

Wireless Vehicular Communications Radio Communications for Smart Transport Infrastructure

Christopher J Skinner BSc(Eng) MEngSc MIET
MIEAust MACS CPEng

Principal, DISplay Pty Ltd

Visiting Lecturer, Institute of Transport & Logistics
Studies, The University of Sydney

cjskinner@acslink.net.au

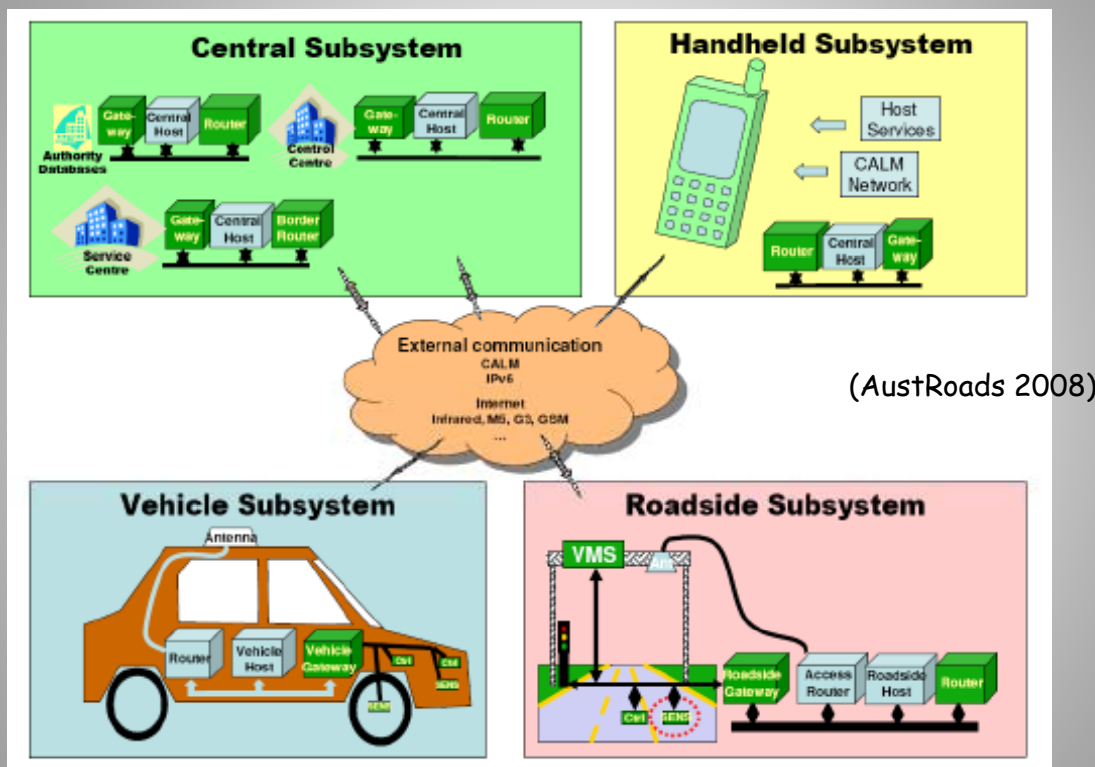
DISplay Pty Ltd

NICTA Smart Transport Infrastructure
Technology Forum 2010-04-28

(C) DISplay Pty Ltd 2010

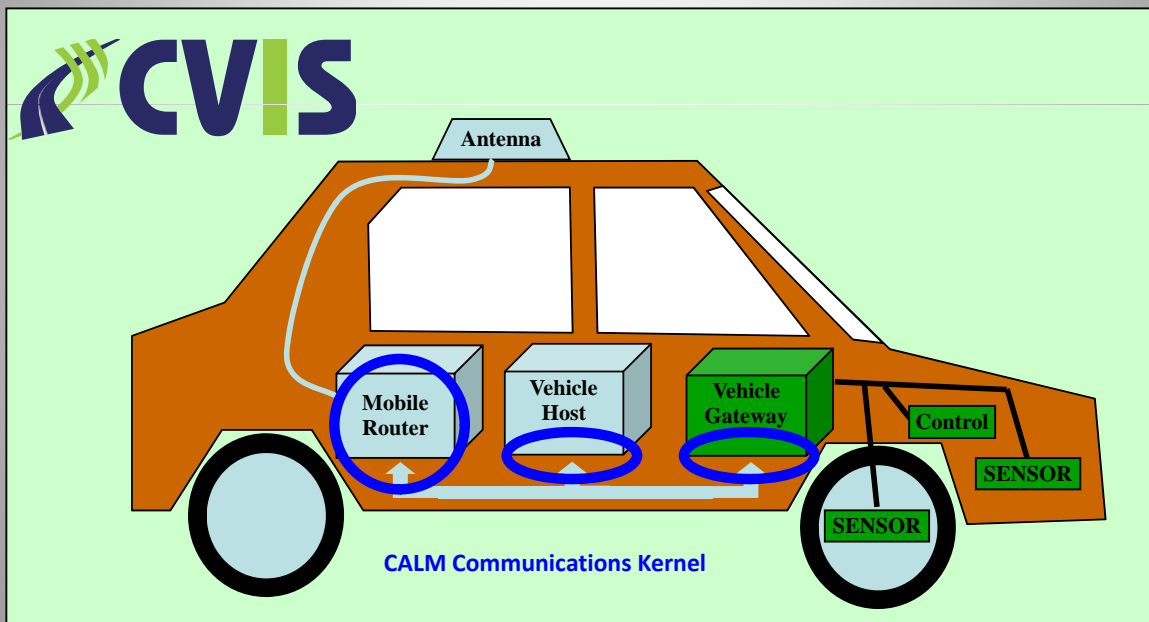
1

Cooperative Vehicle Infrastructure System [CVIS]



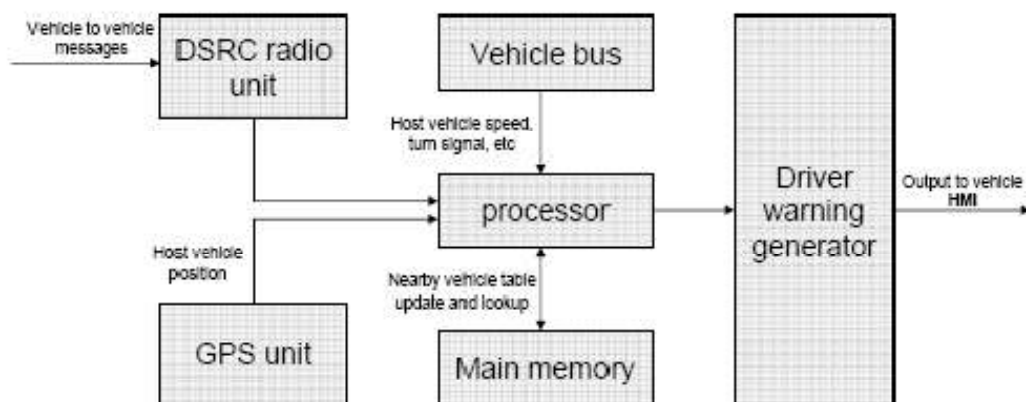
(C) DISplay Pty Ltd 2010

CVIS Vehicle System

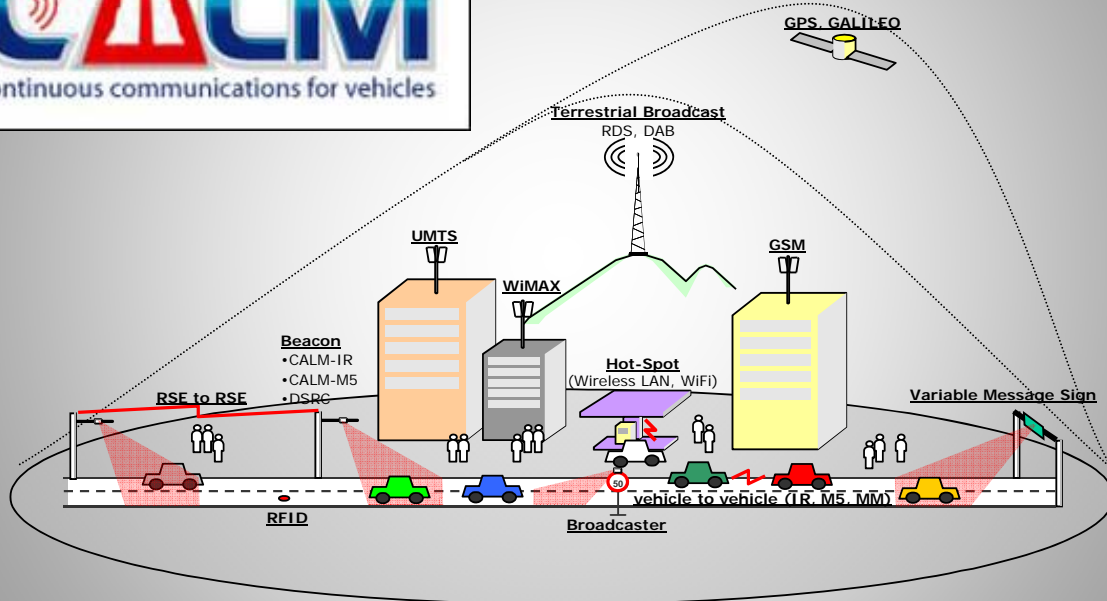


3

Logical architecture

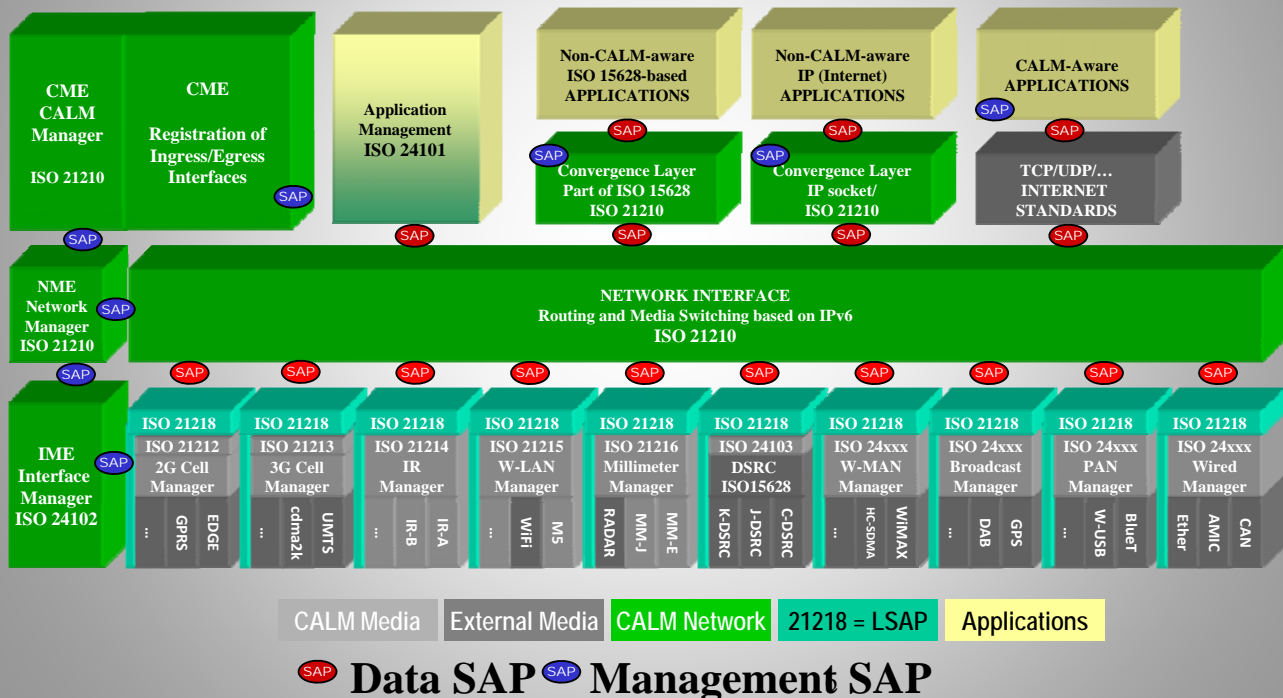


Communication Scenario - CALM



(C) DISplay Pty Ltd 2010

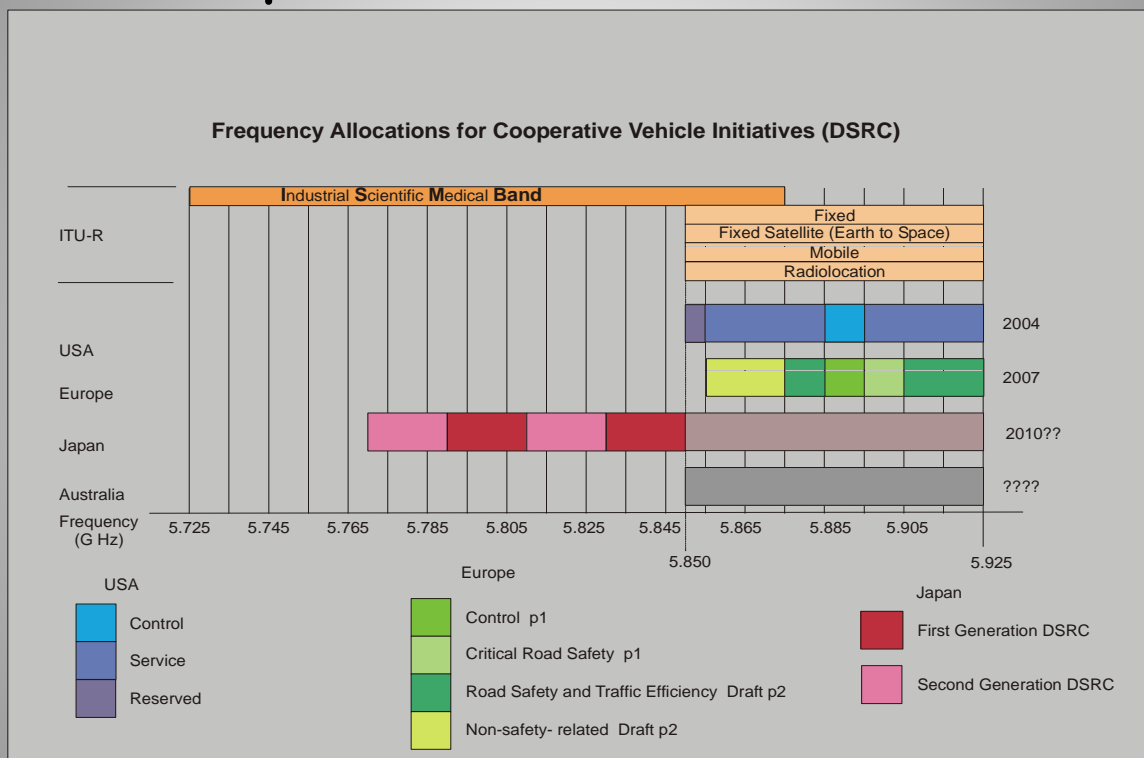
CALM System Architecture (ISO 21217)



Australian Communications & Media Authority [ACMA]

- Manages spectrum allocation and monitors for abuse (interference)
- Licensing authority - three approaches:
 - Spectrum licence eg cellular phone network
 - Apparatus licence eg radio transceiver
 - Class licence eg cellular phone handsets
- Pro-active approach for vehicular wireless communications
 - Discussion papers
 - Inclusion in RadComms09
- Agreement to embargo 5.850-5.925 GHz until DSRC application is decided

Spectrum Allocations



Options for licensing in Australia

•Road-side units

| Type | Interference management | Operational overhead | Quality of Service (QoS) | How it would work for ITS |
|-----------|---------------------------------------|----------------------|--------------------------|--|
| Apparatus | <i>Device-based, shared</i> | <i>High</i> | <i>High</i> | <ul style="list-style-type: none"> •<i>Fee involved</i> •<i>Coordination</i> |
| Class | <i>Generic, shared</i> | <i>Low</i> | <i>No guarantee</i> | <ul style="list-style-type: none"> •<i>No interference protection</i> •<i>Could have user-coordination</i> |
| Spectrum | <i>Parameter based property right</i> | <i>Low (varies)</i> | <i>Absolute</i> | <ul style="list-style-type: none"> •<i>A governing ITS body would manage the spectrum</i> |

9

AustRoads (Australasian federation of road authorities)


Austrroads' purpose is to contribute to improved Australian and New Zealand transport outcomes by:


- providing expert advice to SCOT and ATC on road and road transport issues
- facilitating collaboration between road agencies
- promoting harmonisation, consistency and uniformity in road and related operations
- undertaking strategic research on behalf of road agencies and communicating outcomes
- promoting improved and consistent practice by road agencies.

AP-R330/08

AUSTROADS RESEARCH REPORT

**Intelligent Vehicles and Infrastructure:
The Case for Securing 5.9GHz**




 Austroads
Australasian Federation of Road Authorities

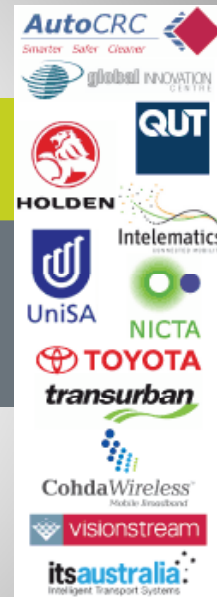
Copyright © 2008 by Austroads. All rights reserved. This report is the property of Austroads and its constituent road authorities.

Australian Dedicated Short Range Communications (AusDSRC) Cluster

AUSTRALIAN DEDICATED SHORT RANGE COMMUNICATIONS CLUSTER



<http://www.ausdsrc.com.au/index.html>

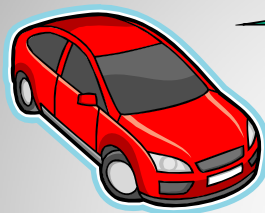


DISplay Pty Ltd

IEEE Advanced Information Networking & Applications, Perth - 2010-04-20

(C) DISplay Pty Ltd 2010

Cohda Wireless Demo System



Positions
exchanged
10x/second



Hardware

- Cohda DSRC Radios
- ST Cartesio App. Proc.
- GPS
- DSRC Antennas

Software

- Communications Protocols
- V2V & V2I Applications
- Human-machine interface

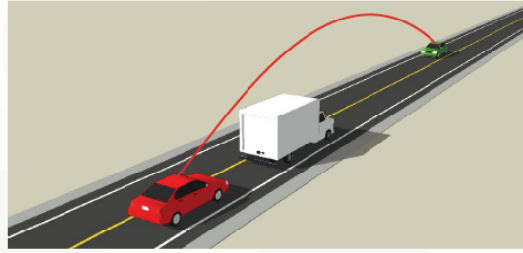
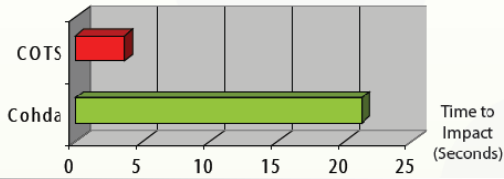
IEEE Advanced Information Networking & Applications, Perth - 2010-04-20

(C) DISplay Pty Ltd
2010

Connectivity Performance: Safe Vehicles

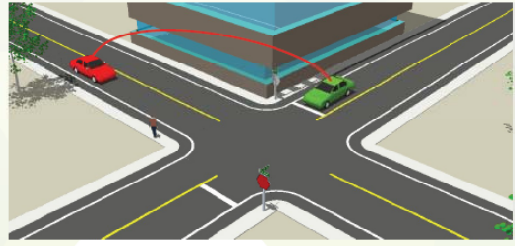
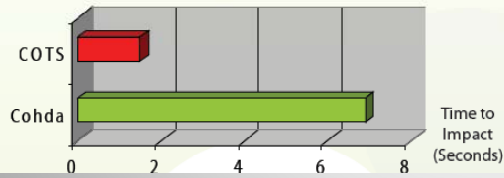
Do Not Pass Warning

Reliable connectivity at extended range in safety-critical scenarios.



Intersection Collision Warning

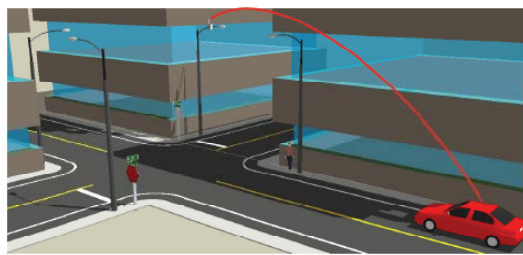
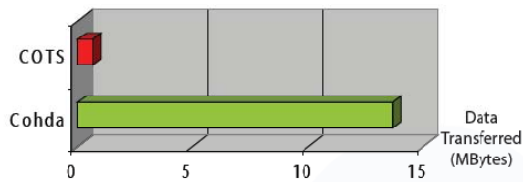
Extends connectivity to non-line-of-sight conditions – dramatically improving V2V applications.



Connectivity Performance : Connected Vehicles

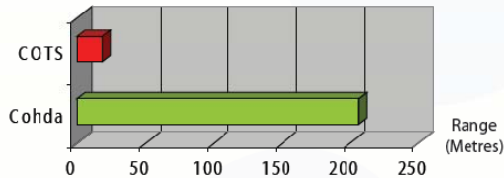
Wi-Fi AP

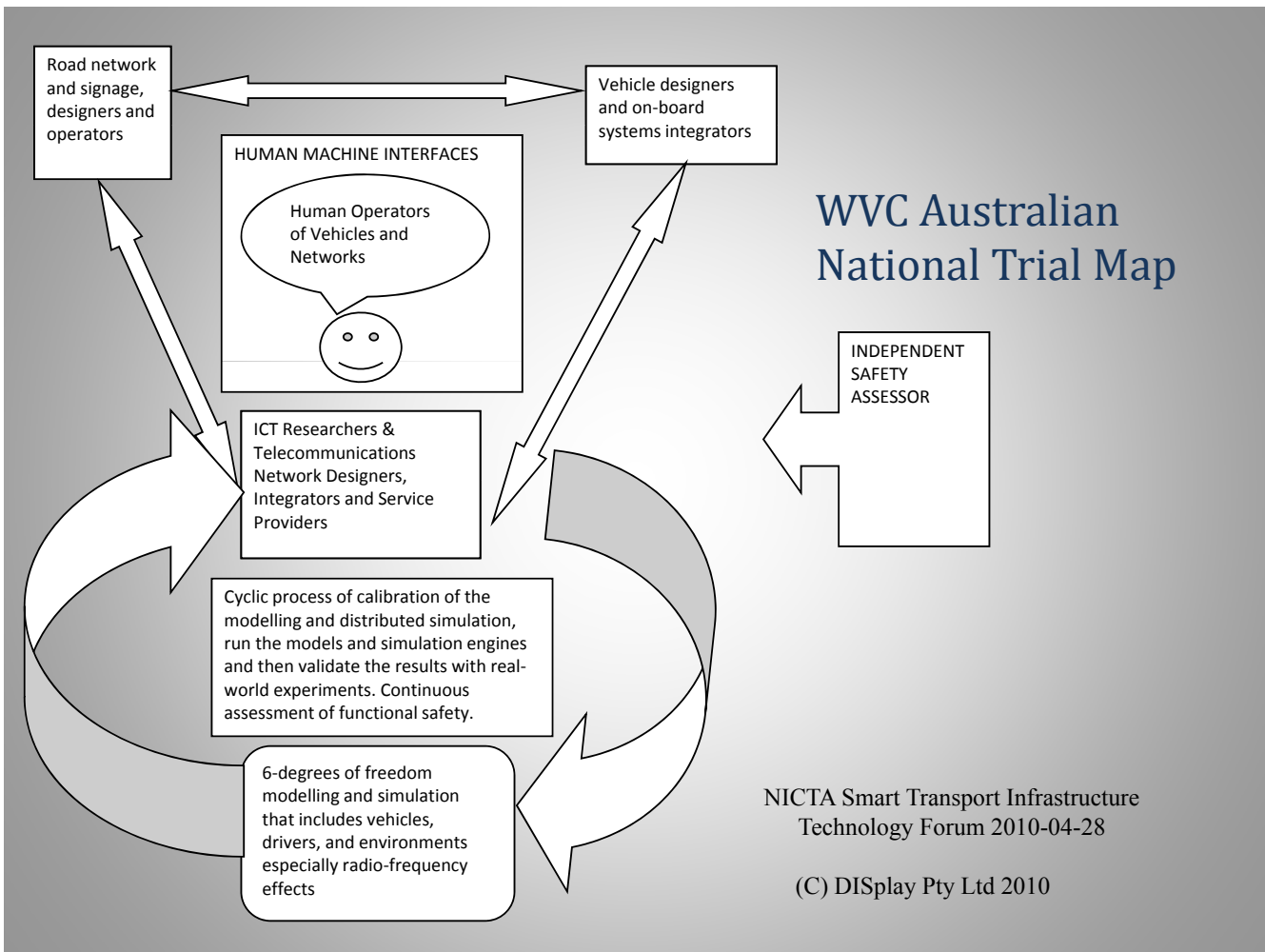
Dramatic increase in amount of data that can be uploaded or downloaded.



Electronic Toll Collection

Significant increase in connectivity range, reducing chance of failed transaction.





Thankyou for your attention 😊

Are there any questions?

EU Cooperative Systems (1)

- Reference: Deployment Challenges for Cooperative Systems (2010-03-26) White Paper by:
 - Lina KONSTANTINOPOULOU (ERTICO-ITS EU) CVIS
 - Zwijnenberg HAN (TNO) SAFESPOT
 - Susanne FUCHS & Doris BANKOSEGGER (HiTec Marketing) COOPERS
- **CVIS**: Cooperative Vehicle Infrastructure Systems; €41 million; 60 partners; 12 countries
- **SAFESPOT**: Cooperative systems for road safety; €38 million; 51 partners; 12 countries
- **COOPERS**: COOPerative systEMs for intelligent Road Safety; €16.8 million; 37 partners; 14 countries

EU Cooperative Systems (2)

- White Paper is in three parts:
 - Identification of the challenges
 - Actions for stakeholders to overcome the challenges
 - Visions on the deployment of cooperative systems
- It discusses:
 1. Technology
 2. Standardisation & Interoperability
 3. Liability
 4. User Acceptance
 5. Privacy & Security
 6. Business Modelling & Organisation
 7. Political
 8. Deployment & Operation

Technology

- **CVIS** goal is to develop technologies allowing vehicles to communicate with roadside infrastructure and other vehicles, and to share data about the traffic status and the immediate road environment.
- **SAFESPOT** goal is to design cooperative systems for road safety based on vehicle to vehicle [V2V] and vehicle to infrastructure [V2I] communication. The project aims to develop and test technology that will enable such cooperation... That will increase the amount of information available to drivers.
- **COOPERS** connect vehicles... with road infrastructure on motorways, for data exchange relevant for the specific road segment to enhance road safety and enable Co-operative Traffic Management.

Standardisation & Interoperability

- Interoperability and standardisation is necessary for cooperative systems deployment
- At least three standardisation organisations [SDO] are developing standards for 5.9GHz Intelligent Transport Systems [ITS] band
 - ETSI TC ITS
 - ISO TC204
 - WG16 CALM
 - WG18 Cooperative Systems with CEN TC278 WG16
 - IEEE 802.11p and 1609 WAVE
- An Architecture Task Force is collecting and consolidating requirements and defining an architectural framework for EU
- Common approach to Field Operational Testing [FOT]

Liability

- UNECE Convention on Road Traffic (the Vienna Convention) states the driver must control his/her vehicle at all times
- Cooperative systems are complex and incorporate many parties, responsibilities and competences.
- Growing technical interdependences between vehicles and infrastructure may lead to failures and thence questions on financial liability and compensation which are governed by other than contract law
- Use cases have been developed and analysed. Actor liabilities have been examined creating contractual matrices, and involving the law of tort.
- Tools being considered include: model contracts, insurance, codes of practice, standardisation, certification, validation, alternative dispute resolution [ADR], 'without prejudice' restoration funds, and risk sharing pools.

User Acceptance

- Cooperative systems that connect vehicles... will only be successful if accepted, implemented and ultimately used by consumers.
- Willingness to pay is an important aspect eg €100 per 10,000km, or €100 per year, would be readily accepted
- The user acceptance of the CVIS system was investigated through a driving simulator study, in scenarios such as: rerouting; speed advice with green wave, infotainment.
- Installing systems in cars as standard equipment is seen as the most useful means to promote cooperative systems. Other important approaches include Field Operational Testing [FOT] and cooperative research
- To optimise CVIS diffusion preferable to use dual approach: government role for common rules, standards and infrastructure, market driven vehicle deployment

Privacy & Security

- ITS applications and services are based on the collection, processing and exchange of a wide variety of data, from both public and private sources, including information on traffic and accidents but also personal data, such as driving habits and journey patterns.
- A number of EU-funded projects to look at privacy and the related issue of security.
- Approaches:
 - 'Privacy by design'
 - Clarification of responsibilities of the various actors involved
 - Safeguards on the use of location technologies
- Use cases under consideration include:
 - Speed alert & profiles
 - Pay-as-you-drive / road user pricing
 - Parking and hotel reservations

Business Modelling & Organisation

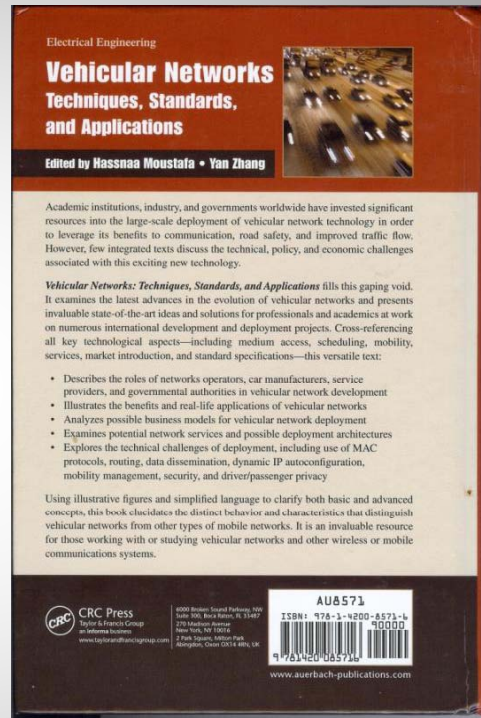
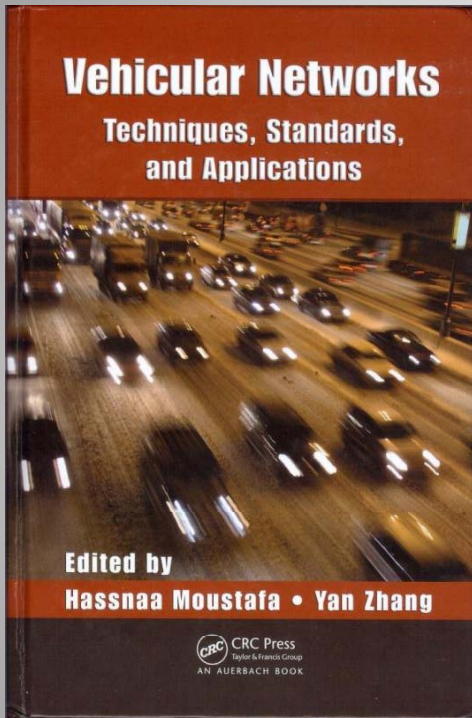
- Cost model based on four main cost objects:
 - On-board unit [OBU]
 - Road-side unit [RSU]
 - Traffic (Information) & Control Centre
 - Communications
- Life cycle costing [LCC] used
- Benefits based on reduction of costs by CVIS services:
 - Safety
 - Efficiency
 - Vehicle operation
 - Environment
- CVIS models cover:
 - Public safety and efficiency
 - Commercial freight and fleet services
 - Personal traffic information services

Political

- To translate the findings from a literature review and an interactive session into practical policy for the deployment of CVIS, fifteen key policy-makers and advisors from ten EU countries were interviewed
- There will be a conflict if efforts concentrate only on private vehicles
- Development of CVIS could be an iterative process of:
 - Gaining more experience by conducting tests
 - Exchanging knowledge among participants
 - Scaling up from previous work
- A road-map would be useful, with a timeline
- Target oriented approach recommended
- Socio-economic studies needed
- Effective public-private partnership [PPP] approach needed

Deployment & Operation

- Assumed vehicle installations start in 2015 (5 year from now)
- Assumed fleet penetration less than 10% by 2020 (a further 5 years)
- Benefit /cost ratio for V2V is neutral to positive (1.0 - 1.1)
- BCR for V2I is negative, mainly due to high investment costs to achieve wide coverage (like, say, the coverage of VICS in Japan which exceeds 90% of all main roads)
- (The first estimate for USA was 300,000 RSU)
- Alternative approach for V2I is:
 - WAVE coverage of accident black spots
 - Use of existing 3G telecommunications elsewhere to achieve benefits of driver traffic information but without the real-time safety-critical benefits



NICTA Short Course Wireless Vehicular
Communications - 2009-11-16/17

(C) DISplay Pty Ltd
2009