



Opportunities and Challenges in DSRC-based Collaborative Safety Applications

(協同式行車安全應用的機會與挑戰)

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ESTI 研發主軸 - 多元車載服務

即時動態導航
交通路況預測
先進收費系統
多模導航系統
需求處理
車輛追蹤、警示與管理
整合式商用車車隊管理



效率

便捷

Ubiquitous
車載系統服務

平台

安全

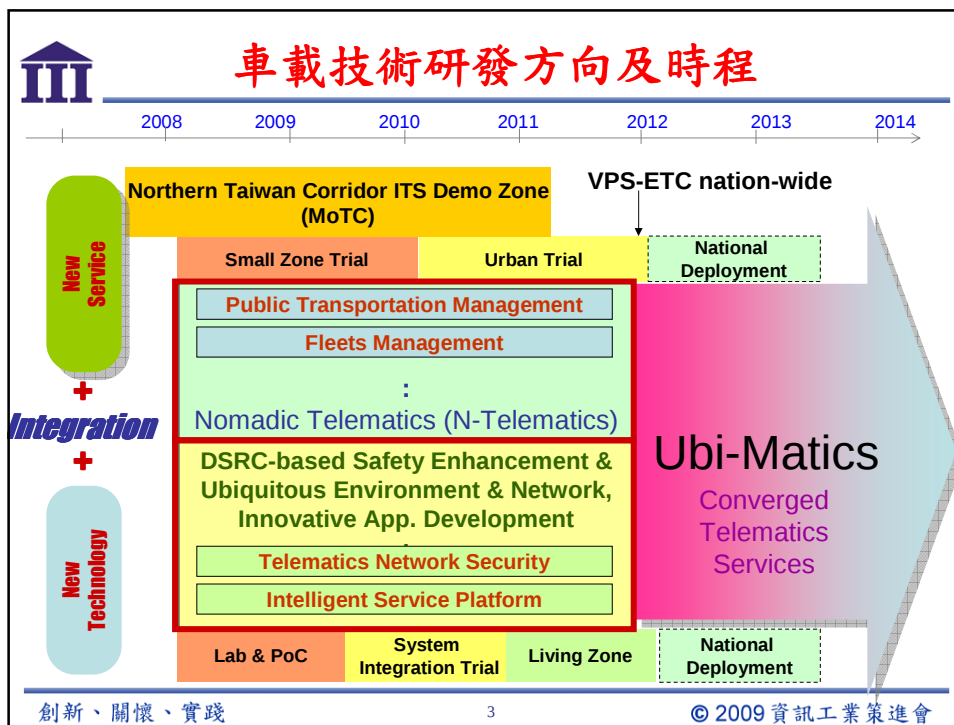
智慧交通基礎建設
交通資訊集散中心
車載服務共通平台
Living Zone驗證平台
社群應用平台
LBS廣告平台



行路情報、提醒、預約
一卡通NFC整合
Pedestrian & Indoor support
交通安全監視
車載社群應用、共乘服務
廣告託播
車輛健診
物流履歷

駕駛人狀況警示
救援及遠距協助
動態路況、事件警示
協同式車距控制
協同式碰撞警示
協同式碰撞避免
殘障行路安全協助

2



車載技術、整合及應用服務驗證平台

- **Lab Test — New Technology Verification**
 - DSRC Network Performance and Advanced Safety Enhanced Application Benchmark and Test
 - Short term: Lab Engineering Test, Mid-Term: Urban Style DSRC Test, Long Term: Integrated Performance Test.
- **Filed Trial – System Integration Trial**
 - A Trial Field Equipped with DSRC, WiMAX and Cellular Networks
 - Various Back-Office Servers Supporting Cooperative Real-time Traffic Information, Media Distribution and Sharing, Security Monitoring, and Safety Enhanced Applications.
 - a sizeable Test field for Technology Development and System Integration.
- **Living Zone – Innovative Service Trial**
 - A Small Area as the Living Telematics Lab to foster “Driving the new Wave of Intelligent Transportation” Vision in Taiwan through Real User Experiences and inter-discipline Integration

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Overview

- Safety applications
- Technologies
 - Active
 - Sensing technology
 - Collaborative
 - Communication technology
- Opportunities & challenges
- Summary



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Why Safety Applications?

- In USA
 - 6.3M crashes per year
 - 43,000 deaths per year
 - \$230 billion in property damage
 - Driver errors: 90%+ of crashes
 - Distraction, road & weather condition, distance, ...

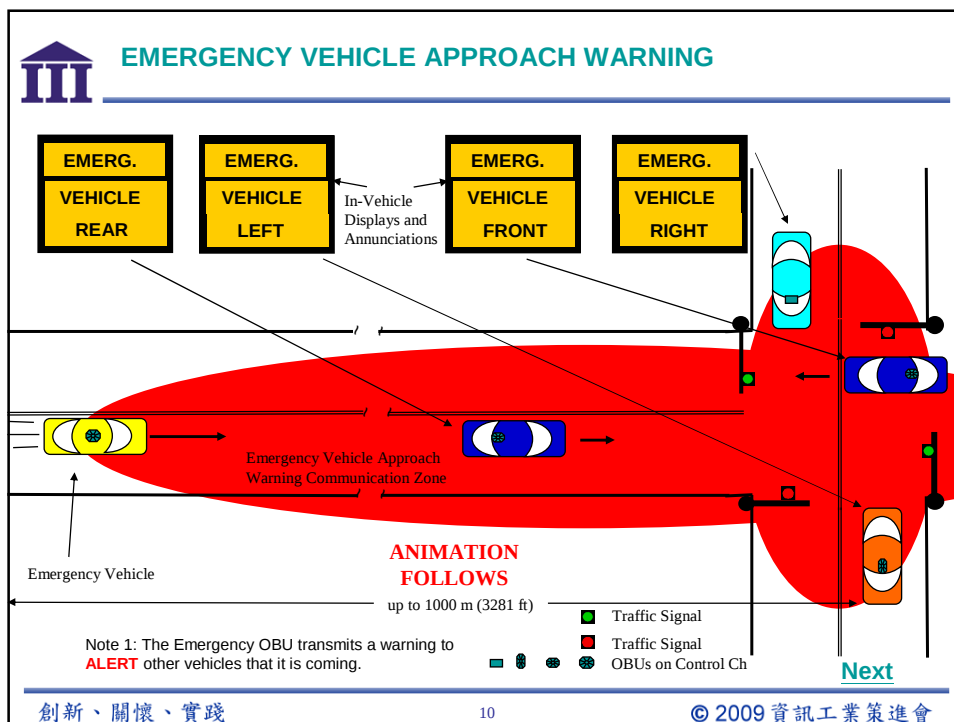
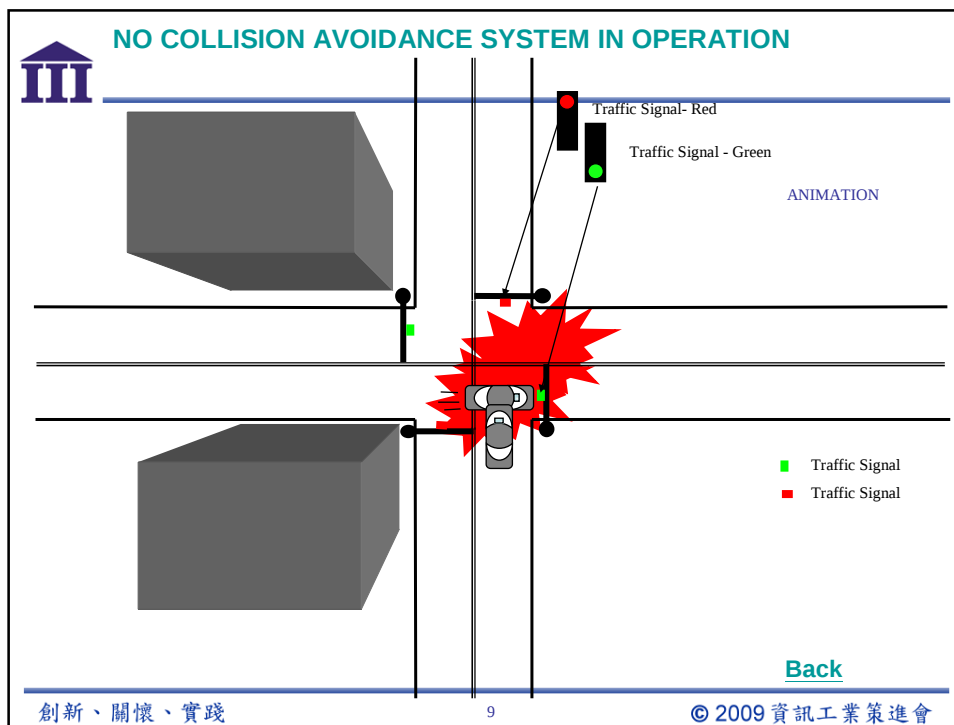


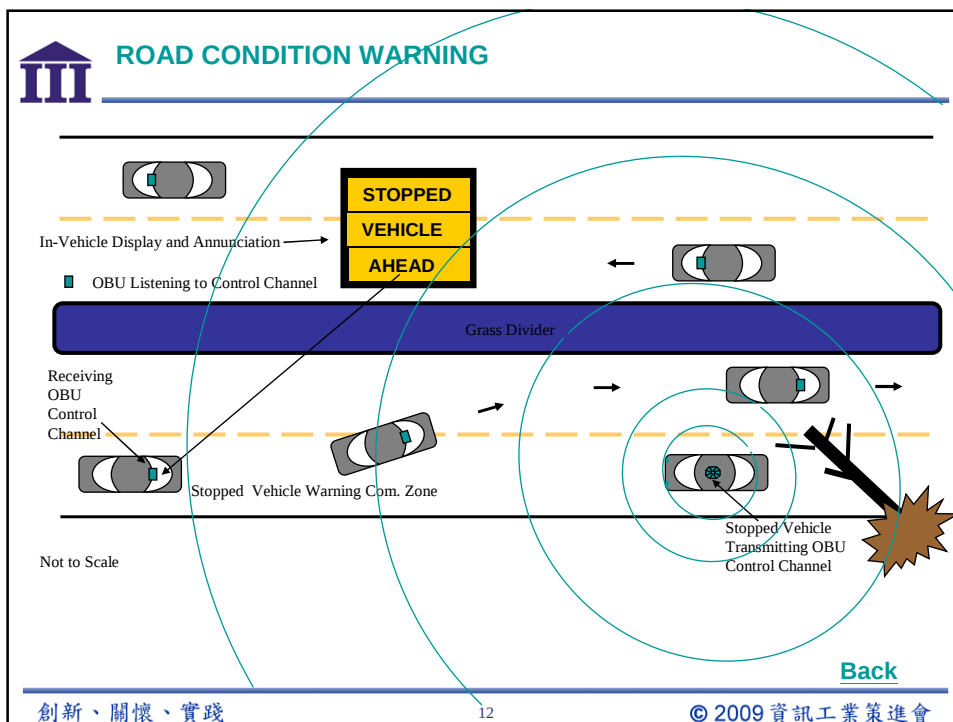
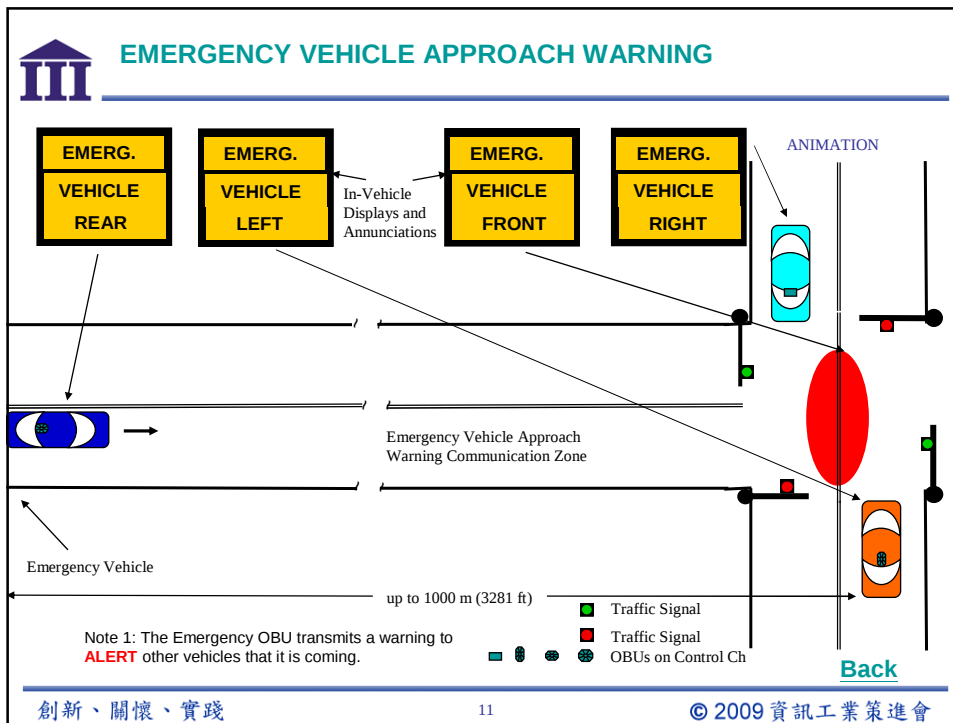
- **The best car safety device is a rear view mirror with a cop in it**
- **Your vehicle knows road way conditions that you can't see**
 - **Your vehicle can "see" vehicles you can't see**
 - **Your vehicle knows the speed and location of approaching vehicles**
- Dudley Moore (1935-2002)



Safety Applications

- Collision warning/avoidance
- Lane change warning
- Approaching emergency vehicle warning
- Emergency vehicle signal preemptive
- Brake warning
- Road condition warning
- Breakdown/Crash ahead warning
- Congestion warning
- Low bridge warning
- ...







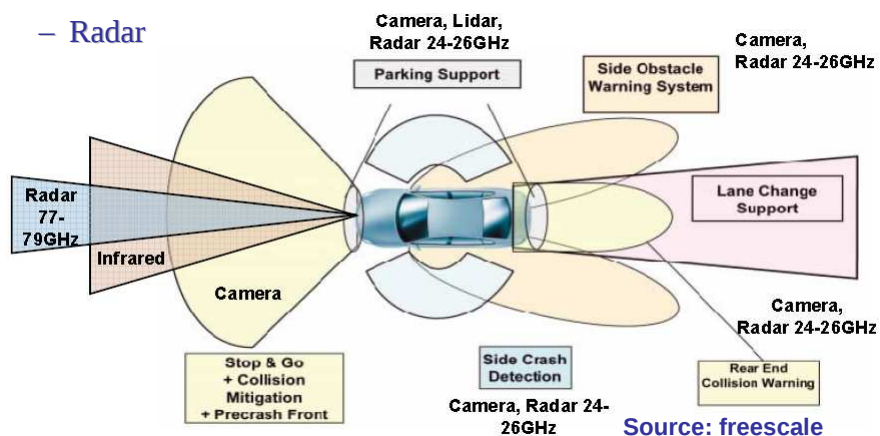
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Active Solutions

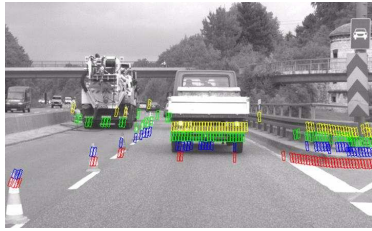
- Sensing technology
 - Camera
 - Infrared
 - Radar





Active Solutions

- Sensing technology
 - Laser



Source: iBEO



Overview

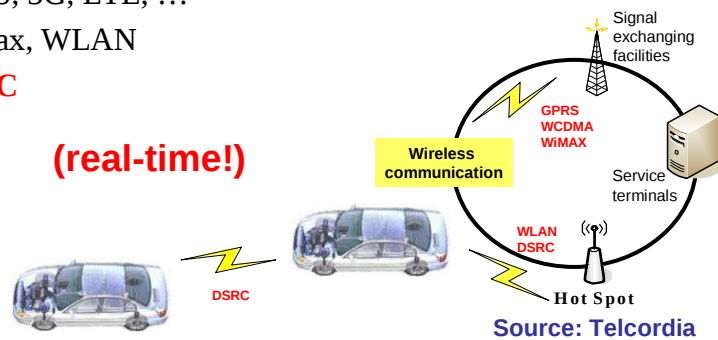
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Collaborative Solutions

- Positioning technology
 - GPS
- Communication technology
 - Public broadcast systems
 - GPRS, 3G, LTE, ...
 - Wimax, WLAN
 - **DSRC**

(real-time!)



DSRC Concepts

- **D**edicated **S**hort **R**ange **C**ommunications
 - Short range communication service
 - Support both **public safety** and **private operations**
 - Support **vehicle to roadside** and **vehicle to vehicle** scenarios in **highly mobility environments**
 - **Minimize latency** in the communication link

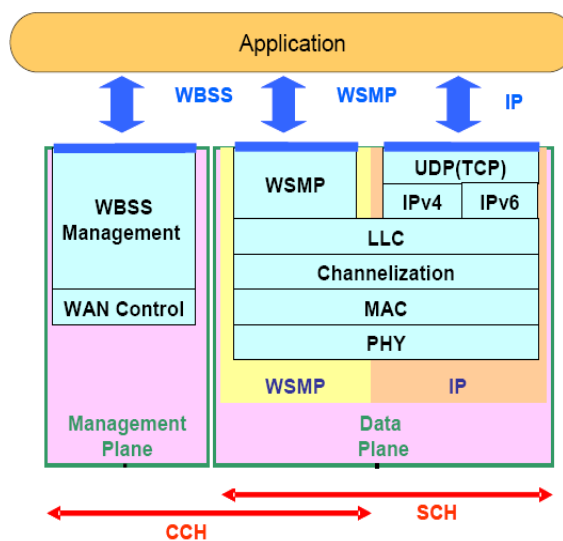


WAVE/DSRC與其他無線技術比較

	WAVE/DSRC	Wi-Fi	Cellular	WiMax
Delay	< 50ms	Seconds	Seconds	Seconds
Mobility	> 60 km/h	< 5 km/h	> 60 km/h	> 60 km/h
Range	< 1000 m	< 100 m	< 10 km	< 15 km
Data rate	3~27 Mbps	6~54 Mbps	~ 3 Mbps	1~70 Mbps
Bandwidth	10/20 MHz	20 MHz	< 3 MHz	< 10 MHz
Spectrum	5.86~5.925 GHz	2.4 GHz, 5 GHz	800 MHz, 1.9 GHz	2.5 GHz
Standard	802.11p/1609	802.11a/g...	WCDMA...	802.16d/e...



WAVE/DSRC的架構



Source : Renesas , 2008/06

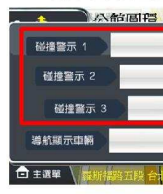


Demo Scenario – ICWS (Intersection Collision Warning System)

- According to the statistics in the United States, **2 million auto accidents** happen at the intersections and cause **6700 fatalities** each year
- ICWS** is a **V2V application** that alerts the drivers when a potential collision may occur at an intersection

1. Collision Warning Timers

- Set timers of level 1, 2, 3 respectively.
- Determine how soon ahead to get alerted.
- If collision warning level 1 is set to off, level 2 and 3 will be disabled.



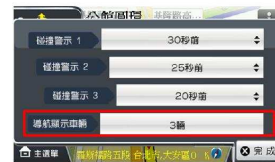
Level 1 Warning Message

- Red Mark flashes once per second
- TTS inform drivers of an upcoming collision with its direction, distance and time.



2. Navigation Display, on/off

- Set the number of vehicles displayed on ICWS.
- Collision-prone and emergency relief vehicles have the higher priority to be displayed.



Warning Messages of Level 2 & 3

- Level 2: a dialogue box with final-countdown prompted, with short beeping sound once per second.
- Level 3: the beep-frequency increases to 3 times per second



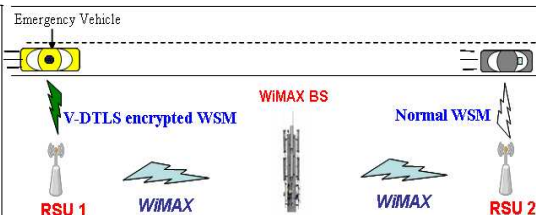
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Demo Scenario – EVAWS (Emergency Vehicle Approaching Warning System)

The emergency vehicle announces the V-DTLS encrypted emergency alert with its position info (to follow SAE J2735 this year). The RSU retrieves the emergency vehicle's information from the encrypted msg and then forwards to nearby RSUs. The normal vehicle thus can be notified by its neighboring RSUs.



Emergency alert announcement

- Emergency vehicle's driver can push the button to enable the emergency alert announcement



Emergency alert display

- Emergency vehicle is displayed in the PND screen
- The distance to the emergency vehicle is marked in the emergency vehicle and is also announced by voice



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CVPC Demo : OBU/RSU

-- 2008.12.5 Ann Arbor, Michigan

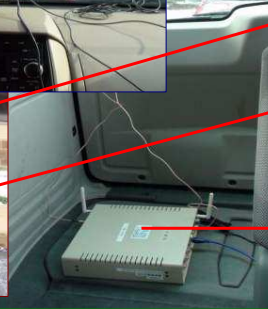


PND with MAP
Integration

LTS

WAVE Box –
RSU

WAVE Box –
OBU



- **WAVE/DSRC-based Applications**

- V2V: ICWS (Intersection Collision Warning System)
- V2R: EVAWS (Emergency Vehicle Approaching System)

- **Devices & Techniques**

- Transmission Platform: OBU & RSU
- Application Platform: PND, LTS (Local Traffic Server), MAP integration



Video



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Opportunities & Challenges

- GPS accuracy
- Obstacle affection
- Channel congestion
- Multi-hop forwarding
- DSRC device popularity
- ...



US GPS System

- From 1995 by US DOD

Chip / Chipset	SiRFstarIII	Copernicus	S4E19863	QinetiQ Q20 H	PMB 2520	UBX-G5010
Manufacturer	SiRF	Trimble	Seiko Epson	QinetiQ	Infineon	u-blox
Horizontal Accuracy Autonomous Assisted	<2.5m <2.0m	<3.0m na	<10m na	<5m na	5m na	2.5m 2.0m
Velocity Accuracy	<0.01 m/s	0.06 m/s	na	<0.05	na	na
TTFH Hot Start Warm Start Cold Start	<1s <35s <35s	9s 36s 39s	2 -3s na na	<1s <38s <45s	<1s <38s <45s	na

Source: GPS Technology Reviews



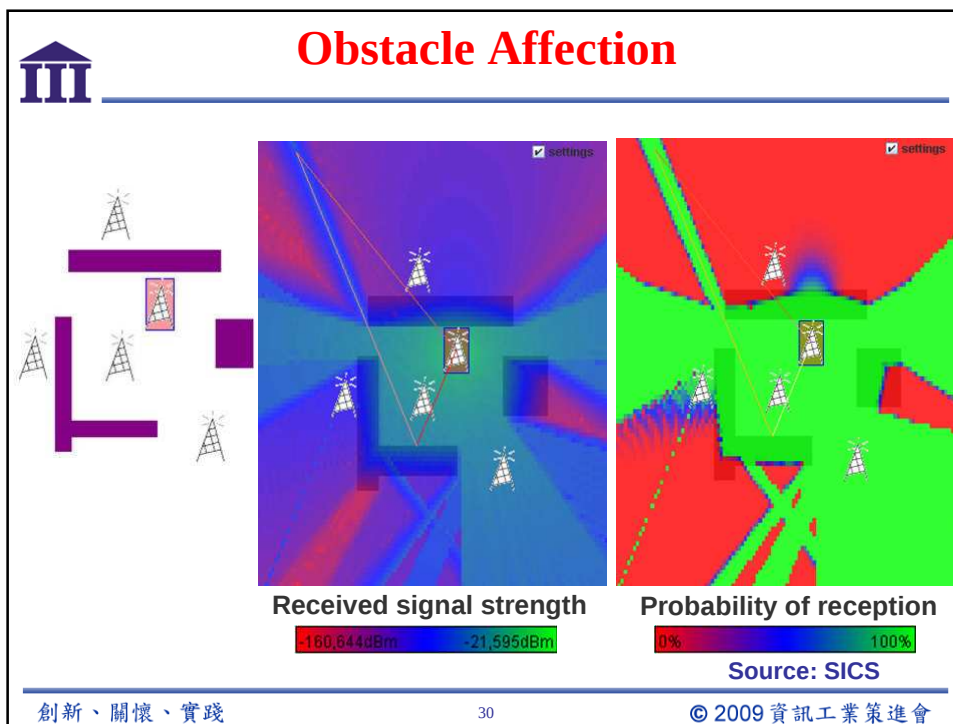
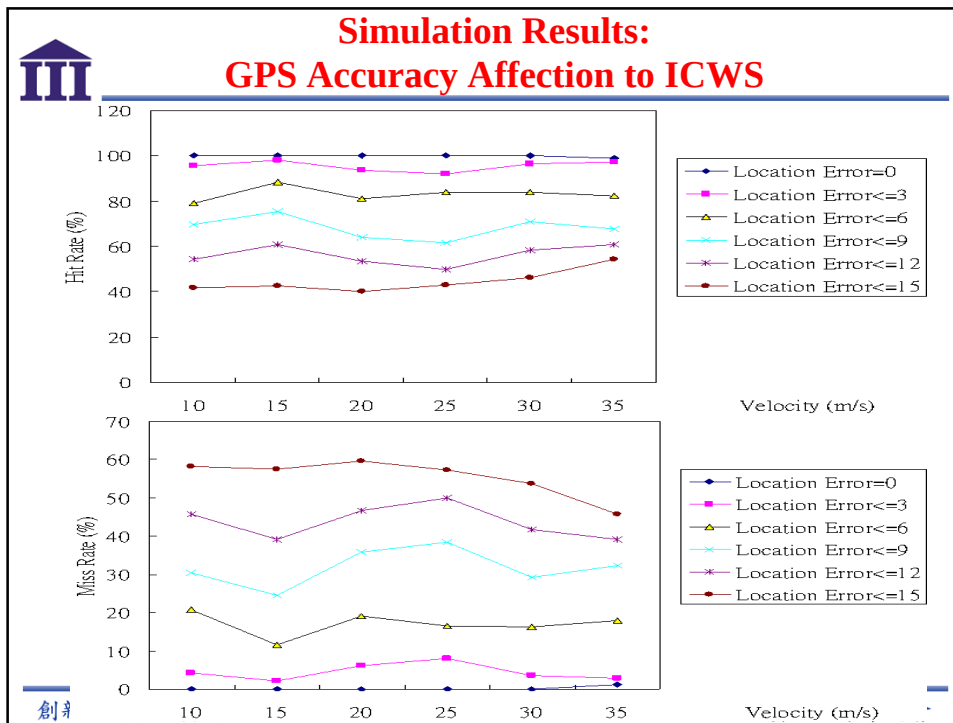
EU GPS System (Galileo)

- The project is initiated by EU & European Space Agency in 2002
- 2005年發射第一顆衛星, 預計於2010年完成30顆衛星系統建制?

伽利略提供之應用服務類型

服務類型	服務內容說明
開放服務 (Open Service)	免費提供使用者定位、導航及標準時間等訊息, 主要的對象是一般大眾
商業服務 (Commercial Service)	服務對象是需要高精進度(精進度可小於1公尺)的應用服務, 系統將藉由加密的方式確保服務傳遞過程中之安全, 不過也因此而需要付費方能使用
公共規範服務 (Public Regulated Service)	此部分服務係指與國家安全、警政等公共安全事務相關之應用服務, 例如警政、海岸巡邏、海關、國防等各類公共事務應用
生命安全服務 (Safety of Life Service)	主要應用於交通運輸, 包括引導船隻入港、鐵路運輸管制、飛航管制等。
搜尋與救援服務 (Search and Rescue Service)	主要用於人員之搜尋與救援

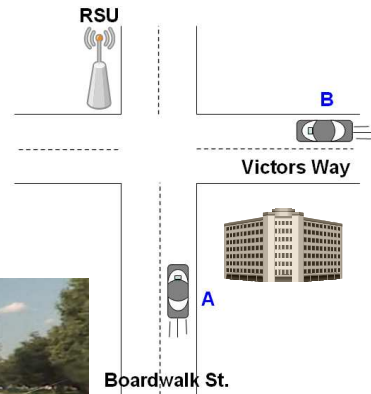
資料來源: Galileo Project(2008/4)





Obstacle Affection

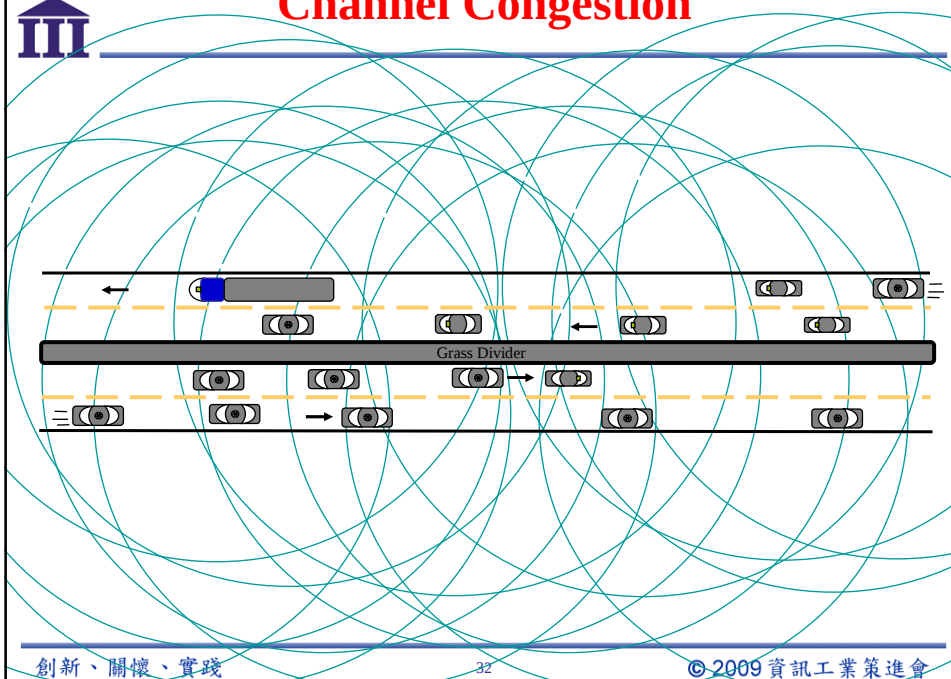
- From our experience, ICWS worked very well in obstacle free environments
- 5.9 GHz DSRC signals **were very affected by the barriers** such as buildings, walls, trees, and so on
- **A relay station** was recommended to be placed at the intersection



Demo @ CVPC, Michigan

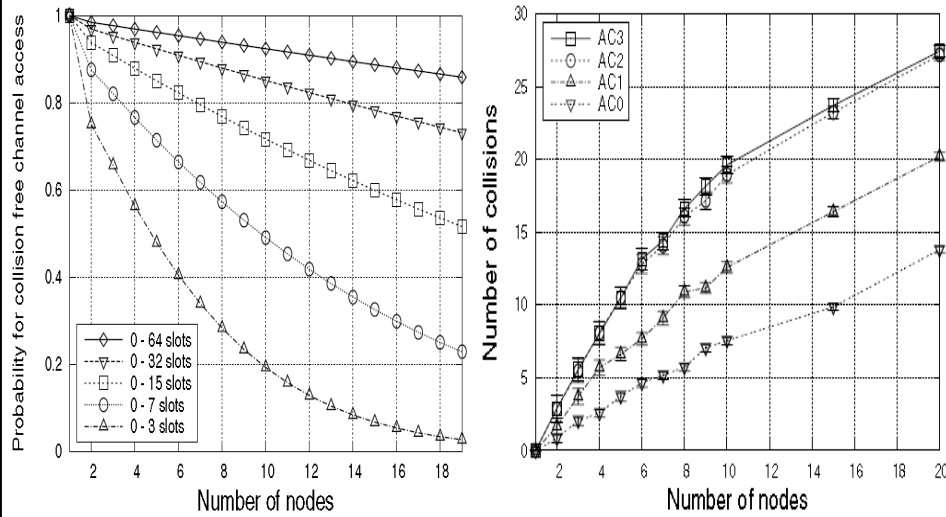


Channel Congestion





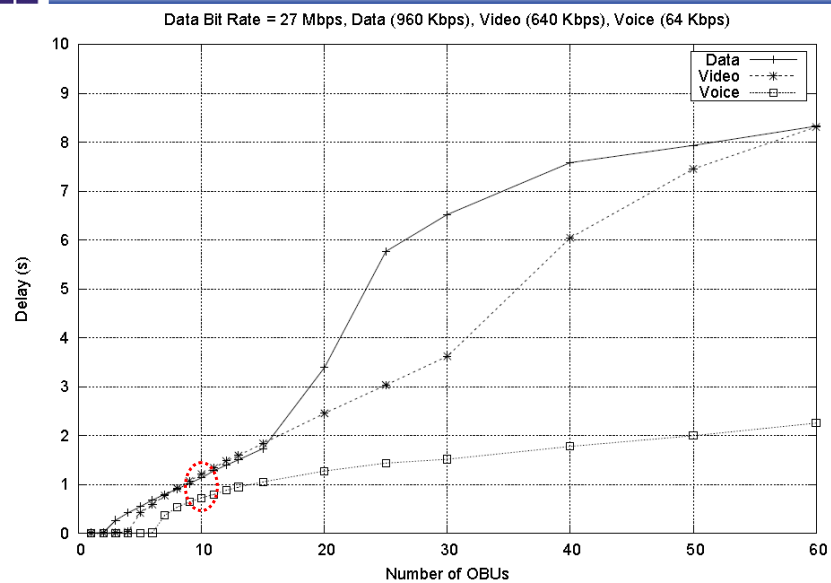
Channel Congestion



Source: Eichler's VTC 2007 Fall paper



Channel Congestion



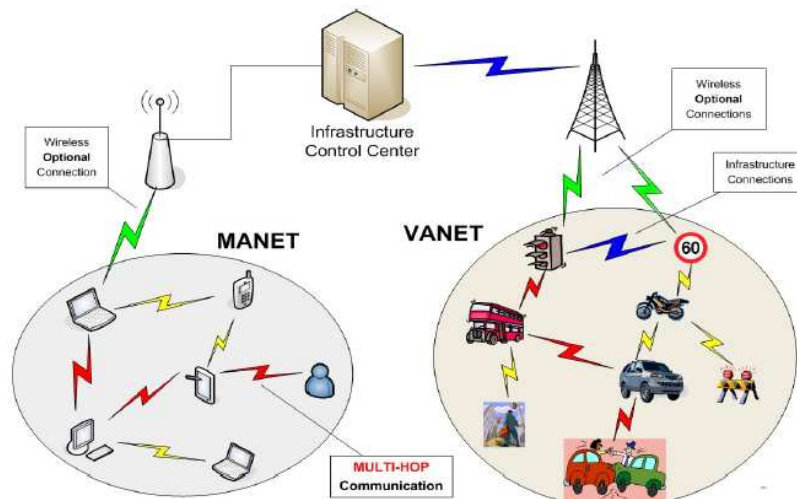


Channel Congestion

- Possible solutions
 - Mac layer
 - Effective media access mechanism
 - App. layer or cross layer design
 - Adaptive power adjustment
 - Adaptive beacon interval
 - Others...?



Multi-hop Forwarding



Source: Hitachi

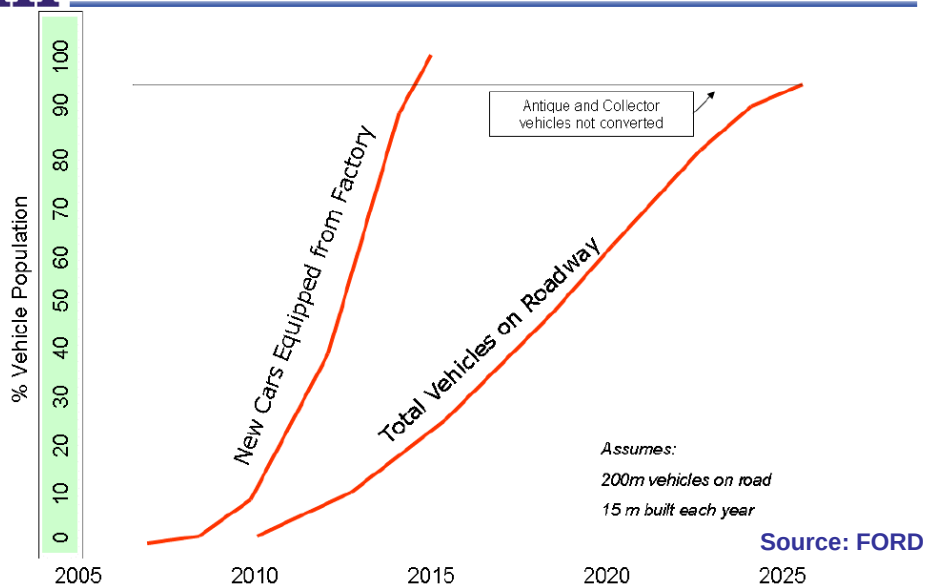


Multi-hop Forwarding

- VANET (vs. MANET)
 - Predefined routes
 - Mobility pattern
 - Energy is no longer an issue
- Both scalability & security/privacy are important!!
 - Position-based forwarding
 - Store-and-forward
 - Malicious attack
 - Anonymity issues
 - ...



DSRC Device Popularity





DSRC Device Popularity

- *Savari networks*
 - MobiWAVE (~\$2,000/unit)
 - Wi-Fi, Bluetooth, Ethernet
 - 802.11p, 1609.3, 1609.4
- *TechnoCom*
 - MCNU (~\$8,000/unit)
 - Ethernet
 - 802.11p, 1609.2, 1609.3, 1609.4
- *Renesas*
 - WAVE system platform
 - Ethernet
 - 802.11p, 1609.3, 1609.4
- III/ITRI's solution – to be delivered by this year



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Summary

- Hybrid technologies are recommended to achieve fully vehicular safety
- DSRC is appropriate for time critical applications (has been proved by VII, USDOT)
- Opportunities and challenges
- GPS accuracy is the most important



Thank You / Merci / Danke / 謝謝 / ありがとう

*Your Comments Are Much
Appreciated*

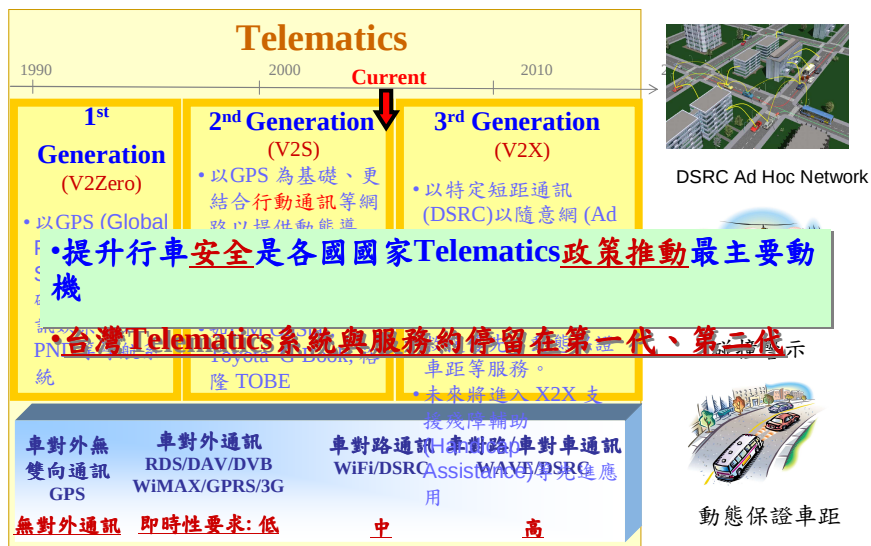




Appendix



Telematics 系統演進





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- Source: Nissan Motor Manufacturing (UK), 2008**

