Transportation Facilities)

- Section A 設施與營運(Facilities)
- Section B 使用者與車輛(Users and Vehicles)
- Section C 維護(Maintenance)

Group 4 法律資源(Legal Resources)

Group 5 群組資源與議題(Intergroup Resources and Issues)

3.4 學術研討會

研討會各場次的討論，分為下列各領域及類別

- ✓ 行政與管理 ***Administration and Management***
- ✓ 航空運輸 ***Air Transportation***
- ✓ 橋函及隧道之設計與績效 ***Bridge, Culvert and Tunnel Design and Performance***
- ✓ 壅塞 ***Congestion***
- ✓ 施工(一般、鋪面、結構物)***Construction***
- ✓ 資料 ***Data***
- ✓ 能源 ***Energy***
- ✓ 環境與美學 ***Environment and Aesthetics***
- ✓ 設備、裝備之設計與績效 ***Facilities, Equipment Design and Performance***
- ✓ 財務、經濟與社會經濟 ***Finance, Economics and Socioeconomics***
- ✓ 預測 ***Forecasting***
- ✓ 貨運 ***Freight Transportation***
- ✓ 公路營運與交通 ***Highway Operations and Traffic***
- ✓ 水工、水文與水質 ***Hydraulics, Hydrology and Water Quality***
- ✓ 資訊系統 ***Information System***
- ✓ 智慧運輸系統 ***Intelligent Transportation System***
- ✓ 複合運輸 ***Intermodalism***
- ✓ 法律 ***Law***
- ✓ 維護 ***Maintenance***
- ✓ 材料(瀝青、水泥，混凝土、級配料)***Materials***
- ✓ 鋪面管理、設計與績效 ***Pavement Management, Design,and Performance***
- ✓ 行人與自行車騎士 ***Pedestrians and Bicyclists***
- ✓ 規劃 ***Planning***
- ✓ 鐵路 ***Railroads***
- ✓ 安全與人因績效 ***Safety and Human Performance***
- ✓ 保全與復原 ***Security and Recovery***
- ✓ 土壤、地質與基礎 ***Soils, Geology, and Foundations***
- ✓ ***Spotlights***
- ✓ 策略公路研究計畫 ***Strategic Highway Research Program***
- ✓ ***TEA-21 and ISTEA***
- ✓ 捷運與公共運輸 ***Transit and Public Transportation***
- ✓ 貨運 ***Trucking***
- ✓ 水運 ***Water Transportation***

四、參訪 Houston Transtar

Houston Transtar(照片四)係由 City of Houston, Harris County, Metropolitan Transit Authority of Harris County(METRO)及 State of Texas(TXDOT)等四個機構於 1996 年四月所組成，用以負責大休斯頓地區(the Greater Houston Region)四個政府部門運輸系統的規劃、設計、營運以及緊急事故管理。其服務之區域廣達 5,436 平方英哩，人口數為四百萬人。

照片四、Houston TranStar

TranStar 工作與管理範圍包含：

- 160 英里之高速公路管理系統(Freeway Management System)以及其他道路系統約 300 英里
- 高速公路與主要街道事故管理
- 於 128 個匝道實施匝道儀控
- 316 具高速公路閉路電視監控器
- 154 座動態資訊標誌(Dynamic Message Signs)
- 12 座固定位置 及 1 座移動式的公路路況廣播(Highway Advisory Radio) 系統。
- 94.4 英里長的隔離雙向式 HOV 車道，以及 10 號州際公路約 6.6 英里長的共乘車道(diamond lanes)

- 2,800 座地區性交通號誌系統
- 智慧運輸系統(Intelligent Transportation Systems, ITS) 計畫
- 緊急管理運作(Emergency Management Operations)
- 洪水警報系統 (Flood Alert System)及道路天候資訊系統(Roadway Weather Information Systems)

該中心的主要工作包括

(1) 運輸管理(Transportation Management)：該中心為美國建立全國智慧運輸系統(ITS)之主要一環，已有許多最新的技術應用於該地以改善地區交通狀況。這些技術包括閉路電視(CCTV)、動態資訊標誌(DMS)、連鎖交通號誌(Synchronized Traffic Signals)、速度感應器(Speed Sensor)、路況廣播電臺(Highway Advisory Radio)等。

(2) 緊急事故管理(Emergency Management)：大休斯頓地區經常有颶風、洪水、工廠爆炸等意外事故發生，此時即需啟動 TranStar 的緊急運作中心(Emergency Operation Center, EOC)以為因應；由四個政府單位所派駐中心的代表於事故發生時即迅速集會研商，以採取迅速有效的對策。目前使用的技術包括：自動洪水警報系統(Automated Flood Warning System)、都普勒雷達影像(Doppler Radar Imagery)、衛星氣象地圖(Satellite Weather Maps)、道路淹水警示系統(Road Flood Warning Systems)、HAM 無線電台等。

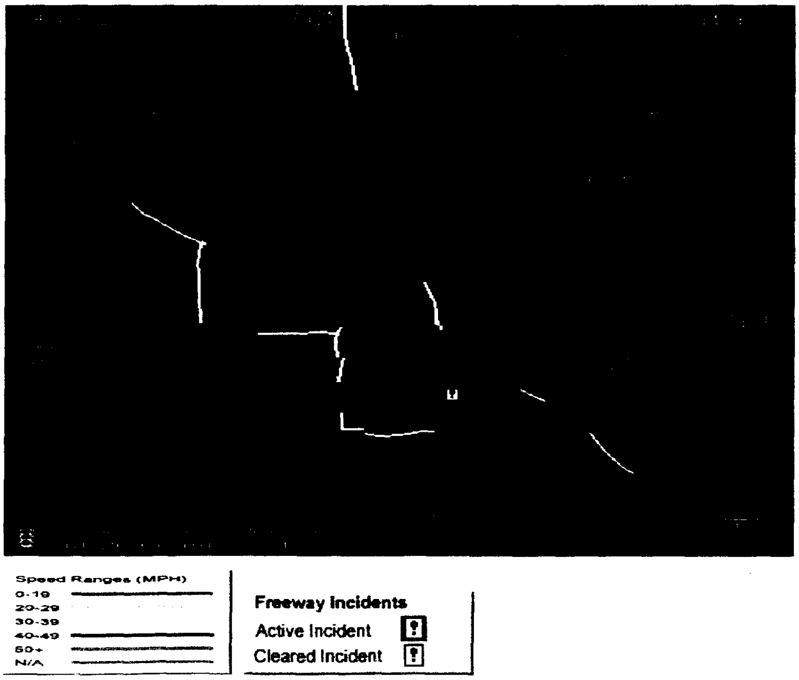
(3) 影響資源(Leveraging Resources)：該中心由四個政府部門派來工程師、執法人員、資訊技師、緊急管理人員等，各自帶來管理其各自功能之系統且可互相支援。

(4) 創新(Innovation)：TranStar 是美國第一個將運輸管理與緊急事故管理結合的一個組織，也是第一個將市與郡的緊急管理中心予以合署辦公，第一個研發先進運輸控制器(Advanced Transportation Controller)及共用的控制中心軟體(ICONS)。

由於 TranStar 是一個成功的將州政府與地方政府的公共運輸單位合作運作的單位，而且運作績效卓著，因此已成為美國一個跨越行政門檻而成功整合資源一個典範。其具體績效為減少旅途時間、減少能源耗費、減少汽車污染排放等，同時減低因洪水、氣候相關及人為疏失而導致之受傷、死亡及財產損失等等，照片五為 TranStar 交控中心。

照片五、Houston TranStar 交控中心

附圖一即為 TranStar 於網路上提供之即時路況資訊，分別以六種顏色來表示行車速率，同時也以二種圖案標明事故位置與處理之進度，提供用路人參考。



附圖一、TranStar 的即時交通資訊網頁

五、相關考察心得

5.1 華府捷運系統

華盛頓地區的捷運系統路網圖如下圖所示，一共有紅(Shady Grove ~ Glenmont)、橘(Vienna/Fairfax-GMU ~ New Carrolton)、黃(Huntington ~ Gallery Palace/Chinatown)、藍(Franconia-Springfield ~ Addison Road/Seat Pleasant)、綠(Branch Ave. ~Greenbelt)五線，各路線間設有八個轉運點，可以方便的轉乘於各路線間；路線上亦設有 Park and Ride 的停車場與大眾運輸轉運站(MARC)，以利旅客使用。對於搭乘飛機到華盛頓特區的旅客，藍線與黃線均設有雷根國家機場(Ronald Regan National Airport)站，使用之旅客極多。

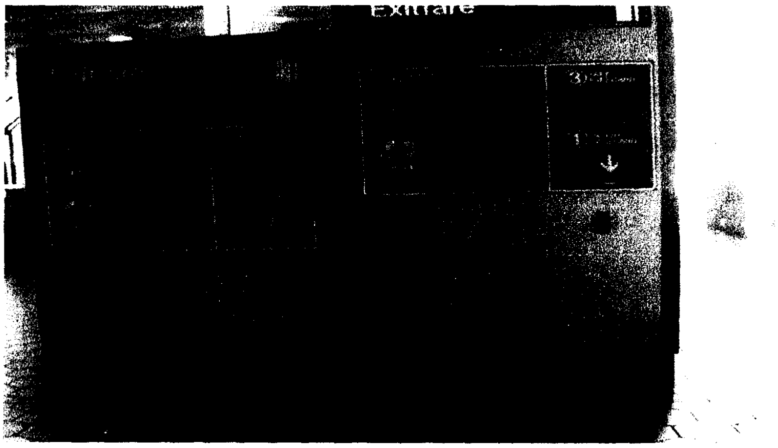
附圖二、華盛頓特區之捷運路網圖

照片六為捷運站內所設置的路網圖，以利乘客查尋出口鄰近地區地圖及

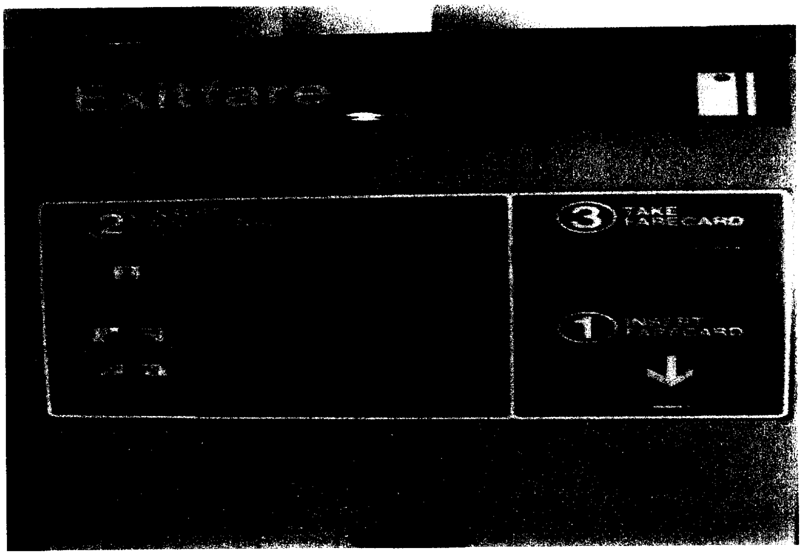
轉乘站位置與相關票價等資訊。

照片六、捷運站內導引圖

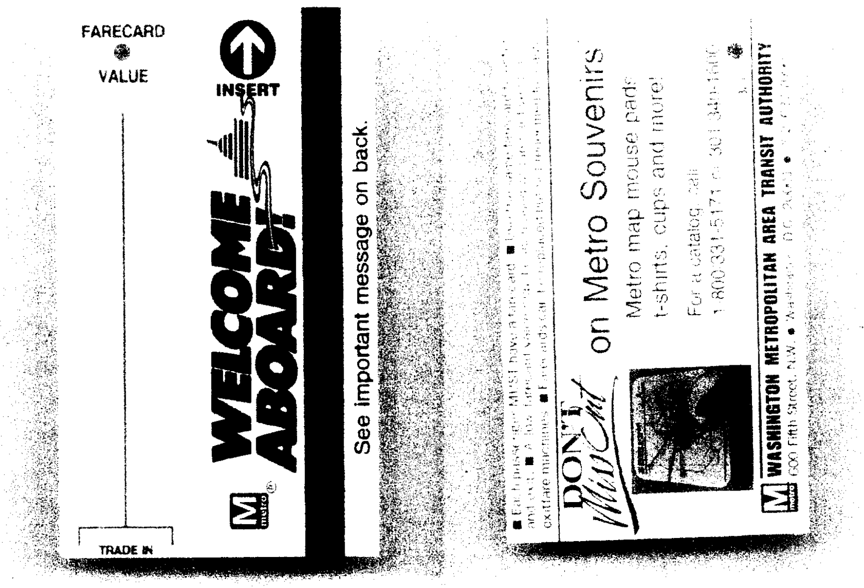
照片七、八為捷運站內所設之的自動售票機，與台北捷運系統不同的是其票証是採用紙票，乘客可以依該次所擬搭乘路段間之站別，購買單程的車票，或是投入較多的費用買票，俾得以多次來往不同的車站間。若單次或多次票證所含之金額不足以支付該趟車資時，於出站匝門前亦設有加值機；惟加值後是重新發出新的票証，附圖三為票証的型式。這樣的設計，似乎可以避免目前台北悠遊卡所引起消費者質疑於購買儲值卡時須預繳100 元的保證金的問題。



照片七、捷運站內售票機

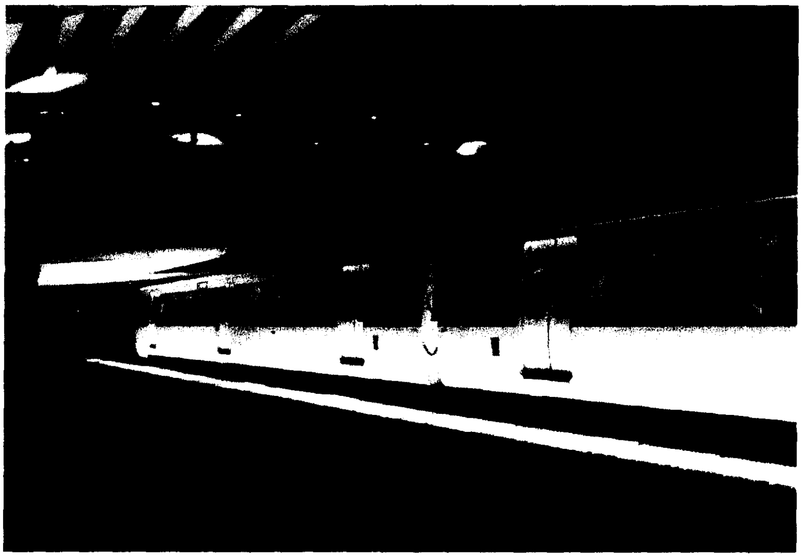


照片八、售票機上標示售票及加值操作程序



附圖三、華盛頓特區的捷運票證

照片九、捷運之地面車站景觀(國家機場站)



照片十、捷運之地下車站景觀(Woodley Park-Zoo 站)

5.2 華府車道調撥設施

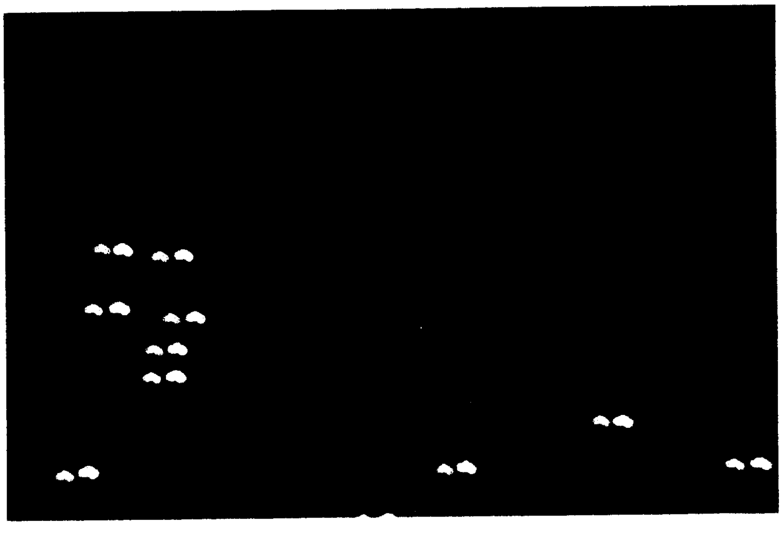
為了有效處理尖峰時段的交通量，華府市區道路亦有採取時段調播的機制；照片十一為 Connective Ave. 上所懸掛之標誌，說明於晨峰時段(早上七點至九點三十分)時，南向進城方向為四車道，於昏峰時段(下午四時至六時三十分)則改為出城方向為四車道，進城方向為二車道。路上並未見到交通警察指揮，也未見到設有交通錐等劃分逆向車道之設施，然而駕駛人卻仍然會遵循規定車道行駛。

照片十一、車道調撥標誌(Connective Ave.)

5.3 Houston TranStar 的緊急應變中心(Office of Emergency Management)

Harris County 與 Houston 均設有緊急應變辦公室，並於 TranStar 內設置合署辦公之機制。緊急應變計畫所關切之事項包括：家庭災變(Family Disaster)與天候災難(Weather Hazards)，後者包括洪水、暴風雨、颶風。由於大休斯頓地區之東側地形較為低窪，排水較為不易，因此在 TranStar 中裝有監視螢幕隨時注意地區之淹水警報情況，如照片十二、十三所示。

照片十二、TranStar 的緊急應變中心洪水監視銀幕

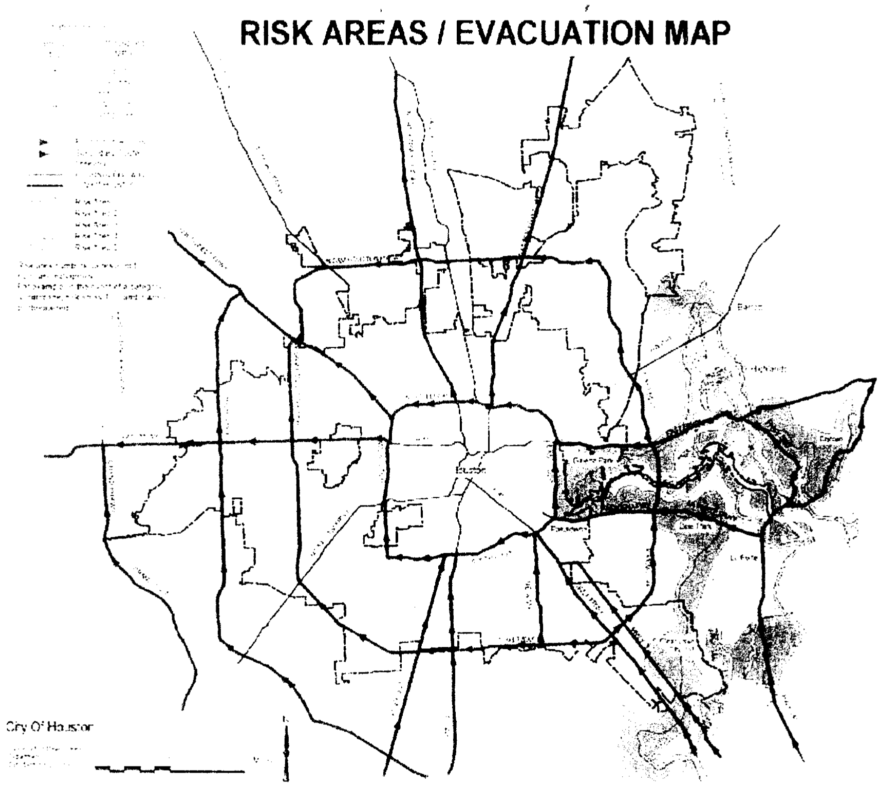


照片十三、TranStar 的緊急應變中心牆上顯示各監視站之運作狀況

該中心將颶風依 Saffir-Simpson scale 分為五級，即

Category	Windspeed (MPH)	Damage
1	74-95	Minimal
2	96-110	Moderate
3	111-130	Extensive
4	131-155	Extreme
5	Greater than 155	Catastrophic

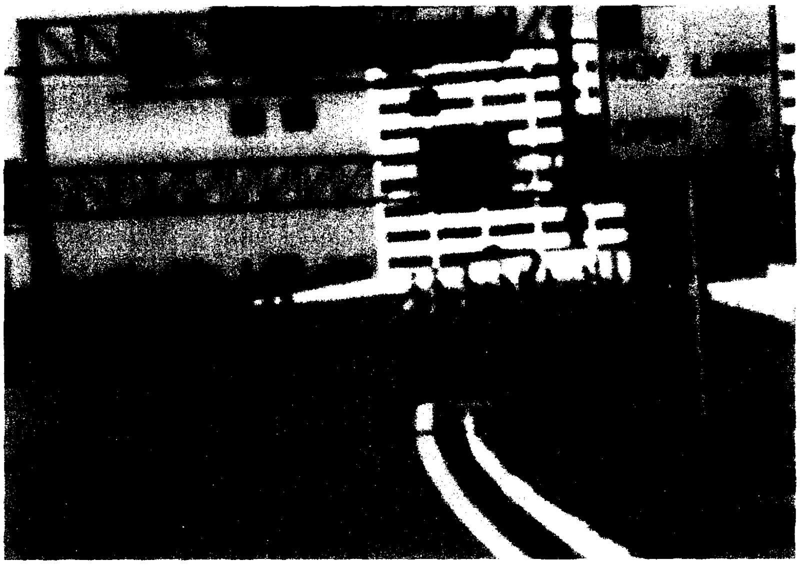
並將 Harris County/Houston 地區依危險程度劃分為五級，於圖上以不同顏色標示，圖上並以紅線標示主要疏散道路(I-45N, TX 225, I-10, 610 Loop, TX 288, US 290, Beltway 8, TX 6, US 59N)，以藍色標示次要疏散道路(SH 3, SH 35)，以利緊急危難時之交通疏導控制，附圖四即為大休斯頓東側危險區域及緊急撤離計畫圖。



附圖四、危險地區疏散路線示意

5.4 休斯頓地區的共乘車道(HOV lane)

TranStar 所規劃的共乘車道為雙向可逆式車道，是依晨、昏峰交通方向的不同，而給予共乘車輛某一方向的通行權，因此在共乘車道起點之路口前，會設置標誌牌，提醒用路人依循架空號誌所顯現之燈號行駛，如照片十四所示。照片十五突顯出共乘車道於尖峰時段相對於一般車道車道的良好交通情況。



照片十四、HOV 車道起點

照片十五、HOV 車道交通情況

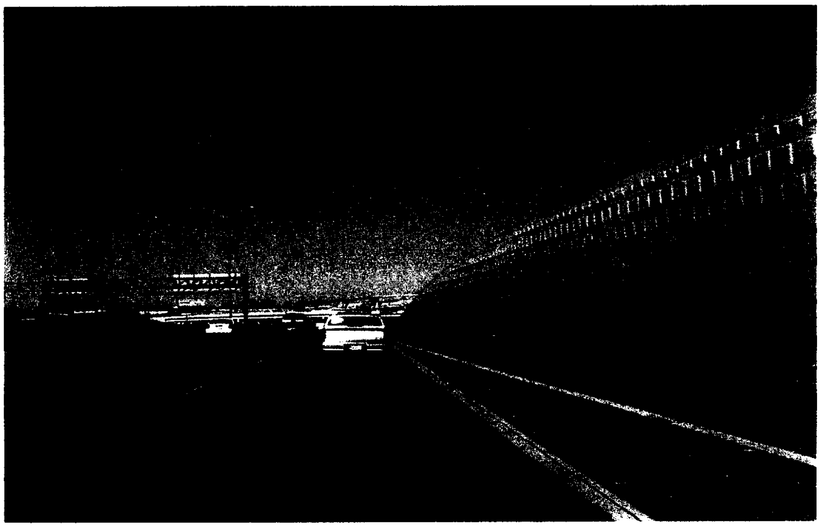
5.5 高速公路設施

照片十六為德州 6 號州道(State Route)的路況，由部分地區尚未拓寬且中央僅以分隔標線而未設置護欄等區隔設施，因此遂有日、夜間不同速限之設計，如照片十七所示，日間速限為 70 英哩，夜間即降為 65 英哩，以維護行車安全。

照片十六、德州 6 號州道(State Route)路況

照片十七、德州 6 號州道(State Route)日、夜間速限不同

照片十八為 I-35 州際高速公路的路況，與州屬高速公路之設施及有顯著之差別，照片右側為地工加勁擋土牆。照片十九為加州 I-710 高速公路上行駛許多載重貨車之情況，與德州高速公路路況有顯著之不同。



照片十八為 I-35 州際高速公路的路況

照片十九、加州 I-710 高速公路較多載重貨車之路況

六、心得與建議

1. TRB 為美國政府運輸部門所強力支持的學術研究團體，公私部門均提供相當之財務以支持學會之運作;學會每年之年會均會吸引國內外數以千計的運輸領域產、官、學、研單位人員與會，共同交換研究心得與啟發新的觀念與思維。為了啟迪新的學子參與，年會針對新與會人員除了提供二項服務：(1)New and Young Attendees Welcome Session and Networking Reception (2)Presentation Training 之外，亦藉由名牌上所附加的白色絲帶顏色標示新與會人員，而請學術委員會人員(Blue Ribbon)、場次主持人(Ribbon Yellow)及工作人員(Ribbon Red)隨時加以協助，對新與會人員誠屬一項貼心的服務。國內尚未見到受政府部門如此信賴且支持之研究單位，對於推動具體之研究及協助各運輸領域參與之向心力實有不足。

2. 年會發表的論文範圍極廣，數量更多；於有限的時間內要造訪各個會場，實為一項不可能的任務。因此，若事先可以依據年會所發給的手冊或於會前由網路下載相關資料，以預為選擇擬參與的場次，將較易作有效率的安排。由於論文數量太多，近年來各項研討會均傾向於不印製書面之論文集，因此若未能親臨該場次聆聽作者的報告，實難了解該篇論文的內涵。欲有效率的獲得進一步的資訊，會後由年會所發的資料光碟印製所擬了解的論文全文，自為重要的工作；而親臨會場與與作者作當面的溝通，並交換日後的聯絡資訊更是有效的方法之一。

3. 近年來國外參與 NACOTA 年會者多來自大陸，大陸人士對該學會的影響力亦日漸加強。為避免海外學人對台灣發展情形有所脫鉤，國內奉派參加 TRB 年會人員，宜於行前先與 NACOTA 取得聯繫，妥為安排行程，撥出時間參加北美華人運輸學會的活動，並提供國內發展情形的報告，將有助於與對岸及美方學人之良性交流與互動。

4. Houston TranStar 結合四個政府單位合署辦公，共同解決大休斯頓地區的交通控制與危難處理機制；各單位派駐 TranStar 人員雖仍受原單位之行政管理，但亦充分接受 TranStar 的整體協調運作節制與管控。由於合署辦公，因此各單位間的協調運作極為良好，各項行政資源亦能作最有效的運用，為美國一個相當卓越的運作典範。國內各

級政府之交控單位間若欲改善彼此之間的協調合作關係，以有效整合區域交通之管理，似乎可以有所借鏡。

5. 交通管控技術可以說是一項藝術(state-of-the-art)，規範的規定自有其一定之標準，而實際運用則要由工程師作最靈活之作為，以發揮最大之功效。休斯頓地區實施的可逆式 HOV lane 以及日夜間部同的速限規定，應該是一個良好的例子。不同時段的車道調撥技術，在國內大都市已行之有年，效益亦極為顯著，惟為適應交通行為的不段改變，交通主管單位仍宜經常作交通調查與車流模擬，以尋求更有績效的運作。

附錄一：NACOTA 年會所提簡報資料

台灣智慧型運輸系統發展之回顧 ~2002年

陳一昌

交通部運輸研究所

報告內容

一、台灣地區ITS發展進程
二、標準與制度之建立
三、發展近況
四、推動組織
五、推動策略
六、實施ITS之主要效益
七、台灣地區發展ITS之未來展望
八、數位台灣 (e-Taiwan)計畫
九、法制化之推動現況
十、結語

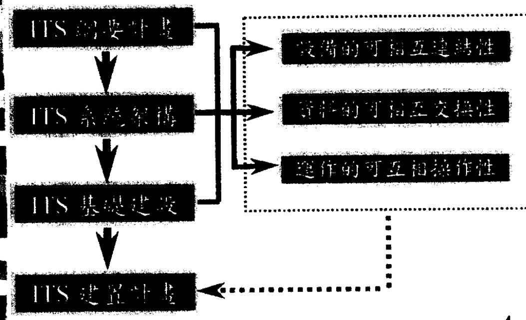
2

一、台灣地區ITS發展進程

1.「台灣地區發展智慧型運輸系統」研討會(80/8)
2. 行政院第十四次科技顧問會議(82/9)
3. 運輸政策白皮書(84/5)
4. 促進大眾運輸發展方案(84/8)
5. 全國能源會議(87/5)
6. 中華智慧型運輸系統協會(ITS Taiwan)(87/7)
7. 交通部ITS專案小組(87/8)
8. 全國科技會議(90/1)
9. 全國交通會議(90/6)
10. NICI智慧運輸組(90/10)
11. 數位台灣計畫-e Transportation(91/5)
12. ITS科專計畫經費(91/8)

3

ITS推動進程



4

二、標準與制度之建立

- ❑ 綱要計畫
- ❑ 系統架構
- ❑ 通信協定

5

2-1 「台灣地區智慧型運輸系統綱要計畫」

七項發展策略

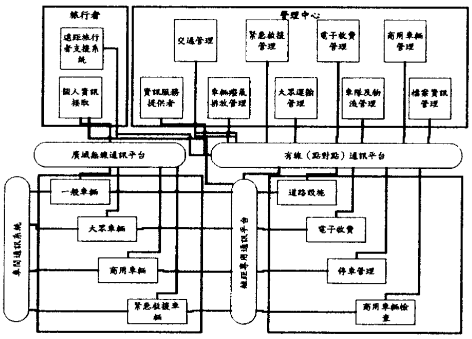
- 以陸路運輸為主體，以複合運輸為方向；
- 從路的智慧化，再透過使用者導向的資訊系統智慧化，帶動車的智慧化；
- 以城際公路智慧化為優先，再擴展至都會區 運輸系統的智慧化；
- 由政府主導，優先訂定必要的資訊與通信介面標準，並建構通信及資訊網路基礎建設，作為系統發展平台；
- 以先進交通管理系統的佈建為優先建設目標，以先進旅行者資訊系統作為成果檢驗標準；
- 以公車站牌及票證的智慧化示範計畫，帶動大眾運輸系統之服務與經營管理的智慧化；
- 優先完成動態追蹤車流與物流所必須的基礎建設，以構建商用運輸系統之整體性智慧化後勤服務。

6

台灣地區ITS發展領域與項目

發展領域	使用者服務項目
先進交通管理(ATMS)	[illegible]
先進旅行者資訊系統(ATIS)	[illegible]
先進大眾運輸系統(APTS)	[illegible]
商(業)車(輛)營運系統(CVO)	[illegible]
電子(收)付費系統(EPS)	[illegible]
緊急事故處理系統(EMS)	[illegible]
先進車輛控制及安全系統(AVCSS)	[illegible]

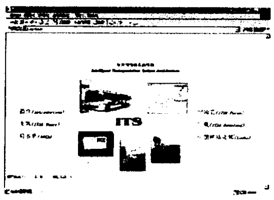
2.2 ITS系統架構

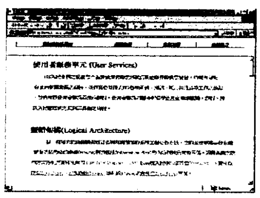


8

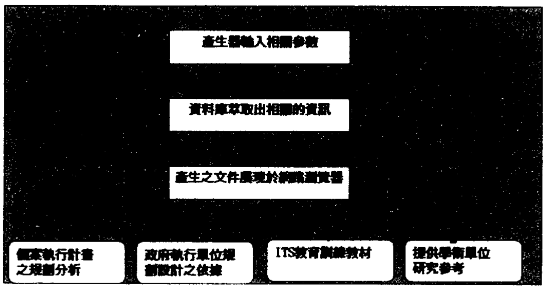
網站查詢系統

- 網站提供簡介、查詢、問答集、討論區、下載、相關網站連結等功能。
- 使用者可透過各種搜尋條件快速查詢內容，以及組成單元相互間對應關係。
- 所有搜尋條件皆以下拉式選單，自動條列出資料庫中可選擇項目。





ITS系統架構產生器之開發



相關計畫之使用者服務單元比較

發展領域	ITS 綱要計畫	ITS 效益評估與供需調查計畫	ITS SA
ATMS	○	○ 增加「運輸規劃支援」	○
ATIS	○	○	○
APTS	○	○	○ 新增「大眾運輸車輛安全」
CVOS	○	○	○ 新增「重車安全管理」
EPS	○	○	○
EMS	○	○	○ 增加「災害管理」
AVCSS	○	○	○
VIPS	N/A	重車車輛安全管理 易受傷害之道路使用者之安全提昇	行人/自行車安全 機車安全
IMS	N/A	N/A	資料蒐集彙整 資料歸檔 歸檔資料管理 歸檔資料應用
彙整結果	7大領域 21項使用者服務單元	8大領域 22項使用者服務單元	9大領域 35項使用者服務單元

2-3. 通信協定

- 89年度已完成「智慧型運輸系統(ITS)通訊協定之研究-通訊網路評選模式之建立」計畫，於今年度進行成果推廣，以利國內政府單位及廠商在規劃智慧型運輸系統建設時，可篩選符合需求之通訊網路及標準。(運輸研究所)
- 正進行「智慧型運輸系統通訊協定NTCIP之研究與探討」計畫，了解美國針對ITS電子裝置間資料傳輸所制定之標準通訊協定，以作為我國發展ITS的參考。(科顧室、運輸研究所)
- 完成「ITS資訊與通信發展平臺整體架構規劃與標準化之探討」(科顧室、運研所、交大)

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三、發展近況

- 綱要計畫、系統架構與通信協定。
- 台灣地區在ATMS、ATIS、APTS，以及CVO等方面的發展較為顯著。
- ATMS：電腦化交通號誌、匝道儀控、可變標誌、電子自動收費、公路路況廣播，以及電視路況報導等。
- ATIS：全球定位系統、最佳路線導引，以及車內顯示系統正吸引大量的民間單位投入研發與推廣工作。
- APTS：著重於公車動態資訊與定位系統的應用，亦兼具蒐集路況資訊之功用，及智慧卡整合票證之應用。
- CVO ：自動車輛定位、雙向無線電通訊，以及即時調派等功能，為民間相關產業研發與應用的重點。

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3-1 先進交通管理系統（ATMS）

- 於90年6月6日舉辦「都市交通控制系統軟體標準化成果推廣」說明會(科顧室、運研所)
- 並於90年進行標準化軟體教育訓練與研提認證實施計畫，並與相關縣市交控系統建置案配合實施；
- 針對交通部號誌控制器原型機研提87年版通訊協定認證實施計畫，並擴充標準化軟體功能以利不同控制中心間資訊之交換。（科顧室、運研所）
- 交通號誌控制實作方面，高雄市政府進行規劃設計，台中市進行初步規劃，台南市擬進行更新計畫。交通部已委託號誌協會完成控制器原型機的開發，後續將進行相關之推廣工作。（科顧室、運研所、台中市、台南市及高雄市等市政府）

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3-2 先進旅行者資訊系統（ATIS）

- 完成「網際網路式地理資訊路況查詢系統」、「智慧型路況語音查詢系統」及「國省道即時路況資料庫」之開發建置。(運研所、高公局)
- 已完成台灣地區1/25000經建版地形圖之數化作業，經87年底發行至今，普遍獲得國內各單位的廣泛使用與好評。（科顧室、運研所、中科院）
- 於89年起展開「台灣地區新世紀版交通路網數值地圖」製作，針對台灣本島與澎湖本島近年所新增道路與縣轄市以上都市地區八米以上道路進行調查，除更新及擴大原有路網資料庫外，亦擴充行政區界、河流湖泊、鐵路捷運與地標地物等圖層資料，並於90年正式對外公佈發行。（科顧室、運研所）

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3-3 先進大眾運輸系統（APTS）

- 90年各補助600萬元於高雄市及台中市推動以「車機設備與通訊整合租用」之方式建置公車動態資訊系統，規模各為250輛公車與120座智慧型公車站牌。(科顧室、運研所、高雄市政府及台中市政府)
- 完成「台北市公車優先號誌之研發與示範」計畫及「大眾運輸車隊管理系統核心模組之規劃與建置」計畫，以與現行公車動態資訊系統整合，並輔助業者開發新建車隊管理及派遣模組。(運研所)
- 完成「先進大眾運輸系統整體發展架構與推動策略之研究」，以作為各相關部門（包括產、官、學、研）推動APTS之依據。（運研所）

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3-4 商車營運系統(CVO)

- 完成「示範性砂石車運輸管理系統之建置--一般道路部分」、「危險品運送管理系統整體需求規劃暨高速公路示範系統建立」、「建立示範性計程車營運安全管理系統之研究」等計畫。(運研所、中華電信)
- 完成「商用運輸系統智慧化整體發展架構與推動策略之規劃」，作為後續國內各界落實推展ITS/CVO的依據。(運研所)

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3-5 電子收/付費系統(ETC/EPS)

- 台北「悠遊卡」結合捷運、公車、公有停車場等票證功能已經於90年1月31日開始進行捷運木柵線及棕線接駁公車的第一次試運轉測試活動。自4月26日起擴大第二次試運轉活動。自6月1日起至7月10日舉辦再包括興雅國中停車場試用的第三次試運轉活動。並於91年正式推動。（台北捷運公司、台北智慧卡公司、台北市政府等）
- 已於90年1月8日正式結束高速公路電子收費兩年之試用計畫，並已於90年5月及7月完成電子收費ETC系統規格需求三次公開說明會及展覽。目前正進行「高速公路電子收費系統建設委任技術顧問服務」之招標。(高公局、中華電信公司)

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3-6 緊急事故處理系統(EMS)

- 有效規劃並建立國內道路交通意外事故之緊急事故處理系統(成大)

3-7 先進車輛控制及安全系統(AVCSS)

- 完成「自動導航公路系統 ADVANCED-F 實施可行性研究」(運輸研究所)。
- 完成「自動導航公路系統 ADVANCED-F 之行車控制研究及其實驗室試驗」(運輸研究所)。

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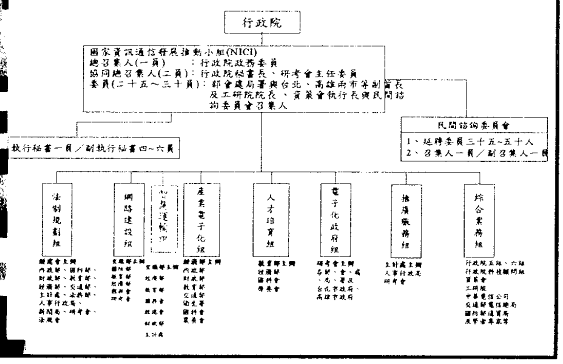
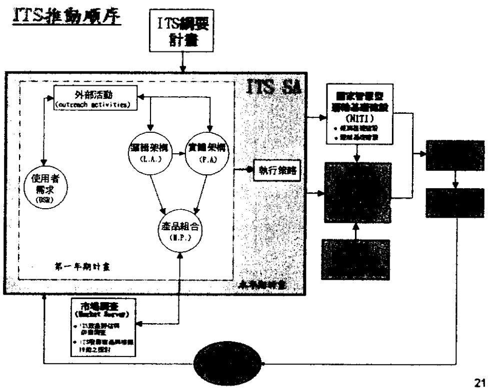
四、推動組織

NICI組織架構





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4.1 NITI之推動策略及實施重點

- ✓ 1.建立推動機制 (院級跨部會推動組織及部級工作督導會報)
- ✓ 2.訂定策略計畫 (部頒ITS綱要計劃)
- ✓ 3.健全法規組織 (ITS發展法)
- ✓ 4.研訂通信協定標準(NTCIP/TTCIP)
- ✓ 5.建立實驗平台加強應用 (實驗城/Test Bed)
- ✓ 6.加強人才培訓與教育宣導(網路及網站)
- ✓ 7.擴大民間參與之方式與管道(應用服務)
- ✓ 8.發展智慧型運輸系統相關產業(國家重點科技、促進產業升級條例)
- ✓ 9.參與國際合作(ITS Japan, ITS China, ITS America)
- ✓ 10.奠定堅實之發展基礎(ATMS,ATIS,APTS,CVO,EMS)
- ✓ 11. 健全ITS採購與維護制度(最適招標作業程序)

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4.2 NITI推動方案的目標(願景)

- 民國九十三年底前達到即時交通資訊服務五十萬用戶，建設台灣成為亞太地區ITS發展與應用的樞紐，並成為全球ITS產品銷售中心之一。
- 民國九十五年年底行車導引系統可望達到車輛總數的五分之一，其中的三分之一並具有能夠接收即時交通資訊服務的功能。
- 民國九十五年年底前高速公路上車輛使用ETC百分率預估達90%以上。
- 至民國一百年年底前，ITS關聯產值佔GNP比例達到10%以上

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五、推動策略

標準制定(推動策略1)

- ➢ 3I of ITS
  - 設備接續相互可相容(facilities interconnectable)
  - 資料相互可交換(data interchangeable)
  - 運作相互可操作(operation interoperable)
- ➢ 交通部ITS資訊與通訊發展平台專案計畫
  - 交控軟體標準化
  - 交控邏輯標準化
  - NTCIP like雛型系統
  - 交通號誌控制器規格標準化
  - 控制中心間(C2C)通訊協定
  - ITS通訊架構及通訊協定

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測試平台(推動策略2)

- ITS TANGO(TAipei Nan Gang Operation)
  - ITS模擬實驗平台建置
  - 模擬交通管理資訊中心(S-TMIC)建置

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法令制定(推動策略3)

- 全國科技會議(2000)
  - 國家智慧型交通運輸基礎建設方案 (NITI)
  - 運輸服務智慧化推動方案
- 全國交通會議(2001)
  - ITS法案制定
  - TTCIP(Taiwan Transport Communication for ITS Protocol)標準確立

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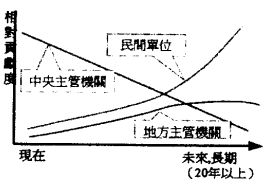
補助機制(推動策略4)

- 依據ITS外部效益配合SA內容建立補助機制
- 以汽車之空污費汽燃費等作為基金來源
- 公私合作形成自由化之市場機制追求財務永續經營



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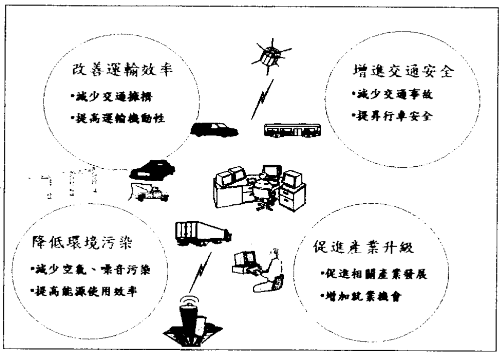
六、實施ITS之主要效益



預估產值：「智慧型運輸系統之效益評估與供需調查研究」 環球經濟社/運輸研究所

- 估計ATMS產值，在短(2001-2005年)、中(2005-2010年)、長期(2010-2020年)各為新台幣160億元、530億元及1,000億元；
- 以ATMS產值為基礎，進而推估ITS整體產值，在短、中、長期各為新台幣603億元、2,304億元及10,000億元。

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七、台灣地區發展ITS之未來展望

7-1 發展目標

- 近程發展計畫
  - 目標：進入旅行資訊化及車隊管理智慧化時代
  - 發展先進旅行者資訊系統(ATIS)、先進大眾運輸系統（APTS）、商用車輛營運系統（CVO）。
- 中程發展計畫
  - 目標：進入系統化交通管理時代
  - 發展先進交通管理系統(ATMS)、先進鄉區運輸系統(ARTS)。
- 長程發展計畫
  - 目標：進入高性能運輸工具時代
  - 發展先進車輛控制及安全系統(AVCSS)、機車安全系統(MSS)

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7-2 未來ITS的發展方向與相關財源規劃

- ITS科技研究計畫(國科會科技預算)
- ITS建設計畫(經建會國家重大建設發展計畫預算)
- 行政院NICI小組下ITS組相關計畫(行政院NICI小組相關預算)
- 交通部科技顧問室與運輸研究所ITS相關技術研究計畫(二單位研究計畫預算)

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❖A. ITS<u>科技研究計畫</u>之推動現況(1/2)

➤ 7項延續性ITS科技研發計畫：

—國家智慧型運輸基礎建設與推動方案研擬及其永續發展機制之研究

—台灣智慧運輸系統通信協定研訂及其在交通控制系統之示範計畫

—複合運輸場站整合資訊系統研發與實作

—大眾運輸智慧卡功能整合與推廣示範研究

—公車動態資訊系統與車載行車安全裝置之研發與示範計畫

—商用運輸系統智慧化之示範與推廣計畫－砂石車運輸管理系統核心模組之規劃與建置

—軌道運輸系統智慧型即時安全檢測與通報技術之研發示範

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❖A. ITS<u>科技研究計畫</u>之推動現況(2/2)

➤ 9項新興性ITS科技研發計畫：

—我國NTCIP整合式通訊平台之研究、開發、與實作

—交通路網數值地圖之維護更新

—區域級智慧型運輸系統示範計畫

—國家運輸事故緊急救援管理系統建立之研究

—商用運輸系統智慧化整體研究發展計畫

—都市交通號誌全動態控制邏輯模式之研究

—公路行車時間資訊管理系統之規劃研究

—先進大眾運輸系統(APTS)整體研究發展計畫

—大型車輛側邊安全警示系統開發與示範評估計畫

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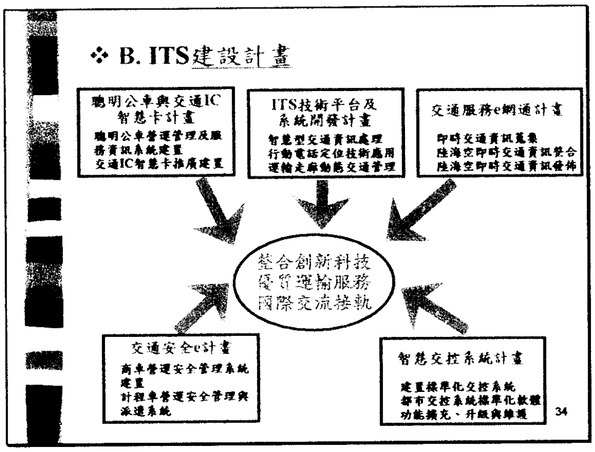

❖ B. ITS建設計畫
聰明公車與交通IC智慧卡計畫
聰明公車營運管理及服務資訊系統建置
交通IC智慧卡推廣建置
ITS技術平台及系統開發計畫
智慧型交通資訊處理
行動電話定位技術應用
運輸走廊動態交通管理
交通服務e網通計畫
即時交通資訊蒐集
陸海空即時交通資訊整合
陸海空即時交通資訊發佈
整合創新科技
優質運輸服務
國際交流接軌
交通安全e計畫
商車營運安全管理系統建置
計程車營運安全管理與派遣系統
智慧交控系統計畫
建置標準化交控系統
都市交控系統標準化軟體功能擴充、升級與維護
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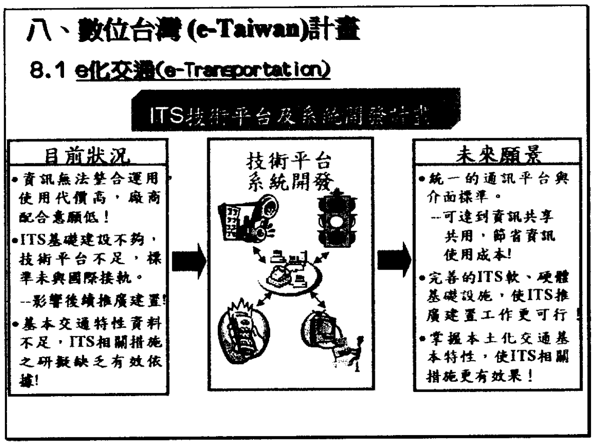
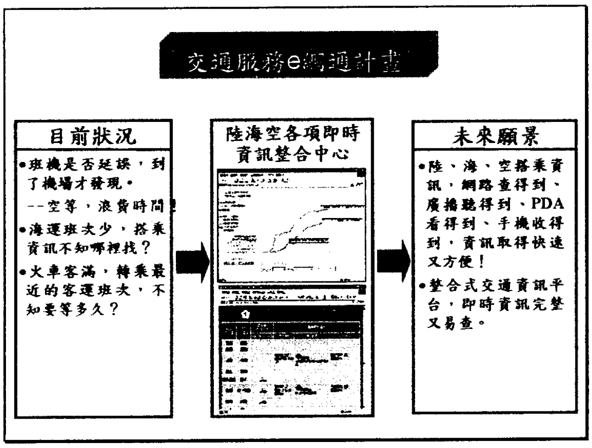


八、數位台灣(e-Taiwan)計畫
8.1 e化交通(e-Transportation)
ITS技術平台及系統開發計畫
目前狀況
•資訊無法整合運用，使用代價高，廠商配合意願低！
•ITS基礎建設不夠，技術平台不足，標準未與國際接軌。
--影響後續推廣建置!
•基本交通特性資料不足，ITS相關措施之研擬缺乏有效依據!
技術平台系統開發
未來願景
•統一的通訊平台與介面標準。
--可達到資訊共享共用，節省資訊使用成本!
•完善的ITS軟、硬體基礎設施，使ITS推廣建置工作更可行!
•掌握本土化交通基本特性，使ITS相關措施更有效果！



交通服務e網通計畫
目前狀況
•班機是否延誤，到了機場才發現。
--空等，浪費時間!
•海運班次少，搭乘資訊不知哪裡找？
•火車客滿，轉乘最近的客運班次，不知要等多久？
陸海空各項即時資訊整合中心
未來願景
•陸、海、空搭乘資訊，網路查得到、廣播聽得到、PDA看得到、手機收得到，資訊取得快速又方便！
•整合式交通資訊平台，即時資訊完整又易查。

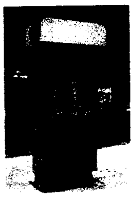
聰明公車與交通IC智慧卡計畫

目前狀況

- 公車在哪裡？不知道！還要等多久？不知道！末班車走了沒？不知道！
  只有一癡癡地等！
- 等了很久，結果同時來兩班公車。
  --資源浪費！
- 啊!公車過站怎麼不知道! 怎麼辦？
- 皮夾內到處是卡片，捷運卡、公車卡、停車卡、...，找來找去，滿身大汗！

計畫

1. 聰明公車營運管理及服務資訊系統建置計畫
2. 交通IC智慧卡推廣建置計畫



未來願景

- 公車在哪裡，智慧站牌、電腦網路、手機、PDA上一目了然，就連打電話嘛ㄟ通！要等多久，自己有把握!
- 控制公車班次，不會一次來兩部，有效利用公車資源！
- 公車上播報站名，打點瞌睡也沒關係。
  --不會錯過下車地點！
- 一張卡通行全國，不管搭捷運、乘公車、付停車費、坐火車..都可以，實在是有夠方便！

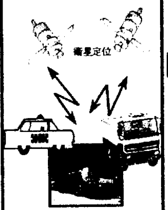
交通安全e計畫

目前狀況

- 矽石車超時、超速又超載，一旦肇事傷亡重！
- 危險物品運送極具潛在危險性，事故發生對生命安全及環境影響深遠
- 深夜回家害怕搭上恐計程車，計程車司機也怕乘客搶劫。
  --大家都不安心！

計畫

1. 商車營運安全管理系統
2. 計程車營運安全管理與派遣系統



未來願景

- 衛星定位技術全程監控砂石車運行，一有違規馬上知。
- 危險物品運輸即時監控，建立緊急救援反應機制。
- 親朋所搭計程車上網查的到；計程車司機遇劫可利用踏板連線求救。
  —乘客安心、家人放心，就連司機也安全
  —商用運輸e化，安全更有保障

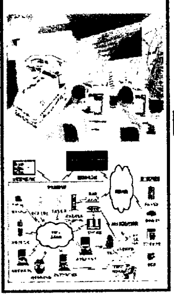
智慧交控系統計畫

目前狀況

- 道路那裡塞車?不知道!塞多久?不知道!是不是有車禍?不知道!
- 連續假期要由高速公路回老家，到了交流道才知道高乘載管制!繞大一段路，浪費時間，又塞車!
- 燈泡式紅綠燈大太陽下看不清楚!
- 等紅燈等了很久，結果另一方向沒車，白等了!
- 交通控制中心是否了解附近都市道路行車狀況?不清楚!高速公路行車狀況?不清楚！

計畫

智慧型都市交通控制系統



未來願景

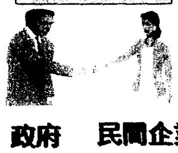
- 透過車輛偵測器、攝影機蒐集與掌握動態行車塞車資訊!
- 透過資訊可變標誌將道路即時資訊提供駕駛人!同時利用電腦網路、手機提供民眾即時路況！
- 建置LED式紅綠燈，亮度足，既省電又清楚！
- 利用路口動態控制方式即時調整紅綠燈時間，減少駕駛人不必要延誤
- 透過都市與高速公路交通控制中心間的即時資訊交換，一路通行，順暢無阻！

九、法制化之推動現況(1/3)

- 為了引進民間充沛資源與效率來加速各項ITS建設，同時帶動關聯技術產業發展，ITS需採行獎勵民間參與公共建設之方式辦理。

合作夥伴

公權力
法令條例
政策
行政



資金
制度彈性
經營效能
風險管理

政府　民間企業

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九、法制化之推動現況(2/3)

- 交通部於今(91)年修正[illegible]的規範內容，將ITS納入促參法的規範，並由行政院公共工程委員會於今(91)年5月予以發布執行。
- 促參法施行細則第2條第2項規定：「智慧型運輸系統，指經[illegible]運用於各種運輸軟硬體建設，以使整體交通運輸之[illegible]，或[illegible]之系統。」

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九、法制化之推動現況(3/3)

- 為使促參法施行細則第2條第2項之規定更加明確，乃於91.8研提[illegible]，作為ITS納入促參法的配套規範，以使後續民間投資ITS建設之相關事宜得以更加順利推動。

ITS相關技術 + 運輸服務品質 + 主管機關認定

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十、結語(1/2)

- 為了要推動各項ITS所需之基礎建設，需積極進行院頒「**NITI推動方案**」，並納入NICI**體**系發展
- 交通部在91年度預算內已編列經費，將進行「**國家智慧型交通運輸基礎建設方案(NITI)之規劃**」以及「**策略性運輸科技產業發展計畫之制訂**」等兩項計畫，其成果將使NITI推動方案更為具體及落實執行。
- 藉由「**ITS發展法**」之立法，構建永續之財務機制，有效引進民間之投資研發及創新，公私部門合作，完成「智慧型運輸系統綱要計畫」所規劃的各項專案計畫及後續的運作維護作業
- **ITS科技研究計畫**與**ITS經濟建設計畫**為ITS計畫研究推動的兩大主軸，在計畫執行時程上具有密切之關聯性，後續仍需持續積極推動

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十、結語(2/2)

- 鑑於ITS在國內尚屬初步推展階段，許多**基礎設施(Infrastructure)**建置目前仍未全面規劃完成；但極為迫切需要完成基礎設施之建設工作。未來除就已規劃完成或技術成熟項目，先進行實體建置之計畫外，更宜參酌**Master Plan**及之**SA**規劃，就優先發展項目積極推動。
- 初步研擬之「**NITI推動方案**(芻議)」已提出推動方案之架構；因涉及部會間之分工，應再參酌各主管部會之意見，充分討論後提出更具體措施與實施重點。
- 由於「**ITS發展法**」所需涵蓋的業務範圍及所需作為廣泛且涉及相關部會機關的權責，為使條文完備可行，以利後續立法作業順利進行，是故應先檢討及修正相關法規，並持續辦理法案草擬與制定的工作。

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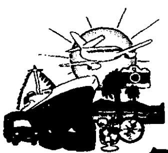
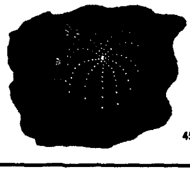


簡報完畢
敬請指教



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附錄二：TRB 年會所提論文

The Integration of Weigh-In-Motion, Automatic Vehicle Identification, and Electronic Toll Collection into Commercial Vehicle Operation

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Abstract

Electronic Toll Collection (ETC) is one of the major developing fields of Intelligent Transportation Systems (ITS) in recent years. The field trial of ETC had been implemented for two years in Taiwan Freeway System. The main components of ETC include Automatic Vehicle Classification (AVC), Automatic Vehicle Identification (AVI) and Video Enforcement System (VES). In addition, Weigh-In-Motion (WIM) has been widely applied and incorporated into Commercial Vehicle Operations (CVO) with Automatic Vehicle Identification (AVI) technologies in Taiwan for more than eight years. This is also considered as a sub field under ITS. With the integration of AVI and WIM technologies, the weight and safety check of commercial vehicles and drivers can been done in real time on highway main lanes under normal traffic speed. Since AVI is the key-bridge between ETC and CVO, the integration will not only significantly increase the total system benefits but also can dramatically improve the effectiveness of commercial vehicle operations and law enforcement. The objectives of this study are to develop the system architecture, build up the system operating mechanism, and carry out the field trial of the prototype system. The prototype system that performs the function of electronic screening of overloaded trucks has been developed and tested on freeway in this study. All overloaded test trucks are identified satisfactorily, verifying the technological feasibility of this integrated system.

INTRODUCTION

Taiwan's first Freeway has been opened to traffic since 1978. The second and third freeways jointed the service in 1993. The network functions as a toll system. It is known that Electronic Toll Collection (ETC) is one of the major developing fields of Intelligent Transportation Systems (ITS) in recent years. The main components of ETC are Automatic Vehicle Classification (AVC), Automatic Vehicle Identification (AVI) and Video Enforcement System (VES). Although the current toll collection is handled manually, a full scale field test of ETC in Taiwan had been conducted on National Freeway 3 from November 1998 to January 2001 by Chunghwa Telecom (CHT). A total number of 2500 passenger cars with transponders (on-board-unit) were tested during that time period. The test results indicate that ETC is highly feasible on the freeway system. In view of the successful outcome of the ETC field test, Taiwan's Ministry of Transportation and Communication (MOTC) decides to install the ETC system on the entire freeway network. It is scheduled to commence in early 2004 and at least one toll booth at each toll station will be equipped with the ETC components, so cars equipped with ETC on-board unit (OBU) can pass the toll station at much higher speed (around 45 kmph) than the current manual toll collection system.

Under current freeway traffic control regulations in Taiwan, all loaded trucks must enter the weigh station that is located in both sides of each toll station for weight checking. Trucks equipped with or without OBU are all required to be pulled in for weighing, and the ETC does not provide any benefit to the driver in this weight checking due to the delay in the weigh house. In order to improve the commercial vehicle operation efficiency, using the ETC system alone is not sufficient. Some other technologies must be integrated with the ETC system to improve the weight check efficiency. The Weigh-In-Motion (WIM) is a possible solution.

OBJECTIVES

Since AVI is the key-bridge between ETC and CVO, the integration will significantly increase the total benefits of the system and can dramatically improve the effectiveness of commercial vehicle operations and law enforcement. This paper does not address the technologies of the detecting devices but rather focuses on the following objectives.

- Develop the architecture of the integrated system,
- Build up the system operation functions, and
- Carry out the field trial of the prototype system.

PROJECTS REVIEW

WIM has been widely applied for many decades and incorporated into Commercial Vehicle Operations (CVO) with AVI technologies, a sub field under ITS. With the integration of AVI and WIM technologies, the weight and safety check of commercial vehicles and drivers can be done in real time on highway main lanes under normal traffic speed. Those trucks that passed all the checks need not be pulled into the weigh station. There will be a significant reduction in travel time for commercial vehicles, and highway patrols can focus more on trucks that may violate the weight and/ or other vehicle regulations. Currently, there are three major CVO systems, PrePass, Oregon Green Light, and NORPASS, have been operated in North America since mid 90's and the benefits have been proved (1,2,3).

Both PrePass and Oregon Green Light are oriented from a research project, called HELP (Heavy Vehicles Electronic License Plate), started in 1983(4). Field trial of HELP project was called Crescent Project started in 1989 at I-5 and I-10. When the Crescent Project ended in 1994, a public-private-partnership company, named HELP, Inc. was established. The Crescent Project was changed to the name of PrePass System and began it commercial operation since 1996. PrePass system has become the largest CVO system in North America. There are around 200 operation sites in 21 states in the U.S. and more than 200,000 trucks participate in this system (1).

Oregon, also a member state of Crescent Project, decided to operate their CVO system after the project ended with the funding from federal government. Their system is called Oregon Green Light. There are 21 weigh stations in Oregon State installed with CVO equipment and about 1,900 trucks participate in this system in 2001 (2). In addition to the above two systems, the NORPASS system is newly organized. The system is formerly called Advantage I-75. NOPPASS has five member states, eight partner states in the U.S. and one partner province in Canada currently (3).

The technologies used in Prepass, Green Light, and NORPASS are very similar. Main lane WIM systems, as well as AVI antennas, are installed at upstream of the weigh station. All trucks equipped with AVI transponders would have a safety and registration check when they pass the system. The weight of the truck, safety records, and registration data are compared with the preset criteria. Those who cannot meet any of the criteria will be asked to pull in the weigh station by sending message back to the transponder.

The possible benefits of these systems are,

1. saving the traveling time for those trucks who can bypass the weigh station,
2. saving the operating costs of motor carriers since trucks get better fuel efficiency and suffer less vehicle wear and tear,
3. lessening safety hazards created by heavy traffic at weigh stations,
4. enjoying better driver retention and easier driver recruitment, and
5. increasing customer service as fewer stops mean quicker delivery.

SYSTEM ARCHITECTURE

The architecture of the whole system is shown as FIGURE 1. It is composed of four sub-systems, namely roadside sub-system, vehicle sub-system, administration sub-system, and external sub-system. Each sub-system will be described in detail in the following sections.

Roadside Sub-system

The roadside sub-system is composed of several Changeable Message Sign (CMS) and the Main-lane Surveillance Station (MSS). The primary function of CMS is to provide travel information to road users and they are directly controlled by the Central Surveillance Center (CSC). The MSS installed at the main-lane of highway is controlled by the nearest downstream Weigh House Control Center (WHCC). The MSS consists of five units with functions described as follows.

1. Weigh-in-Motion (WIM) system: This system detects the speed, gross vehicle weight, axle number, and axle distances of each passing truck. All WIM collected data will be transferred immediately to the Roadside Operation Computer (ROC).
2. Roadside Unit (RSU): The main function of this unit is to communicate with the OBU on the vehicle. The communication between the RSU and OBU using the Dedicated Short Range Communication technology (DSRC) to identify each passing truck. The ETC transaction and the notification of the results of weight and safety record check can also be done through the DSRC. Since most of the vehicles pass the WIM and RSU at a relatively high speed (e.g. 90 to 100 km per hour), two RSUs are needed in one MSS. The second RSU is located around 100 m downstream and used to send the check results back to the driver.
3. Automatic Vehicle Classification (AVC): The AVC is designed to detect the classification of each passing truck. The loop detectors of the WIM can be used in AVC. Through the comparison between data from AVC and RSU, any possibility of mis-using OBU by truck driver will be identified and reported immediately.
4. Vehicle Enforcement System (VES): The VES will automatically start and catch the image of any violated vehicle that is reported by the MSS. Not only the vehicle weight check but also the other vehicle safety related issues are checked by the whole system. Although the WIM cannot be used for law enforcement directly, the image is still transmitted to the WHCC for the possible citation latter. However, the driver will then be notified by the OBU through the data transmitted from the second RSU.
5. Roadside Operation Computer (ROC): All data and information from the above units are gathered here. The ROC serves as the data processing and transferring bridge between the WHCC and other MSS units.

Vehicle Sub-system

The On-Board Unit (OBU) is the major component of the vehicle sub-system. With the use of OBU, the ETC transaction and truck weight and safety record check can then be processed. The OBU must be capable of displaying "red" and "green" lights on the small LCD screen or providing different sounds to indicate the various checking statuses to drivers.

Administration Sub-system

The administration sub-system is composed of the Weigh House Control Center (WHCC) and Central Surveillance Center (CSC).

Weigh House Control Center (WHCC)

The WHCC is located in the weigh house near the toll station and operated by the highway patrols. WHCC controls all the MSSs between itself and upstream WHCC and is composed of the following sub-systems. The computer system used in the weigh house is called Weigh House Computer (WHC) which controls the static weigh pad, truck record checking sub-system, violation citation sub-system, traveler information sub-system, and fleet management sub-system. These five sub-systems are described as following. The relationship among the WHCC, toll station, and MSSs is illustrated in FIGURE 2.

1. Static weigh pad: All trucks that are not equipped with OBUs must pass the static weigh pad for weight checking. Trucks equipped with OBUs but identified as suspicious overloaded trucks by the upstream MSS have to be weighed again for confirmation.
2. Truck record checking sub-system: This system receives the truck information transmitted from the upstream MSS and checks the safety records based on the database of the Department of Motor Vehicles (DMV). If the truck meets all the criteria, e.g. taxes issue, insurance issue, and weight limits, it is no need to pull the vehicle to the weigh house.
3. Violation citation sub-system: All violation images captured by the upstream MSS will be sent back to here. The system will process the image and make the violation citation to the driver if the vehicle's static weight is above the weight limits.
4. Traveler information sub-system: The macroscopic traffic flow data of the roadway section is derived in this sub-system. All data will then be transmitted to the CSC.
5. Fleet management sub-system: The microscopic truck data of all trucks are stored in this sub-system. Data will be transferred via the truck surveillance system in the CSC to the truck company's surveillance computer for fleet management.

Central Surveillance Center (CSC)

The CSC comprises the truck surveillance sub-system, weight analysis sub-system, and traveler information providing sub-system.

1. Truck surveillance sub-system: The microscopic truck data of all trucks are transmitted to this sub-system and again to the truck company's surveillance computer for fleet management. Moreover, the system will hook up with the DMV computer periodically, update the CSC database and transfer the data to the WHCC.
2. Weight analysis sub-system: All weight data gathered by the MSS will also be transmitted here. This
information will be stored in a database and can be used for pavement management. In addition, the data can also be used for many other purposes, such as travel mileage and fuel tax calculations.
3. Traveler information providing sub-system: The macroscopic traffic flow data from each WHCC are
transmitted here. The data will be shown on the CMS and transferred to the traveler information service provider.

External Sub-system

The external sub-system comprises the truck company's surveillance computer, DMV computer, and traveler information service provider.

1. Truck company's surveillance computer: This computer is located in each truck company's administrative office and is linked to the CSC through the internet. The locations of all trucks belong to the same company can be retrieved by company owner for managing the whole fleet.
2. DMV computer: The CSC hooks up with the DMV computer through the wide-area network (WAN) at a certain time period, e.g. every 24 hours. Vehicle registration and safety records can be downloaded and updated in the CSC database.
3. Traveler information service provider: The traveler information service provider can retrieve traveler information from the CSC. After processing the data, information will be sent again to the CSC by the provider.

Data Flow

The proposed data flow chart of major components is shown in FIGURE 3. Most data flow between the MSS and the OBU. Station ID, date/time, WIM-detected vehicle type, ETC transaction results, and weight check results are transmitted from the MSS to the OBU. Vehicle ID, permitted gross vehicle weight (GVW), and the check time at last MSS are transmitted from the OBU to the MSS.

The MSS will transmit vehicle ID, Date/Time, WIM data, and the image of vehicle, if it violates any criteria, to the WHCC in real time. These data might be used as prove of the violation latter. After data analysis carried on in the WHCC, the traffic information would be transmitted to the CSC periodically. The information will be used as the source of traveler information. The MSS also downloads vehicle registration data that provided by DMV data center periodically. Vehicle's license plate number, pass date/time, and passing station ID are transmitted from the CSC to the truck company's surveillance center for the fleet management purpose. The CSC will also transmit traffic information to the ISP (Information Service Provider) for information broadcasting.

Communication Protocols

Data transmission of the integrated system is achieved by the following various technologies.

Wireless LAN

Wireless LAN technology is used for a relative short distance, such as among WHCC, MSS, and CMS. The technology has been used widely in ITS application. The frequency of 2.45GHz, belongs to the ISM band, is introduced for use under "ad-hoc" mode of IEEE802.11b protocol and spread spectrum technology.

Wired LAN

Wired LAN technology is widely used for long distance data transmission in this system, such as multi-DMVs transmission, multi-WHCCs transmission, and between WHCC and CSC. The technology is also an alternative while the on-site condition is not suitable for wireless LAN. The Ethernet architecture will be used.

WAN (Wide Area Network)

WAN technology is used between the system and any other private components, such as ISP and truck company's surveillance centers. The common hypertext protocol shall be adopted with standard internet browser as the interface.

DSRC (Dedicated Short Range Communication)

DSRC technology is the protocol adopted for the data transmission between the MSS and the OBU. Basically, DSRC can be used through infrared or microwave. It is suggested that the same technology used for ETC project should be used in this system.

SYSTEM OPERATING MECHANISM

There are five operational functions developed in this integrated system, they are

- pre-screening the overloaded trucks,
- monitoring the specially permitted vehicles,
- checking trucks' safety and registration records,
- overspeeding enforcement, and
- executing the ETC transaction

FIGURE 4 illustrates the flowchart of all the functions, and each function is described below in detail.

Pre-screening The Overloaded Trucks

For any truck equipped with OBU its ID, the weight checking results as well as check time at last MSS or static weight house, and other necessary truck information will be identified by the DSRC communication between the OBU and RSU. At the mean time the truck is weighed by the WIM at the MSS site. If the time gap of passing this MSS and the upstream weight check point is within the preset tolerable limit, and the truck meets the bypass criteria earlier, say with a qualified record, a bypass signal (green light) will be given again to the truck through the second RSU to OBU. If the time gap of passing this MSS and the upstream checking point is not within the preset tolerance, the ROC will compare the weight detected by the WIM and the legal gross weight limit obtained from the OBU.

If the truck is identified as a suspicious overloaded truck, the VES will start and take the photo of the truck immediately. All the data will then be transmitted to the downstream WHCC. If the truck passes all the checks (including other checks described above), a bypass signal will be given to the truck through the second RSU to OBU. Otherwise, the truck will receive a violation signal (red light) and be pulled into the WHCC. The suspicious overloaded truck will be weighed again by the static weigh pad at the WHCC for double check.

At the initial stage of system implementation, the MSS will be only installed at 800m~1000m upstream the WHCC for the pre-screening purpose (indicated as MSS 1 in FIGURE 2). For further system implementation, the MSSs can also be installed at other highway main-lane locations, such as MSS 2, MSS 3, and MSS 4 in FIGURE 2. For any truck equipped with OBU and being detected as a suspicious overloaded one, it will be pulled into the nearest downstream weigh house. If the truck does not comply with this order, the system will automatically send an overloaded violation citation to the driver. In order to prevent any mis-citation, a higher threshold value shall be used in these MSSs.

For trucks not equipped with OBU, the truck type can be classified by the WIM and the weight can be detected. Detected data and photo image, if the truck is considered overloaded by comparing the WIM data with the rough estimation based on the truck type, will be sent to the WHC in real time for further analysis. Trucks without OBU are requested to go through the downstream weight house at no choice.

Monitoring of Specially Permitted Vehicles

For any vehicle that need a special permit to use highway, it is required to equip with OBU and its license plate number will be stored in a dedicated database. When any OBU-equipped truck passes the MSS, it will be checked to see if it has the right permission to operate on the highway. If the truck has a valid permit number, the position of the truck will be reported to the CSC via the WHC. Otherwise, the VES will take a picture of this truck and the highway patrols at the weigh house will be notified. The truck will then be pulled into the WHCC. If the truck fails to comply with the order, a citation will be made by the highway patrol using its violation image.

Checking Trucks' Safety and Registration Records

The safety and registration record of each OBU-equipped truck will be checked each time it passes the MSS. If the truck has no qualified safety and registration records, the driver will be notified by a fail signal, and the highway patrols will also be informed at the same time. The truck will be pulled into the WHCC.

Over-speeding Enforcement

The AVC installed at each MSS is capable of detecting the vehicle's speed. If any passing vehicle is over-speeding, it will be detected by the AVC. The over-speeding vehicle will be pictured by the automatically engaged VES. All the violation information including the image of that vehicle will then be transmitted to the downstream WHCC. It will be cited by the highway patrols.

Executing ETC Transaction

The ETC transaction will automatically be processed when any OBU-equipped truck passes the system. Trucks who equipped with invalid OBUs will be pictured by the VES and it will also be cited by the highway patrol at the WHCC.

DEVELOPMENT AND FIELD TEST OF PROTOTYPE SYSTEM

In order to verify the technical feasibility of the integrated system, the prototype system has been developed and tested in this research. The prototype system is developed in conjunction with the Chunghwa Telecom (CHT), the developing and operating company of Taiwan's ETC test project. This section describes the development and test results of the system. However, due to the time and budget constrains of this research work, not all the planned functions were tested in the prototype trial.

Operating Procedures of the Prototype System

The primary system function, screening of overloaded trucks, is developed in this prototype system. Only one WHCC and one MSS are included. The detailed operating procedures can be seen in FIGURE 5.

1. When an OBU-equipped truck passes the MSS, the DSRC is automatically engaged between the first RSU (RSU1) and the OBU. The license plate number, truck type, legal gross weight, and check results at the upstream MSS of this truck, all stored in the OBU, will be sent to RSU1. Once the communication is successfully processed, two-beep sound will be generated by the OBU to notify the driver.
2. At the same time, the WIM will detect the vehicle length, speed, axle weight, wheelbase, and gross vehicle weight of each passing vehicle. All the data will be sent to the ROC.
3. The vehicle type can be classified by the ROC using the WIM data. Matching is made between the OBU data and the WIM data, as well as its corresponding vehicle type. As long as all the data appear to be the same vehicle and the time gap between the OBU and WIM data within the preset tolerable time limit, matching can be achieved successfully.
4. For the successfully matched data, the truck's passing record at the last MSS will be checked first. If the truck meets the bypass criteria at the upstream MSS, a bypass sound (one beep) will be given to the driver with the communication between the second RSU (RSU 2) and the OBU. The driver can by-pass the WHCC with permit.
5. If the passing record at the last MSS is not qualified, ROC will compare the data from WIM and its legal gross vehicle weight that is obtained from the OBU. If gross vehicle weight is smaller than the legal gross vehicle weight plus a preset tolerance, the one-beep bypass sound will be given to the driver. Otherwise the driver will be notified by a failure sound (a series beep sound) and the truck must go into the WHCC.
6. The check record of each truck will then be stored in the OBU and sent to the WHC at the weigh house in real time.

The layout of the prototype system is illustrated in FIGURE 6. Two Infrared Red RSUs were installed at the highway roadside (FIGURE 7). The communication between the WHC and MSS is achieved by wireless communication technology. The antenna is also illustrated in FIGURE 7. A Portable high speed WIM sets (including one WIM sensor and two deductive loops) is used in this system. (FIGURE 8) The Infrared OBU used in this research was designed and manufactured by the CHT (FIGURE 9). The interface of ROC is shown in FIGURE 10.

Field Trial of the System

A full-scale field trial of the integrated system was conducted on National Freeway No.3. The system was installed 1000m upstream Long-Tan north-bound weigh house. Two major truck types, four axle semi-tractor trailer (2S2) trucks and single unit trucks (U11), are used in the field test. A total number of six trucks equipped with OBUs were tested for 140 runs in the test site. The combination of truck loading condition and running speed is shown in Table 1. The major objectives of the field trial are to verify the technological feasibility of the system and to evaluate the bypass threshold of this system. The test results are also shown in Table 1 and detail description is given below.

Technological Feasibility Verification of the System

All system functions have been tested and verified at the CHT research lab. During the field trail test the outcomes are relatively satisfied with only two kinds of system malfunctions, mismatch of WIM and OBU data and defect of OBU. However, the problems were solved during the trial test.

1. Mismatching of WIM and OBU data:

   If two trucks of the same type passed the system with headway less than the minimum required matching time, i.e. 8 seconds in this trial test, the WIM and OBU data would be mismatched. In this situation, if both trucks were equipped with OBUs, the WIM data of the first truck would be matched to both trucks. If only the followed truck was equipped with OBU, the WIM data of the first truck would be matched to the followed one. If both are not equipped with OBU, the WIM data of the first truck cannot do any match. It is found that the problem was due to the data matching logic used in this system and it was solved during the test period.

2. Defect of OBU:

   OBU malfunction happened once during the trail test. It was mainly due to the inefficient communication between OBU and RSU. Due to environmental constraints, the RSU was hung on the light post along the freeway. It is suggested the RSU be installed on an overhead or cantilever gantry in order to enhance the communication efficiency.

Bypass threshold analysis

Another objective of the trial test is to study the appropriate bypass threshold that can screen as many overloaded trucks as possible and minimize the number of mis-screened trucks that being pulled into the weigh house. Since the accuracy of the WIM has significant effect on the measured truck weight, the threshold can be defined as Eq.(1).

The concept of threshold selection can be seen in FIGURE 11.

$$Th = GVW * (1 - Accu) \quad \text{......(1)}$$

where

Th : Bypass threshold

G VW: Legal vehicle gross weight

Accu: Accuracy of WIM system, expressed as ±%

The accuracy of the WIM used in this field test at confidence interval of 95% is 14.3 %. The low accuracy is primarily due to the characteristics of selected WIM type. According to this value, the bypass thresholds of 2S2 and U11 are 30.00 tons and 12.86 tons, respectively. The screening outcome of this field-test is shown in TABLE 1. If a more accurate WIM were used for the test, the threshold values could be increased so as to more close to the legal weight limits. In this case only the trucks that have loaded close to the legal limits will be pulled into the weight house. The efficiency of the whole system can be significantly improved under this condition.

As seen in TABLE 1, most of the test runs are classified as "Fail" because most the tested trucks were loaded above the selected threshold values. The average accurate rate of the trial test for 2S2 is 95% for both test speeds. And the average accurate rate for the U11 is 86.7%. The overall accuracy of the trial test is 91.4%. The outcomes reveal that this trial test has very successful results.

CONCLUSIONS AND RECOMMENDATIONS

In this study, the concept and architecture of the integrated system, as well as the system operating mechanism, have been developed. The architecture of the system comprises the roadside sub-system, vehicle sub-system, administration sub-system, and external sub-system. And the operating mechanism can be divided into five major parts, i.e. screening overloaded trucks, monitoring of specially permitted vehicles, checking trucks' safety and registration records, over-speeding enforcement, and ETC transaction. Through the field trial of the prototype system, the technical feasibility of the system is verified. The following recommendations are made,

1. Development of a high-accuracy WIM system and an automatic calibration mechanism: The WIM system accuracy is crucial for the total system performance. Research efforts

should be put on the development of a high-accuracy WIM system. Through the implementation of the system, a huge amount of WIM and static weigh pad data can be collected. The relationship between the WIM and static weigh pad data can then be clarified. An automatic calibration mechanism could be developed from the research outcome.

2. Implementation study of DSRC technology on other commercial vehicle operations: The DSRC technology has been widely used in electronic toll collection. Besides the implementation mentioned in this study, the application of DSRC in other CVO fields, shall also be investigated.

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LIST OF TABLES AND FIGURES

TABLE 1 The Screening Outcome of The Field Test

Truck Type	Legal GVW (tons)	Actual GVW (tons)	Truck Speed			
			80KPH		60KPH	
			No. of Screening Outcome		No. of Screening Outcome	
			OK*	Fail*	OK*	Fail*
SH2	35.0	31.0	4	6	0	10
		33.5	0	10	0	10
		33.8	0	10	0	10
		34.0	0	10	0	10
UH	15.0	12.0	9	1	7	3
		13.0	3	7	1	9
		14.9	0	10	0	10

*: OK means the truck receives a by-pass" signal, and Fail means the truck needs to enter the WHCC.

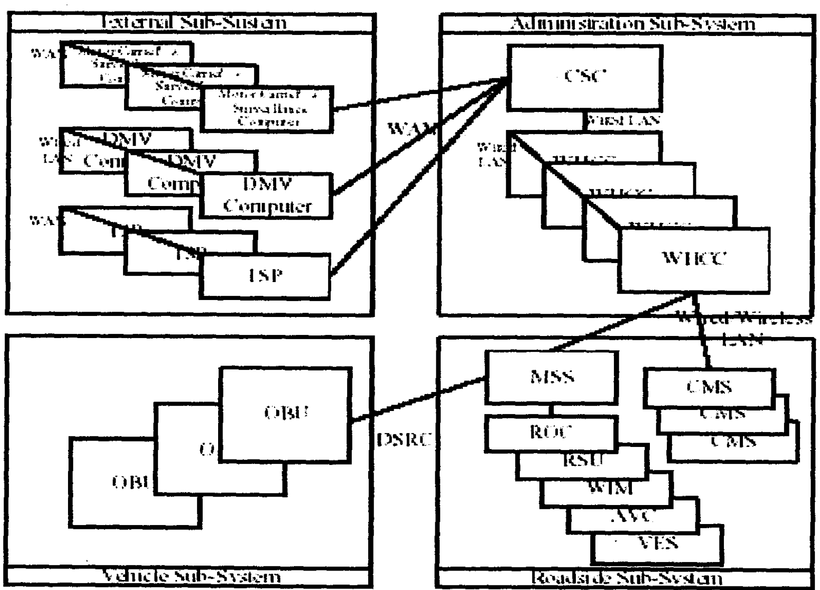

FIGURE 1 System architecture.

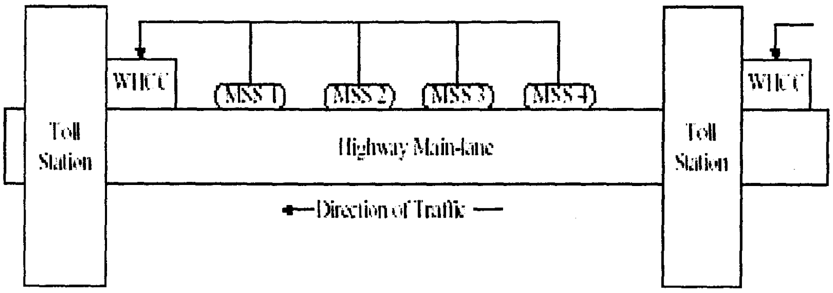

FIGURE 2 The Relationship between WHCC, toll station, and MSS

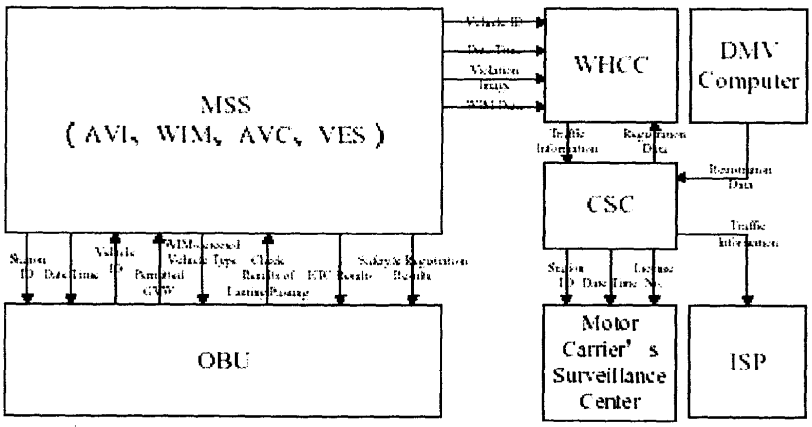

FIGURE 3 Data flow chart of the integrated system.

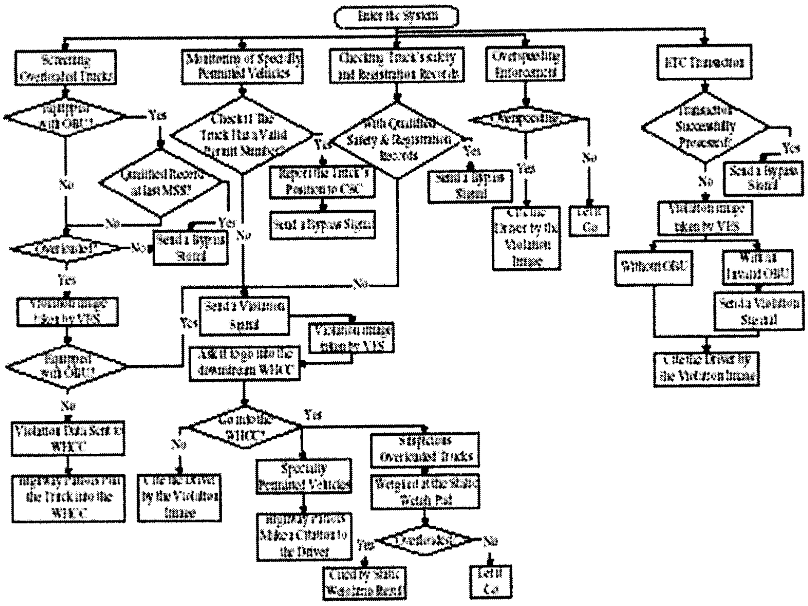

FIGURE 4 Flowchart of all system functions.

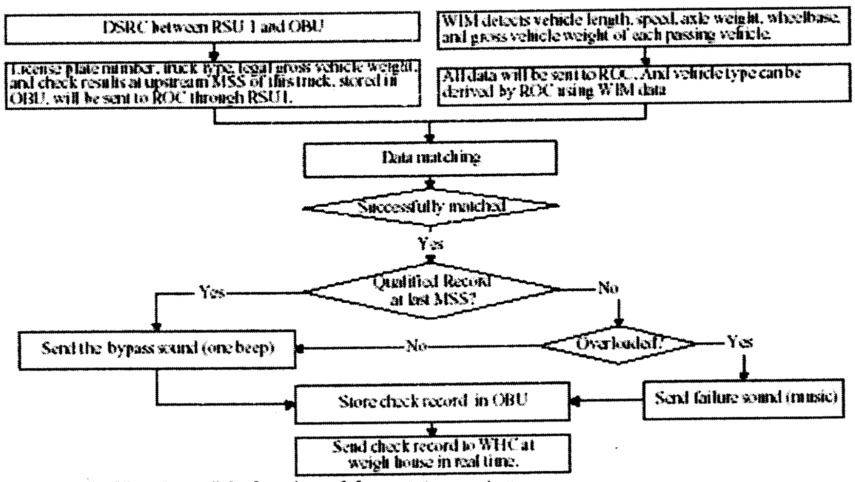

FIGURE 5 Flowchart of the functions of the prototype system.

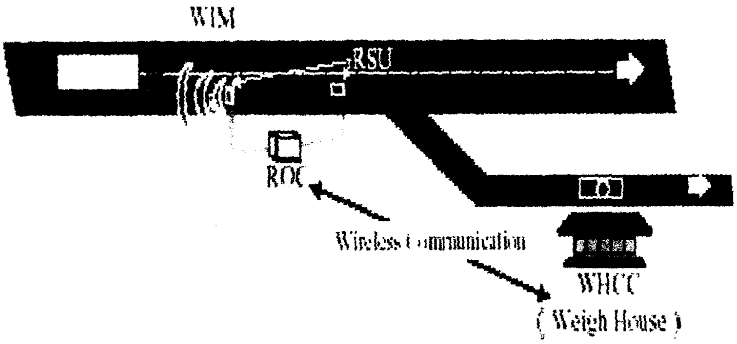

FIGURE 6 Layout of the prototype system.

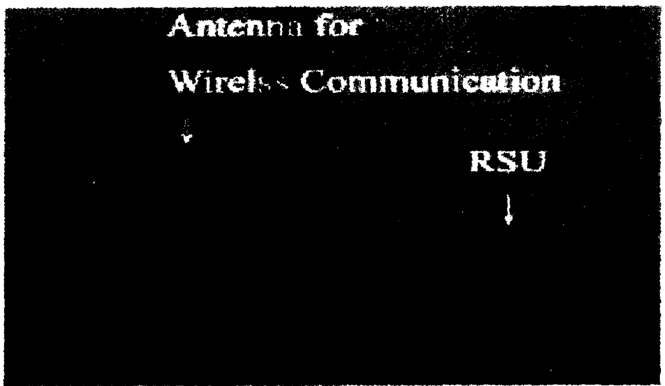

FIGURE 7 RSU and antenna for wireless communication.

FIGURE 8 Portable WIM.

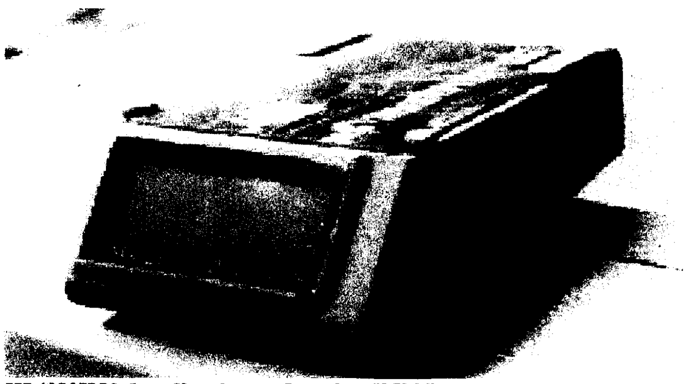

FIGURE 9 On-board unit (OBU).

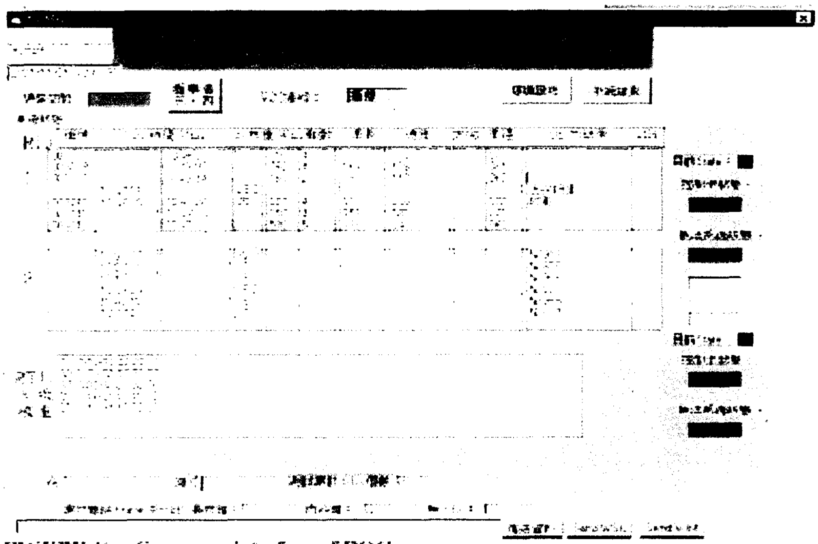

FIGURE 10 Computer interface of ROC.

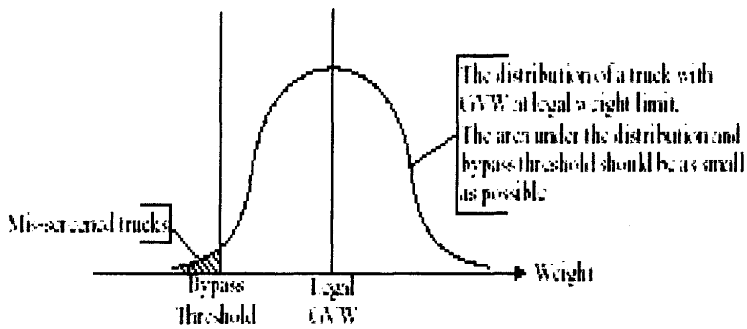

FIGURE 11 The concept diagram of threshold selection.

附錄三：年會中所蒐集資料清單

一、CD-ROM 部分

1. US DOT Publications and US Waterway Data CD (US Army Corps of Engineer)
2. US DOT FRA/Volpe Research
3. National Household Travel Survey, NHTS Version 1.0 (US DOT, Jan. 2003)
4. The National ITS Architecture, Version 4.0
5. FB-Pier v3, Demo Edition (Bridge Software Institute, University of Florida)
6. An Overview to Metropolitan Transportation Planning (National Highway Institute, FHWA)
7. Roadway Aesthetic Treatments 2001 Photo Album Workbook (FHWA)
8. Excellence in Highway Design, 2002 Biennial Awards (FHWA)
9. Moving Safely Across America, the Interactive Highway Safety Experience (FHWA)
10. Implementation Manual CD-Version, 2001 (FHWA)
11. Red Light, Green Light (Institute of Transportation Engineers)
12. Night Lights, How Retroreflectivity Makes Our Roads Safer (FHWA)

二、書面報告部分

1. A Study of the Use of Low Altitude Airborne Multispectral Scanning for Preliminary Analysis of Highway Projects Sites, Final Report (Ohio DOT)
2. Recycling Practices for HMA (NAPA)
3. Perpetual Pavements, A Synthesis (Asphalt Pavement Alliance)
4. Using GIS in the Analysis of Truck Crashes (FHWA)
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