COOPERATIVE INTELLIGENT TRANSPORT SYSTEMS

LEVEL CROSSING SAFETY

Professor Jugdutt (Jack) Singh
Director – Centre for Technology Infusion

LA TROBE UNIVERSITY

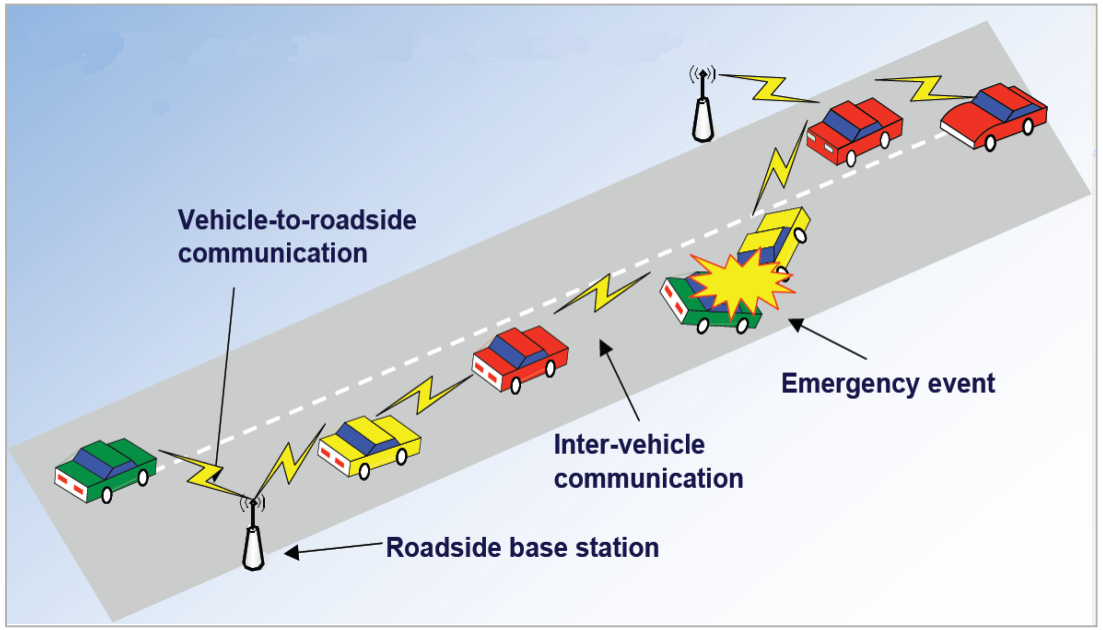
COOPERATIVE INTELLIGENT TRANSPORT SYSTEMS

What is Cooperative Intelligent Transport Systems?

Advanced **INFORMATION & COMMUNICATIONS TECHNOLOGIES** used to enhance **safety**, improve **mobility**, support **commerce**, and help sustain the **environment**

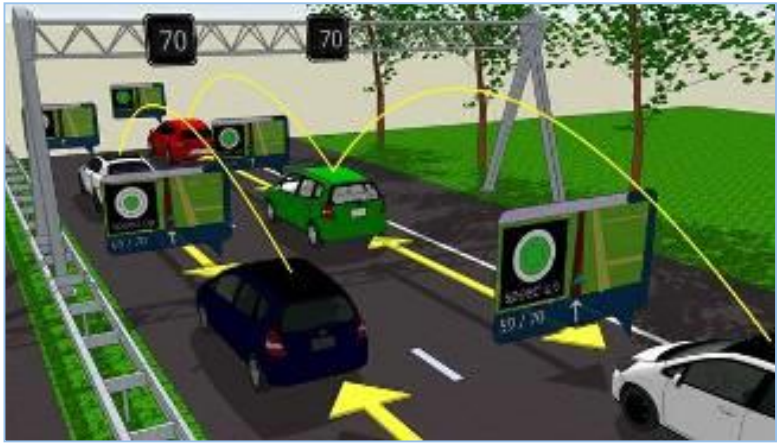
…. Addressing multi-modal

- Transport Safety
- Transport Productivity
- Travel Reliability
- Health & Safety
- Environmental Performance
- Informed Travel Choices
- Social Equity
- Network Operation & Resilience
- etc.



COOPERATIVE MOBILITY CONCEPT

- Anticipating by communication
  - Efficient use of roads during heavy traffic
  - Information on road conditions and traffic flow
  - Information on behaviour of other road users
- Supported by cooperative technology
  - Vehicle-to-Vehicle and Vehicle-to-Infrastructure communication
  - Real-time personal warning and advising

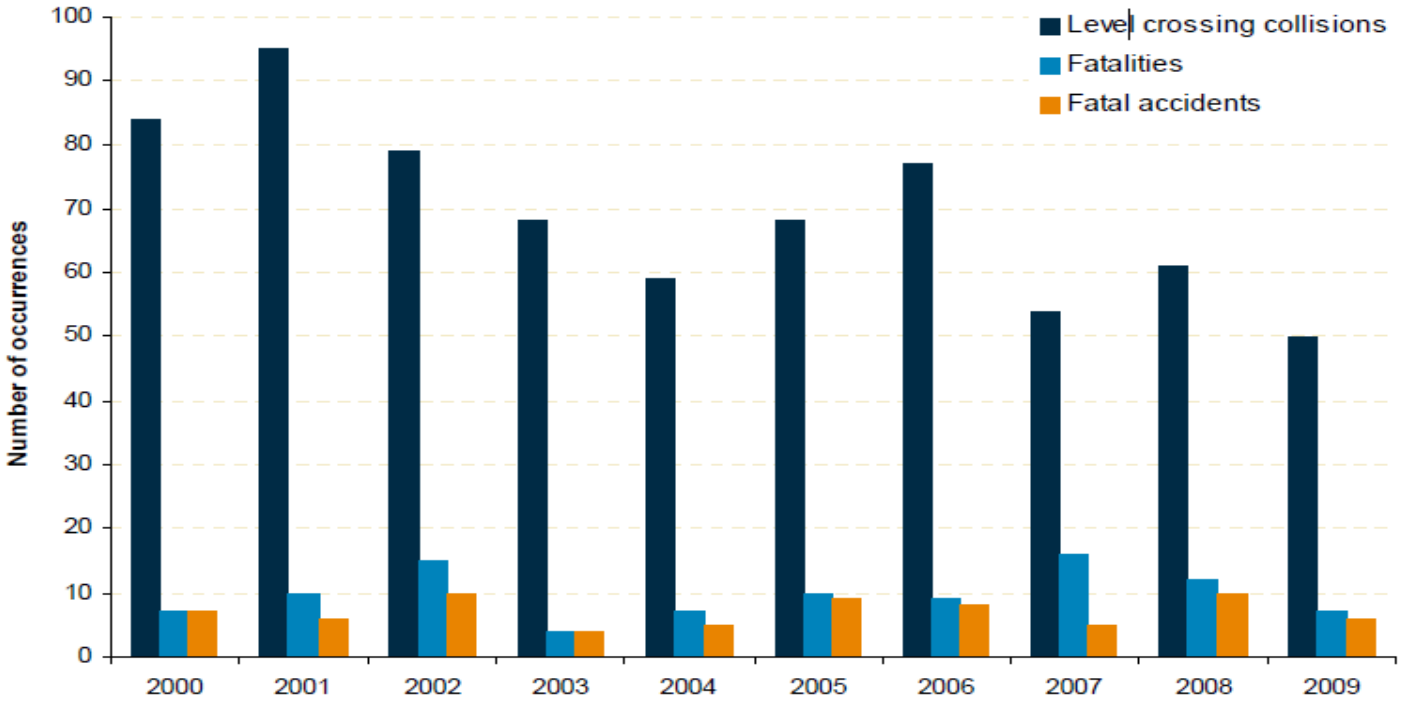


CO-OPERATIVE INTELLIGENT TRANSPORT SYSTEMS TO IMPROVE SAFETY AT LEVEL CROSSINGS

LEVEL CROSSING COLLISIONS IN AUSTRALIA (2000 – 2009)

Statistic	Public road		Private road		Total
	Active control	Passive control	Active control	Passive control	
Number of collisions	356	248	27	64	695
Number of people fatally injured	58	35	0	4	97

- **Over 70 fatalities (1997 – 2002)**



Source: ITSR

NEED FOR A COMPREHENSIVE SOLUTION

- **Causes include**
  - lack of awareness of an on-coming train
  - unintended road user error
  - driver behaviour and other human factors

- **Aust. Government Recommendations**
  - **State Government (Dec 2008)**
  - *Adopt new developing technologies such as ITS*
  - *Govt. to coordinate support to develop, trial and adopt ITS*
  - *Trial, promote/encourage use of ITS at rail-road interface*
  - **Federal Government (June 2009)**
  - *Gov. to support ITS research to speed the implementation*
  - *Research into feasibility of cut-in warning systems*

Lismore 2006:Tipper truck/Freight train collision (est. cost upwards of $13.5 million)

Ban Springs 2006: Trailer road train/Passenger train collision (cause driver behaviour and large heavy road vehicles start/stop time)

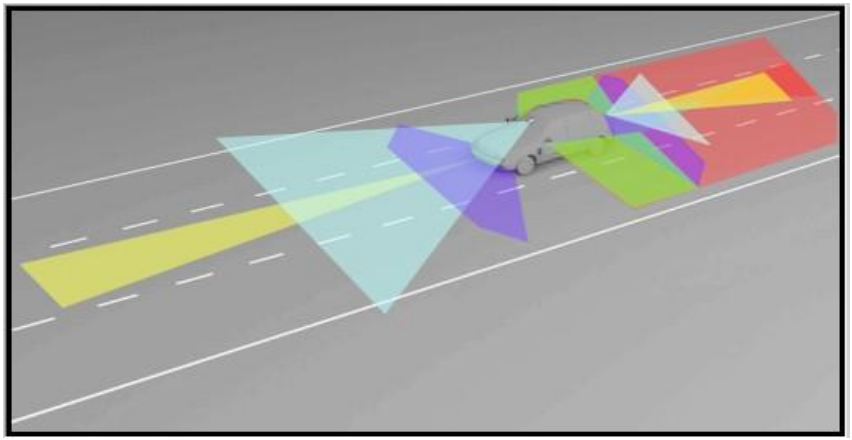
TECHNOLOGY:

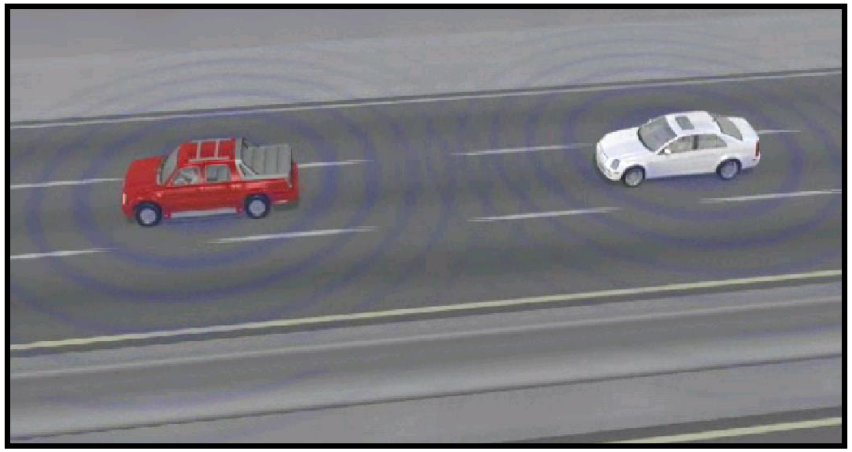
DEDICATED SHORT RANGE COMMUNICATION (DSRC)

- Vehicle safety research is shifting its focus towards crash avoidance and collision mitigation
- Traditional sensors, like radars, have the following limitations:
  - Limited range (sense immediate vehicles)
  - Limited Field of View (FOV)
  - Expensive
- Cooperative Intelligent Transport Systems using wireless comm. (DSRC) for vehicle safety, mobility and commercial apps.

"360 Degrees Driver Situation Awareness" using wireless comm.

TRADITIONAL SENSORS



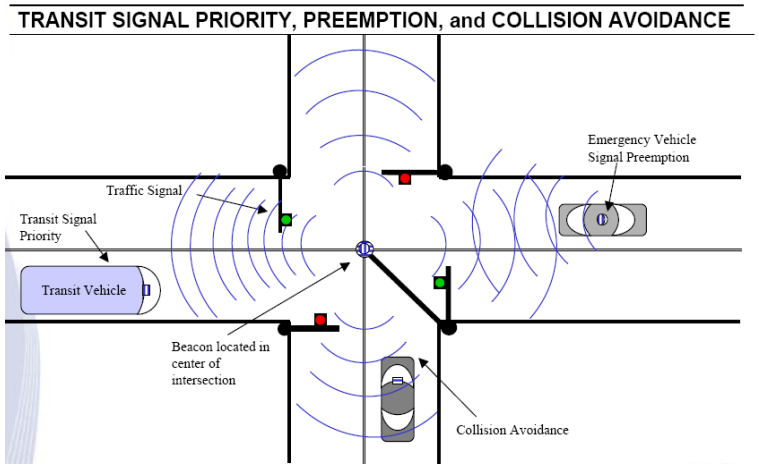


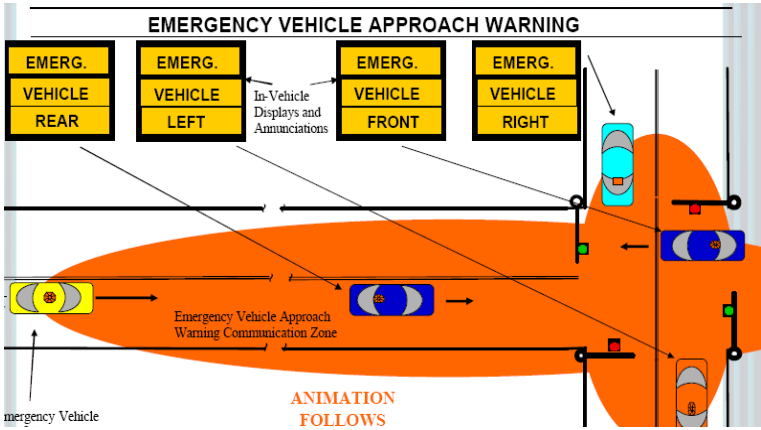
COOPERATIVE COLLISION WARNING (CCW)

COOPERATIVE INTELLIGENT TRANSPORT SYSTEMS

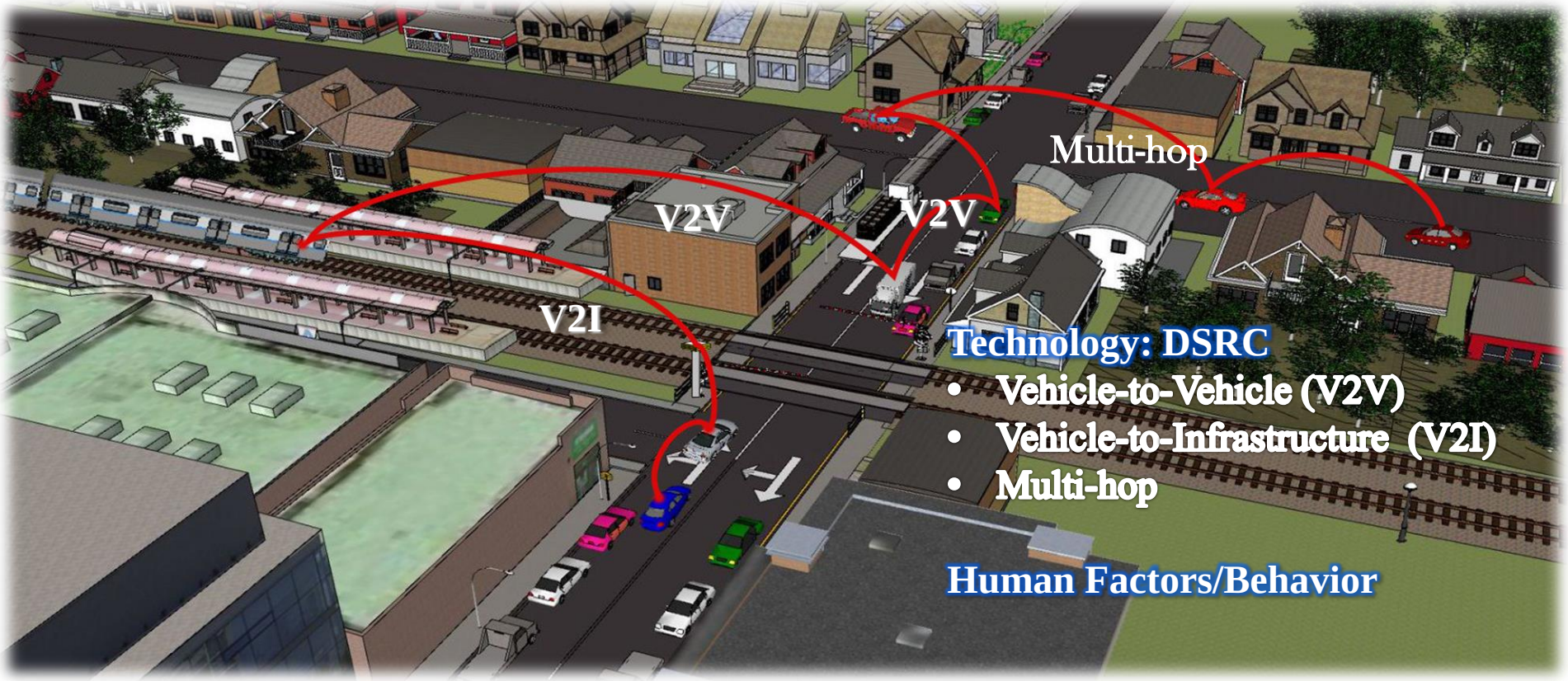
- Vehicle-to-Vehicle Communications
- Vehicle-to-Infrastructure Communications
- Human-Machine Interface (human factors)

- **Safety**
  - Intersection collision avoidance
  - Cooperative collision warning
  - Traffic signal interface
- **Mobility**
  - Traffic congestion management
  - Traffic signal control and management
  - Incident management
- **Consumer & Commercial**
  - Electronic payment
  - Fleet management





SOLUTION



- **Safety**
  - Intersection collision avoidance
  - **Cooperative collision warning**
  - Traffic signal interface
- **Mobility**
  - Traffic Congestion Management
  - Incident Management
  - in-vehicle signage/messaging
  - Traffic signal control & management
- **Consumer & Commercial**
  - Electronic payment
  - Fleet management
  - Information transfer

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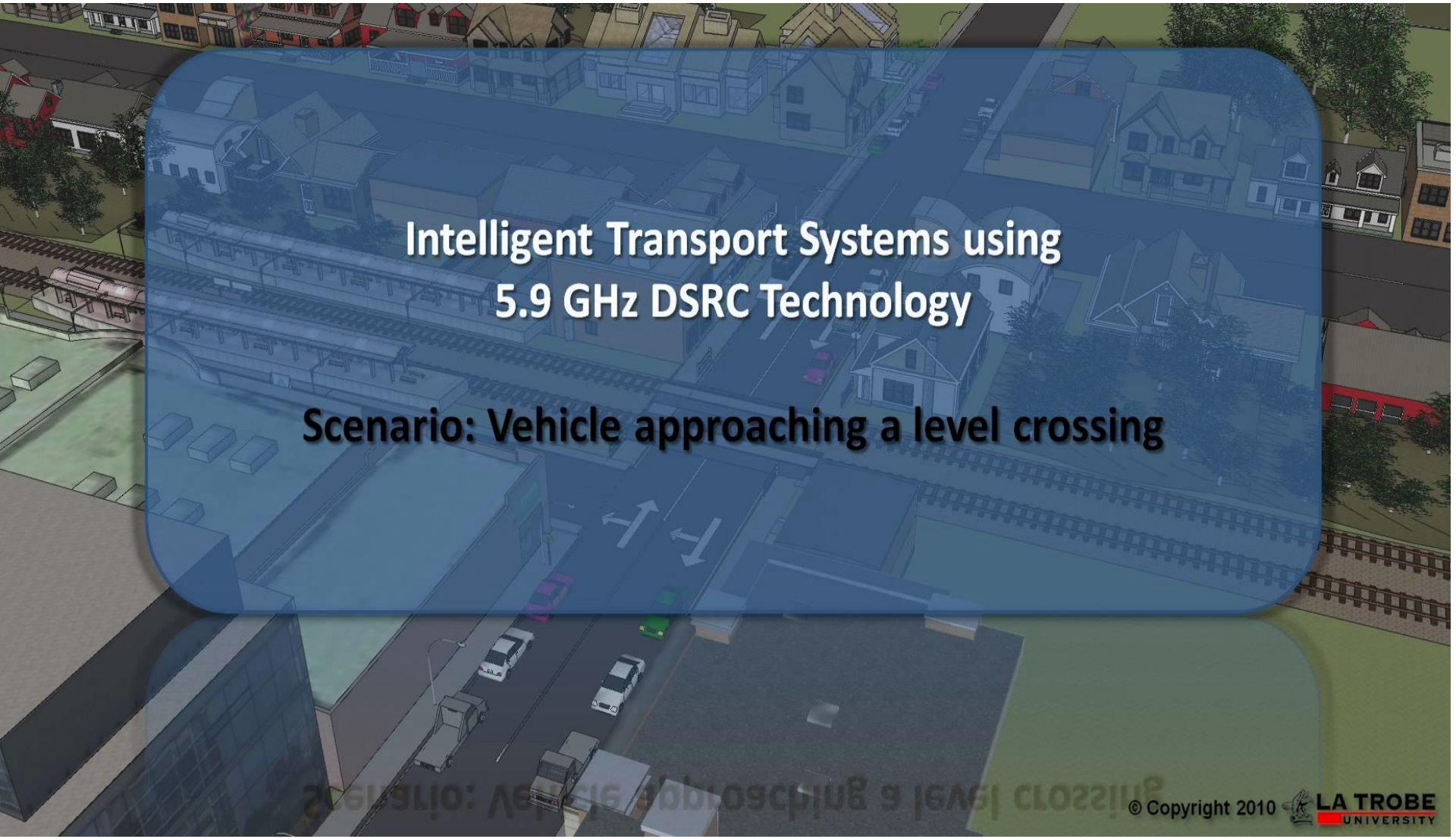
CONCEPT OF THE SAFETY SOLUTION



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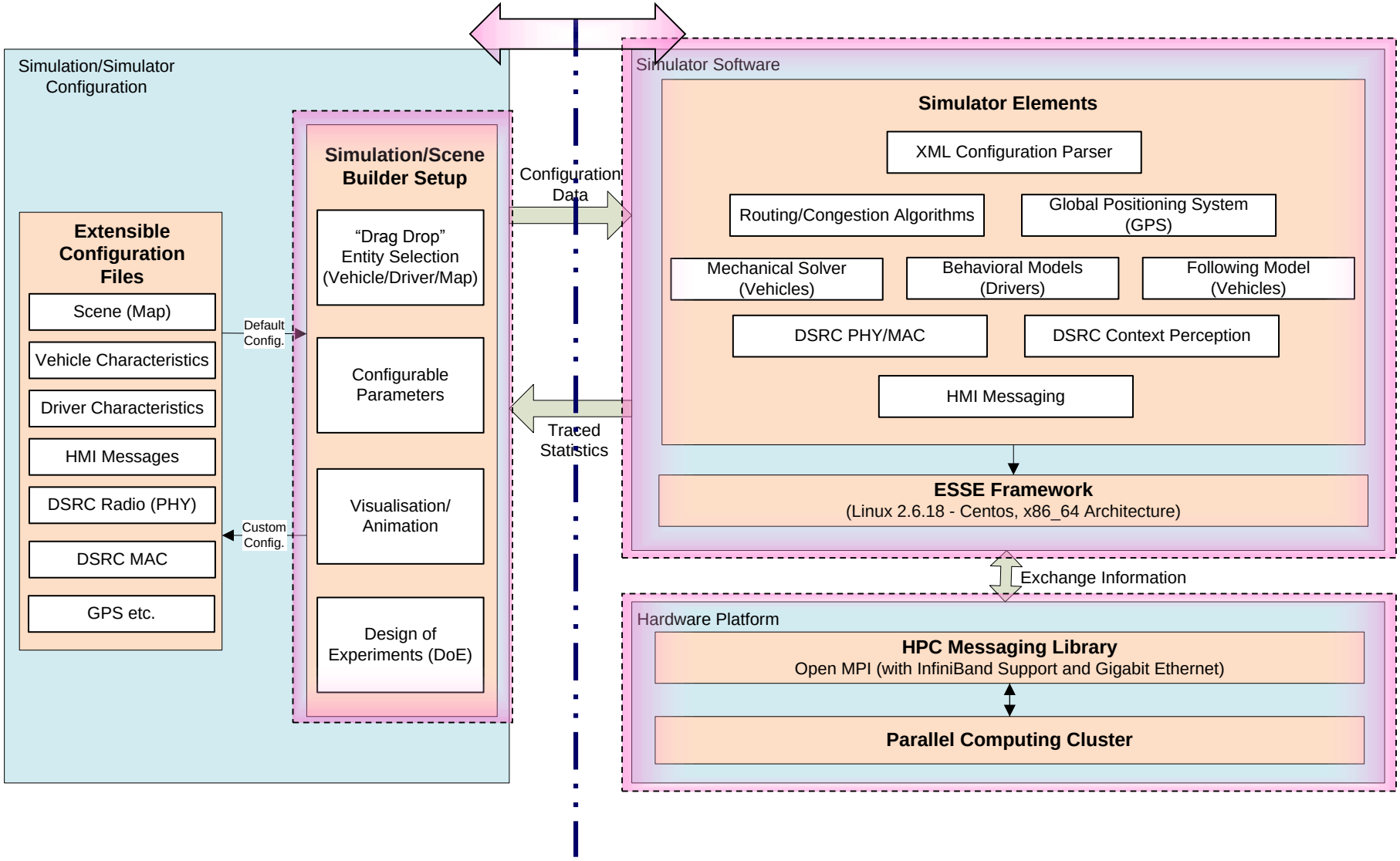
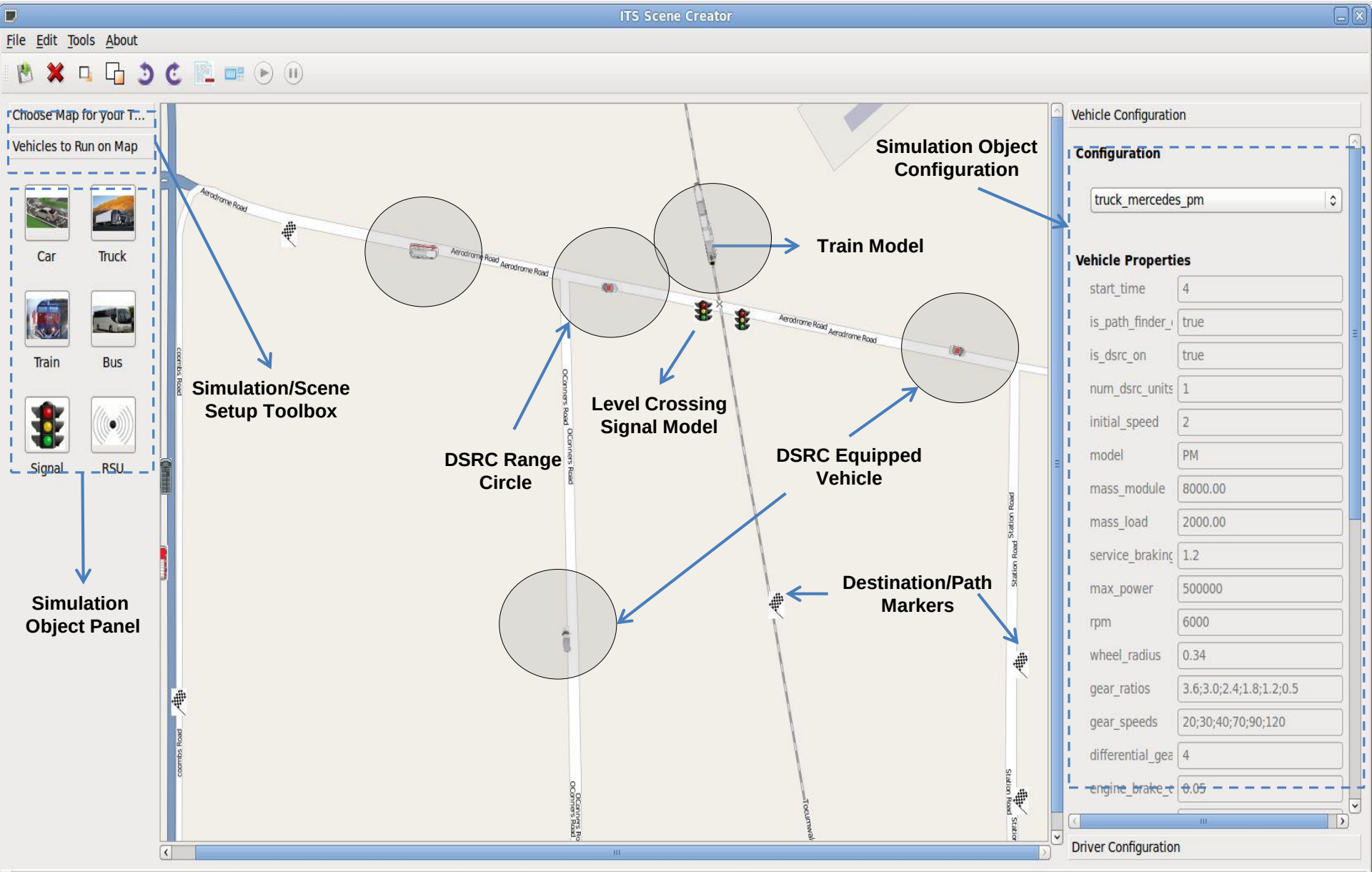
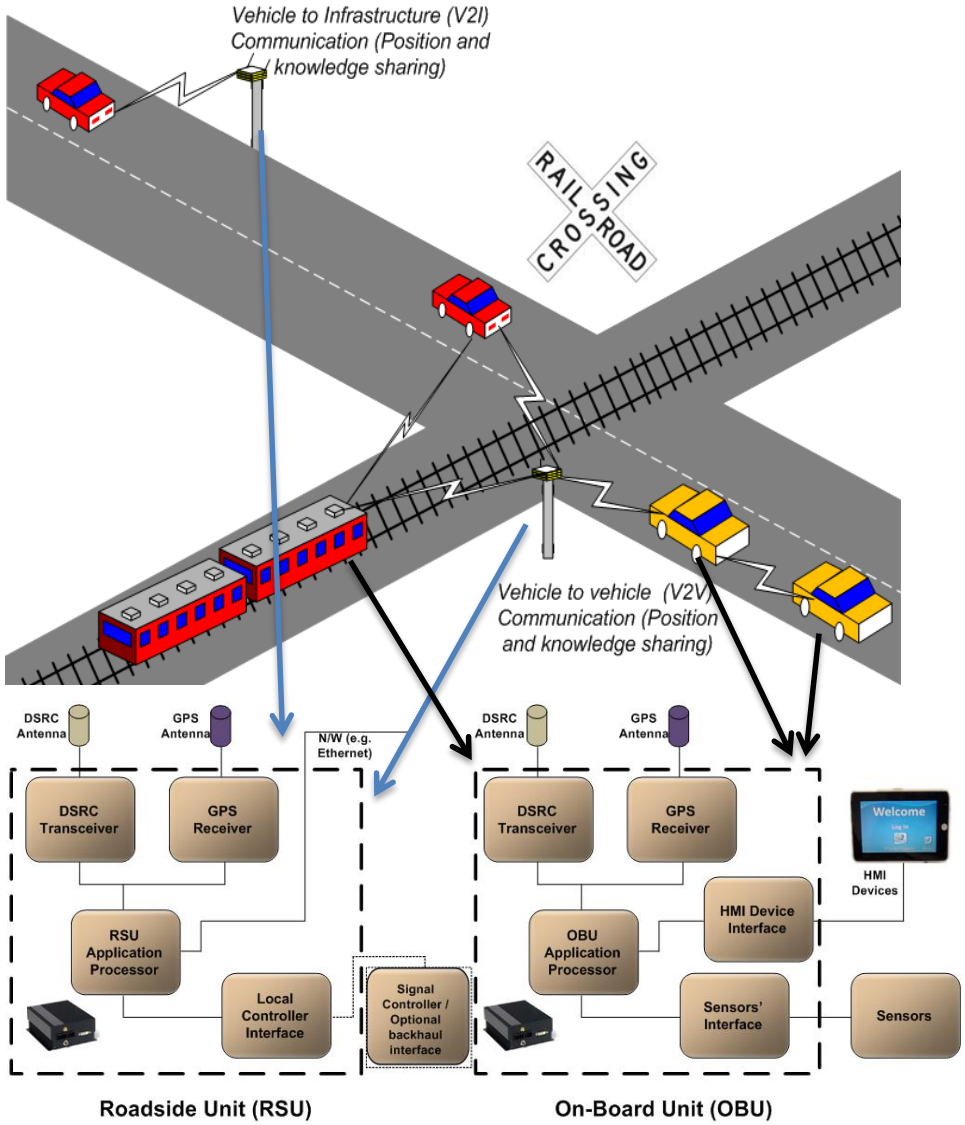
SIMULATION PLATFORM ARCHITECTURE



SIMULATION PLATFORM



SYSTEM IMPLEMENTATION



DSRC Functionality

- CCH Operation (max higher power for RSU and Train)
- T2V and T2I-I2V for train messaging
- V2V BSM send on sync (network performance)

Mapping & Context Perception

- Auto-positioning and map interpolation
- Context perception for Head/Tail detection and trajectory estimation (V2V/V2I)
- Intelligent remote dead-reckoning
- Crossing safety detection

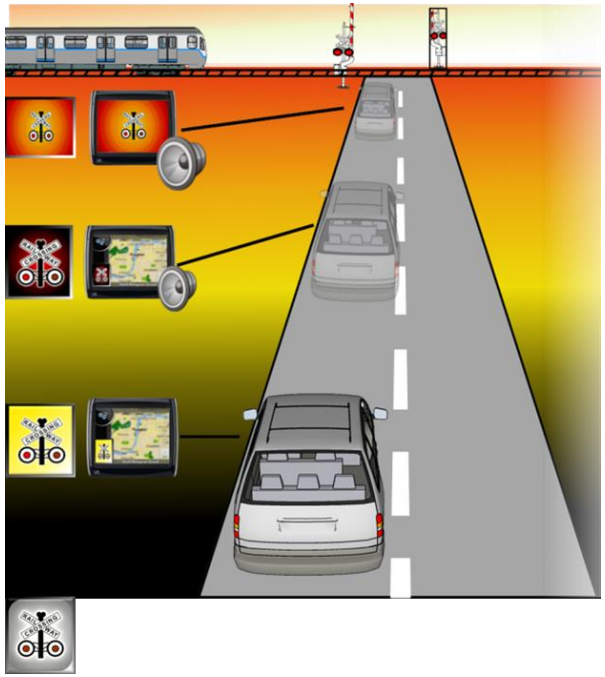
Warning algorithm

- Train critical position detection
- Intersection collision time calculation
- Extended NHTSA Collision Avoidance algorithm

System Software

- Logging events and packet information
- System error auto-detection and recovery functions

SAFETY MESSAGING ALGORITHM AND HMI



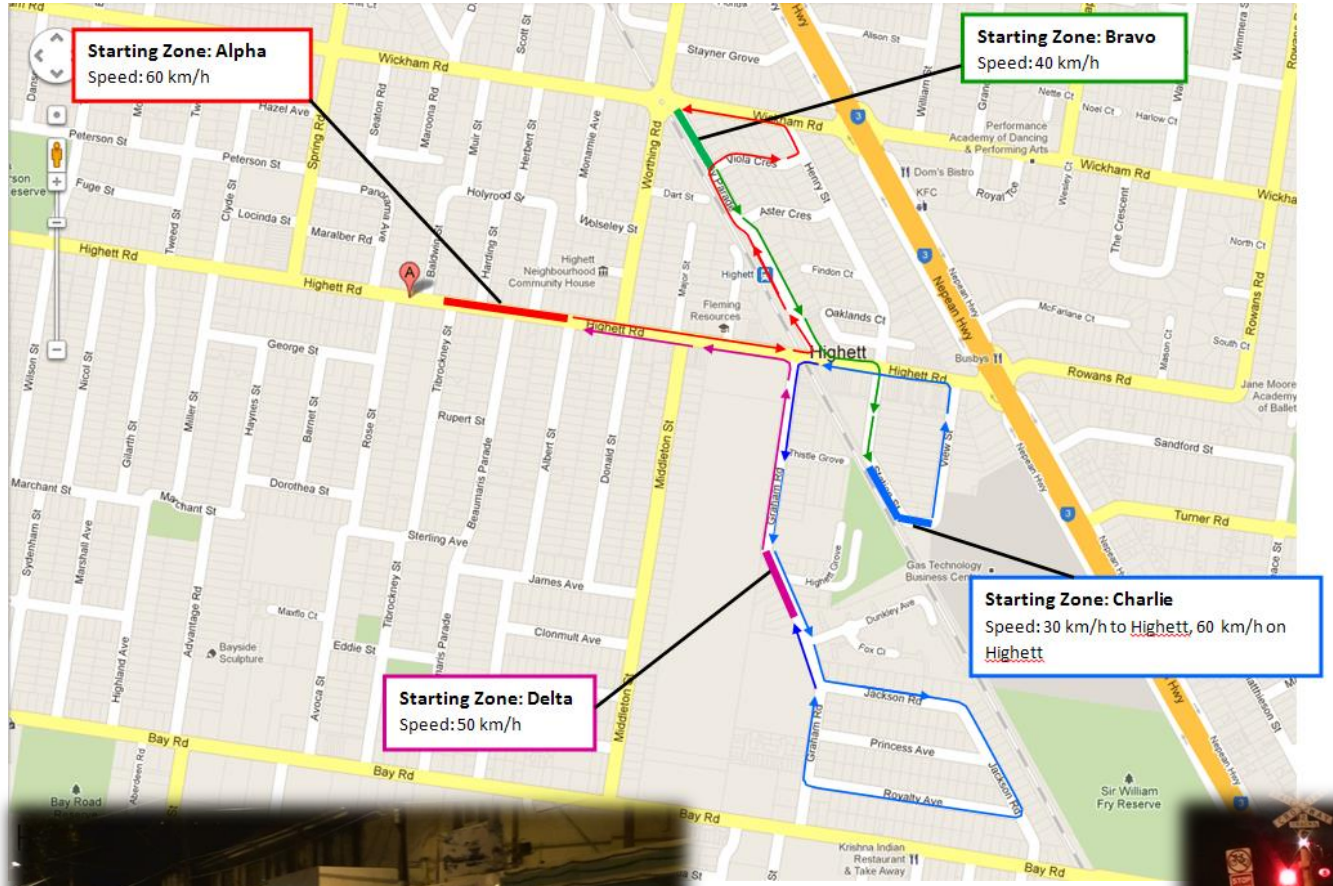
- **Staged intelligent warnings (in-direct path)**
  - Higher level audio-visual alerts are only triggered as driver enters a direct path to the level crossing
  - All alerts extinguish as soon as vehicle has cleared the crossing or is heading away from crossing

- **Staged intelligent warnings (direct path)**
  - First warning: presence of train on current path
  - Higher levels: triggered through algorithm calculations (NHTSA + presentation time, reaction time, safety margins)
  - Combination of audio and video to produce perceptual cascading effect
  - Volume of sound and intrusiveness of visual alert increase with level of urgency

Parallel Path

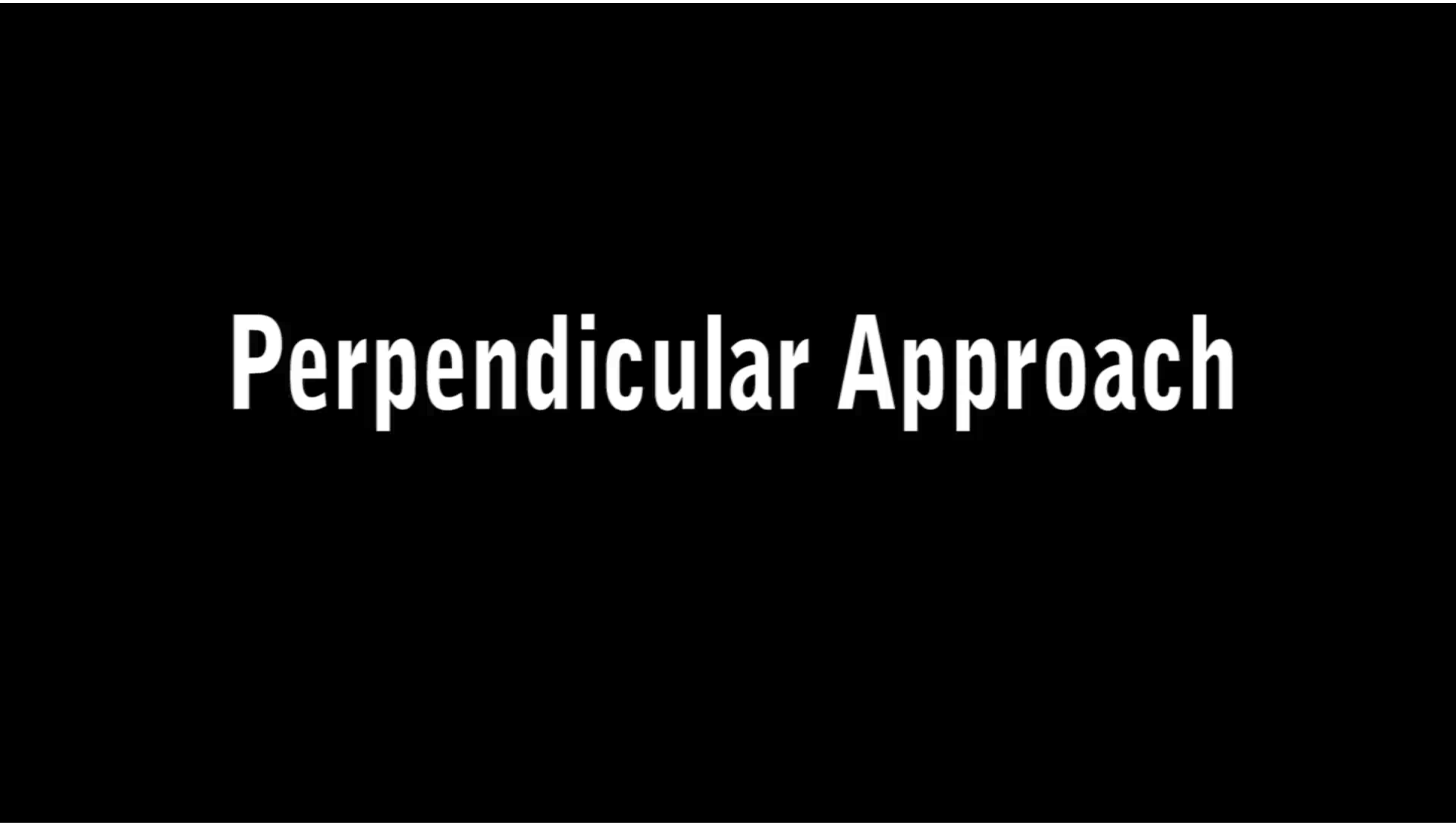
Train Present

FIELD TRIAL SITE
HIGHETT (METROPOLITAN MELBOURNE)



- LOS NLOS radio propagation in city area
- Heavy channel congestion and interference
- Radio fading and path loss in high-building area
- Level-crossing warning threshold in city area
- Complex indirect path operations
- Heavy-traffic and complex road driving habits
- Driving habits at highly controlled crossing

DIRECT APPROACH



HIGHETT SHOWING LOS QUALITY AND CONNECTIVITY

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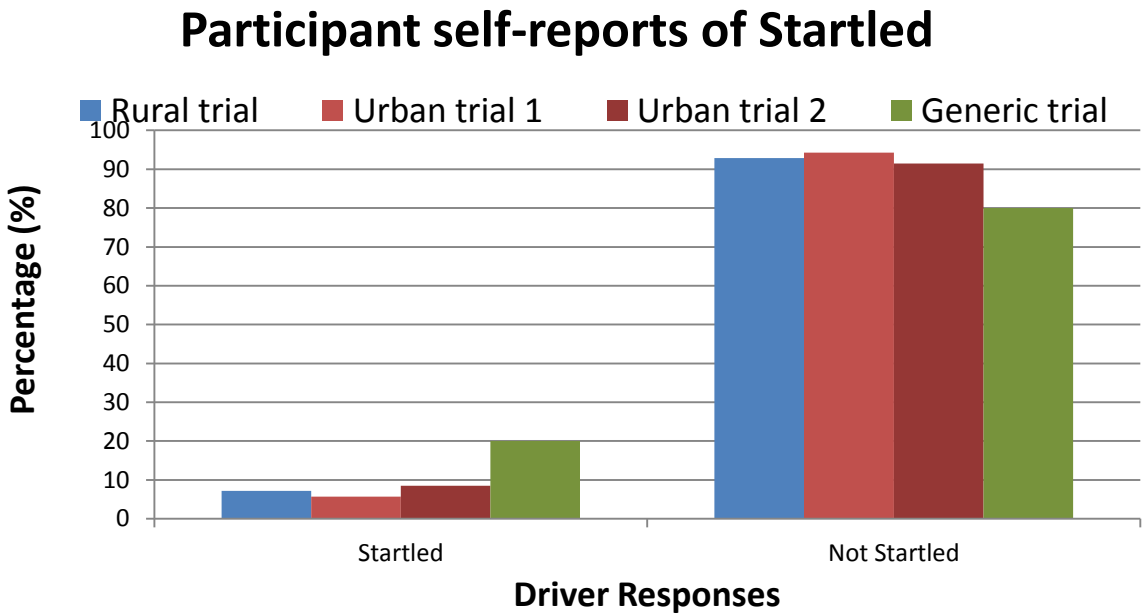
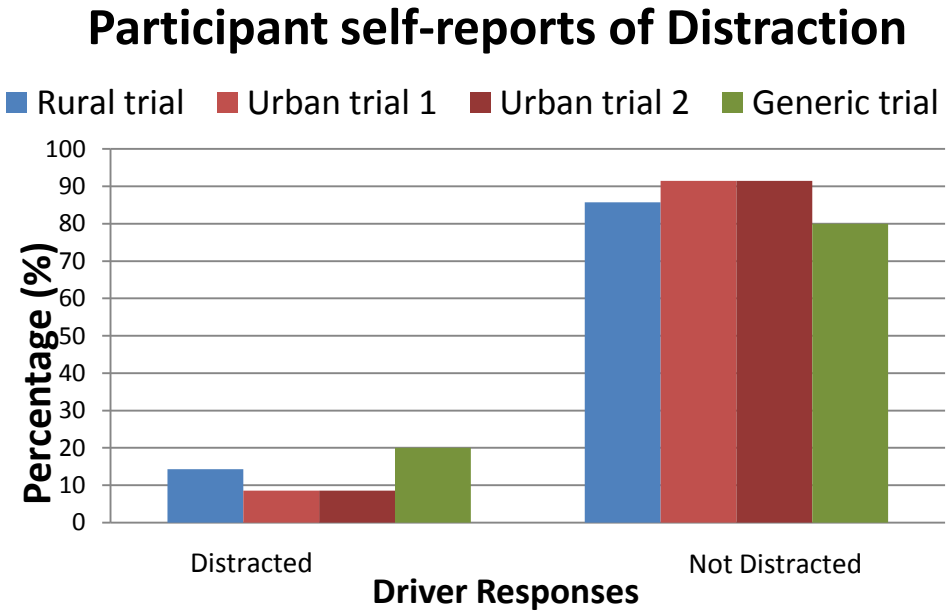
FACTORS AFFECTING CONNECTIVITY AT TRIAL SITES

Site	Street	Distance to Level Crossing for connectivity levels > 90%	50%	< 10%	Building Density	Terrain
Dingee	Dingee Rd	0-200m	700m	> 1050m	Low	Flat
	Queen St	0-250m	1050m	> 1700m	Low	Flat
	King St	0-200m	600m	> 700m	Low	Flat
Highett	Highett Rd (West)	0-210m	380m	> 410m	Medium	Lower than RSU
	Highett Rd (East)	0-100m	150m	> 220m	High	Flat
	Railway Parade	0-110m	130m	> 170m	Medium	Flat
	Graham Rd	0-220m	320m	NA	Medium	Flat
Cheltenham	Park Rd (West)	0-130m	180m	> 240m	Medium	Much Higher than RSU
	Park Rd (East)	0-360m	NA	NA	High	Flat

- Connectivity at **urban sites** (Highett and Cheltenham) is significantly different from that of the **rural site** (Dingee).
- **LOS** quality is clearly the **primary factor** that affects the connectivity.
- **Building density** and **terrain** also notably affect the connectivity.

DRIVER FEEDBACK





LARGE SCALE DEPLOYMENT TRIAL

- Two trials sites in remote Townsville, Queensland: Manton Quarry Road, Calcium and GroMac Quarry Access Road, Broughton
- Trial period: 6 months 2013/2014
- Freight trains and heavy vehicles

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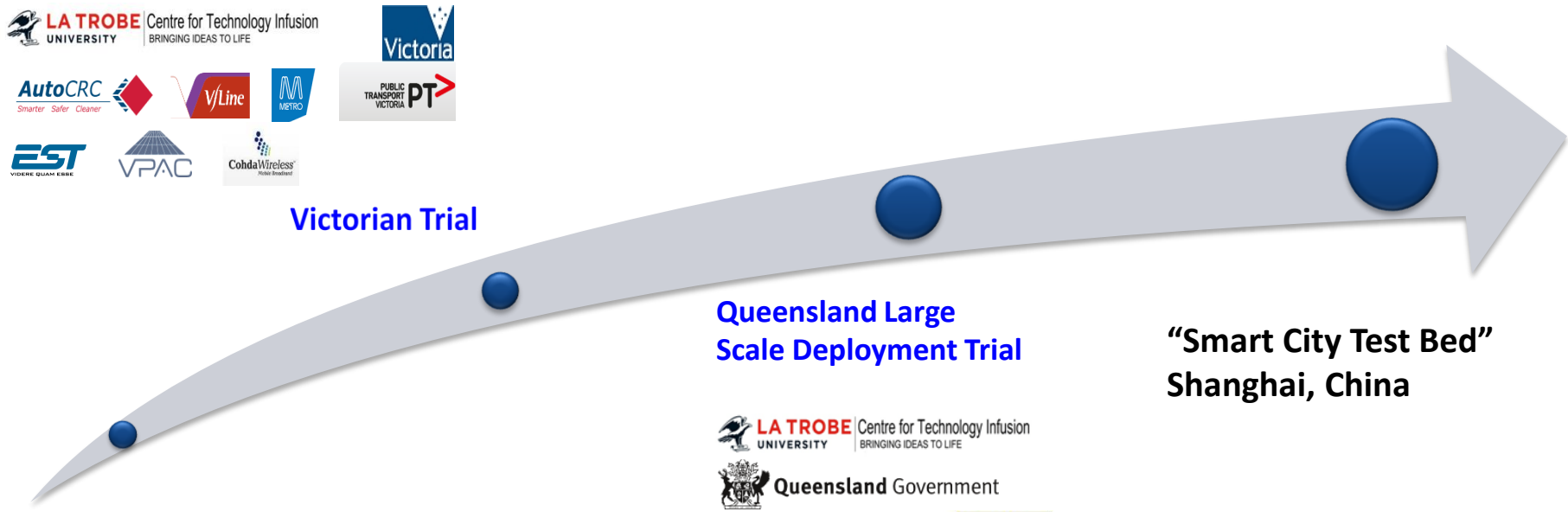
ROAD MAP AND COMMERCIALIZATION



Victorian Trial

Research

Queensland Large
Scale Deployment Trial

"Smart City Test Bed"
Shanghai, China

TRAM NETWORK

- Ongoing interest in improving safety record and reduction of tram-to-tram and tram-to-road vehicles/pedestrian collisions

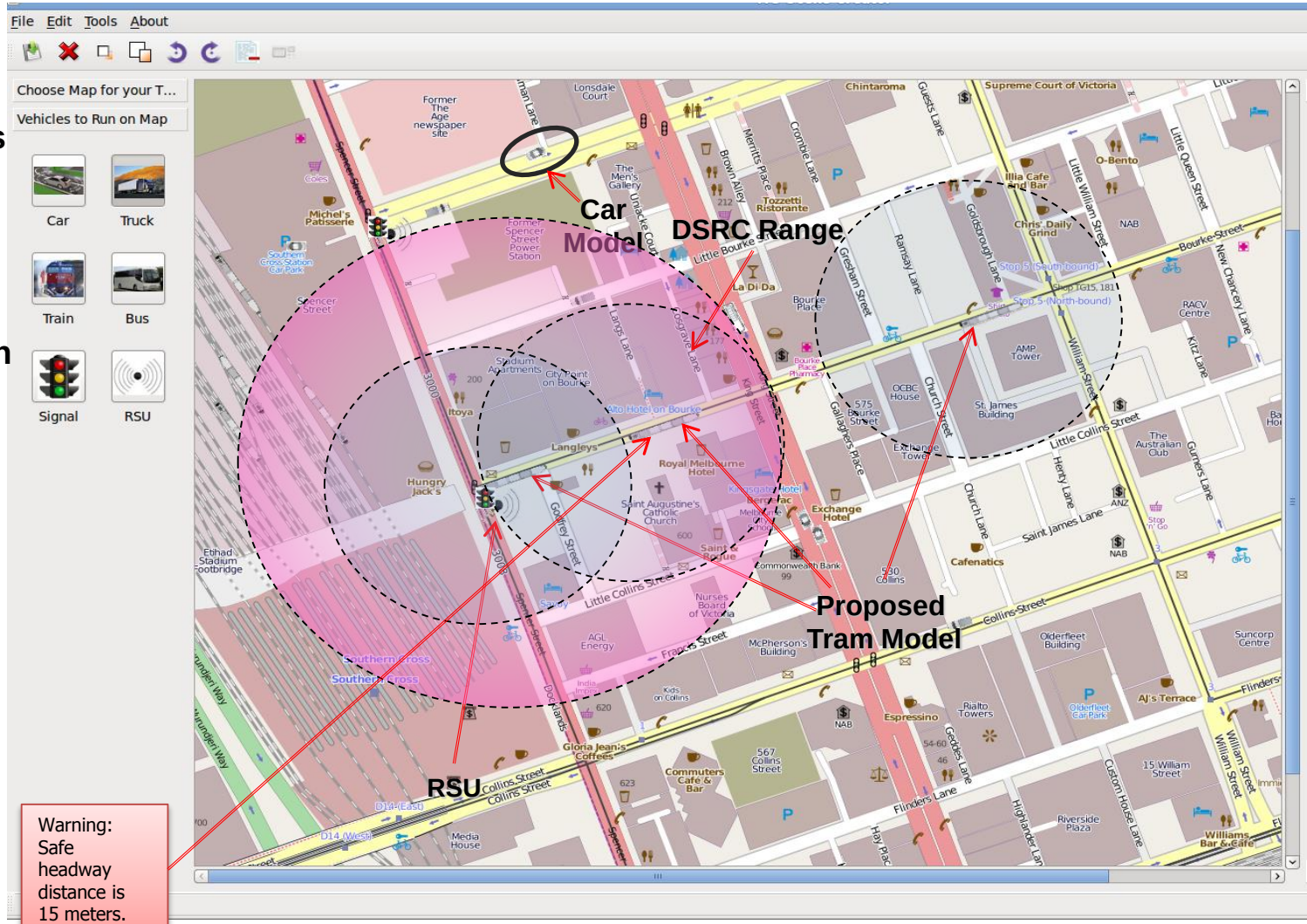
- Commercial & safety benefits
  - Reduce accident rates and tram repair costs of franchise:
    - Reduced tram to tram accidents
    - Reduced tram to road vehicle accidents as the road fleet commences utilising the DSRC capability
    - Reduced tram to pedestrian accidents

- Operational applications
  - Speed restrictions, forced stops, other

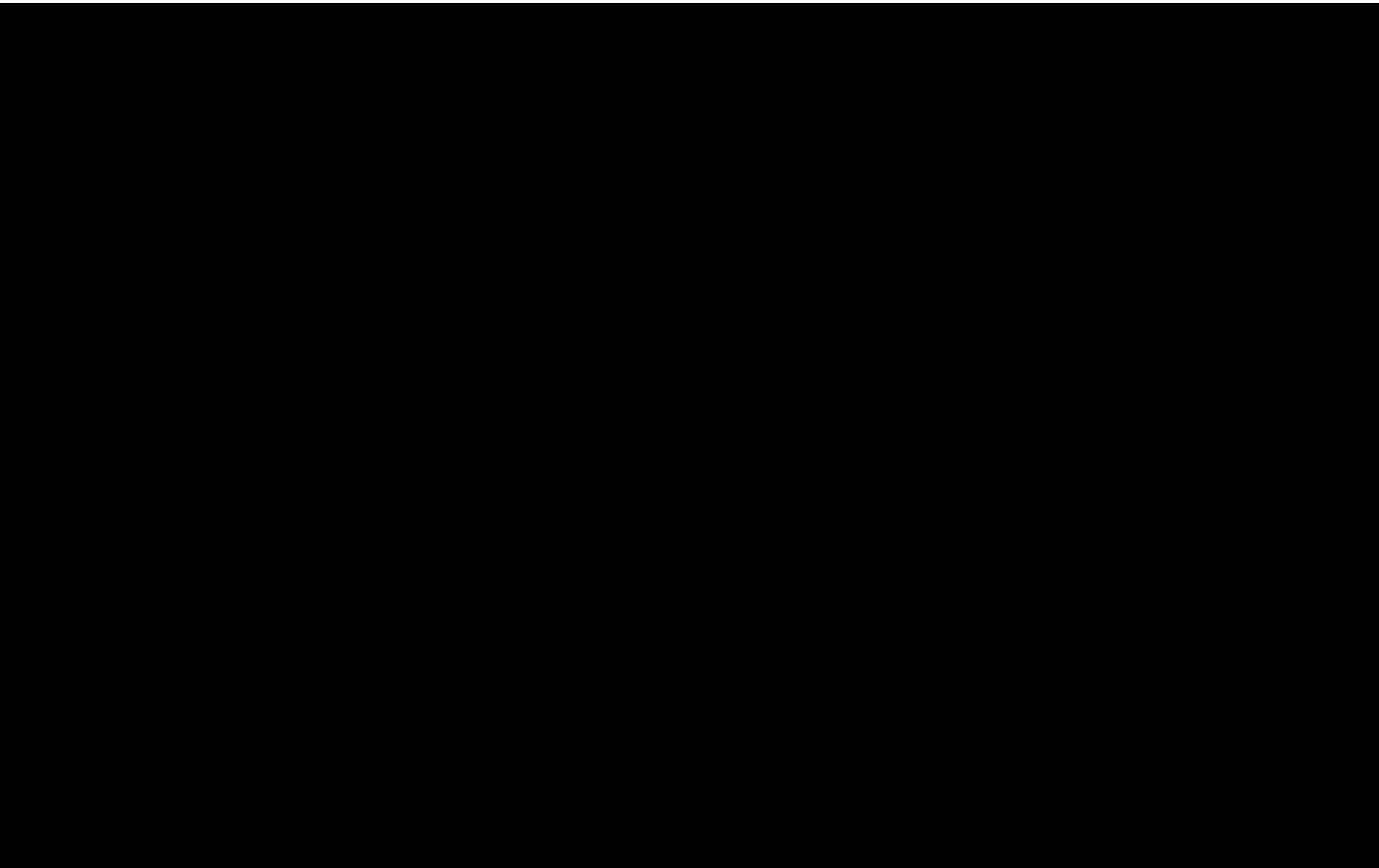
TRAM SAFETY POSSIBLE TRIAL SCENARIO

BOURKE - SPENCER STREET

- **Possible Trial sites**
  - **Bourke-Spencer**
  - **Swanston-Flinders**
- **Collision Avoidance**
  - **Tram-to-Tram**
  - **Tram-to-Vehicle**
  - **Tram-to-Pedestrian**
  - **Speed restrictions**
  - **etc.**
- **Modelling**
  - **Environment**
  - **Trams**
  - **Communication Channel**
  - **T2T, T2V, T2I, etc**
  - **HMI**
- **HMI – Safety messaging**



Demonstration and Launch Video



Thank you

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Professor Jugdutt (Jack) Singh
Director – Centre for Technology Infusion
P: +61 3 9479 3813/3382 M: +61 411 476 976
E: Jack.Singh@latrobe.edu.au
W: http://www.latrobe.edu.au/technology-infusion