MONASH University

Public Transport Planning
New Zealand Transport Agency
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Priority for On-Road Public Transport

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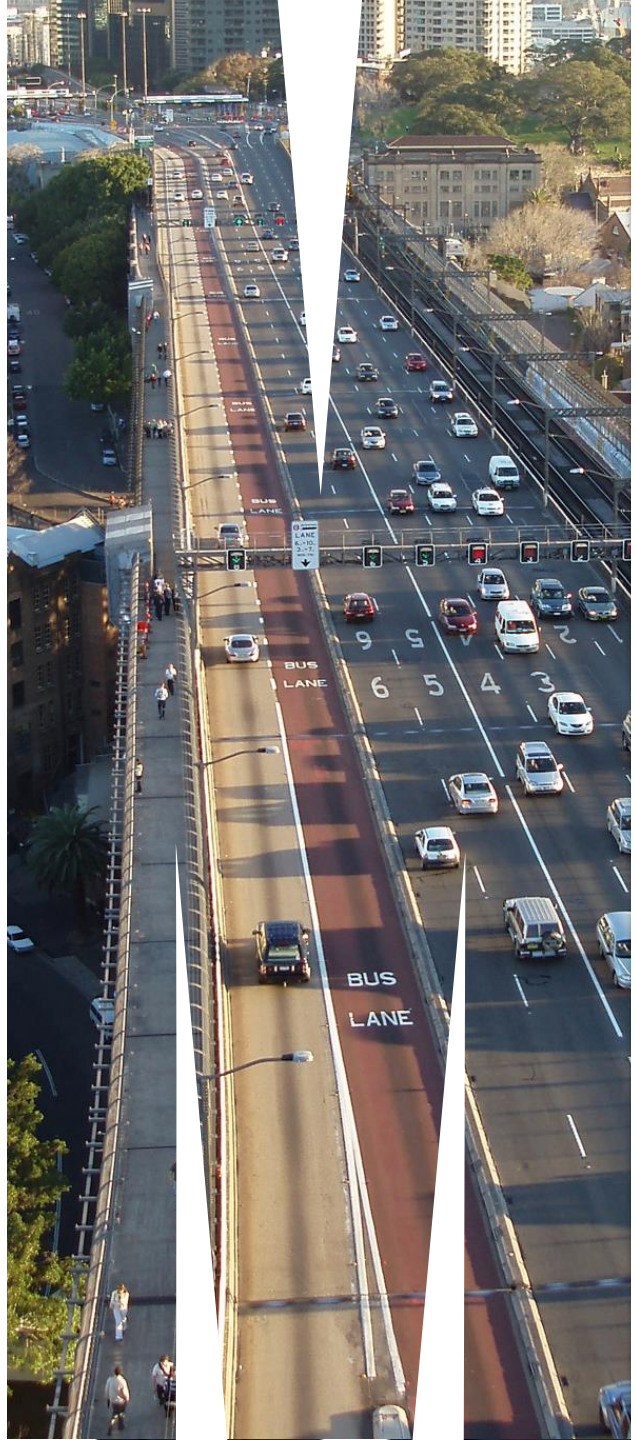
PTRG PUBLIC TRANSPORT RESEARCH GROUP

GROUP OF EIGHT AUSTRALIA

MONASH INSTITUTE OF TRANSPORT STUDIES



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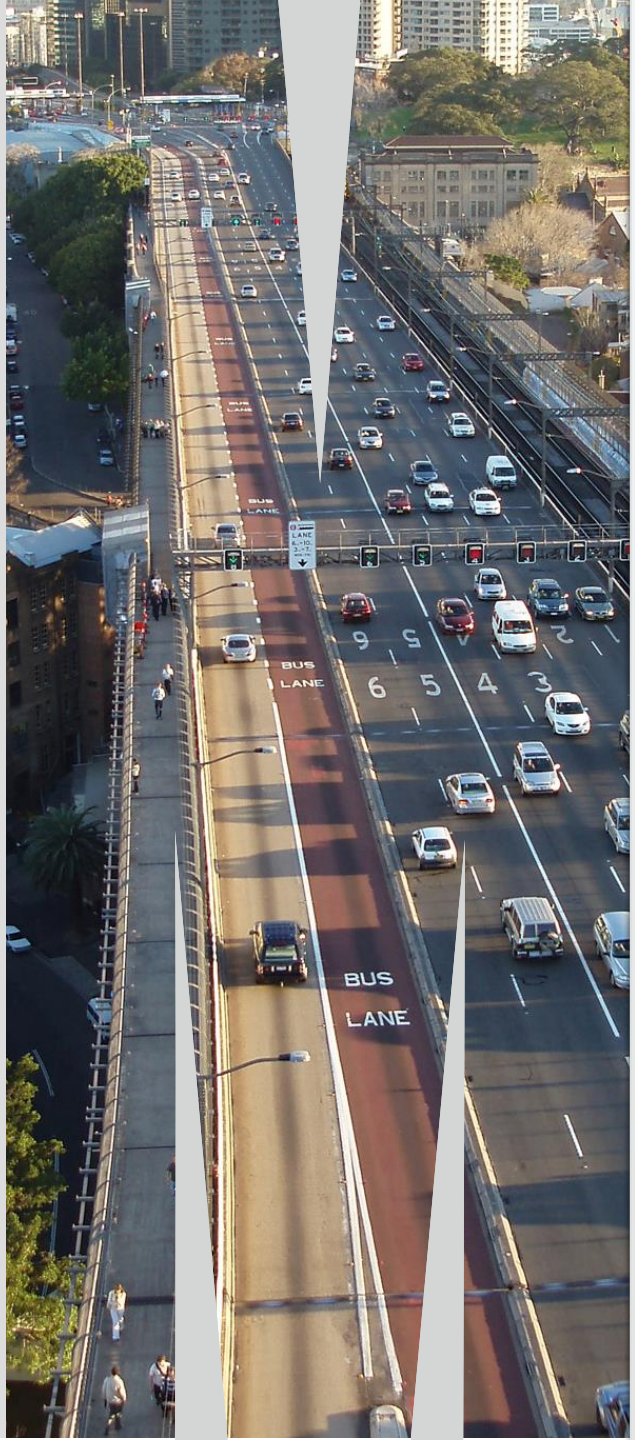
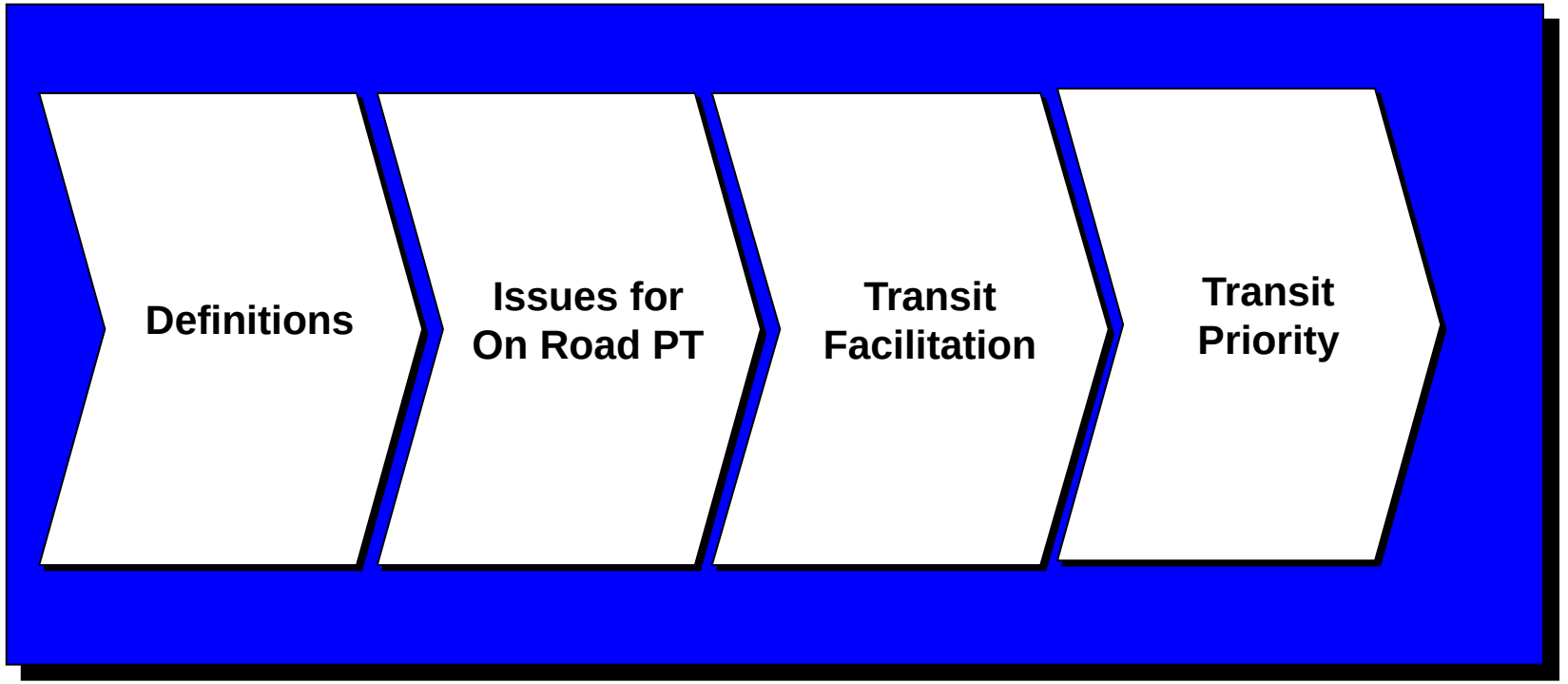
- Introduction
- Definitions
- Issues for On Road PT
- Transit Facilitation
- Transit Priority



This session provides an overview of traffic planning for on-road public transport

- It concerns approaches to planning for bus and tram services in mixed traffic environments
- It provides an overview of the field

…and is structured as follows



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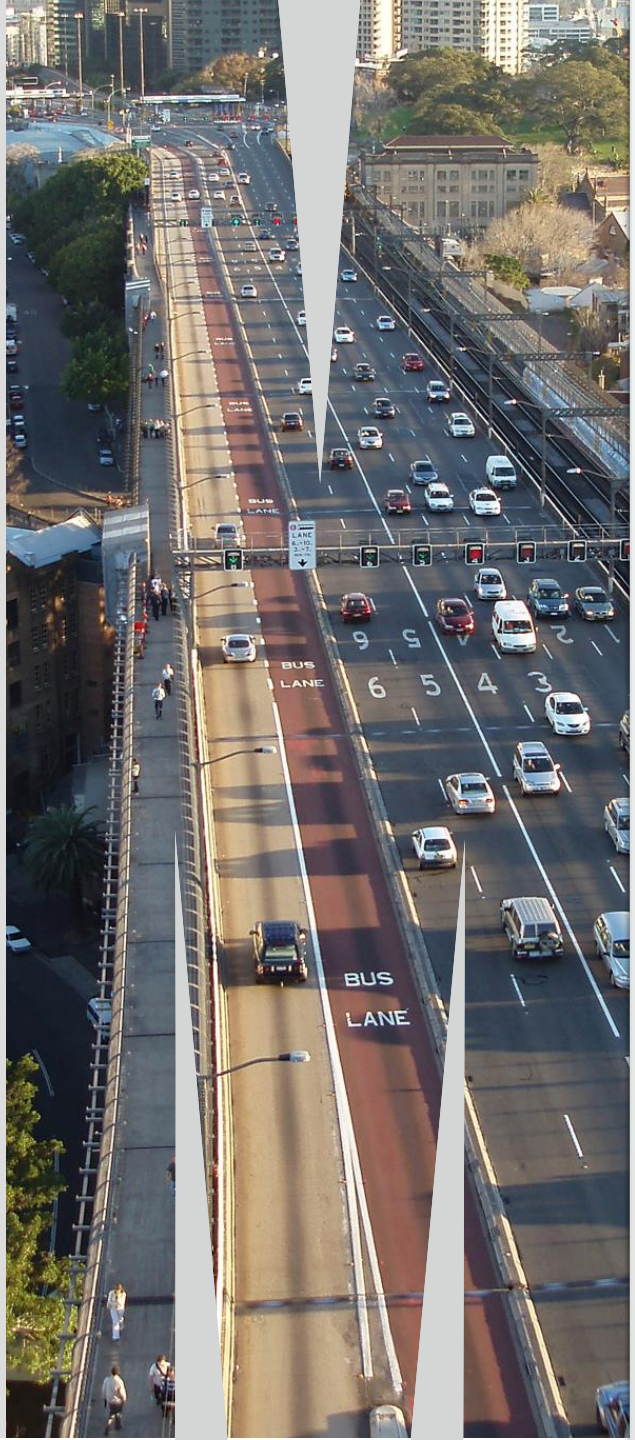
Introduction

Definitions

Issues for On Road PT

Transit Facilitation

Transit Priority



Vuchic defined 3 types of transit right of way two of which relate to On Road Transit

Rights of Way

Category A – Fully Controlled
- **No legal access other modes**
- **Exclusive ROW**
- **Priority at intersections**
- **Rail – some busways e.g. OBahn**

Category B – Physically Separated
- **Separated by curbs, barriers, grade**
- **Has grade crossings for vehicles and pedestrians**
- **Light railways – some busways**

Category C – Mixed Traffic
- **Surface streets mixed traffic**
- **Can have some reserved lanes etc**

On Road Public Transport

So What is this?

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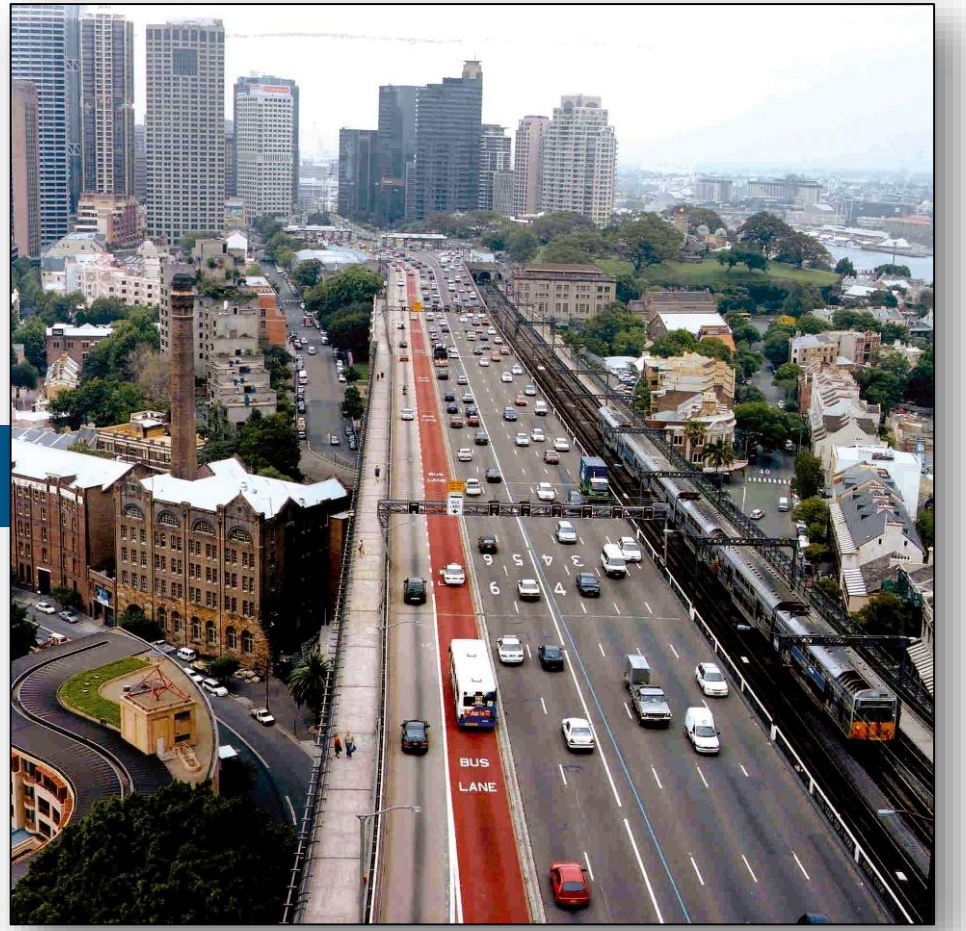

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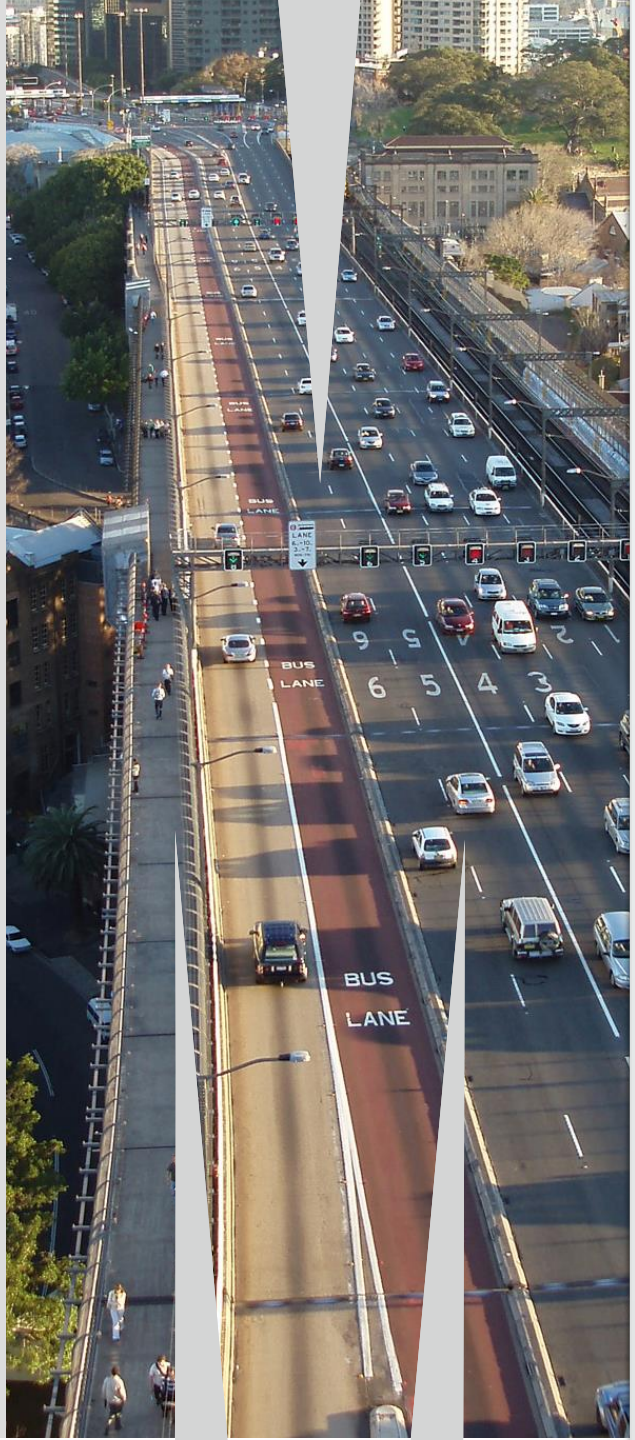
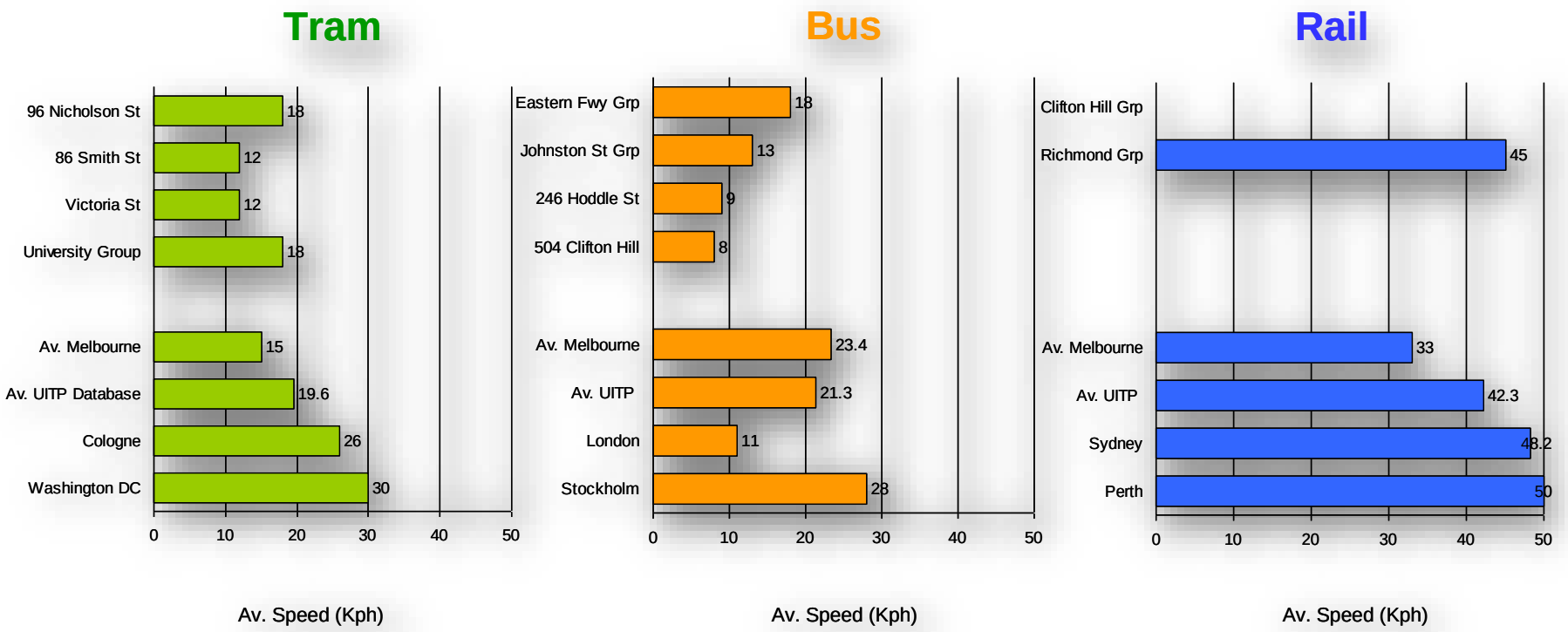


Issue 1: Traffic Interference and Speed

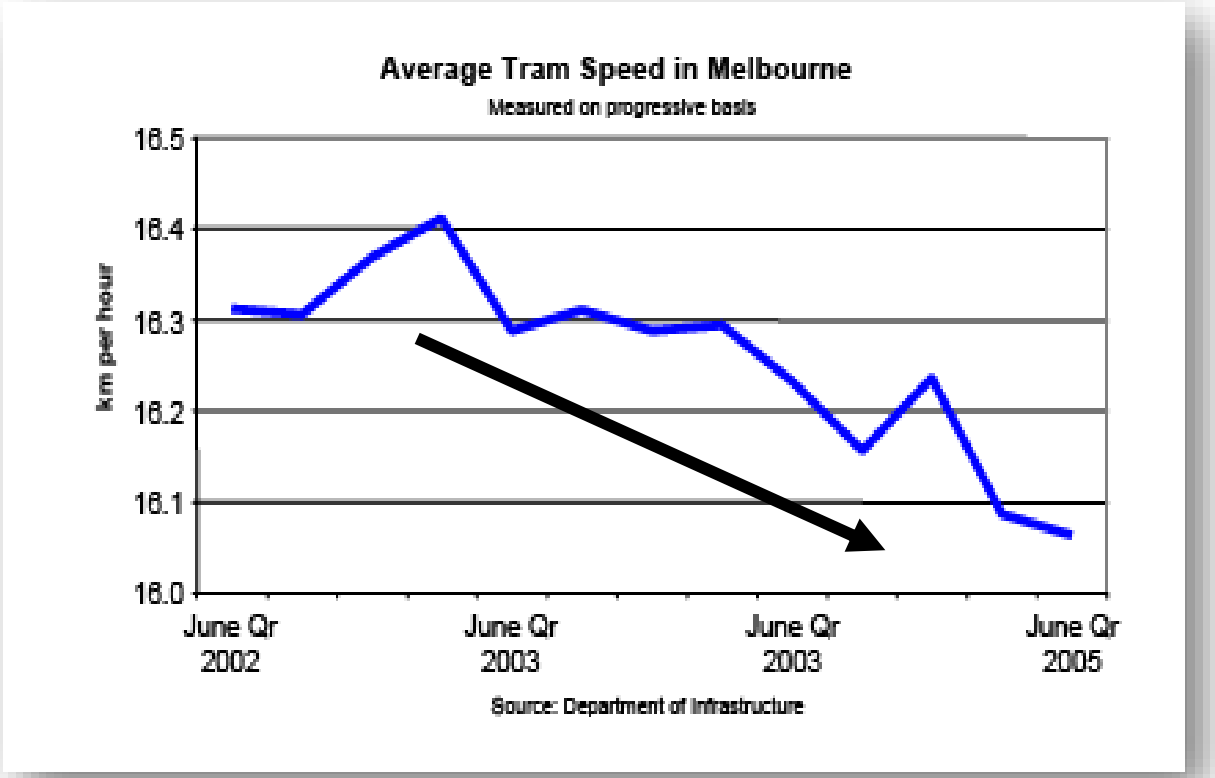
PROBLEM 1 : TRAFFIC INTERFERENCE



Source: Analysis of timetables, UITP Databank

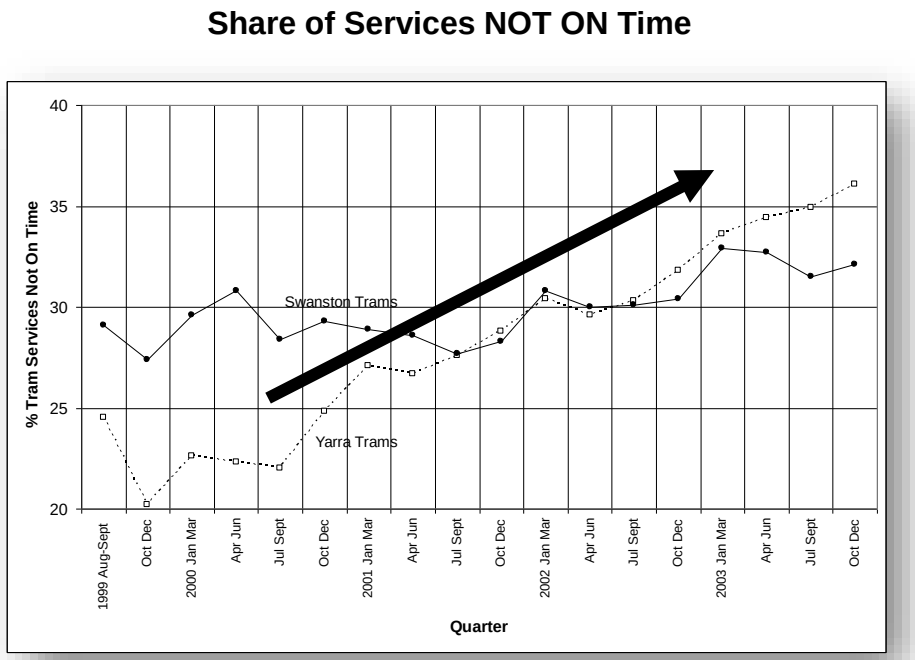
Issue 1: Traffic Interference and Speed

Average Operating Speed (Kph)



Source: Department of Infrastructure

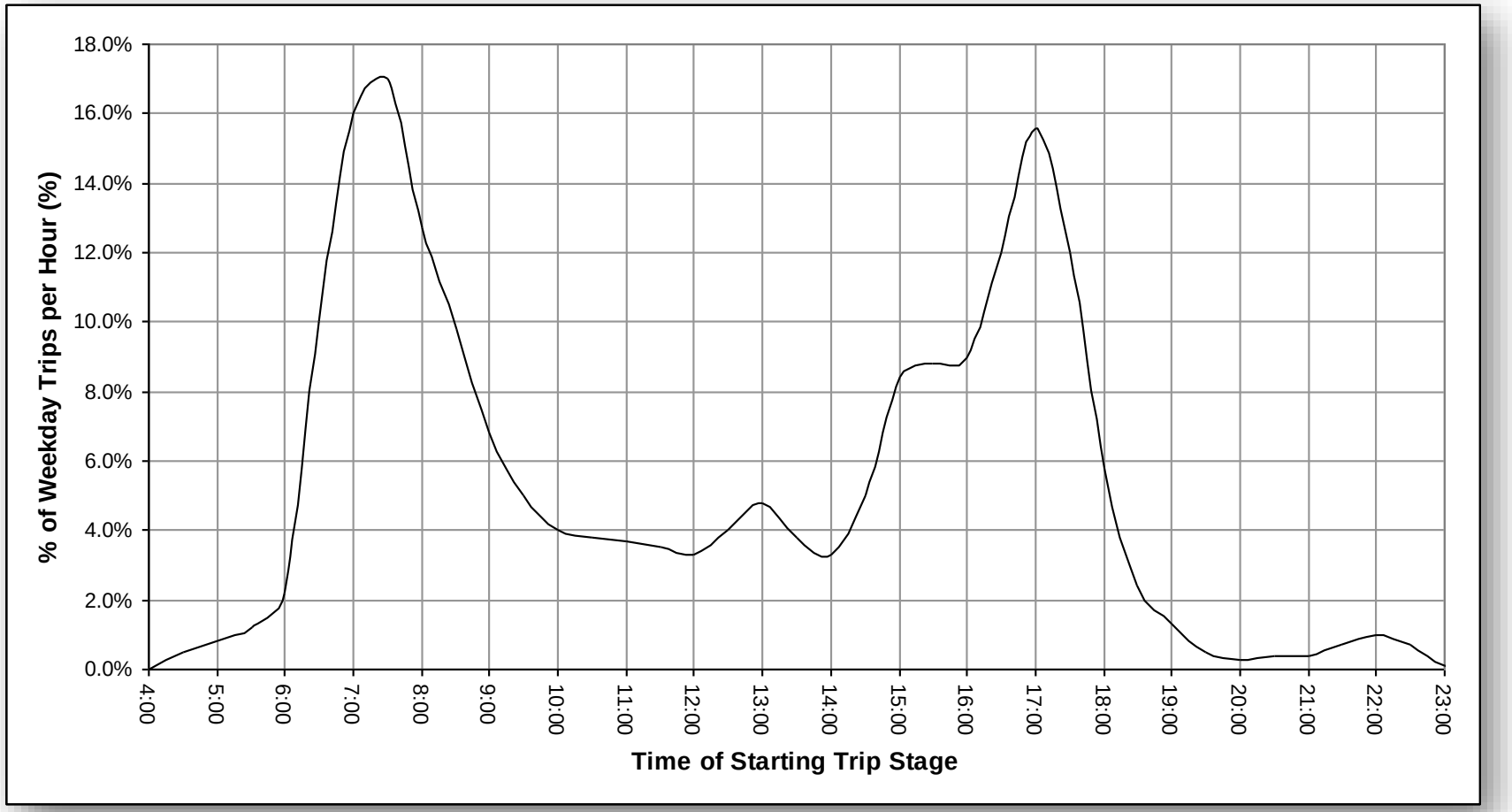
Issue 2: Traffic Interference and Reliability



Source: ITS analysis of 'Track Record' Data

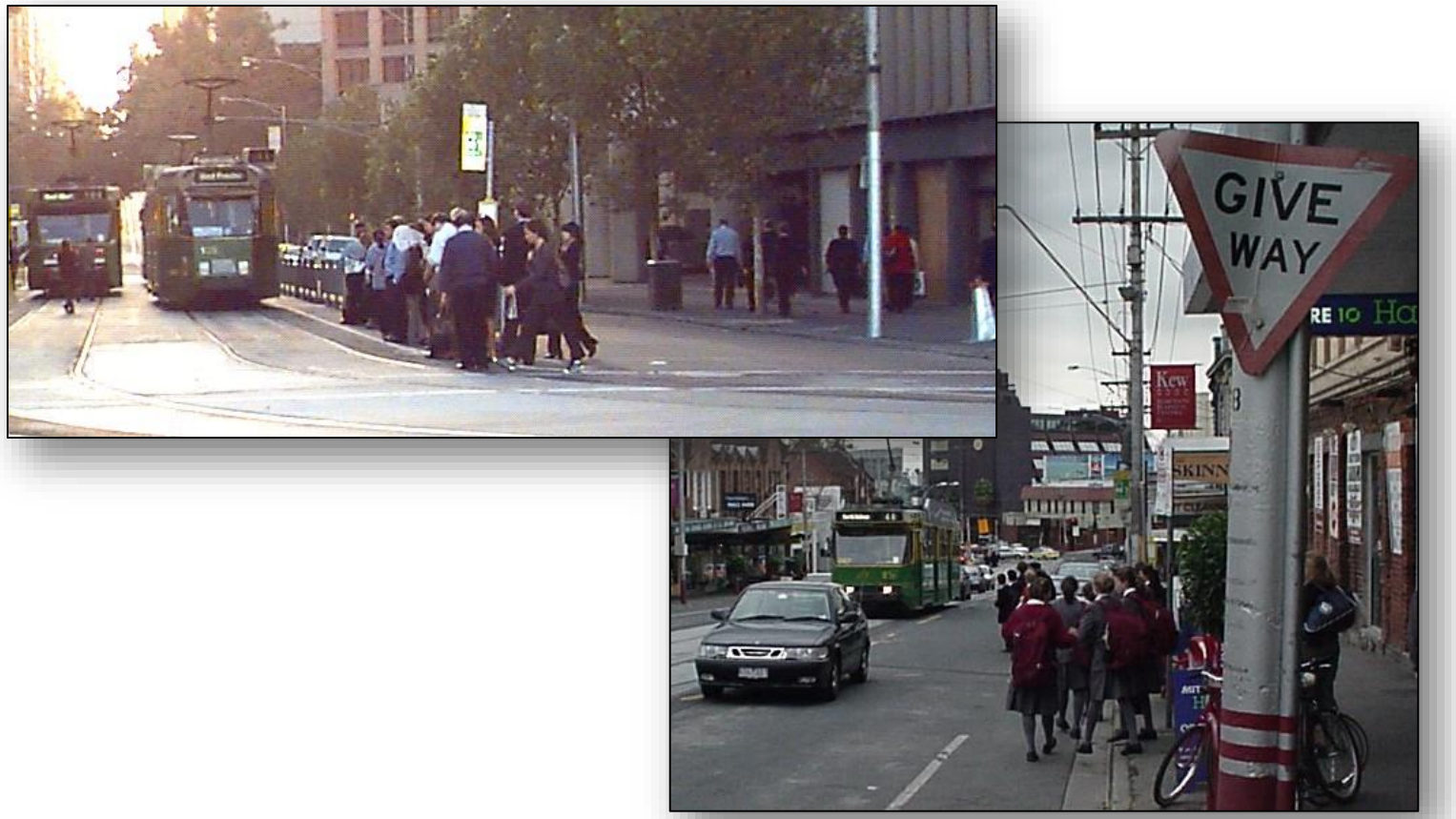
- Tram route 6 experienced +/- 50% of running time variation due to traffic interference
- Evidence that passengers value unexpected delays up to 6 times the actual time experienced
- Delays and bunching

Issue 3: The Peak Period Problem

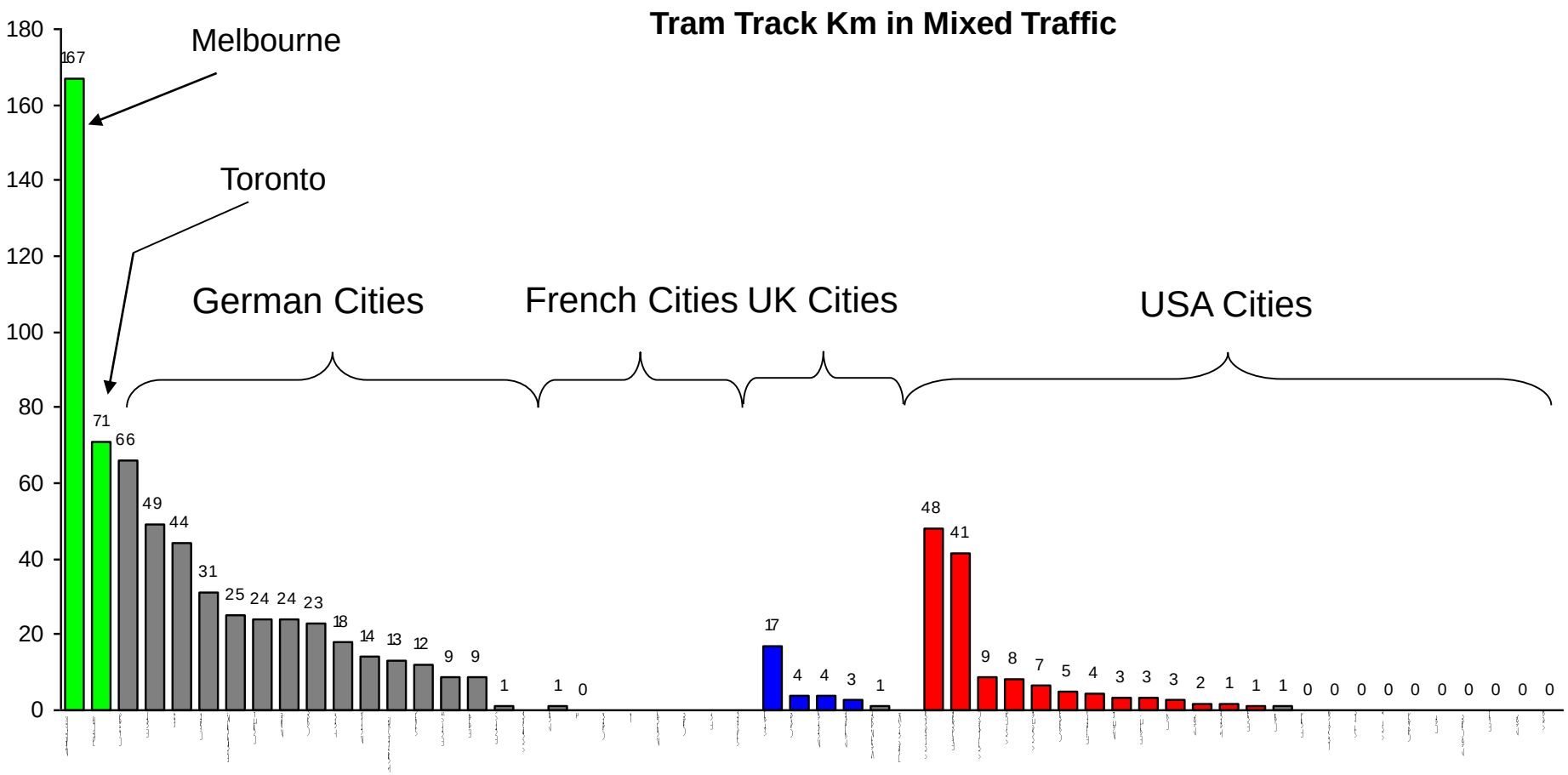


Issue 4: Big Vehicles

Issue 5: Safety/Security



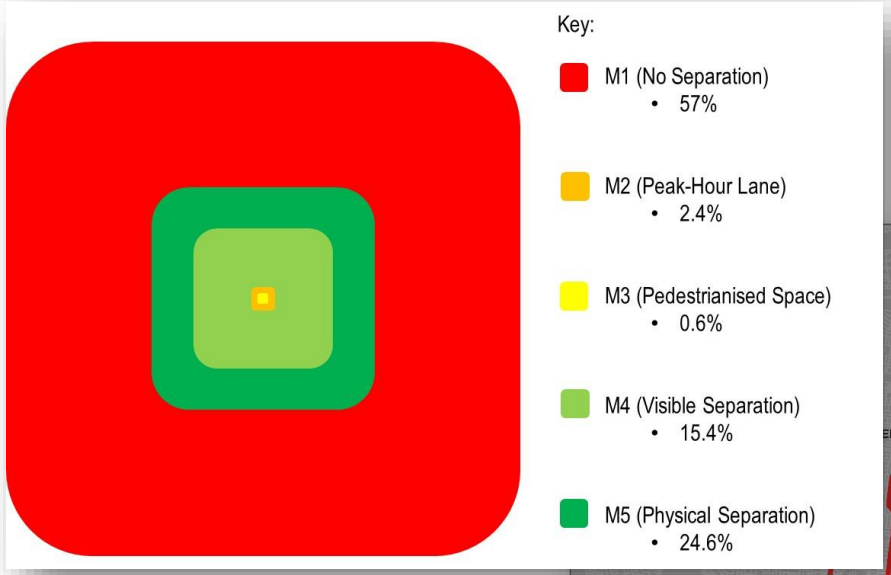
Issue 6: Streetcars



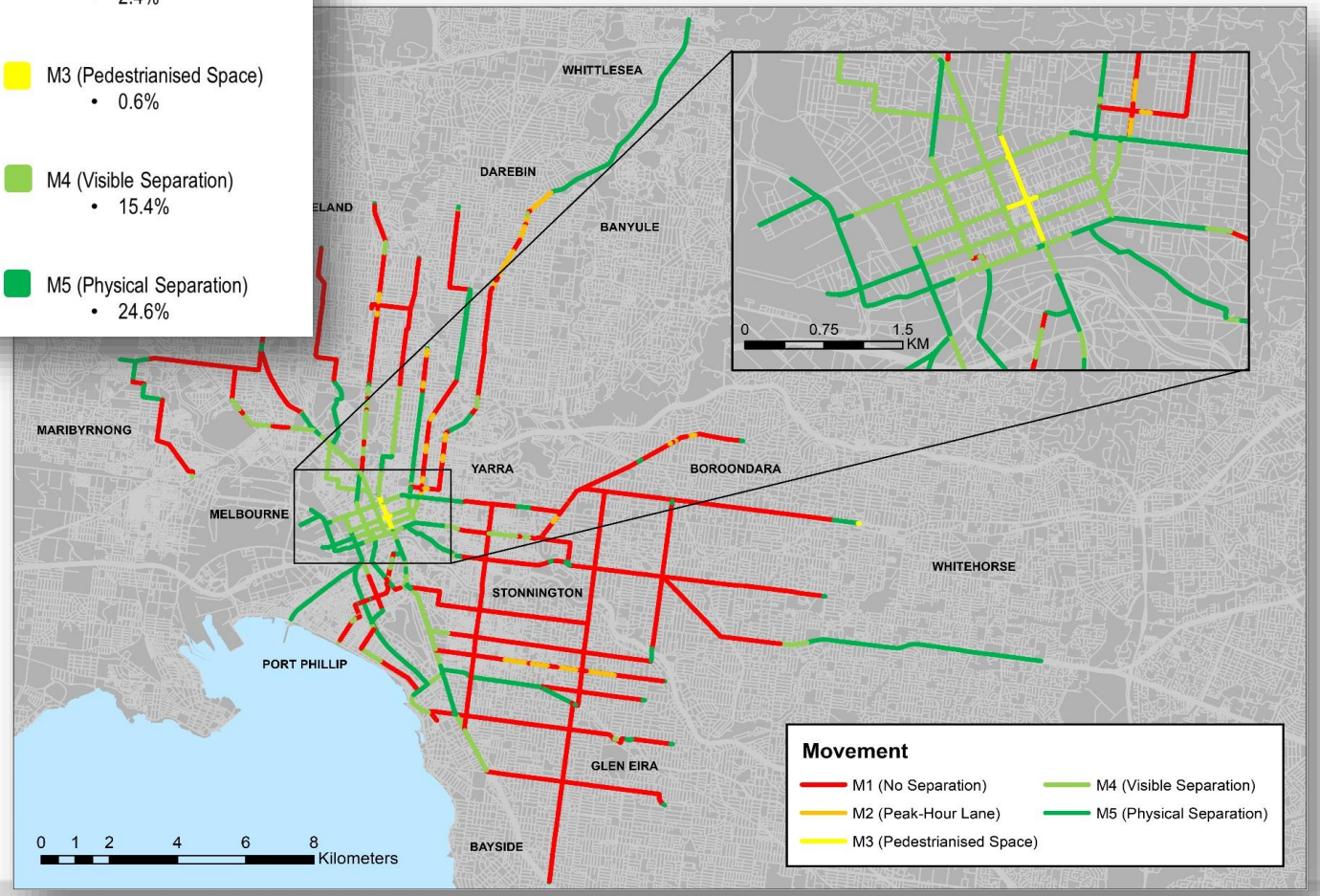
Source: Currie G and Shalaby A (2007) 'Success and Challenges in Modernising Streetcar Systems – Experience in Melbourne and Toronto' Transportation Research Record No 2006 Transportation Research Board Washington DC ISSN 0361-1981 pp 31-39 2007


Le Pine

Current (2018) Tram Right of Way Split



Source: Diemer MJ, Currie G, De Gruyter C and Hopkins I (Under Review) 'Filling the Space between Trams, Transport and Place: Adapting the 'Movement & Place' Framework to Melbourne's Tram Network' JOURNAL OF TRANSPORT GEOGRAPHY submitted February 2018



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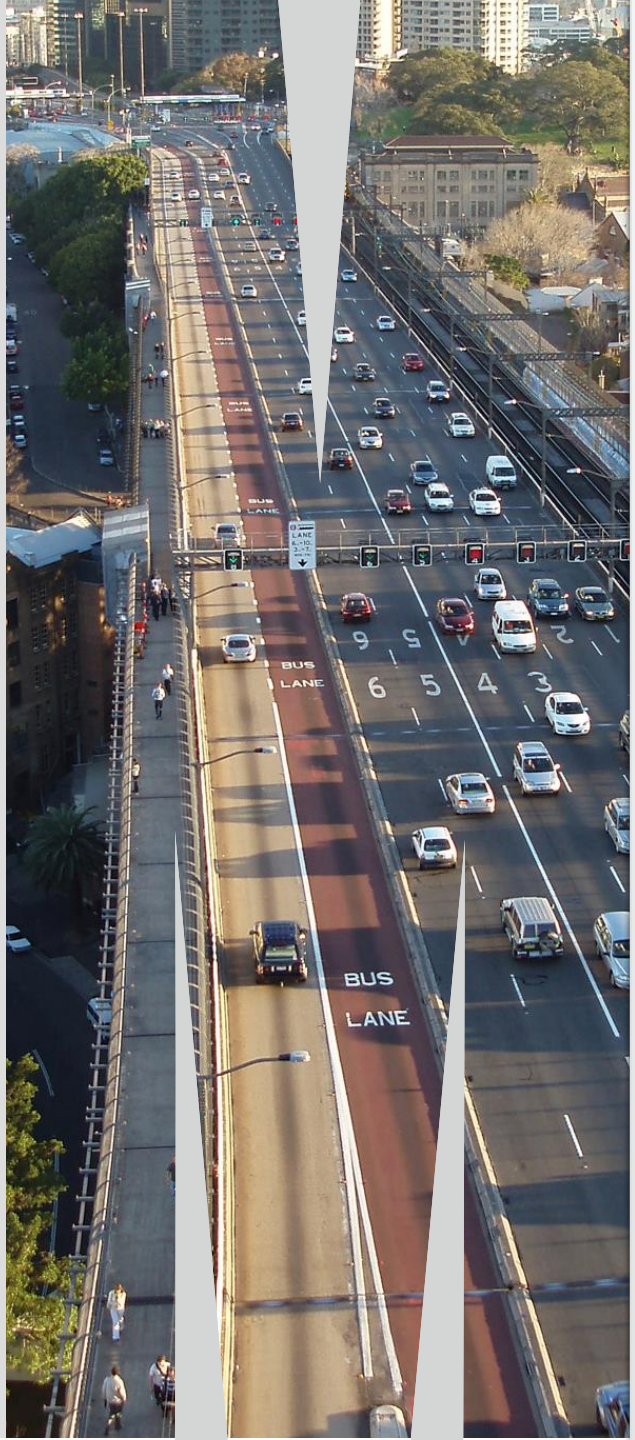
Transit Facilitation

Transit Priority



Transit Facilitation is design to enhance transit performance and access

- Facilitation transit by:
  - Design of the built environment
  - Consideration of transit access issues as a preliminary for planning

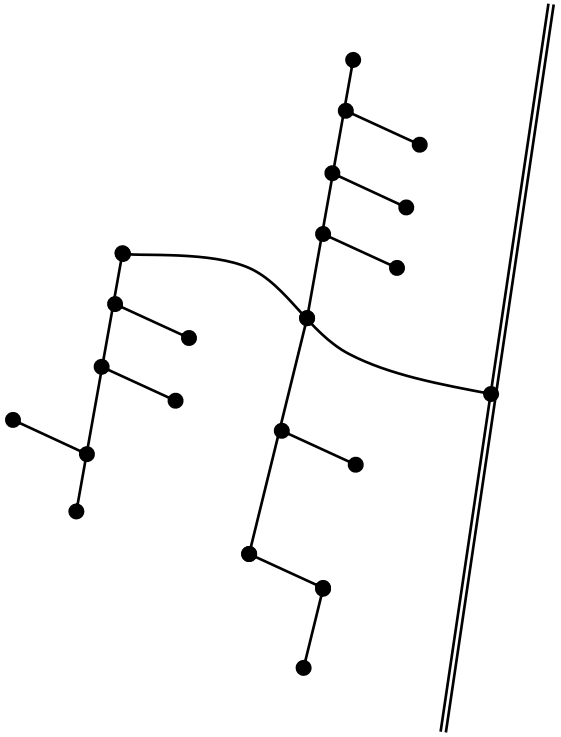
Source:

Currie G (2016) 'Managing On-Road Public Transport in Traffic' in Bliemer M Mulley C and Moutou C Handbook on Transport and Urban Planning in the Developed World, Edward Elgar Publishing Ltd UK

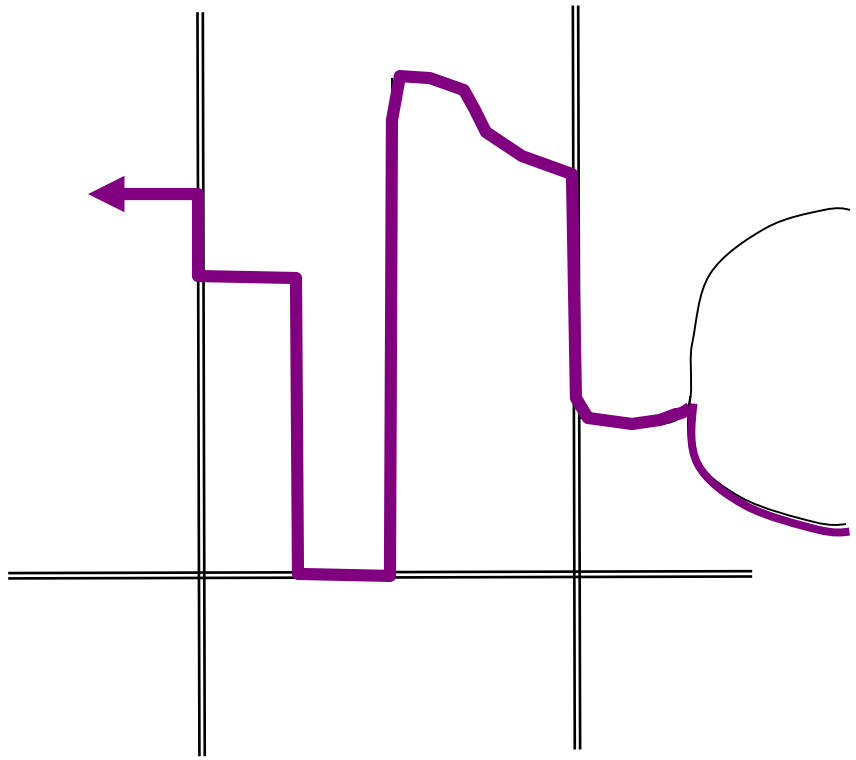
Austroads (2002) 'Road-Based Public Transport and High Occupancy Vehicles – A Guide for Traffic Engineers' ISBN 0 85588 613 7 Austroads Publication N AP-G71/02

Transit Facilitation - Strategic

Land Use Cell Connectivity



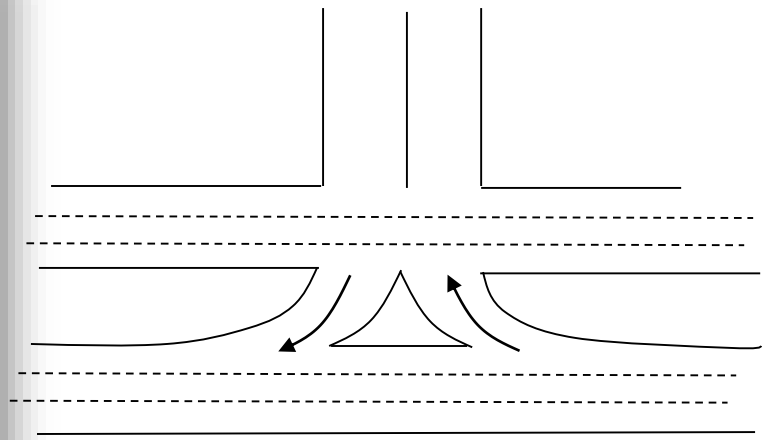
Subdivision Permeability



Transit Facilitation - Strategic

Pedestrian Accessibility

Right Turns

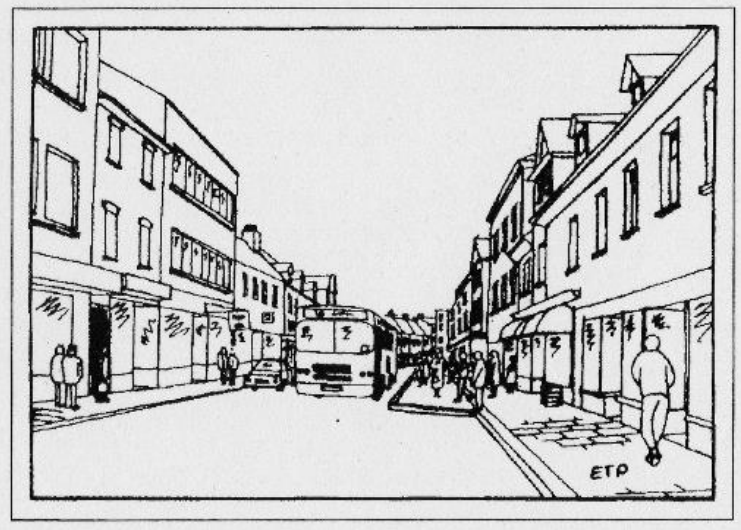


Transit Facilitation - Strategic

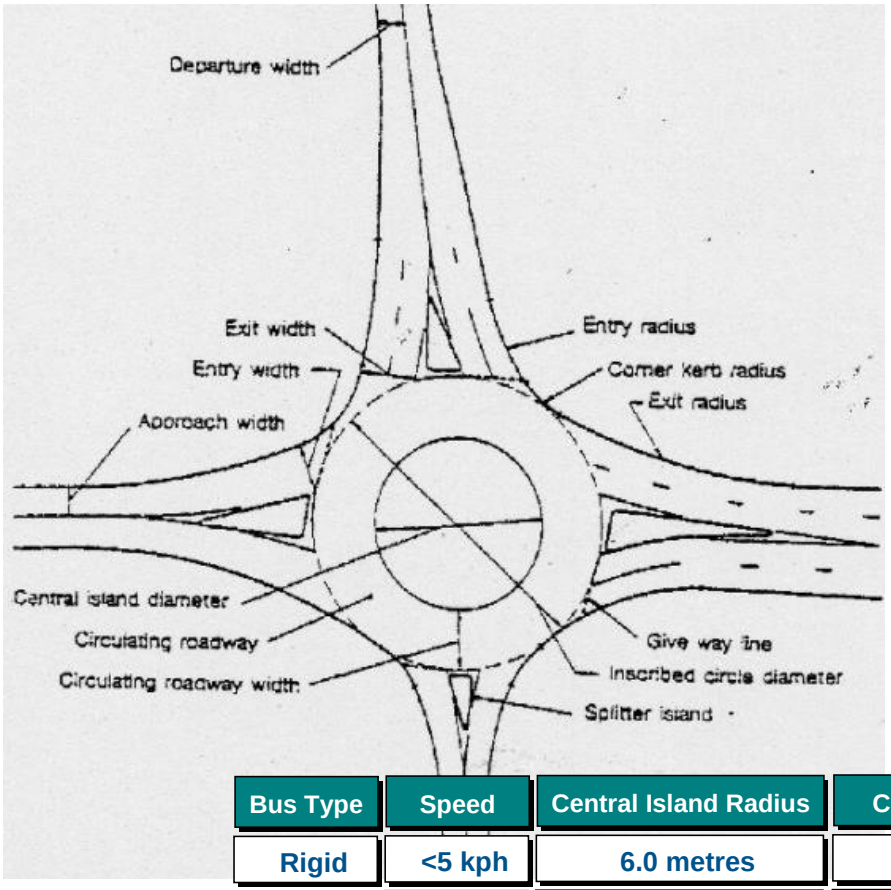
- Lane Widths
- Road profiles
- Turns and cambers
- Bus stops and bays
- Stopping and parking restrictions
- Priority enforcement

Transit Facilitation – Local Level Bus

Bus Boarders/Bulbs



Roundabouts

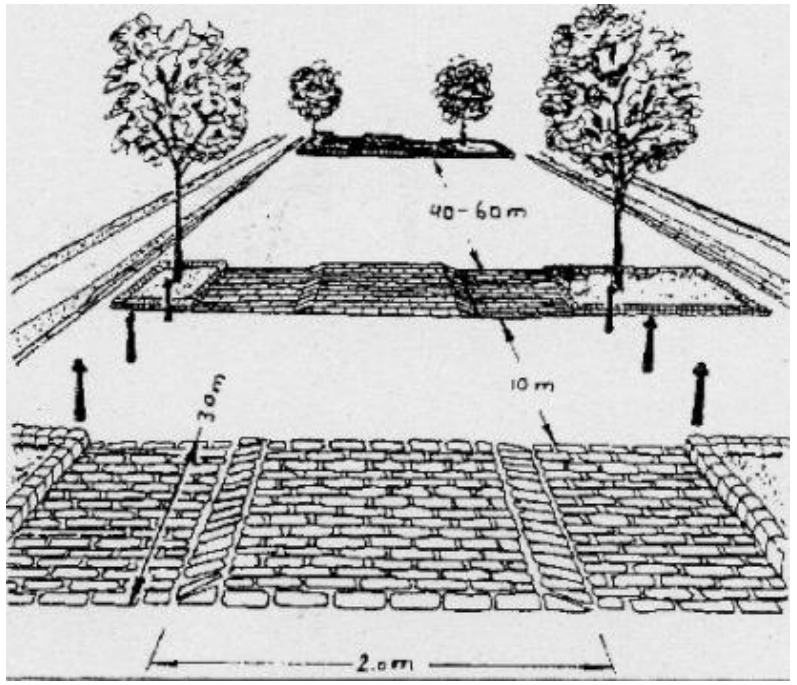


Bus Type	Speed	Central Island Radius	Circulating Width
Rigid	<5 kph	6.0 metres	7.4 metres
Rigid	5-15	8.0 metres	7.1 metres
Artic	<5 kph	10.0 metres	6.7 metres
Artic	5-15	12.0 metres	6.5 metres

Transit Facilitation – Local Level Bus

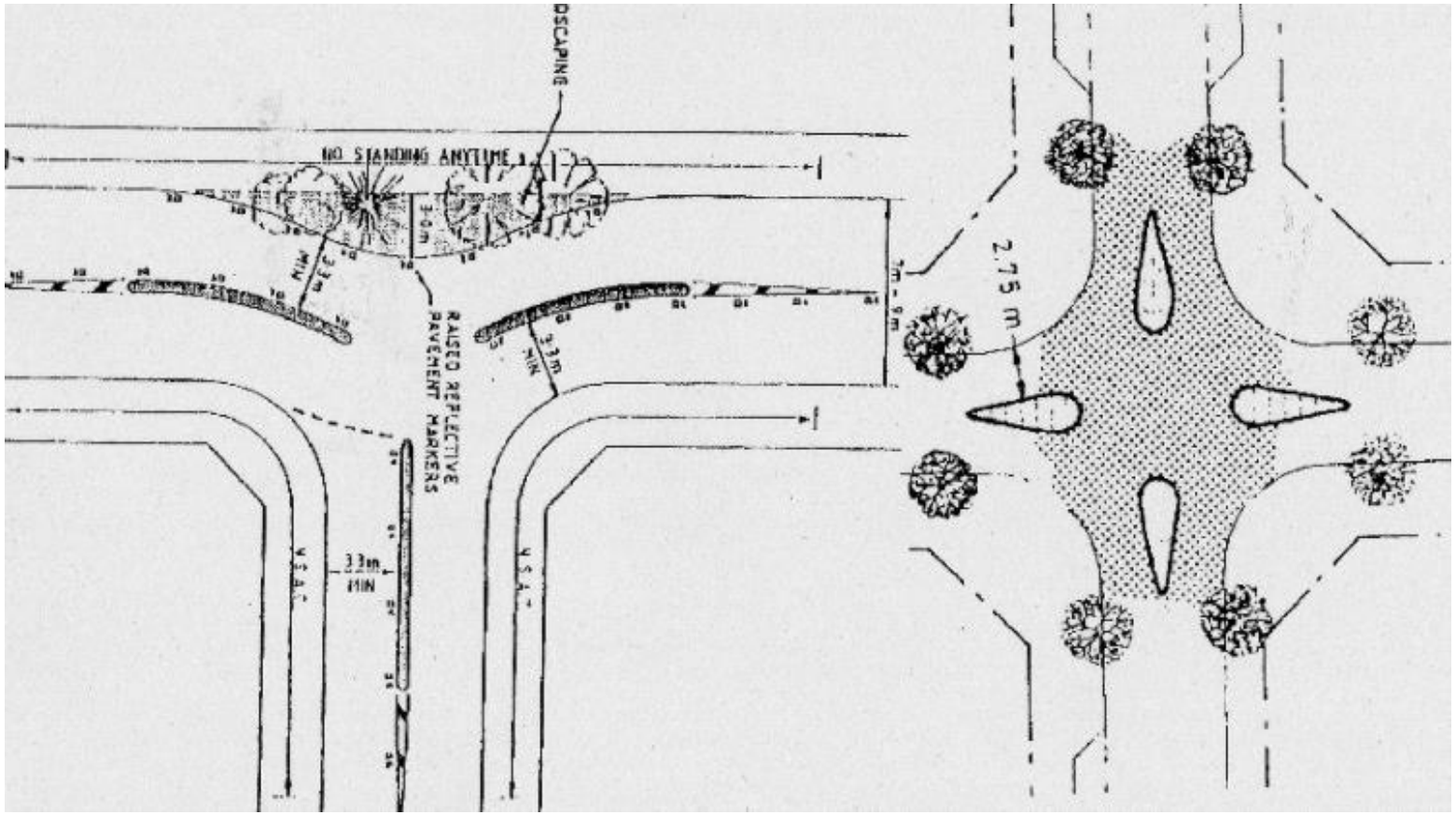
Road Humps

Speed Cushions



Transit Facilitation – Local Level Bus

Splitter Islands and T Intersection Deviation

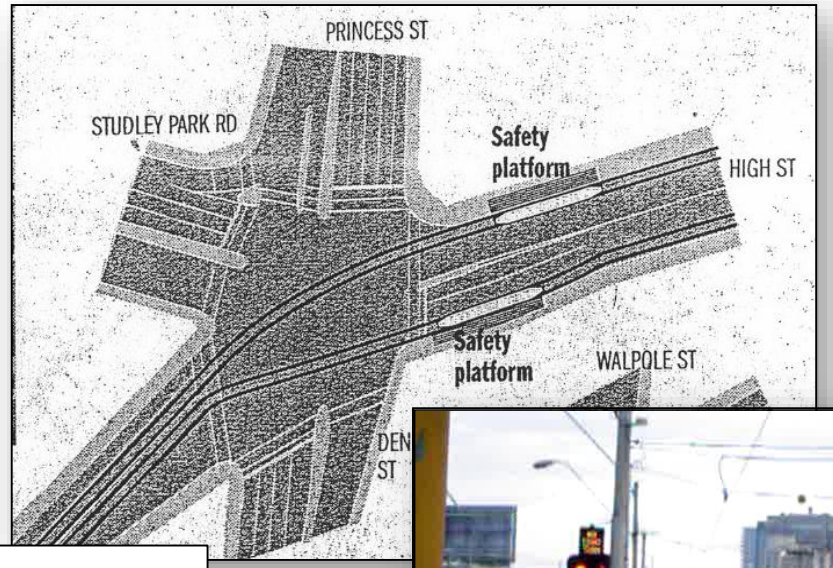


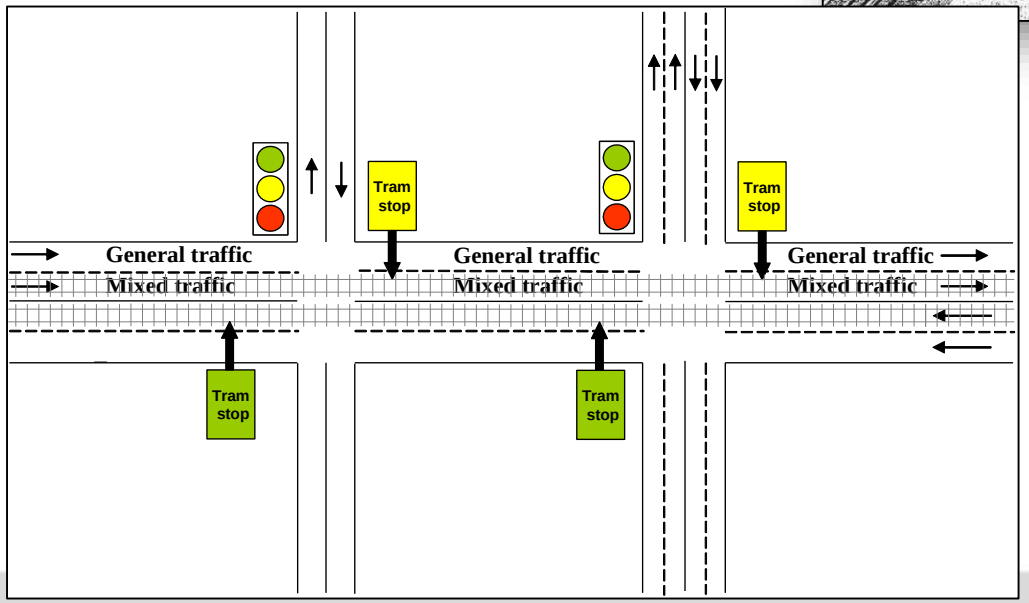
Transit Facilitation – Local Level Bus

- Bus stop run ins/outs
- Bus stop locations (near lights/ traffic calming measures)
- Chicanes

Transit Facilitation – Tram (Right of Way)

- Kerb side running
- Physical Fairway Separation
- Stop Relocation (Departure Side)
- Third Tracks





Transit Facilitation – Tram (Stops)

- Centre Stop/Platform
- Safety Platform
- Kerb Extension
- Raised Traffic Lane – Level Boarding

Transit Facilitation – Terminals

- Location (central/ priority)
- Bus access (free flowing/ segregated)
- Bays and configuration (avoid islands/ segregate passengers and vehicles)
- Passenger waiting areas (shelter/ good sight lines)
- Multi-modal access
  - > Car – don't forget Kiss and Ride
  - > Bike (don't forget)
  - > Taxi

GUIDELINES FOR 'GOOD PRACTICE' DESIGN OF BUS INTERCHANGES AND TERMINALS

LOCATION

- A good location is one of the most important criteria for a 'best practice' interchange/terminal
- A good location is as close as is possible to the centre of activity of a site (or with very easy walk access to the centre of activity of a site)

BUS CAPACITY

- Sites should be designed with bay capacity to maximum peak time conditions
- This should include scope for expansion over the life of the terminal where appropriate
- Peak capacity may be seasonal and should include layover (waiting) bays.

BUS ACCESS CRITERIA

- Buses are large vehicles and can include articulated vehicles.
- Bus access to sites should enable free flowing and easy movement for large vehicles. Reversing and turning movements should be avoided. Hence dual access points are often important criteria for access design.
- Bus access should be separated from other vehicle access if possible
- Bus access should as far as possible be separated from pedestrian flows

BAYS AND BAY CONFIGURATION

- Ideal criteria for bay design are as kerbside or indented storage bays, the alternative, 'saw tooth' configurations require vehicles to reverse and is unsafe for frequent vehicle movements (however this can increase the capacity of the site)
- Kerbside indented storage bays are expensive in terms of space usage.
- Use of island bays should be avoided pedestrians must cross the path of buses
- Segregation of pedestrian and bus movements is desirable

PASSENGER WAITING AREA CONFIGURATION

Waiting areas should be :

- covered where possible including weather protection
- as close as possible to activity areas
- have adequate passenger information
- include information areas
- Include meals/newsagent and all day activities on site if possible
- Passenger access areas should be designed to Australian Standards including access standards for Disabled Persons

MULTI-MODAL FACILITIES

Car Access:

- in general kiss and ride to bus represents the same volume of bus passengers as park and ride. Hence pick up/set down bays should be given as much consideration as car parking on site
- car access should be separated from bus access
- car parking should be safe including use of security measures if appropriate

Bike Access

- bike storage facilities should be available at all major interchanges
- the management of bike storage by a retail concession on an interchange site can often be the best means of providing such services
- bike storage requires weather protection and lockers for storing bike riding gear
- bike specific info. incl. bike path maps etc should be available near bike storage areas

Taxi Ranks

- taxi ranks should be as close as possible to the centre of activity of a terminal site - passengers should approach ranks at the front of the queue
- shared bus and taxi access roads is preferable to give taxis some priority access to the area
- the design of taxi ranks should consider potential queues and shelter/waiting areas - waiting areas should be close to queue 'heads'
- the close association of taxi ranks and retail concessions on the site assure better safety for those working and travelling on the site at night

PASSENGER INFORMATION

- Bus terminals should include the highest quality display boards including bay layout by route
- information provision includes a maintenance requirement that the information provided is kept up to date and stocks of timetables are replenished
- 'real time' info. provision should be considered for high quality sites.

GENERAL FACILITIES

- toilets and toilet maintenance/cleaning are important requirements of major sites
- telephones should be provided at all sites toilets and toilet maintenance/cleaning are important requirements of major sites

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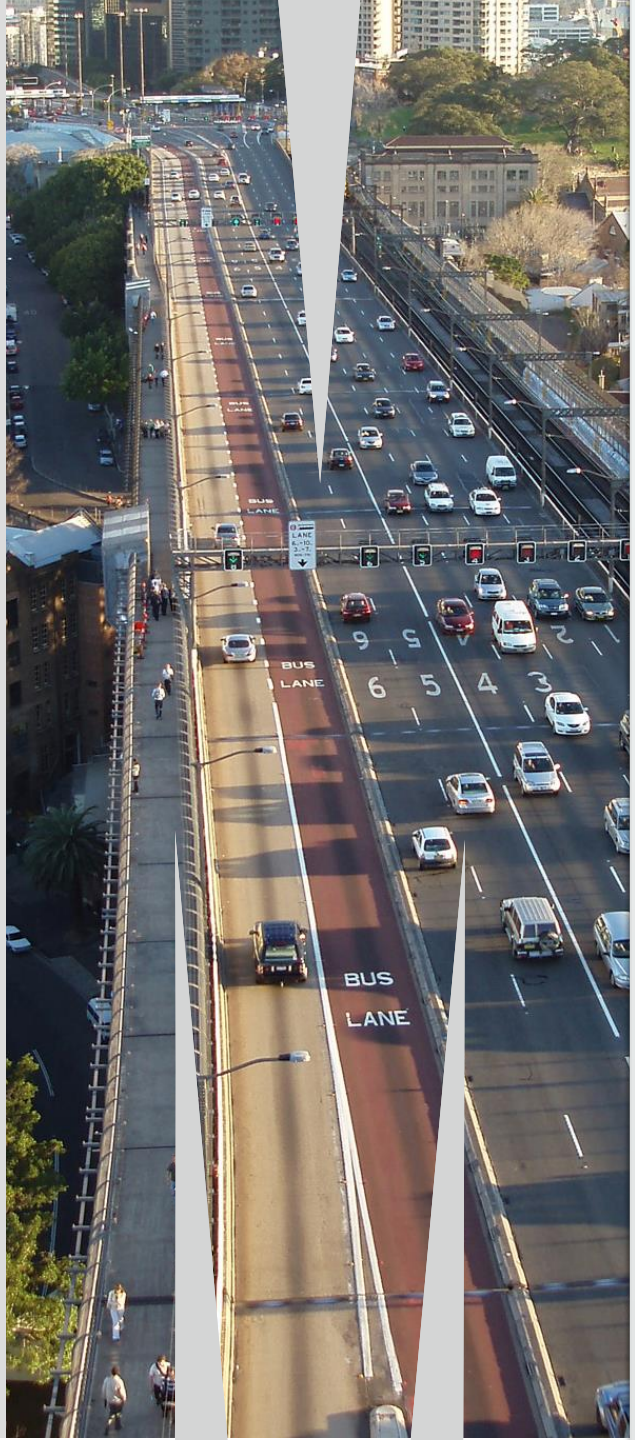
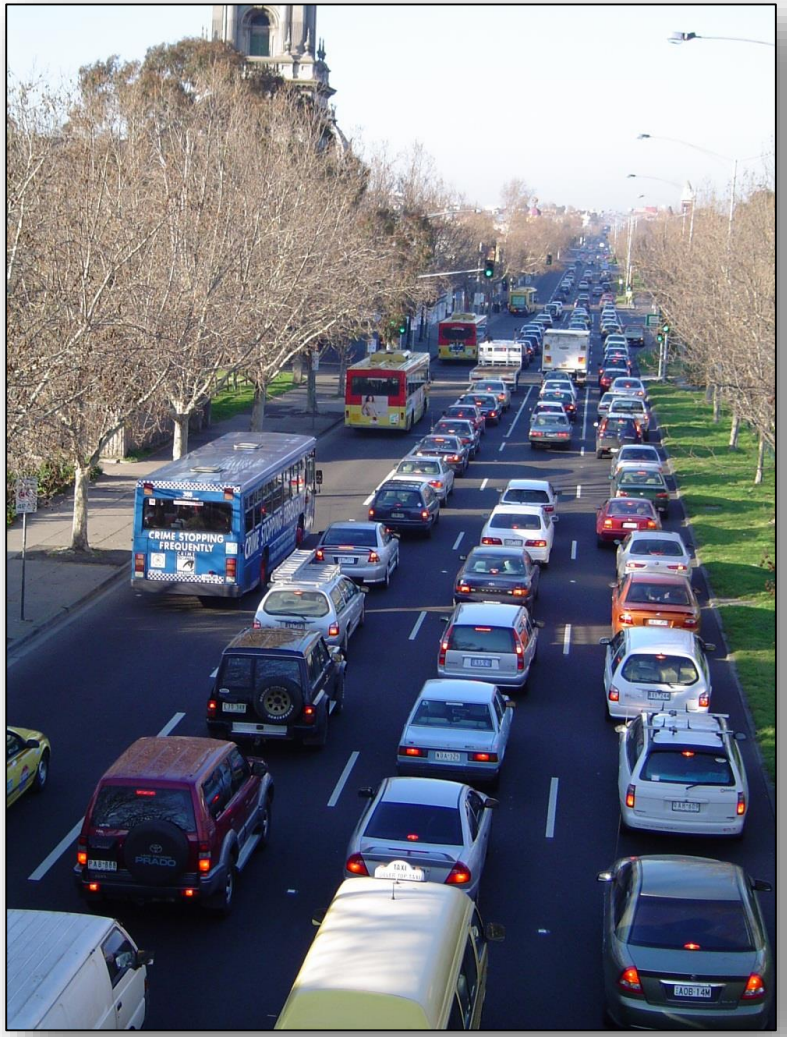
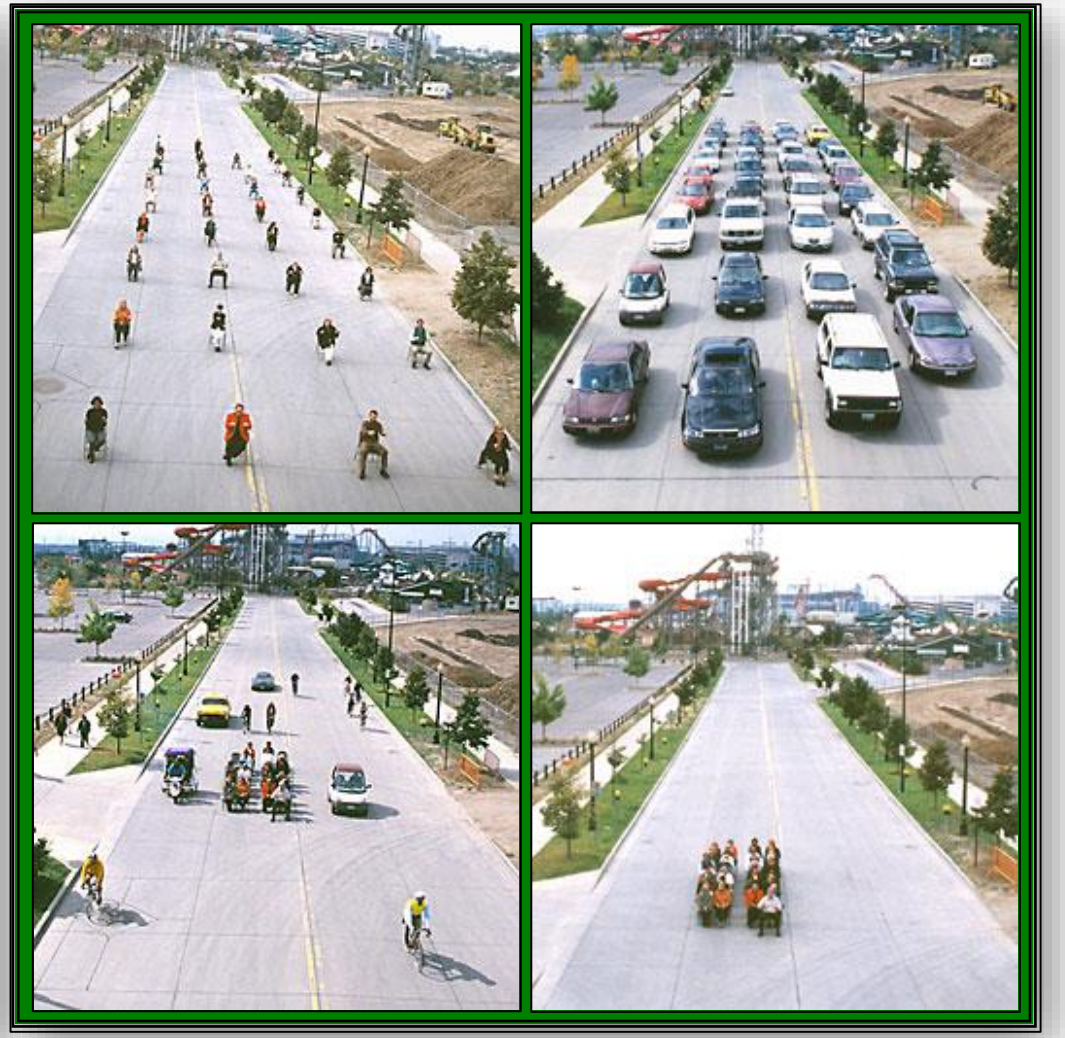
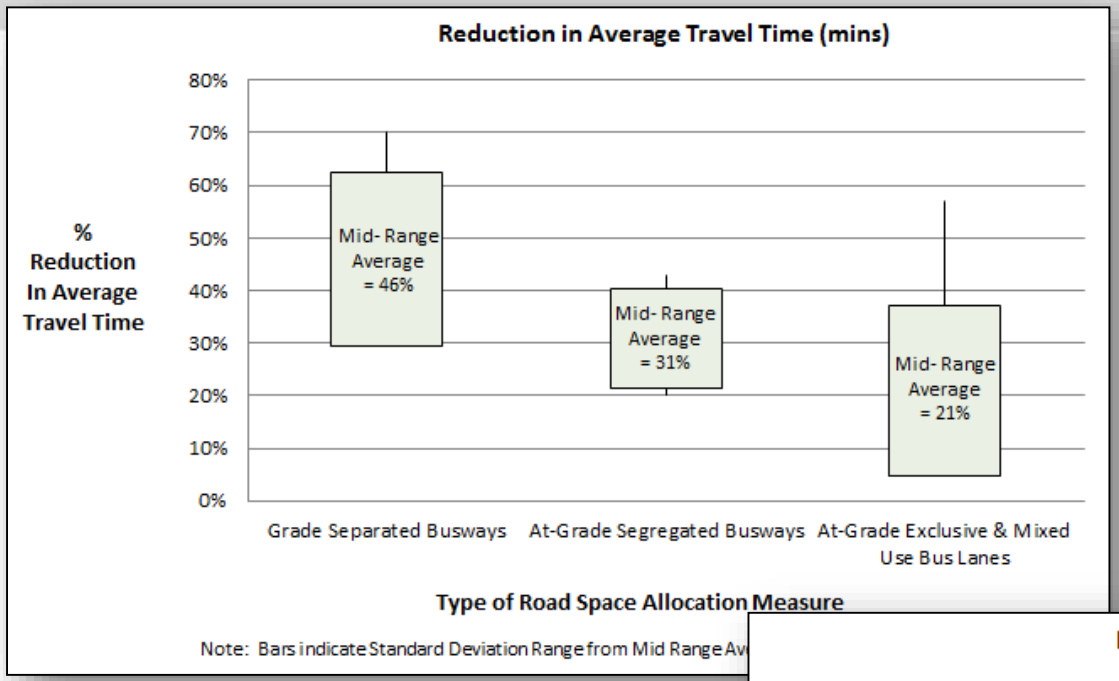


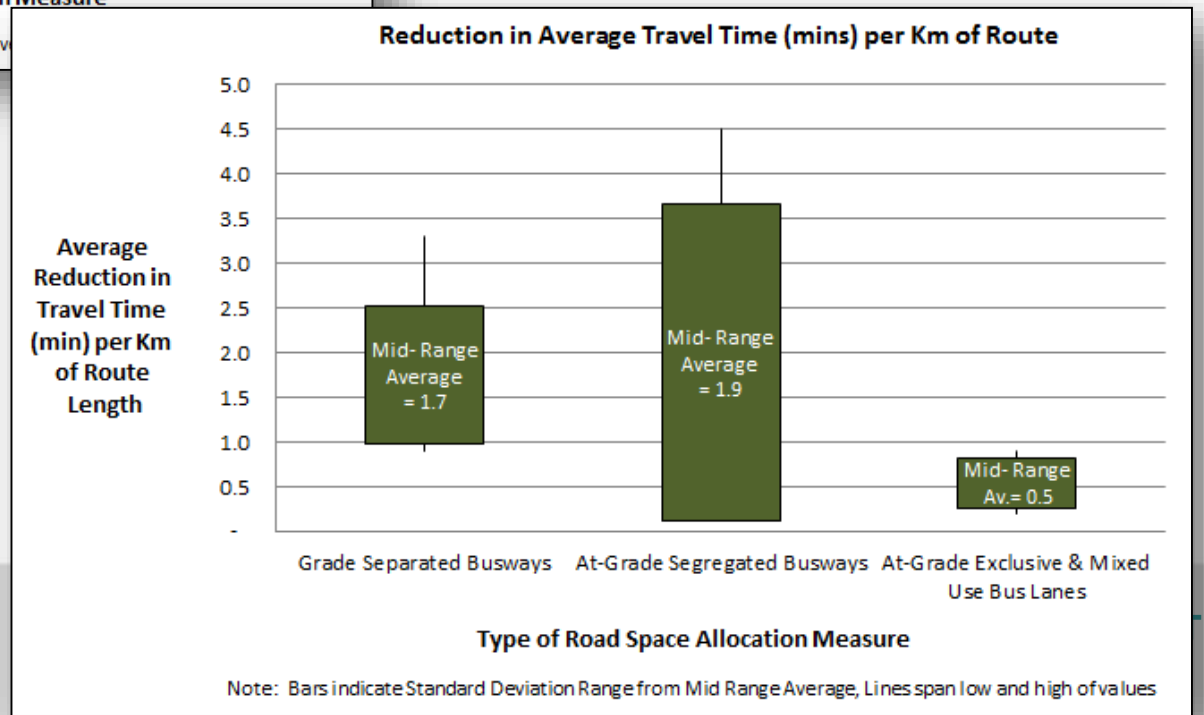
Priority - Rationale





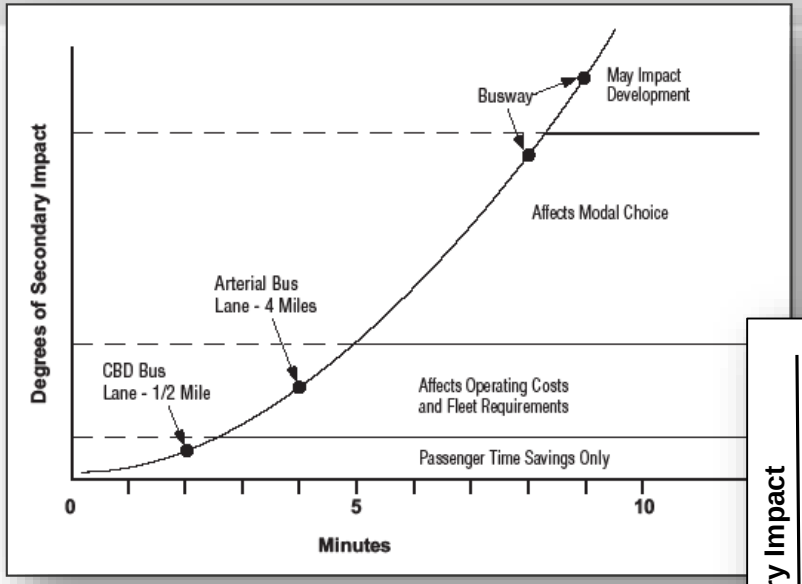
Priority – Benefits



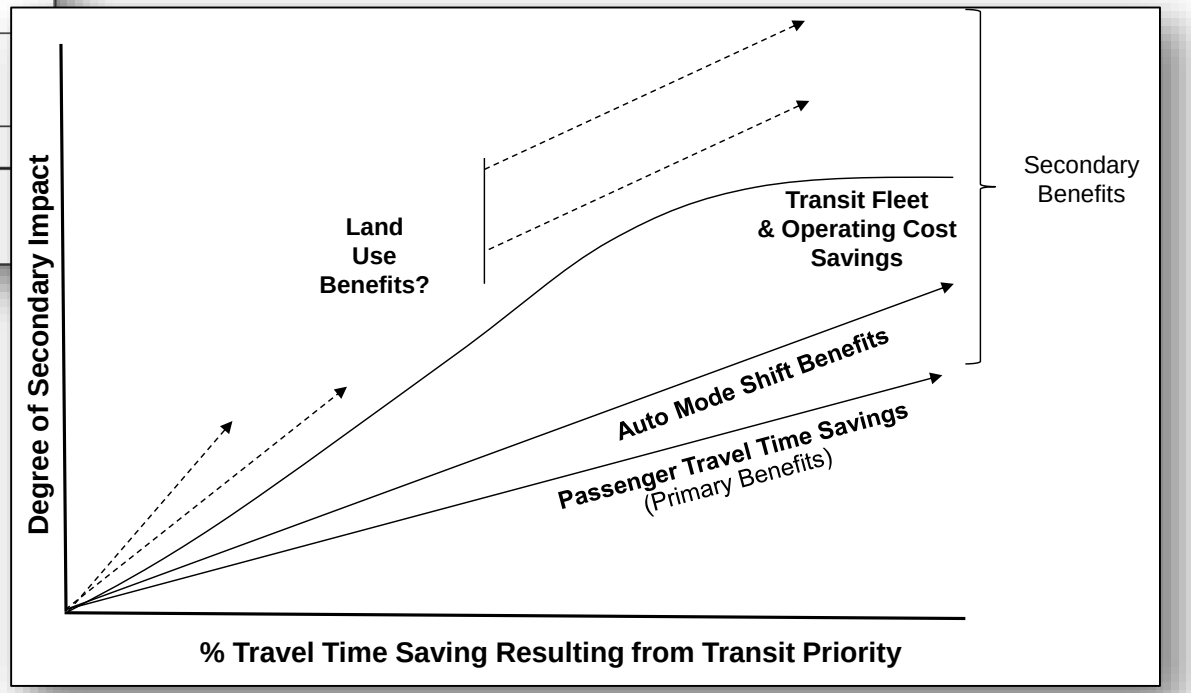


Source: Goh and Currie (2013) Before and After Studies of the Operational Performance of Transit Priority Initiatives ITS Report Feb 2013

Priority – Secondary Benefits



Old Model



New Model

Source: Currie G and Sarvi M (2012) 'A New Model for the Secondary Benefits of Transit Priority' TRANSPORTATION RESEARCH RECORD No. 2276, Journal of the Transportation Research Board pp 63–71

A range of measures are available to achieve traffic priority on road sections

OSPT Priority - Traffic Engineering Measures
ROAD SECTIONS - BUS

- With Flow Lanes
- Contra Flow Lanes
- Busways
- Guided Busways
- Bus/Tram Only Roads

A range of measures are available to achieve traffic priority on road sections

OSPT Priority - Traffic Engineering Measures
ROAD SECTIONS - Tram

- With Flow Lanes
- Contra Flow Lanes
- Tram Only Roads

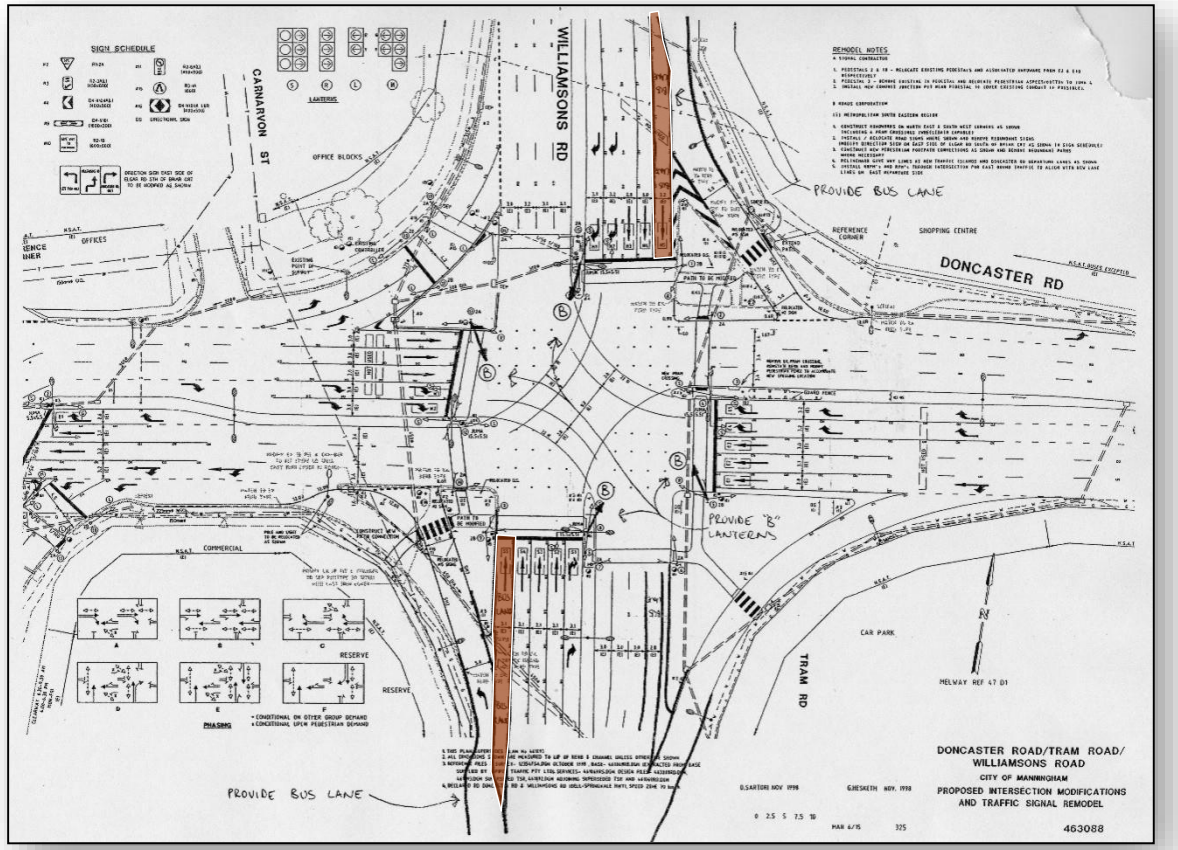
Priority – Road Design Measures

Transit Lane - With Flow

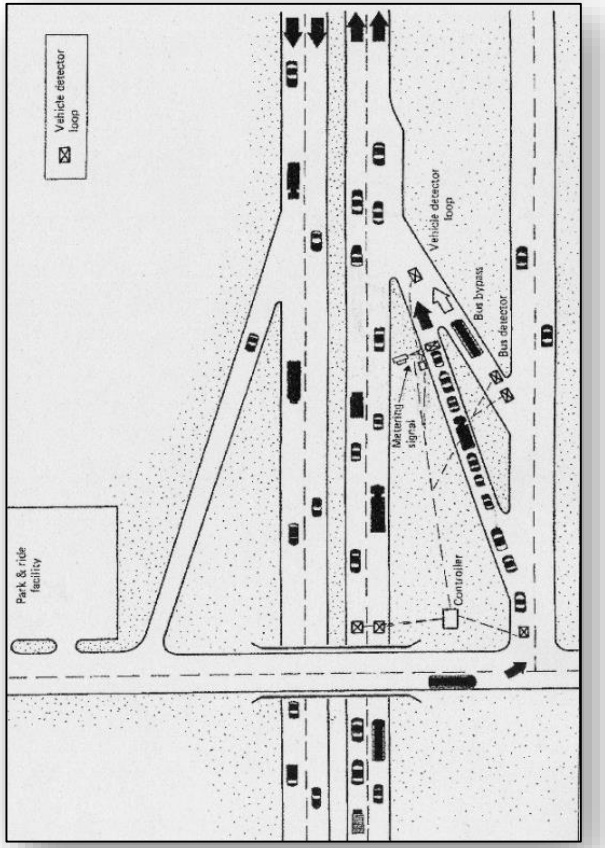
Transit Lane - Contra-Flow

Priority – Road Design Measures

Queue Jump Lanes

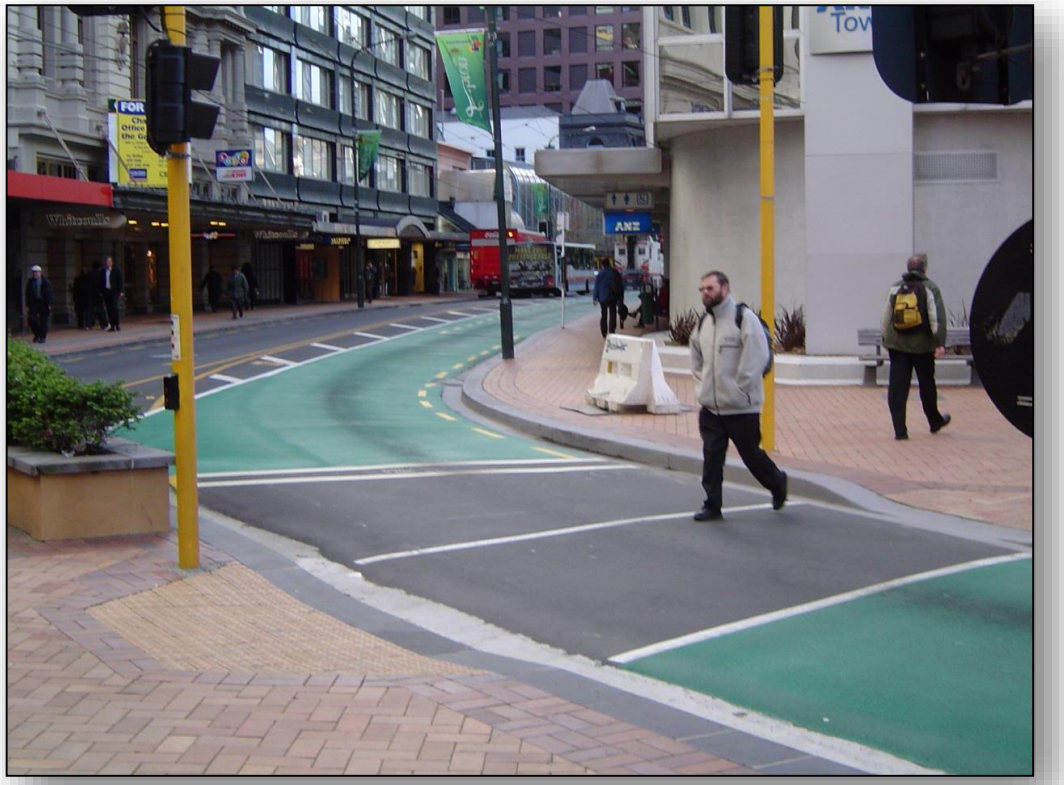


Freeway Access Ramps



Priority – Road Design Measures

Transit Gates



Transit No Turn Exemption

Priority – Road Design Measures

- General Road Orientation (avoid right turns)
- Lane Widths
- Ped. Crossing Locations Away from Intersections
- Junction Incursion Bans
- Smooth/Fast Traffic Flow = Better Transit Vehicle Flow

Traffic Signal Priority is of two types; Passive and Active

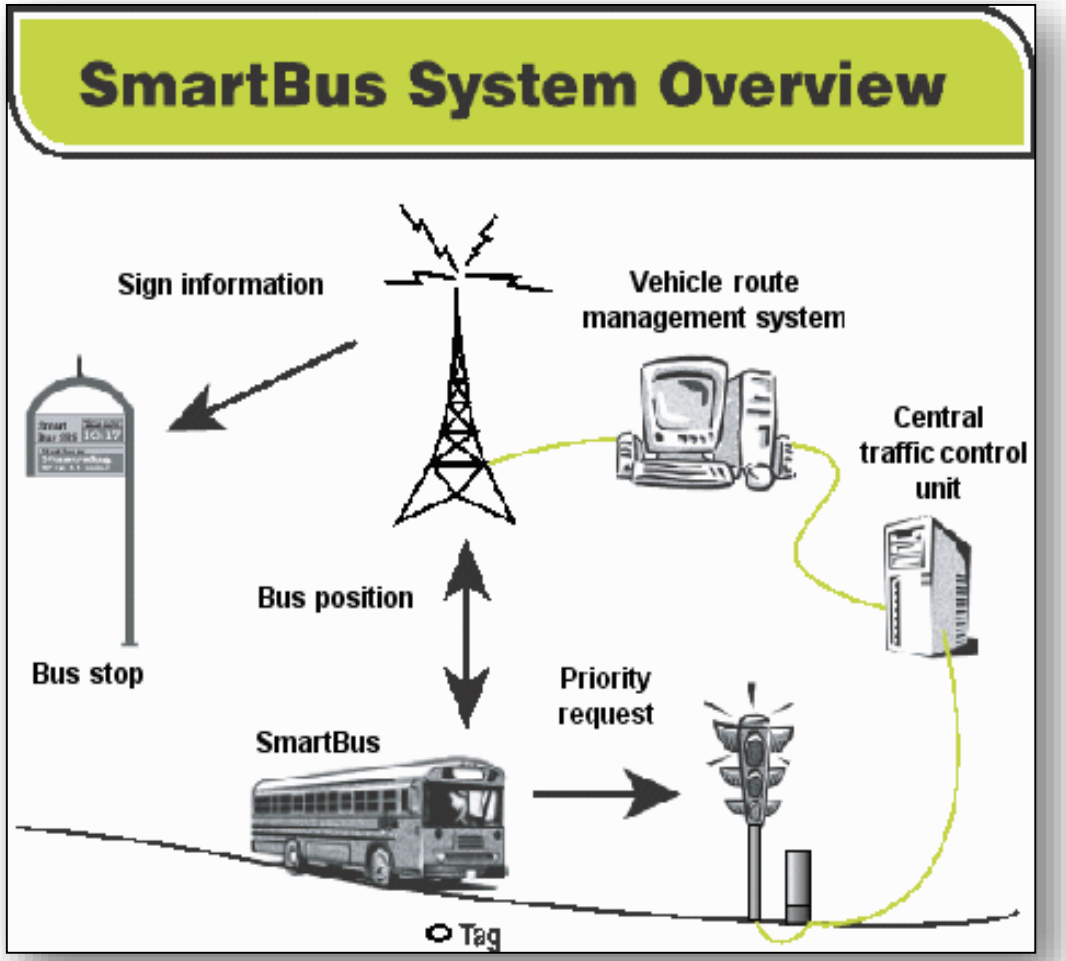
OSPT Priority - Traffic Engineering Measures
TRAFFIC SIGNAL PRIORITY
PASSIVE

- Shorter Cycle Time
- Priority Movement Phase Repetition
- Green Priority Weighting
- Turning Phase Design
- Signal Linking/Green Waves
- Time of Day Phasing Variation

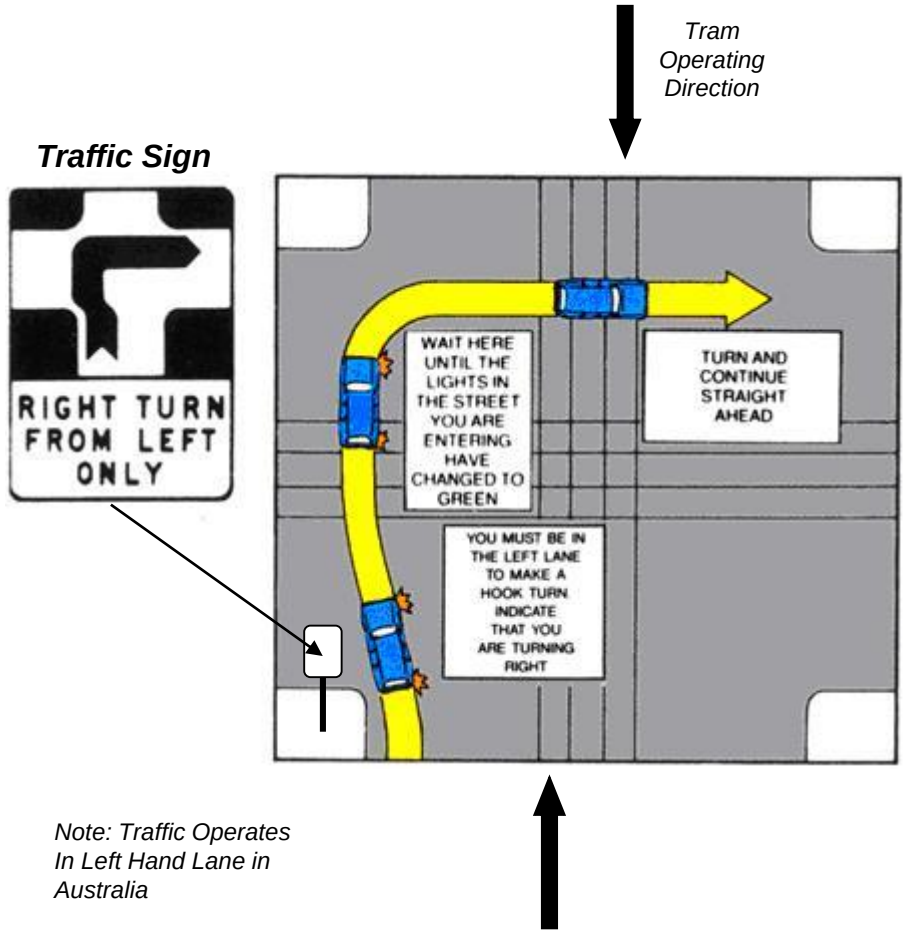
OSPT Priority - Traffic Engineering Measures
TRAFFIC SIGNAL PRIORITY
ACTIVE

- Green Extension
- Early Start
- Special Phase (B/T lights)
- Phase Suppression
- Priority phase sequence (road clearance)
- Compensation
- Flexible window stretching

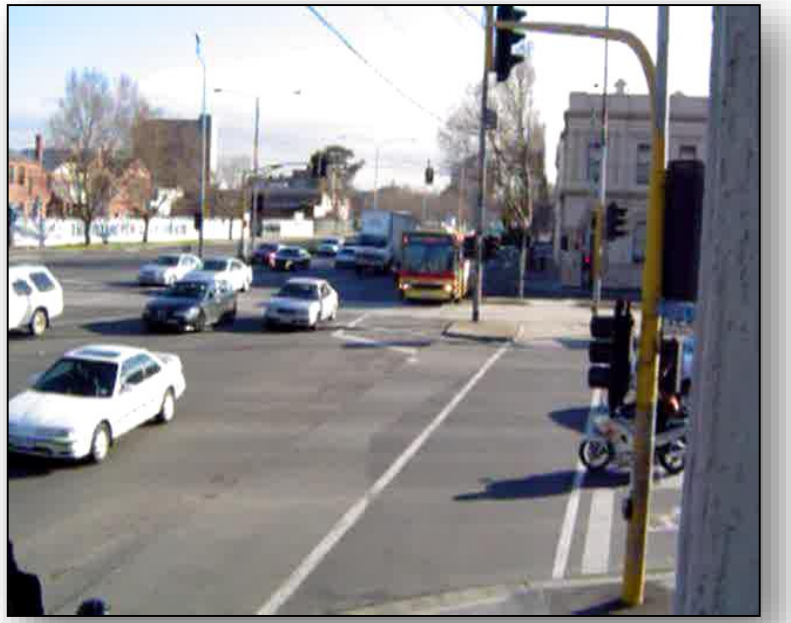
Traffic Signal Priority is of two types; Passive and Active



Selected Treatments – Traffic Hook Turns



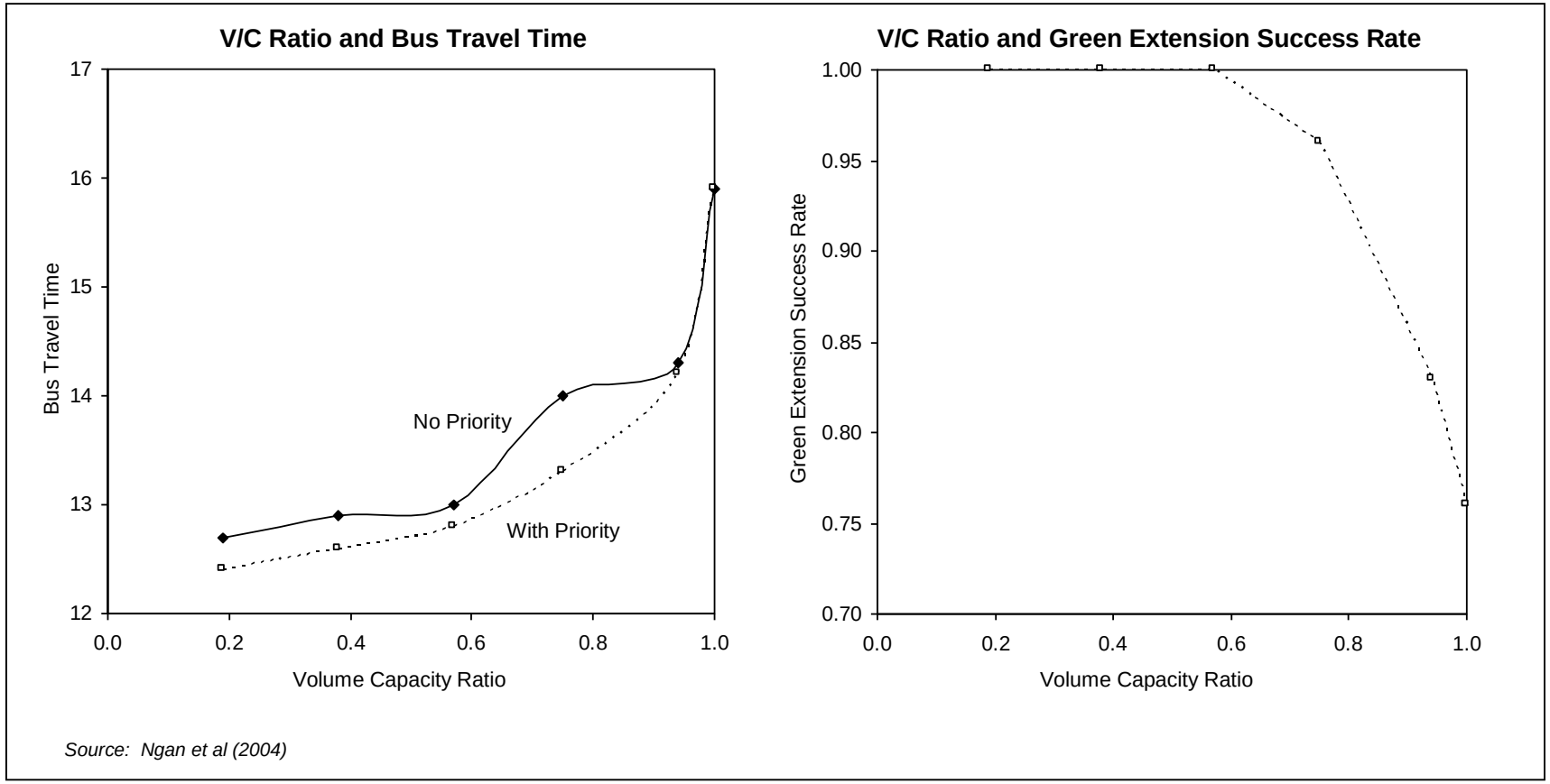
Selected Treatments – Bus Hook Turns



TSP has limited/no benefit at high traffic volume

- There is a consensus that TSP is of limited/no direct benefit at high (saturation) traffic flows
- "Conditional priority" approaches are used to limit priority at high traffic volume:
  - No priority at saturation
  - Relation degree of priority to saturation
  - Restrict multiple calls at high volume
- 'Indirect' priority – where traffic queues are cleared well ahead of bus arrivals, is recommended at saturation volumes

TSP provides higher benefits at medium to high traffic volumes



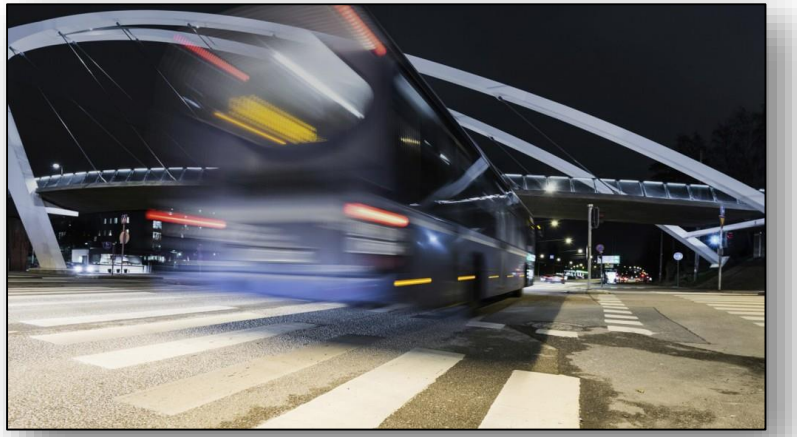
Source: Ngan et al (2004)

Cycle length affects traffic flow efficiency but is not directly a TSP related issue

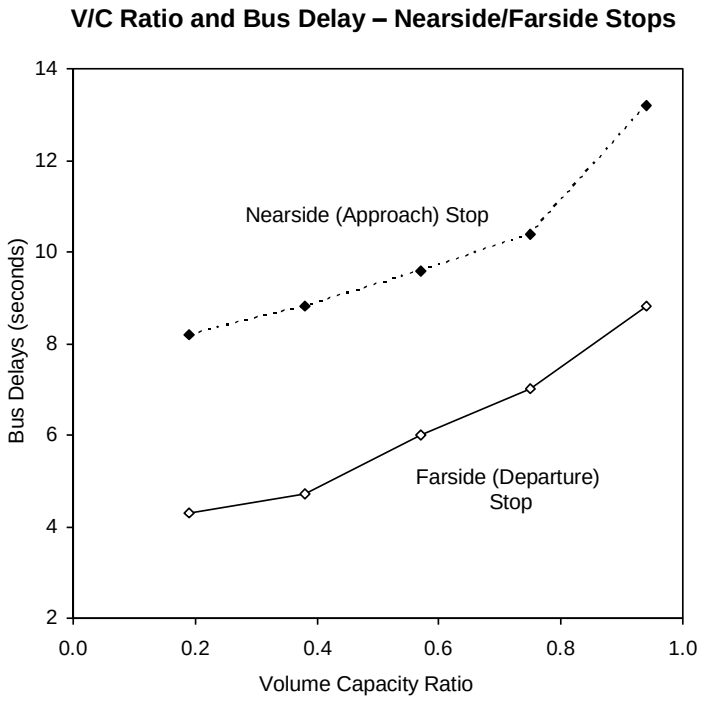
- Short cycles are thought to be better for transit (Hunter, 2000) because it creates more opportunities for passing signals.
- However it also creates more opportunities for delay at signals
- Also all cycles must have fixed inter-green time (amber and all red). For short cycles this unproductive time represents a higher share of the cycle
- Long cycle length is appropriate for peak/congested traffic. Shorter cycle length for off peak/low traffic volume

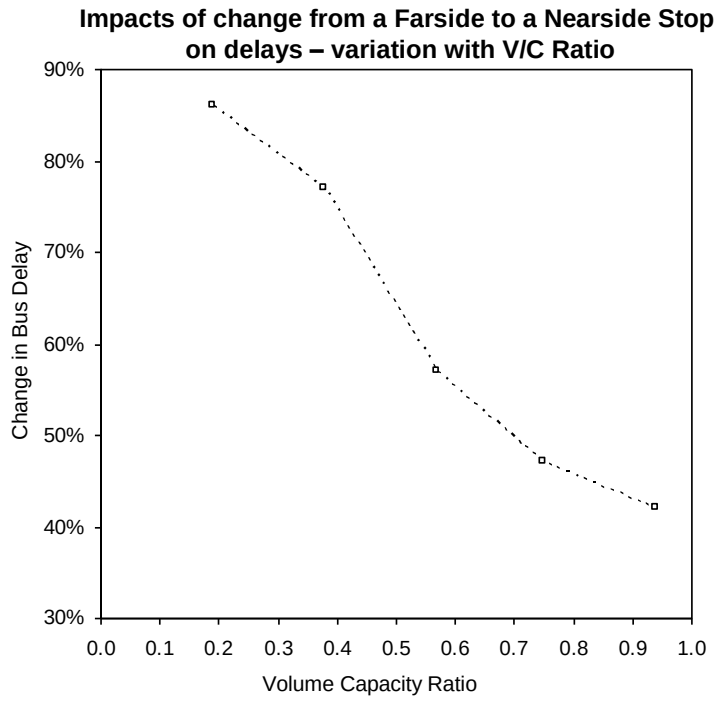
Travel time (TT) error is frequently highlighted as a problem but it is not well researched

- Ability to correctly estimate arrival at signal is critical to quality of priority provided:
  - Overly long prediction – can cause un-necessary calling of green time which is not used
  - Too short prediction – closes green before bus gets through the light
- Common approach to TT prediction is:
  - Use historical average travel time of bus
  - Can add a fixed value for variability of time
- Literature also recognises importance of queues affecting TT accuracy but does not explore this problem further



Approach stops significantly reduce TSP benefits





Source: Ngan et al (2004)

This problem is caused by travel time error

How to justify priority ? – simple warrants

Table 5 **Bus Lane Warrants** (Levinson, Adams and Hoey 1975)

Treatment	Minimum One-Way Peak-Hour Volume		Related Land Use and Transportation Factors
	Buses	*Passengers*	
Bus streets or malls	80-100	3,200-4,000	Commercially oriented frontage.
Curb bus lanes, normal flow	50-80	2 000-3 200	Commercially oriented frontage.
Curb bus lanes, normal flow	30-40	1,200-1,600	At least 2 lanes available for other traffic in same direction.
Median bus lanes	60-90	2,400-3,600	At least 2 lanes available for other traffic in same direction; ability to separate vehicular turn conflicts from buses.
Contraflow bus lanes, short segments	20-30	800-1,200	Allow buses to proceed on normal route, turn around or bypass congestion on bridge approach.
Contraflow bus lanes, extended	40-60	1,600-2,400	At least 2 lanes available for other traffic in opposite direction. Signal spacing greater than 150-m intervals

A National Cooperative Highway Research Program report recommends these bus lane warrants.

Source: Litman T (2016) 'When are Bus Lanes Warranted – Considering Economic Efficiency, Social Equity and Strategic Planning Goals' Victoria Transport Policy Institute http://www.vtpi.org/blw.pdf (last accessed March 2016

Priority – Justification - Vuchic

Vuchic –
Priority is justified if
a lanes worth of people
are travelling by transit

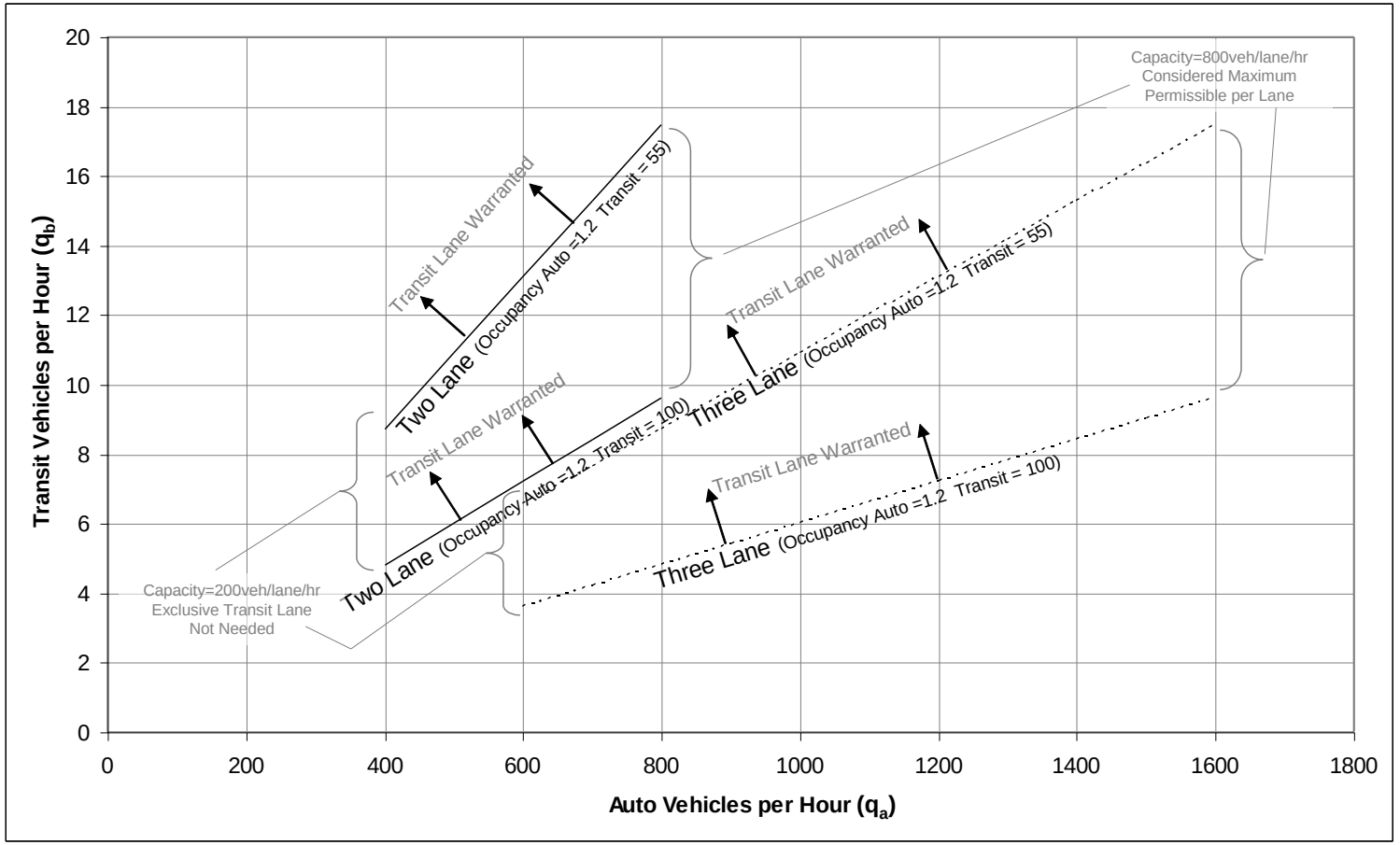
$$q_b \geq \frac{q_a}{N-1} x$$

q_b = Volume of transit vehicles

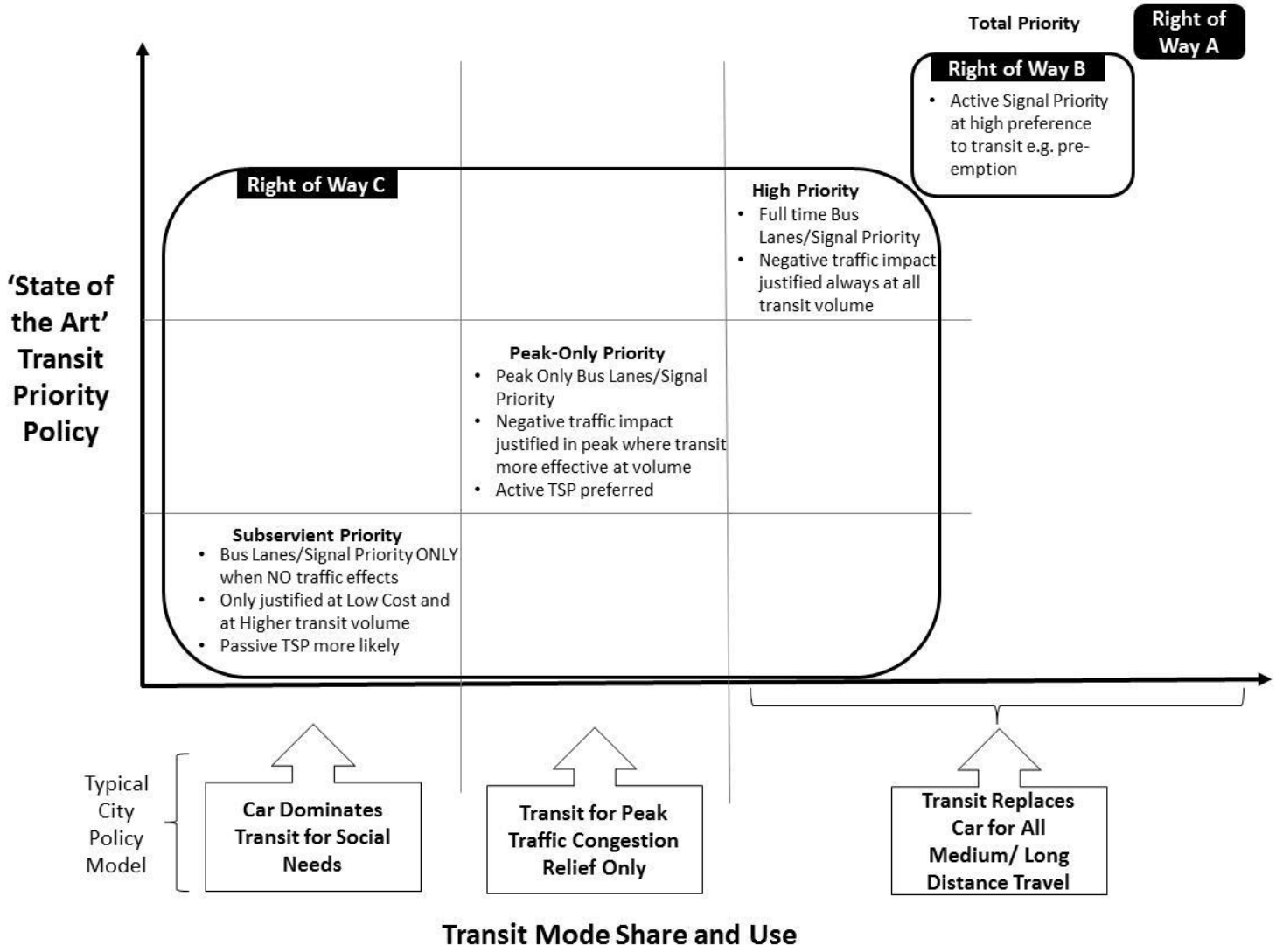
q_a = Volume of auto traffic

N = number of traffic lanes

X = (average auto occupancy/ average transit vehicle occupancy)



State of the Art – Priority Design



Source: Currie G (2016) 'Managing On-Road Public Transport in Traffic' in Bliemer M Mulley C and Moutou C Handbook on Transport and Urban Planning in the Developed World, Edward Elgar Publishing Ltd UK

A Very New Idea - Pragmatic Priority

James Reynolds

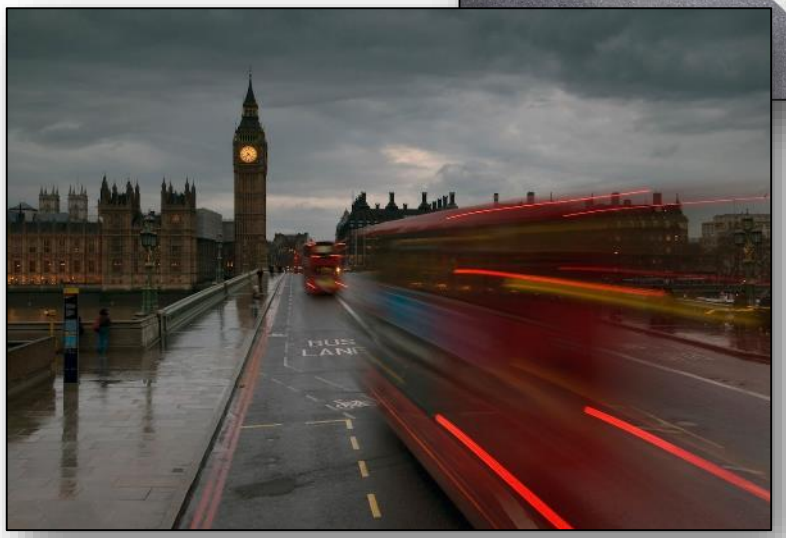
Local politics remains the real barrier to progress with Priority – time to include this in our planning

Questions of Governance: Rethinking the Study of Transportation Policy
Transportation Research Part A Policy and Practice 101 · May 2017

"…there is a need to … pay greater attention to context, politics, power, resources and legitimacy"

(Marsden and Reardon 2017)

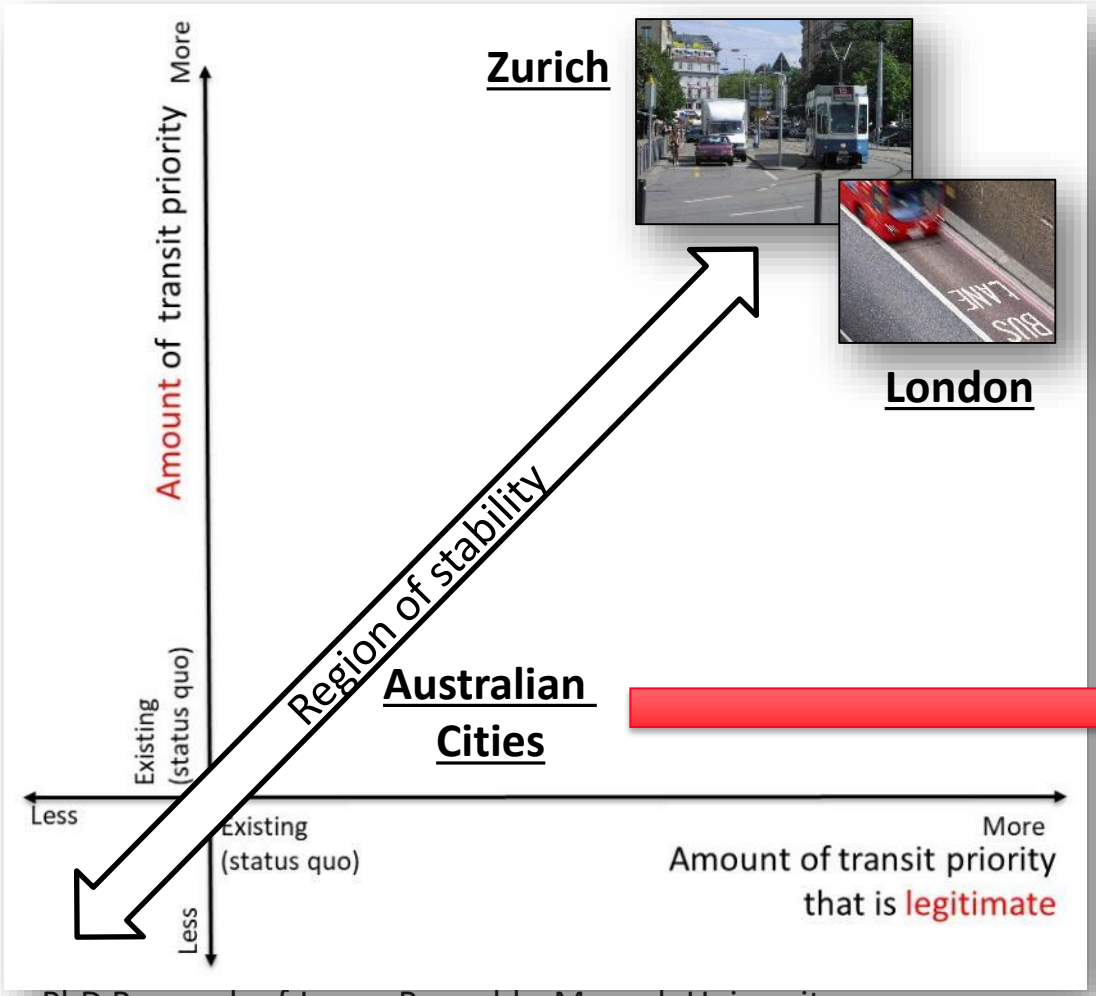
Why can London and Zurich have top quality priority, yet we cant?....



Source: PhD Research of James Reynolds; Monash University

…because they have LEGITIMACY and we dont

Legitimacy Framework



Source: PhD Research of James Reynolds; Monash University

How did they get LEGITIMACY for Transit Priority? How can we get it?

Legitimacy Theory

• Regulatory	**The law requires** a bus lane
• Sociological	We **should** have a bus lane
• Legitimacy by consent	**We voted** for a bus lane
• Legitimacy by reasonableness	The bus is slow and unreliable, a bus lane is **a reasonable solution**
• Unconditional duty	Buses **must always** have bus lanes!
• Legitimacy as conditional normative support	We should have a bus lane, **as long as** there's enough space for a bike lane/ onstreet parking

Zurich

London

Source: PhD Research of James Reynolds; Monash University

How can we get priority when we don't have LEGITIMACY? We identified **THREE APPROACHES AND EIGHT PRAGMATIC STRATEGIES**

Build legitimacy BEFORE implementation

AVOID IMPACTS on other road users

Build legitimacy THROUGH IMPLEMENTATION

Source: PhD Research of James Reynolds; Monash University

How can we get priority when we don't have LEGITIMACY? We identified **THREE APPROACHES AND EIGHT PRAGMATIC STRATEGIES**

Build legitimacy BEFORE implementation

1. Technical enquiry
2. Transport planning, and/or
3. Public processes or hearings

AVOID IMPACTS on other road users

4. Grade separation
5. Subservient priority

Build legitimacy THROUGH IMPLEMENTATION

6. Bottom-up and incremental
7. Pop-ups
8. Trials

Technical/Public Enquiries – such as the St Clair streetcar corridor in Toronto

Build legitimacy BEFORE implementation

1. **Technical enquiry**
2. **Transport planning, and/or**
3. **Public processes or hearings**

AVOID IMPACTS on other road users

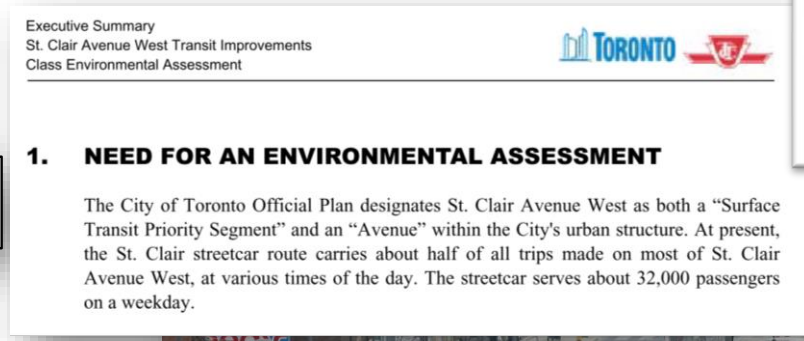
4. **Grade separation**
5. **Subservient priority**

Build legitimacy THROUGH IMPLEMENTATION

6. **Bottom-up and incremental**
7. **Pop-ups**
8. **Trials**

Mediate, arbitrate or resolve issues & build **legitimacy**

- Transport study
- Environmental effects statement process
- Planning processes
- Independent study
- Public enquiry
- Plebiscite (Switzerland only)


Executive Summary
St. Clair Avenue West Transit Improvements
Class Environmental Assessment

TORONTO

1. NEED FOR AN ENVIRONMENTAL ASSESSMENT

The City of Toronto Official Plan designates St. Clair Avenue West as both a "Surface Transit Priority Segment" and an "Avenue" within the City's urban structure. At present, the St. Clair streetcar route carries about half of all trips made on most of St. Clair Avenue West, at various times of the day. The streetcar serves about 32,000 passengers on a weekday.

MONASH University

4. Grade Separation; Adelaide and Brisbane Busways

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5. Subservient Priority; Melbourne; Eastern Freeway emergency lanes, Smartbus Road Widening and Tokyo Bus Tubes

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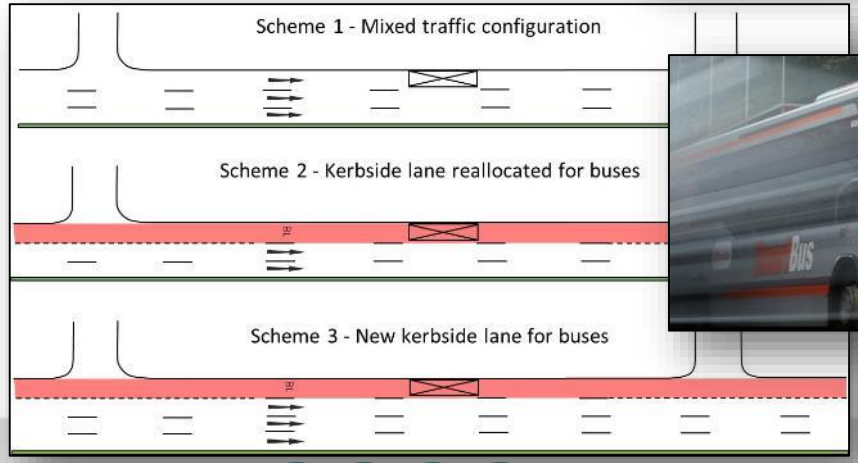

6. Bottom-up & Incremental; **Melbournes vanishing streetcar secret**

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7. Pop-ups; do priority tomorrow; with traffic cones – Boston, USA

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Tactical urbanism

Boston Tests Faster Bus Service Simply By Laying Out Orange Cones

The same low-cost approach that cities have used to quickly reallocate street space to walking and biking can also be used to try out transit improvements.

By Angie Schmitt | Dec 12, 2017 | 77

Boston set up a bus lane using orange cones. Photo: Jacqueline Goddard

8. Trials; Toronto King Street Trail; and the great Melbourne Clarendon Street Trial Failure; or was it Success?

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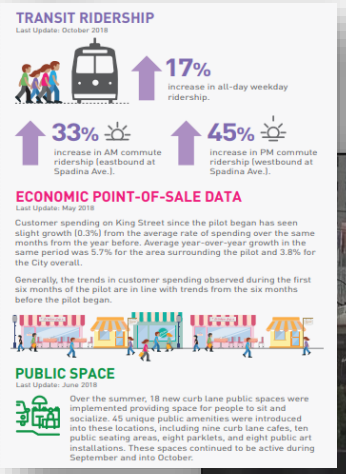

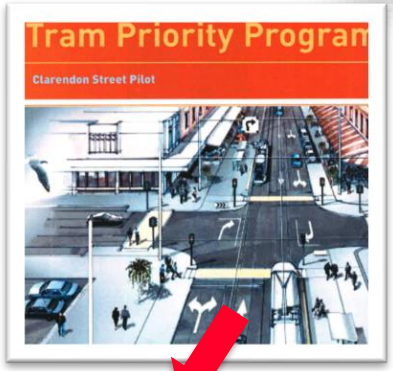

vic roads

Clarendon Street Tram Stop Works

Following a trial of traffic treatments along Clarendon Street, the State Government, City of Port Phillip, Yarra Trams and business representatives have agreed on some changes to the

CITY OF PORT PHILLIP REPORT

STRATEGY AND POLICY REVIEW COMMITTEE
6 JUNE 2005 *POLICY AND PLANNING*

A3	CLARENDON STREET THINK TRAM TRIAL PROJECT
LOCATION/ADDRESS:	CLARENDON STREET, SOUTH MELBOURNE
RESPONSIBLE EXECUTIVE DIRECTOR:	GEOFF OULTON, EXECUTIVE DIRECTOR CITY DEVELOPMENT
AUTHOR:	PAUL SMITH, COORDINATOR SUSTAINABLE TRANSPORT
FILE NO.:	70/04/12
ATTACHMENTS:	13

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PORT
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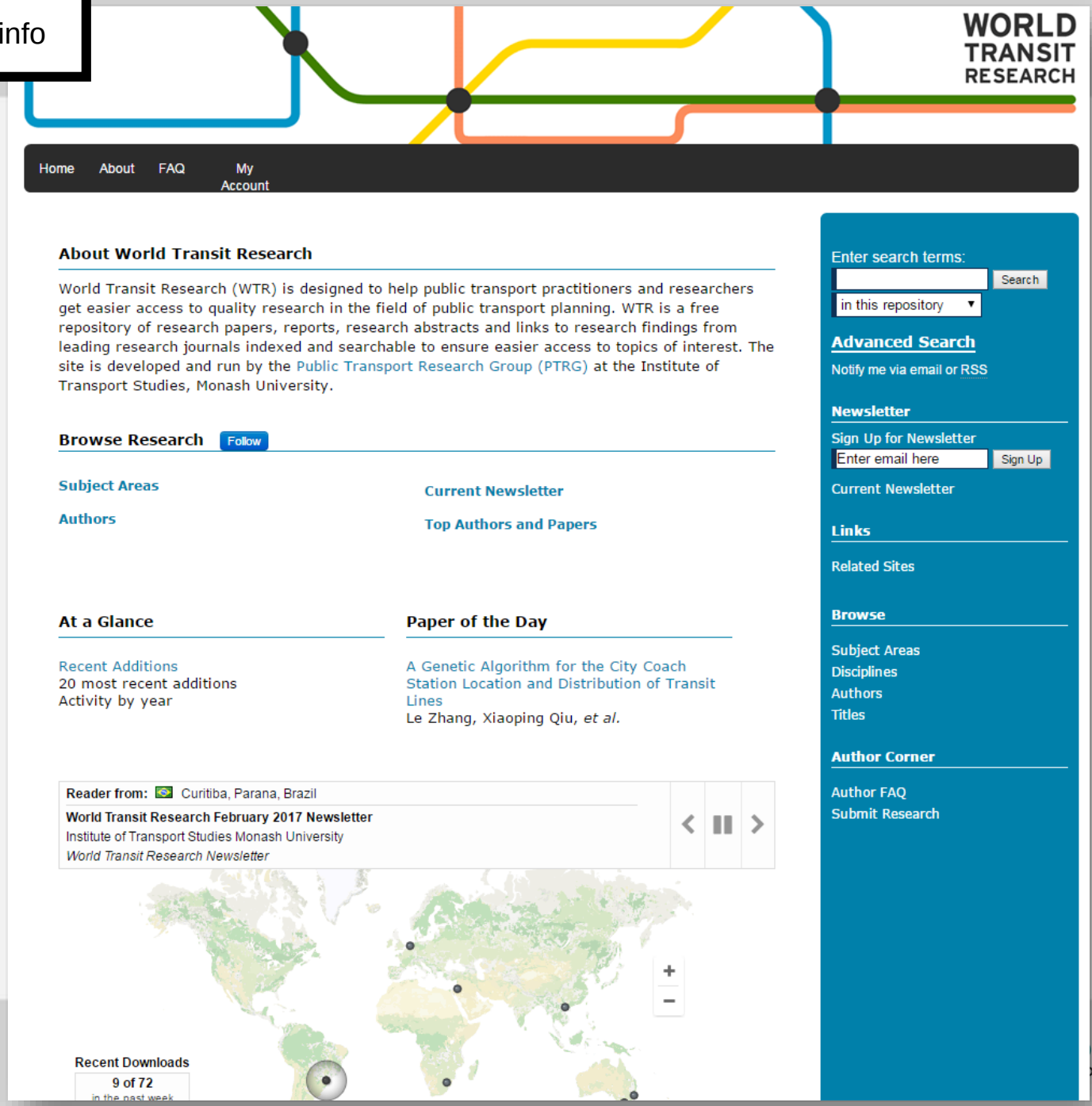
www.worldtransitresearch.info



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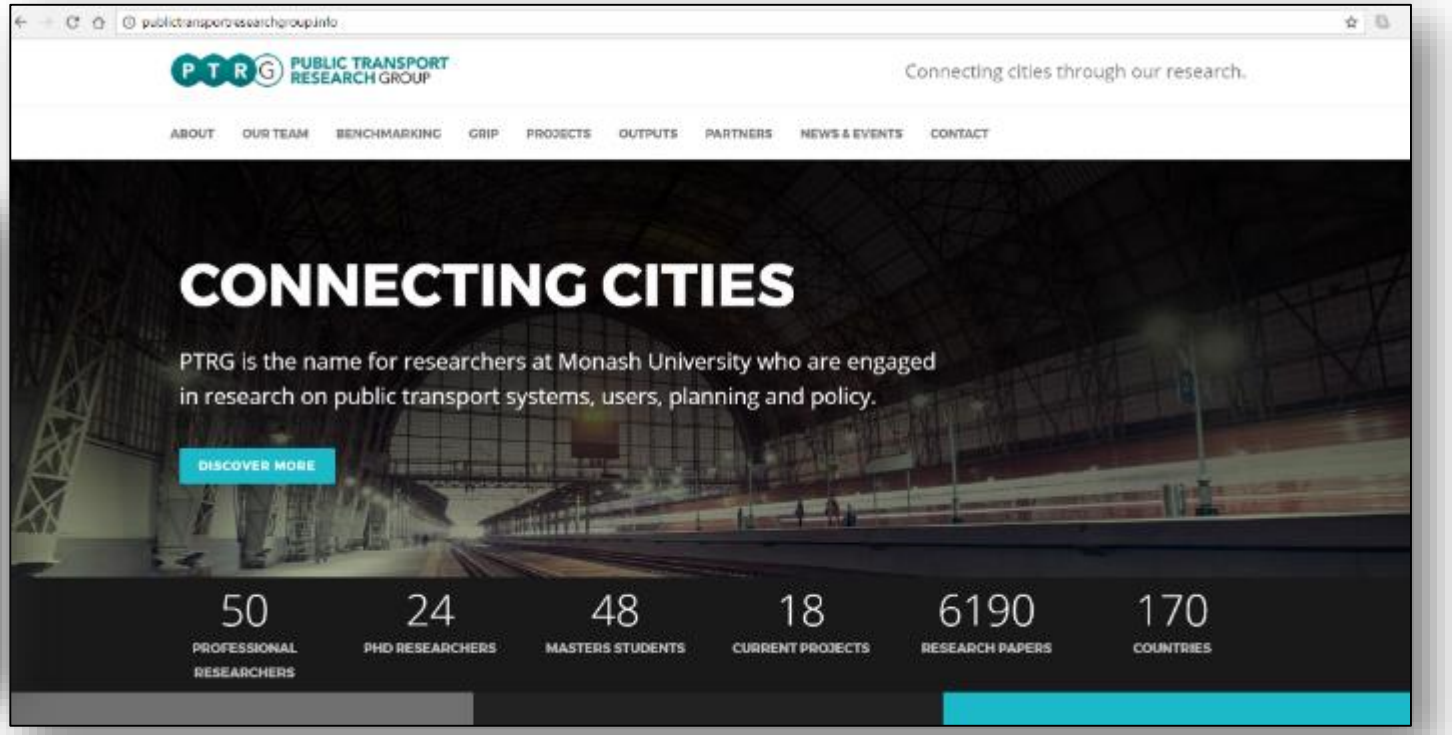
Professor Graham Currie FTSE

Director, SEPT-GRIP, PTRG

Connect with us on LinkedIn twitter



www.ptrg.info