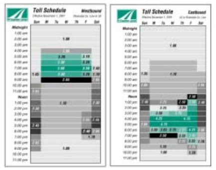

Where next for Road Authorities?

Research points to Efficiency Gains

Professor David Hensher, ITLS, University of Sydney Business School

ITEANZ Seminar 3 Feb 2015

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ITLS

What are some Big Challenges?

- › Doing more with less: Identifying all potential projects and priorities
- › Getting priorities better justified (QuickScan) – value for money
- › Communicating the 'why' better than we do (including the what, how and when)
- › Pricing reform (especially gaining buy in) – car and truck
- › Multi-Modalism (Roads move more PT passengers than rail)
- › Improved traffic assignment methods (where are the bottlenecks?)
- › Wider Economic Benefits (WEBs) as Welfare Benefits and GDP Impacts
- › Unencumbered research – breaking new ground that might be risky initially (financial support from Road Authorities)
  - Examples include allowing for risk and uncertainty in travel behaviour research
  - Improved traffic assignment methods in standard software used by consultants
- › The need to increase investment in education and research
  - Road Authorities need to be more vigilent over consultants

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What has a peer reviewer and adviser to road authorities learnt over the years?

› Early definition of the bigger picture

- Multimodal
- Land use interdependency and feedbacks with travel (“appalling!”)

› Utilisation of methods to get a better idea of options

- Ability to ‘scan’ lots of options and to narrow down ones that show real promise (otherwise opportunities can be missed) – can demonstrate the strategic thinking of Road Authorities
- MetroScan as an example (next slide)

› Writing the brief for consultants

- Major road projects are increasingly urban revitalisation projects (and not simply roads)
  - This should be used to re-position the arguments to reduce criticism about road focus without merit.

› Consultants do not like changing their ways so often, which they have invested in, but academic research is there to do this in part by questioning existing practice and assisting in delivery of improved methods

  › even if they are subsequently developed by spin off companies (e.g., Emme/2, Transcad, Nlogit, Ngene, TREDIS, MetroScan).

MetroScan – An example of Research Cooperation

Introducing MetroScan - A Quick-Scan Tool

Significant costs and effort are required to assess potential infrastructure projects, service improvements and policies for use in land-use and transport plans. Often, a handful of projects and policies are selected for in-depth study by planning organisations and external consultants for a whole lot of reasons. MetroScan as a strategic prioritisation tool provides users with the ability to undertake a quick-scan assessment of a much larger number of potential projects and policies (including both infrastructure and service improvements) in only a few hours using a user-friendly interface. Once this fast scan of many candidate projects and policies is completed, MetroScan can also be used to undertake further analysis using greater spatial detail and socio-economic representation on those projects and policies found to be of the highest level of merit, providing all the evidence required for national funding programs.

MetroScan seamlessly integrates the latest releases of Economic Development Research Group's TREDIS and the Institute of Transport and Logistics Studies' TRESIS models. MetroScan uses integrated passenger, freight, land-use and economic models that have rich feedback between location and travel related decisions, using detailed behavioural data. MetroScan's fully integrated and inter-dependent travel forecasting, benefit-cost and economic impact modules provide decision makers with all the relevant information from a single fully integrated user-friendly interface. It has the following key features:

- User-friendly interface that provides quick results for a large number of spatial and aspatial policies and projects (typically within minutes or less than an hour).
- Detailed behavioural results including choice of mode and time of day for all of the key trip purposes, choice of work, non-work and residential location (including building type and tenure choice) and vehicle choice (including usage), all fully integrated into one system with feedback.
- Full benefit-cost analysis and evaluation of benefits and impacts on the wider economy.

That allow MetroScan to address broad questions on land use, transportation and economic impacts, such as:

- How might transport policies or investments change car ownership and housing patterns?
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- What are the wider economy benefits of a specific transport policy or investment?

Key features of MetroScan compared to other types of models

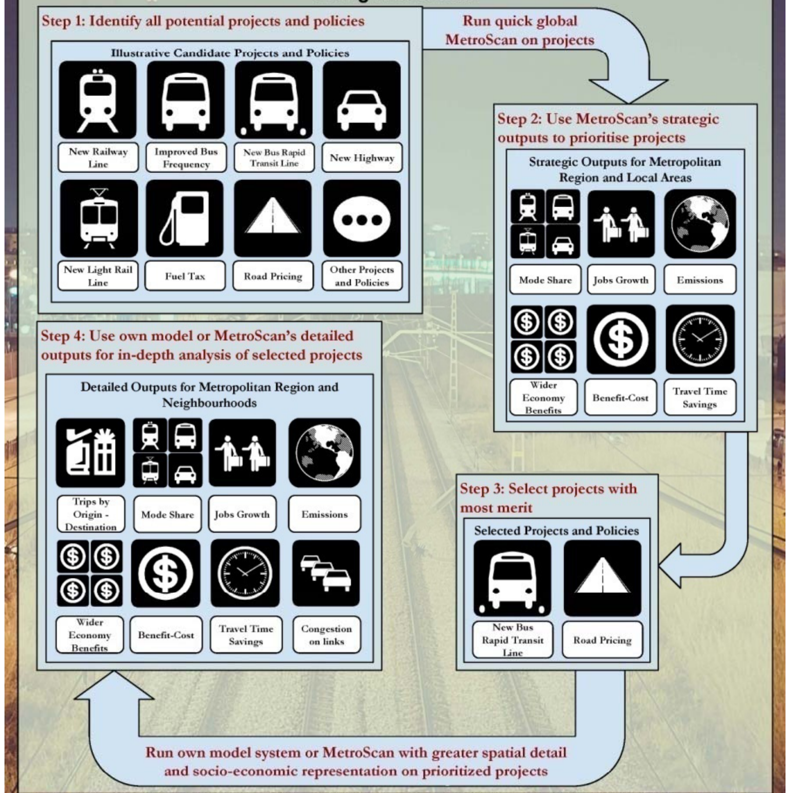
○ Partially implemented
● Fully implemented

	Traditional Benefit-Cost	Economic Development models	Travel demand models	Strategic Transport Planning models	MetroScan
User-friendly interface for project and/or policy selection and specification	○				●
Quick evaluation of multiple alternative projects and/or policies	○				●
Evaluation of major land-use and transport infrastructure, service and regulatory changes		○			●
Integrated passenger, freight and land-use models			○		●
Fully integrated, inter-dependent, travel forecasting, benefit-cost and economic impact modules					●
Built-in capability to choose level of spatial aggregation					●
Default options complying with requirements of government planning and funding programs	○	○			●
User-friendly customisation of model parameters					●
Detailed behavioural results including vehicle ownership and vehicle types, travel choices (mode, time of day, destination), work patterns and flexibility, and location decisions of households and firms.			○	○	●
Detailed economic results including growth and redistribution of employment and residential locations		○			●
Extensive number of detailed and customizable outputs				○	●

Appeal of MetroScan

Provides relevant spatial and socio-economic detail for project and policy prioritizing, designed to provide advice on projects and policies that show great merit which then can be studied in greater spatial and socio-economic detail.

Using MetroScan



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The University of Sydney Business School
www.sydney.edu.au/business/itls

Economic Development Research Group
www.edrgroup.com

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Research Focus: The Challenge in Influencing Policy and Practice

- Academics do good research in traffic/transport/economics etc.
- In general they are weak in "selling" their ideas, something consultants are good at, but latter so often take academic outputs and promote them (e.g., WEBs, specific software developed by Universities); sadly the source is not always (some might say 'rarely') acknowledged.
- The tricky areas are **politics** and **marketing**; for example
  - "The problem with road pricing reform is that we (as a broad community) have failed to show how a reform package might work that can gain votes through community acceptance"
    - Hensher, D.A. and Mulley, C. (2014) Complementing distance based charges with discounted registration fees in the reform of road user charges: the impact for motorists and government revenue, *Transportation* 41 (4), 697–715.
  - A salient reminder:
    - *"I'm struck by what seems to be a huge disconnect between the systems being modeled by academic economists and the proposals emerging from field tests and demonstrations involving actual motorists."* (Poole 2012)

A Specific Issue:
REQUIREMENTS FOR TRAFFIC ASSIGNMENT MODELS FOR IMPROVED TRANSPORT PLANNING

Focussing on an Issue that has been of concern for many years (and which may be a significant source of traffic forecast errors)

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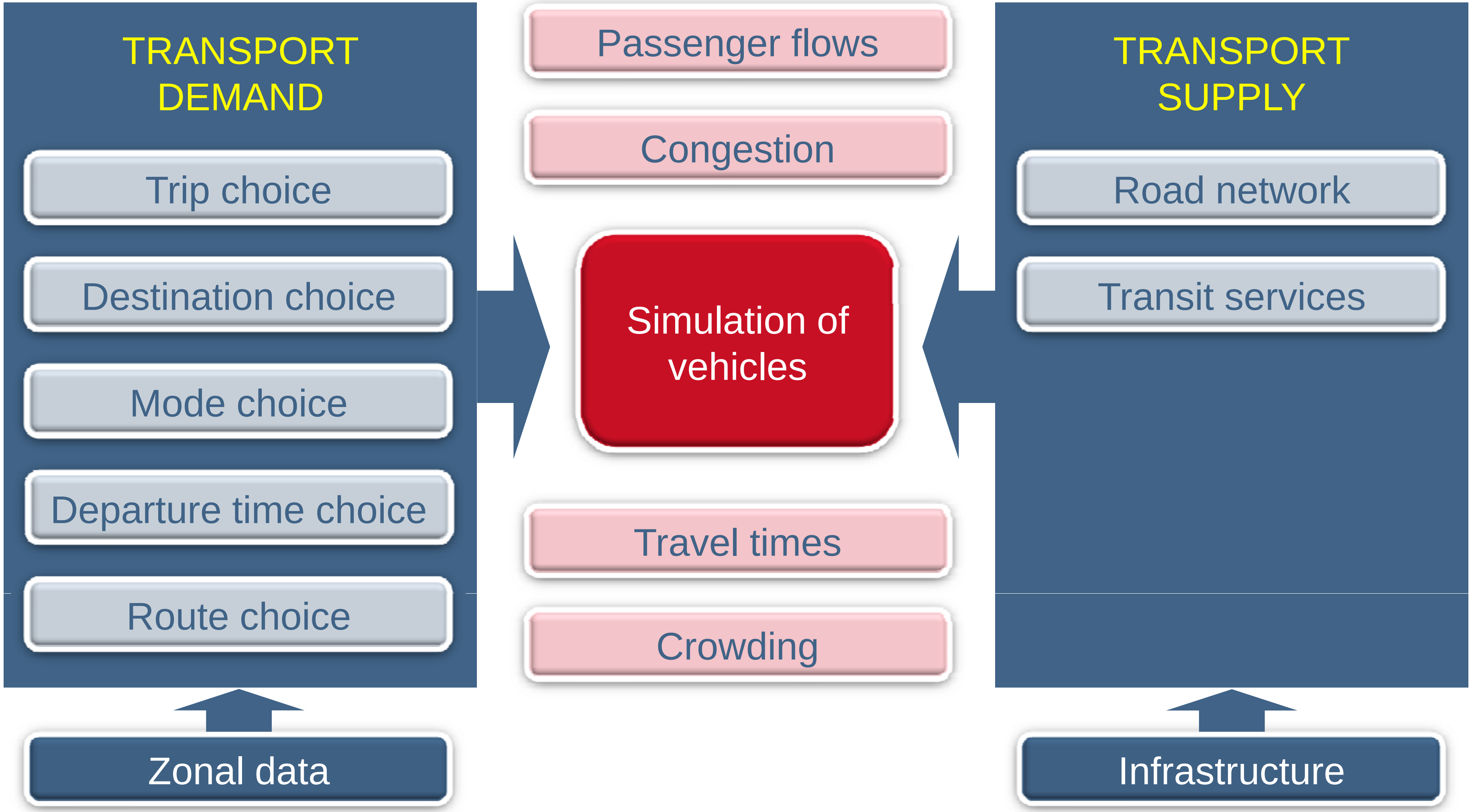
Traffic Models

- Strategic transport models are used to prepare, assess, and implement plans and projects in order to improve and manage transport systems
- Typical outcomes are traffic flows (patronage) and speeds
- These outcomes are used to calculate travel time savings, emissions, etc. for economic appraisal (e.g., cost-benefit analysis)
- In Australia all major metropolitan areas have developed a strategic transport model

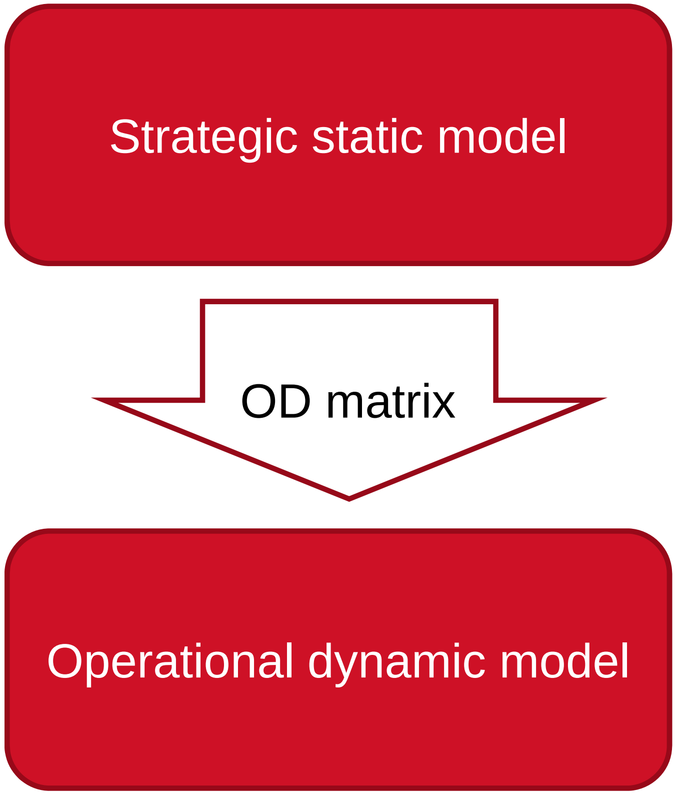
Model name	Abbreviation	State	Area
Sydney Strategic Travel Model	STM	NSW	Sydney
Melbourne Integrated Transport Model	MITM	VIC	Melbourne
Canberra Strategic Transport Model	CSTM	ACT	Canberra
Brisbane Strategic Transport Model – Multi Modal	BSTM-MM	QLD	Brisbane
Metropolitan Adelaide Strategic Transport Evaluation Model	MASTEM	SA	Adelaide
Strategic Transport Evaluation Model	STEM	WA	Perth

Traffic Models

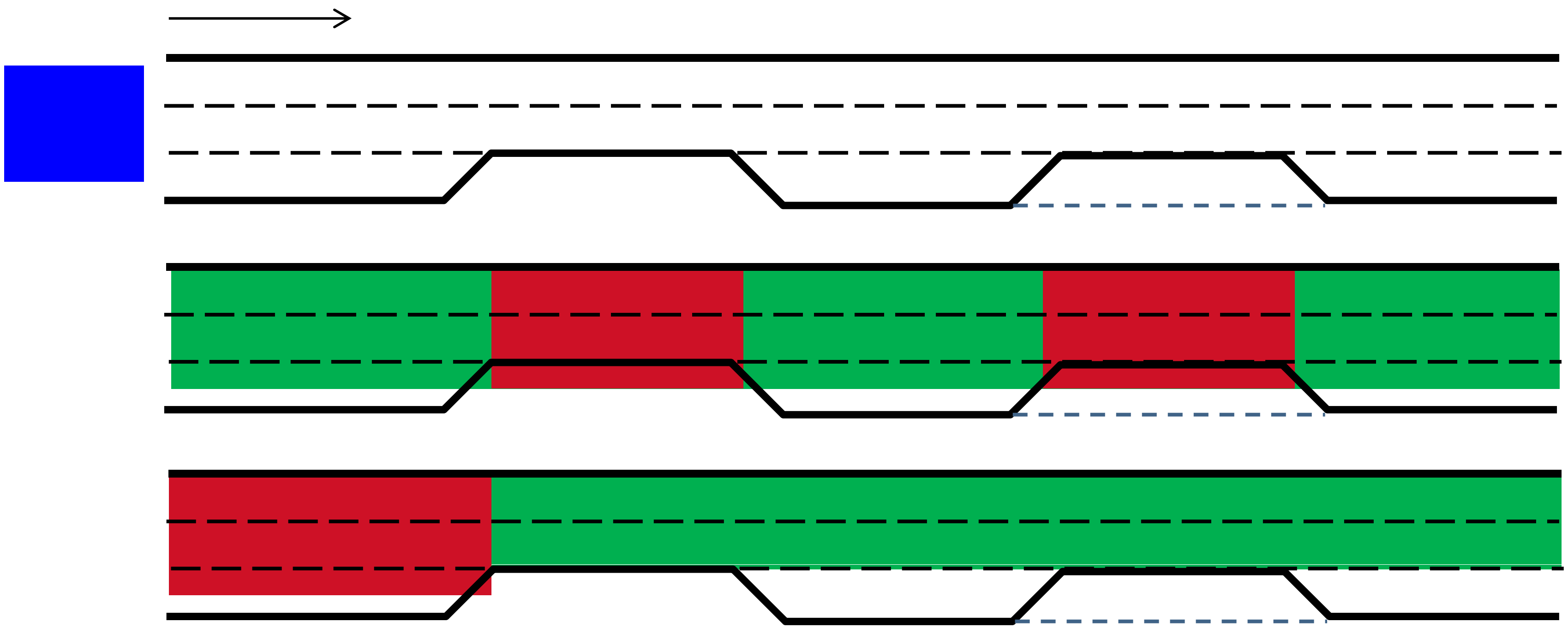


The Dilemma for Traffic Model Relevance in Real Settings

› Consistency between strategic static models and operational dynamic models is needed



- What travel time benefits will expanding link 4 (RHS red box) have?
  - In a static model? (would lead to travel time savings on link 4)
  - In a dynamic model? (would not lead to travel time savings on link 4)



Rethinking Traffic Assignments Methods where much of forecasting error is propagated

- Static traffic assignment considers a single time period with instantaneous flow propagation. Traffic flows are not capacity constrained and queues do not exist.

Alternatives:

Quasi-dynamic traffic assignment - considers a single time period and instantaneous flow propagation, but traffic flows are capacity constrained and residual queues are considered.

Semi-dynamic traffic assignment - considers multiple time periods with instantaneous flow propagation within each time period. Residual queues are transferred across time periods.

Dynamic traffic assignment - considers multiple time periods with time-dependent flow propagation, resulting in time-varying flows and queues.

The Appeal of Quasi-Dynamic Perspective:

It is essentially a static model that is able to produce outputs (traffic flows, queues, and travel times) more similar to dynamic models than standard static models. There are no time dynamics. These are the main features needing inclusion beyond static assignment.

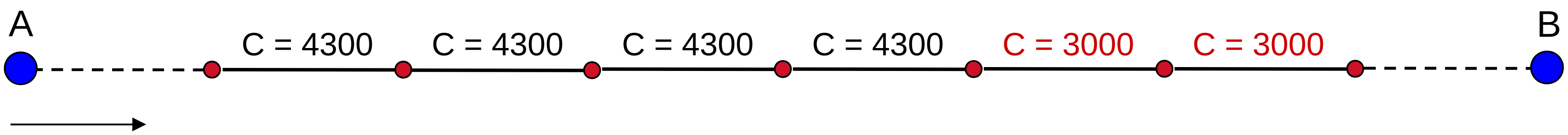
Semi-dynamic models include time-dynamics between time periods, not within time periods.

Dynamic models include time dynamics both within and across time periods.

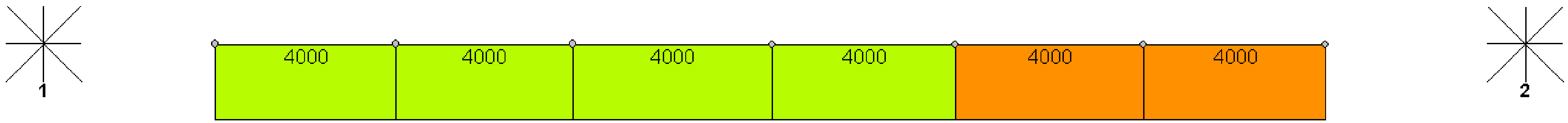
QUASI-DYNAMIC TRAFFIC ASSIGNMENT: Bringing some Reality to the Evidence (C=capacity)

Example

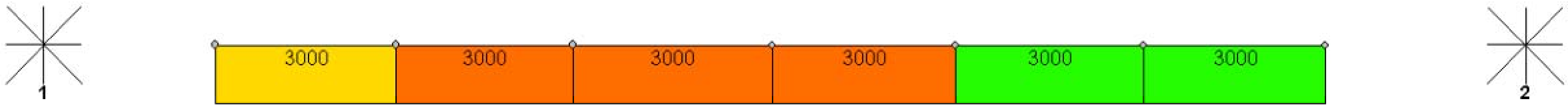
› Consider the following route from A to B with a travel demand of 4000 veh/h



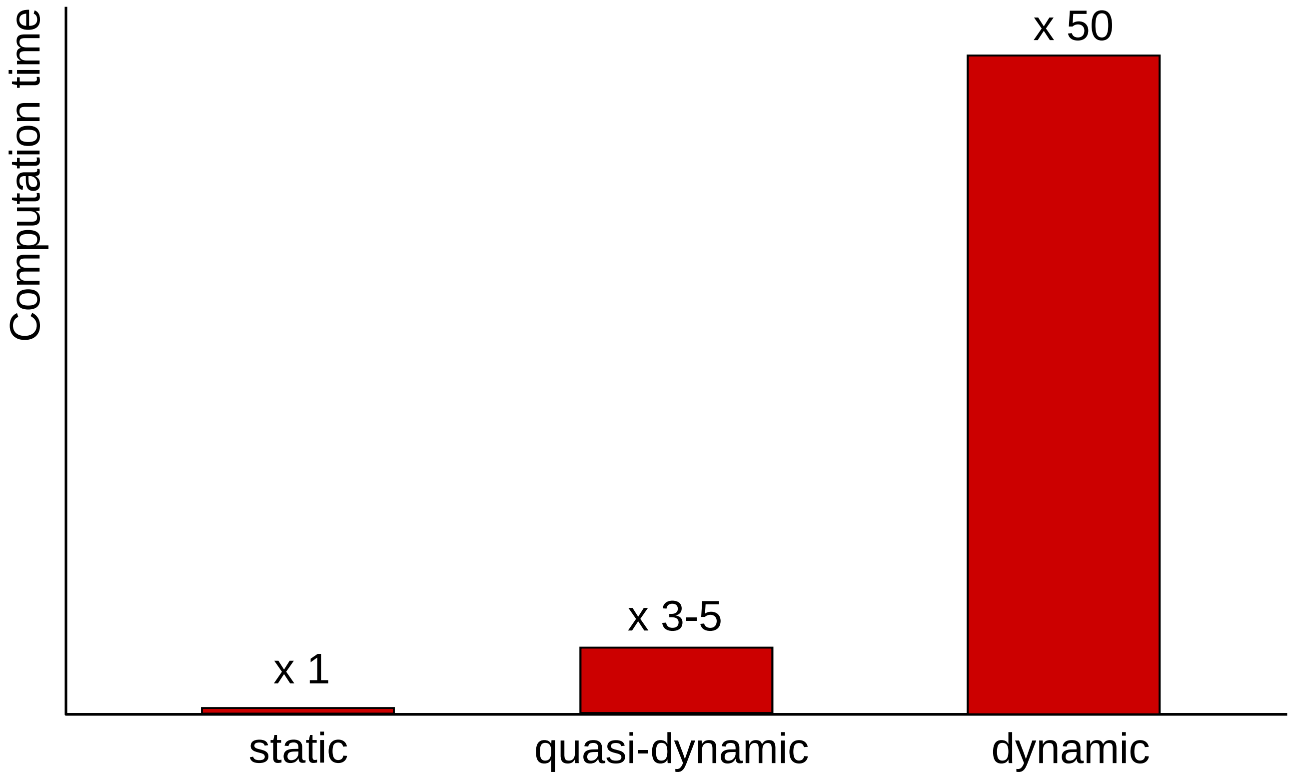
› Traditional static model:



› New quasi-dynamic model:

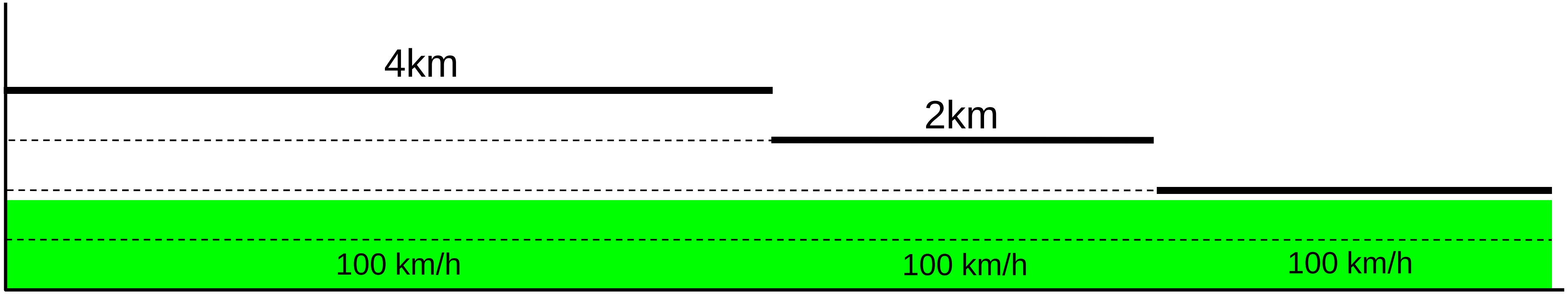


Computer run times for traffic assignment



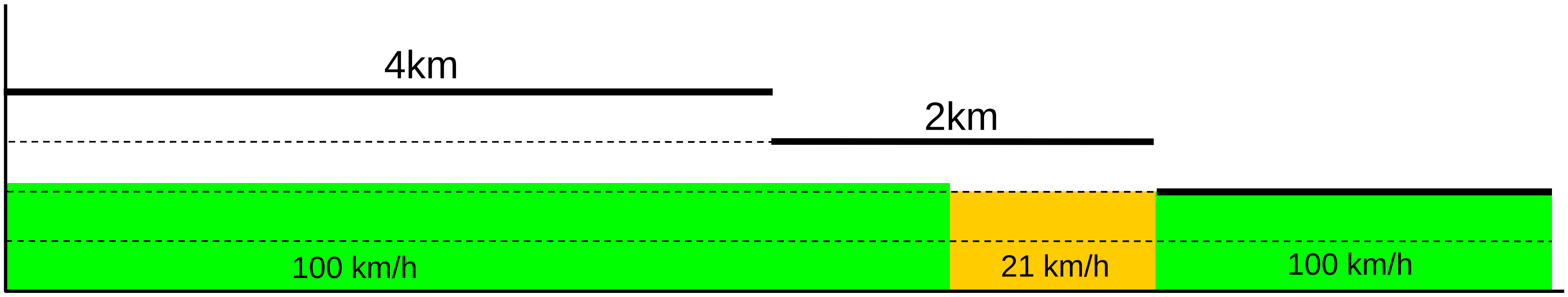
Link model

› Consider the following example with a travel demand of 3800 veh/h:



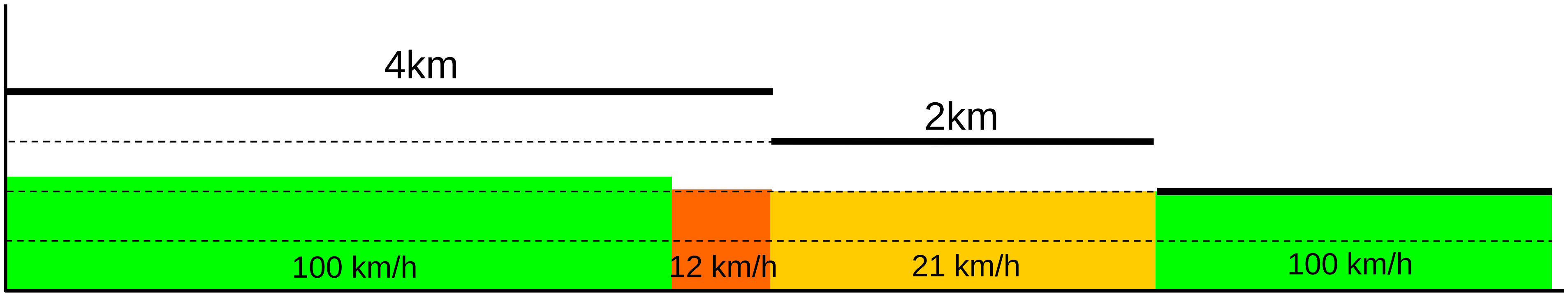
Link model

› Consider the following example with a travel demand of 4200 veh/h:



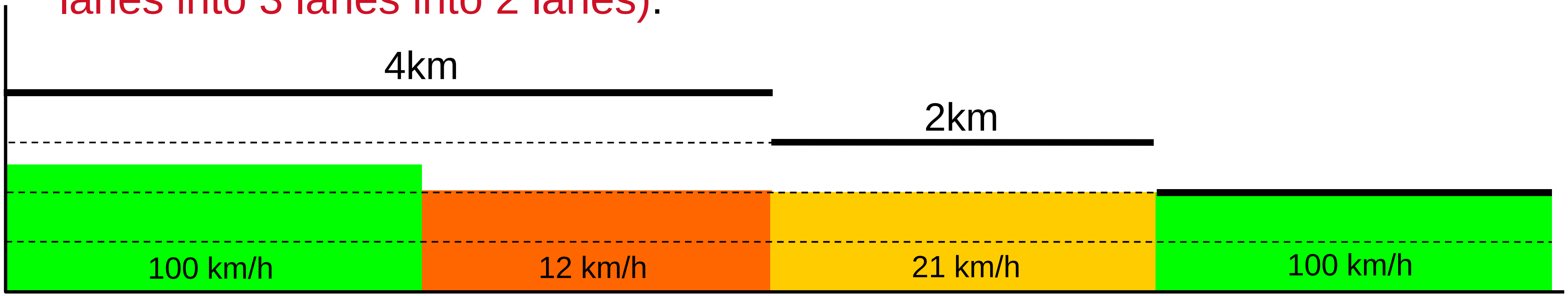
Link model

› Consider the following example with a travel demand of 4500 veh/h:



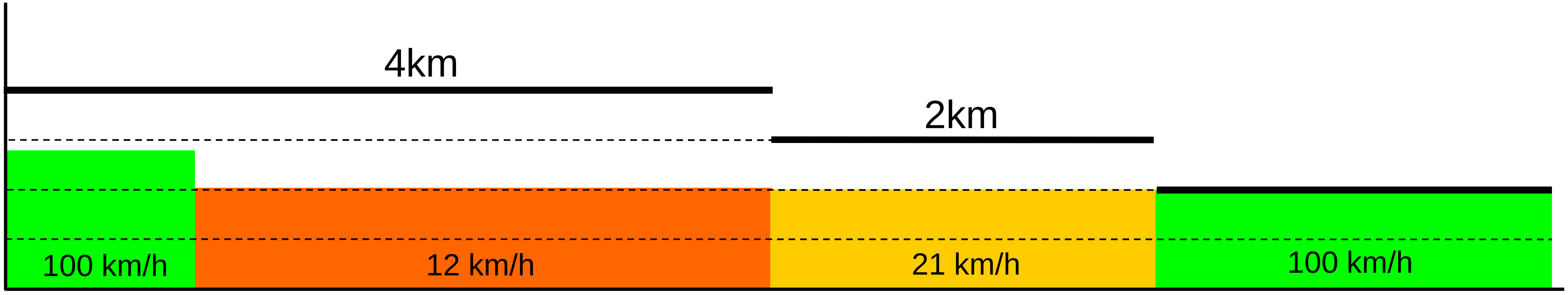
Link model

› Consider the following example with a travel demand of 5000 veh/h (4 lanes into 3 lanes into 2 lanes):



Link model

› Consider the following example with a travel demand of 5500 veh/h:



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CRITICAL ASSESSMENT - SUMMARY

	static	quasi-dyn.	dynamic		
Property	macro	macro	macro	meso	micro
Realistic results	--	+	++	++	++
- stochastic route-choice	-	+	+	+	+
- multiple vehicle types	+	+	+	++	++
- multiple user classes	+	+	+	++	++
- strict capacity constrained	--	++	++	++	++
- queue spillback	--	+	++	++	++
- realistic link model	--	+	++	++	++
- realistic node model	--	+	+	++	++
Robust results	++	++	+	+	-
- stable outcomes	++	++	+	+	-
Consistent results	--	+	++	++	++
- consistent with dynamic model	--	+	++	++	++
Accountable results	++	++	+	+	-
- convergence to equilibrium	++	+	+	+	-
- existence and uniqueness	++	++	-	-	--
- low model complexity	++	+	-	-	--
Ease of use	+	++	-	-	--
- short run times	++	+	-	-	--
- little input required	++	++	-	-	--
- easy of calibration	+	++	-	-	--

Some conclusions on traffic models and assignment

- The novel static/quasi-dynamic traffic assignment model has many advantages over traditional static traffic assignment models:
  - More realistic delays and travel times
  - Correct predictions of bottleneck locations and queues
  - Traffic flows are capacity-constrained, such that calibration towards link counts makes sense
  - Model outcomes are consistent with dynamic (micro and meso-level) models
- The new assignment technique takes approximately 3x more CPU time than traditional static traffic assignment
  - **although when one allows for all the extra runs to try to see what may be wrong with output of static assignment, then the CPU time becomes very attractive!**
- Only infrastructure characteristics (i.e., maximum speed, capacity, number of lanes) are input, no more need for volume-delay or speed-flow curves! (just like dynamic model)
- **ITLS staff research: Bliemer MCJ, Raadsen MPH, Smits E, Zhou B and Bell MGH** 2014 'Quasi-dynamic traffic assignment with residual point queues incorporating a first order node model', *Transportation Research Part B: Methodological*, vol.68, pp. 363-84.

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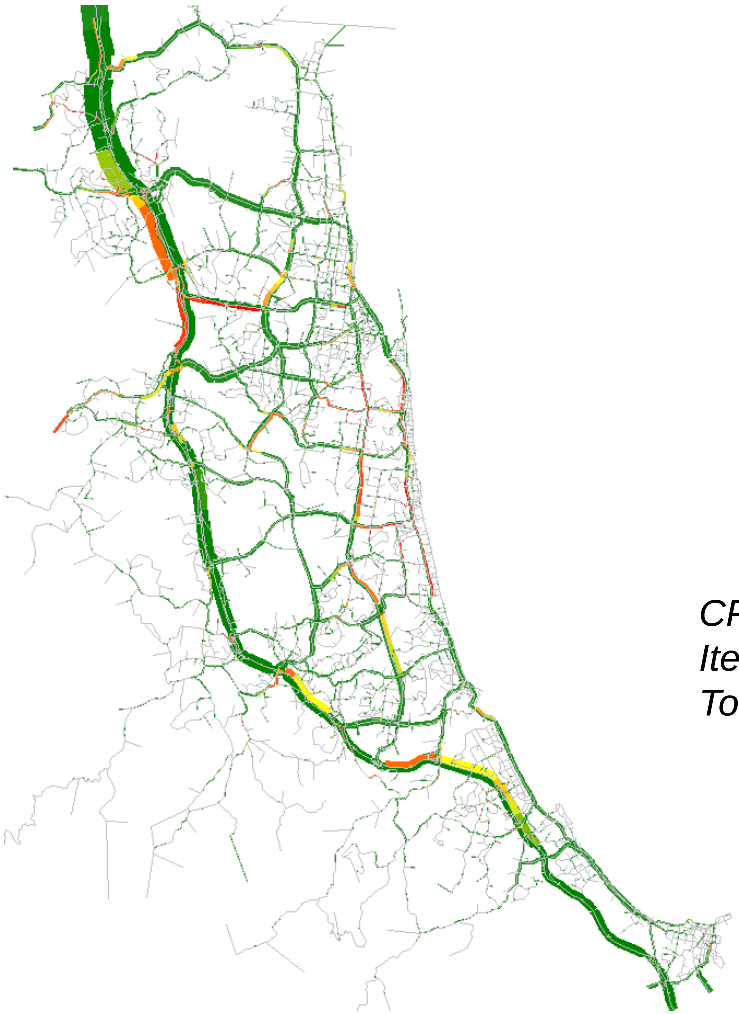
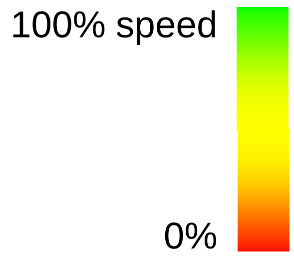
Tolled Roads – A Separate Issue but is the problem linked to the wrong traffic assignment tools?

› Issues that are often Raised

- Massive forecast errors in traffic (CAN BE EXPLAINED)
  - OPTIMISM BIAS
  - STRATEGIC MISREPRESENTATION
- Equity partners lost their money (TRUE BUT RISKS ARE KNOWN)
- Society is worse off (FALSE)

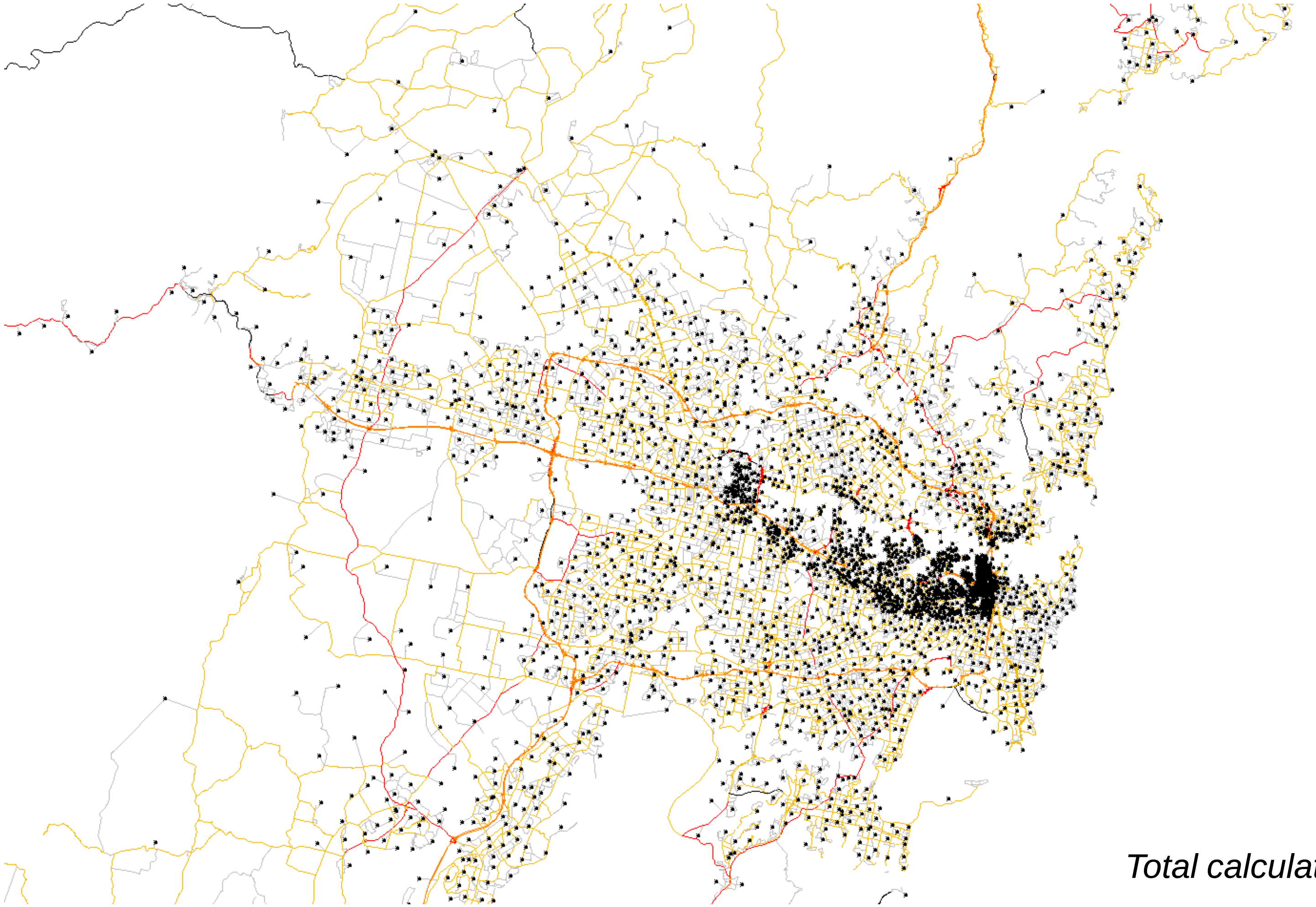
Gold Coast (1067 zones, 9565 links)





CPU time per route choice iteration: 48 sec.
Iterations needed for equilibrium: 24
Total calculation time: 19 min.

Sydney (3264 zones, 75379 links)



Total calculation time: 66 min.

Some conclusions on traffic models and assignment

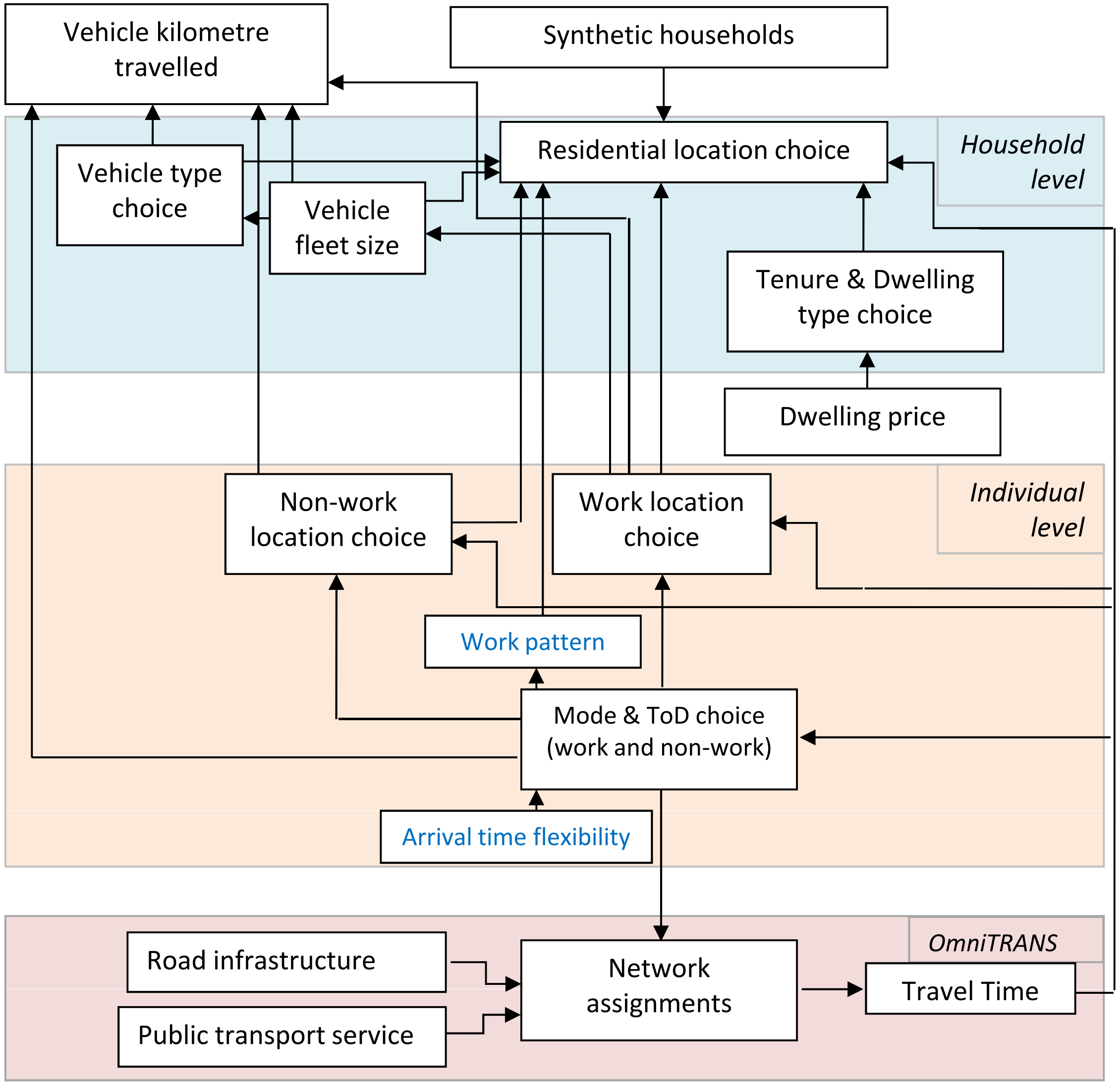
In addition to **MetroScan (ITLS product)**

- ITLS has demonstrated the feasibility of the model on large networks
- The new quasi-dynamic traffic assignment model has been implemented in

OmniTRANS Transport Planning Software

Aimsun

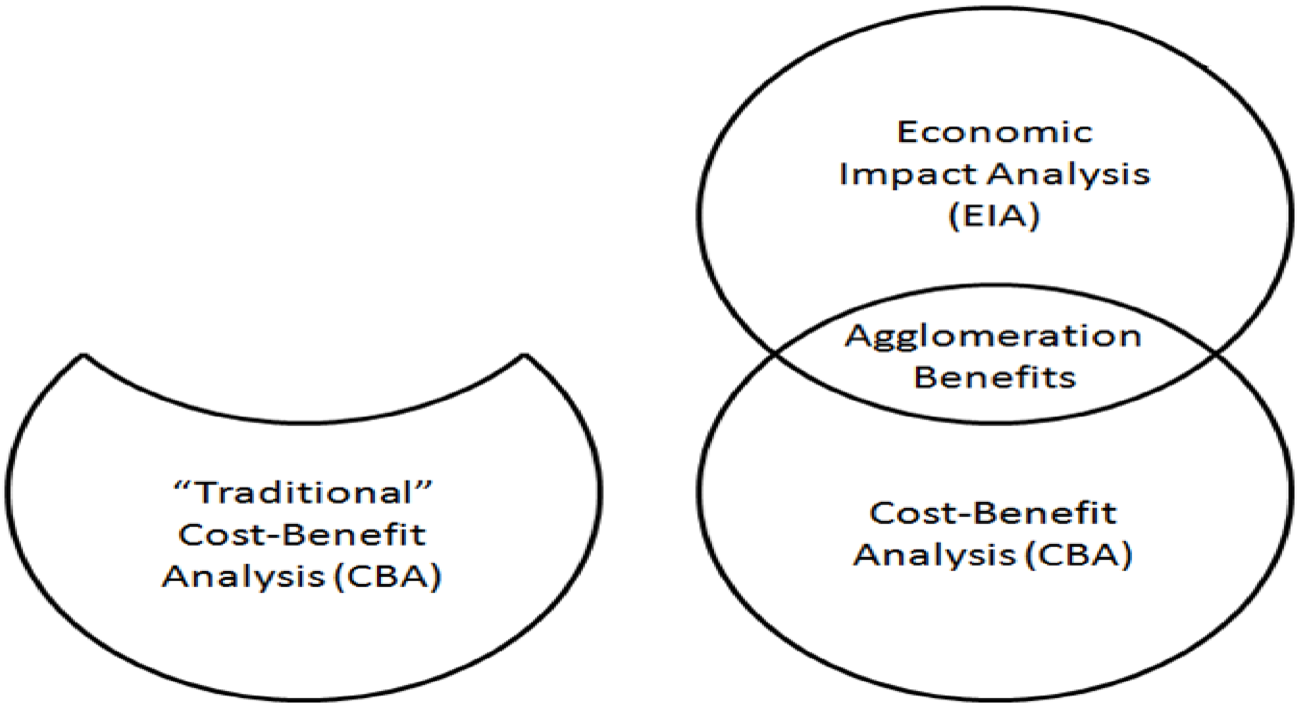
Location Feedbacks (MetroScan – New Tresis)



Wider Economic Benefits (WEBS)

WEBs are the set of welfare benefits (WBs) included in a conventional cost-benefit analysis and additional economic impacts (AEIs) (often called GDP impacts) which are outside the calculation of the conventional benefit cost ratio

Relationship of Wider Economy Impacts to "Traditional" Cost-Benefit Analysis



Defining Wider Economic Benefits

Traditional User Benefit

- Travel time
- Operating cost & tolls

Expanded User Benefit

- Safety
- Reliability & Logistics
- Cross-modal

Wider Transport Benefits

- Accessibility
- Mobility
- Connectivity
- Social inclusion

Wider Economic Benefits

- Productivity from wider market access: agglomeration & scale

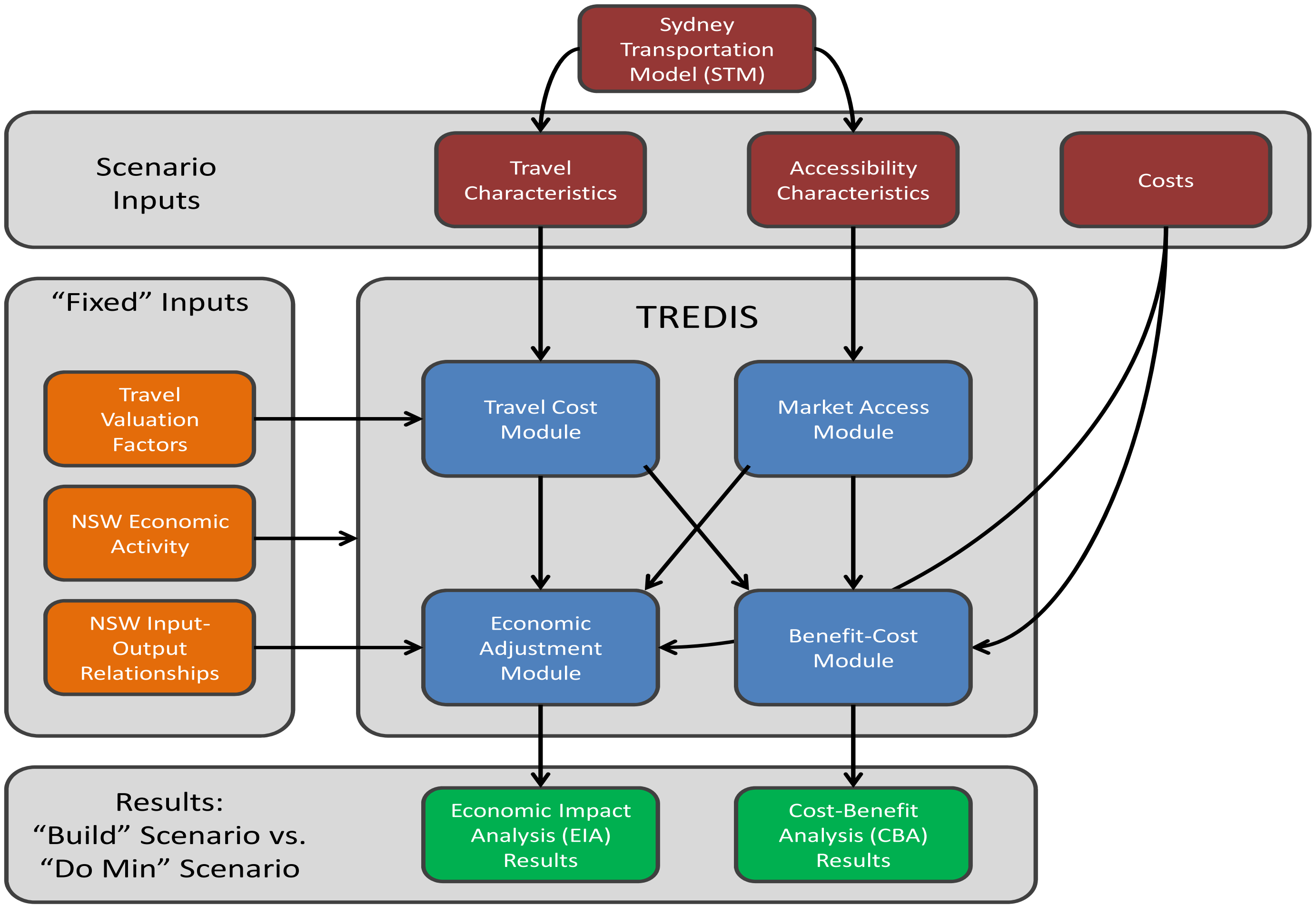
Local Effects

- Economic Multiplier Effects
- Relocation of industry & jobs

Transport Decision-making

- Public Policy Development
- Vision & Strategic Plans
- Project Prioritization & Selection
- Alternatives Analysis & EIS
- Funding Justification
- Grant Applications

Overview of Method Used to Estimate Benefits and Impacts of NSW Rail Investment Options (ITLS-ERDG project 2013)



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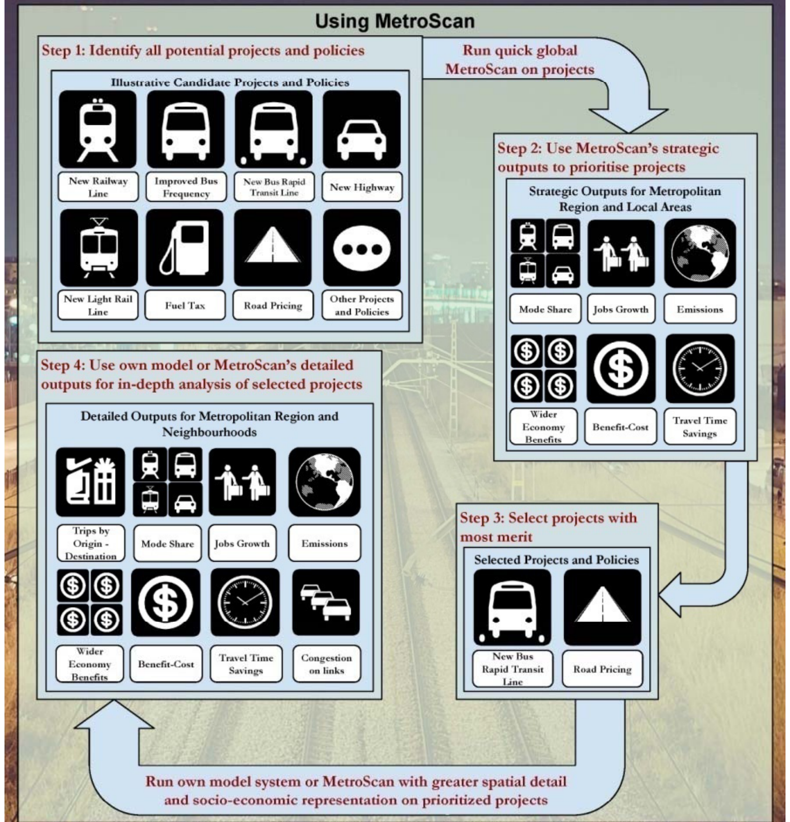

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Economic Development Research Group
www.edrgroup.com

MetroScan-TI Outputs

Economic Impacts

- Jobs and income
- Industry sales
- Freight impacts

Benefits & Costs

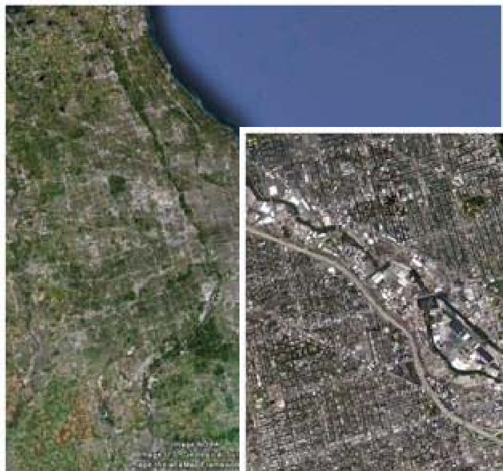
- Multiple measures
- Multiple viewpoints

Finance

- Fiscal Impact: generation of tax revenues
- Public-private revenues & costs (PPP)

Importance of Spatial Scale

Needs and Economic Consequences differ depending on the scale and region being considered

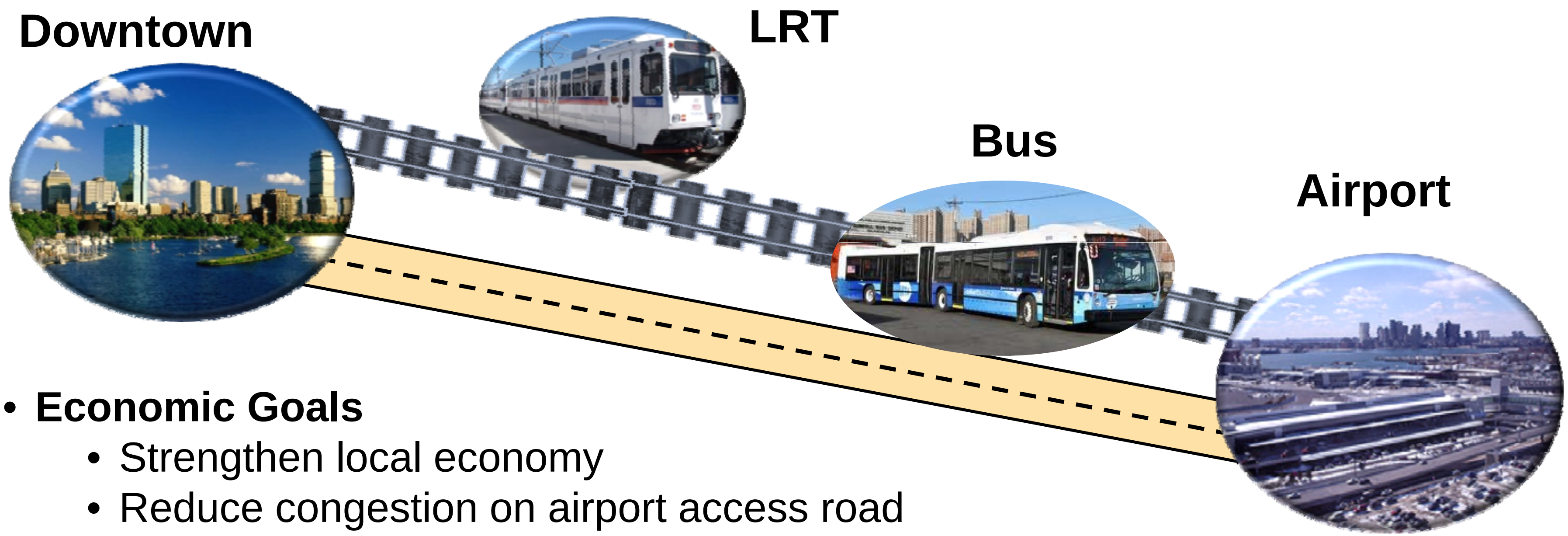

National industries

Regional business clusters

Metropolitan labor markets

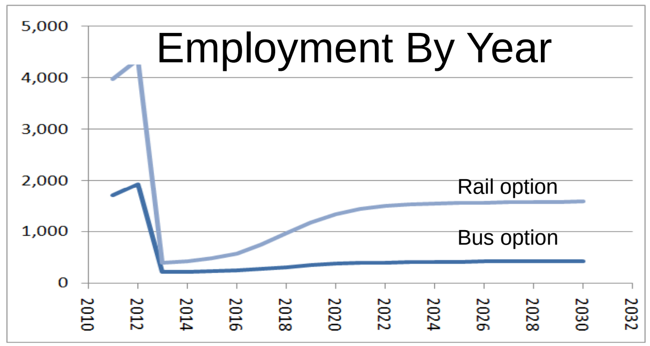
Neighbourhood land/housing markets

Hwy or transit link performance



- **Economic Goals**
  - Strengthen local economy
  - Reduce congestion on airport access road
  - Enhance speed & reliability of travel time between airport & downtown

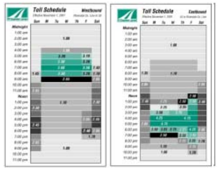
- **Project Alternatives – Rail vs. Bus**
  - Transit Link to Airport
  - Park and Ride Lot
  - Express service



Economic Benefit Accounting

Present Value of Benefit Stream ($m 2011 Const dollars)								
Mode	(A) Traveller Benefits ($)		(B) Traveller Benefits (non-$)			(C) Shipper/ Logistics Cost ($)	(D) Business Productivity ($)	(E) Social/ Environ. (non-$)
	Vehicle Operating Costs	Business Time & Reliability Costs	Value of Personal Time & Reliability	Safety Cost	Additional Consumer Benefit			
Pass Car - Business	116.2	23.5	0.0	12.5	0.0	0.0	--	--
Pass Car - Commute	184.4	0.0	13.9	37.3	0.0	0.0	--	--
Truck - Freight - Business	477.8	50.8	0.0	3.2	0.0	78.5	--	--
Pass Bus - Commute	4.7	0.0	3.8	0.0	0.0	0.0	--	--
Pass Rail - Commute	0.0	0.0	14.7	0.0	0.0	0.0	--	--
Air - Freight - Business	2.7	0.6	0.0	0.0	0.0	9.8	--	--
Pass Air - Personal	7.0	0.0	32.3	0.0	0.0	0.0	--	--
Project Totals	**9.28**	**74.3**	**64.4**	**53.0**	**0.0**	**88.3**	**69.3**	**38.2**

Present Value of Cost Stream ($m 2011 Const dollars)				
Facility Type	Startup Costs	Annual O&M Costs	Residual Value	Net Total Costs
Road	49.3	0.0	0.0	49.3
Rail	197.1	169.4	0.0	366.5
Air	0.0	0.0	0.0	0.0
Marine	0.0	0.0	0.0	0.0
Total for All Facilities	**246.4**	**169.4**	**0.0**	**415.8**



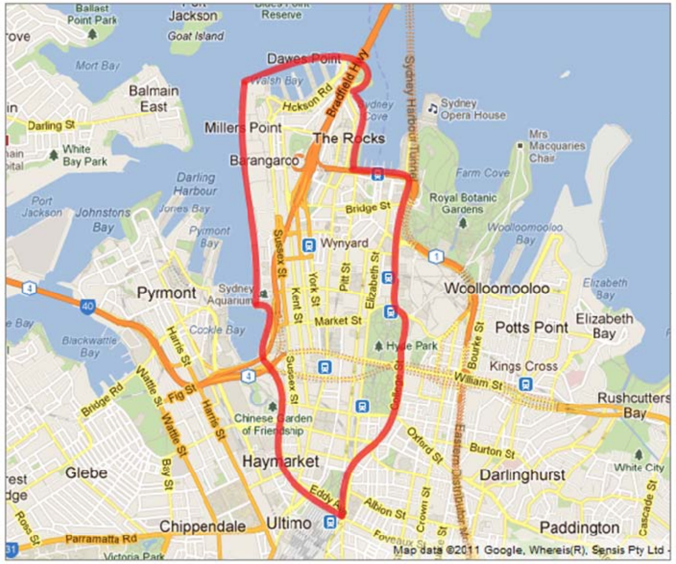
Pricing Reform

What Type of Road Pricing Scheme might appeal to Voters and Decision Makers?

Gaining the citizen vote by staging reform

Proposed Cordon Charge Area In Sydney CBD

Taxis, and residents living inside the cordon zone would be exempt from the cordon charge.



'paying for what you do and not what you own'

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However

To Make PT more Attractive Requires

(at least) making the Car Much Less

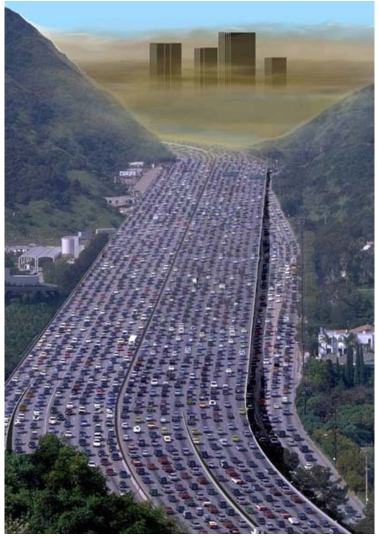
Attractive

SO ACT NOW

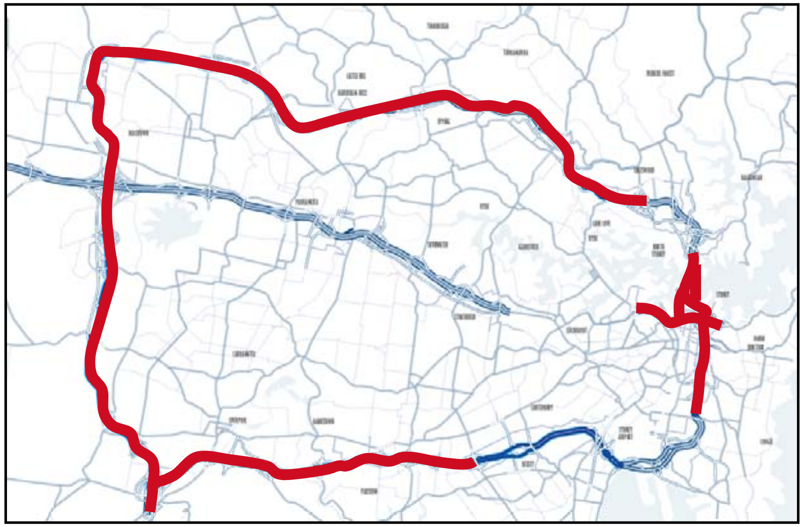
Road Pricing Reform is Needed

What we all know

- Road pricing reform is needed, because just investing in more roads is too costly, too unliveable, too polluting
- Road pricing reform is an emotional topic
- Road pricing reform is a political problem
- Road pricing reform requires strong leaders



What we currently pay (average per car per year)



› NSW – for using the roads
  - Annual registration fee (approx. $300)
  - Road tolls (approx. $220)

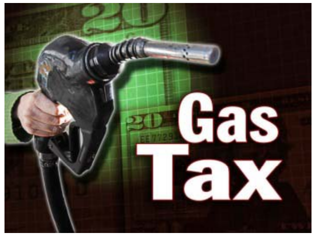
› Commonwealth – for driving
  - Fuel excise tax (approx. $720)

› My observations:
  - Annual registration fee is low (in global comparison)
  - Fixed registration fee is unfair to people who drive little
  - Toll system is unfair to people who live close to toll roads

Many different strategies

› Annual registration fee

› Toll roads



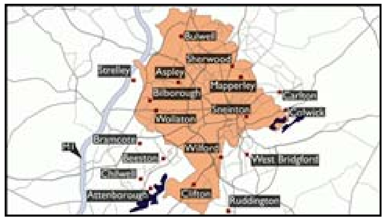
› Fuel excise tax

› Cordon charges

› Accessibility pricing

› Peak avoidance

› Kilometre pricing



› Workplace parking levy

Main objectives of road pricing reforms

1. Finance maintenance of current infrastructure
2. Increase revenues for new infrastructure
3. Increase efficiency of current infrastructure
4. Decrease externalities (e.g., emissions)

What are the key Road Blocks?

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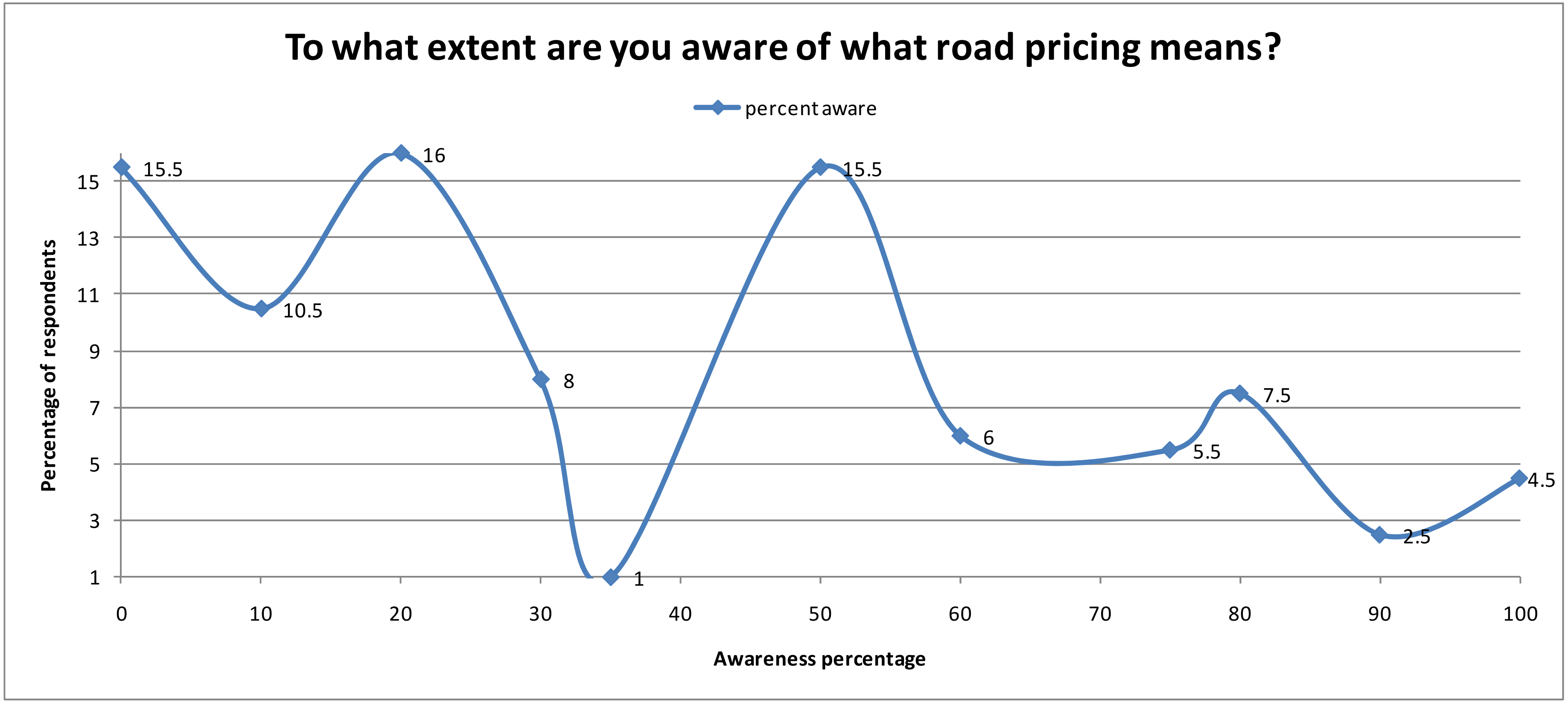
A typical political response

- “We will not introduce a congestion tax for motorists … due to the lacklustre standard of the state’s public transport system. …The Minister … has ruled out imposing a tax on motorists entering the CBD similar to a system used in London.

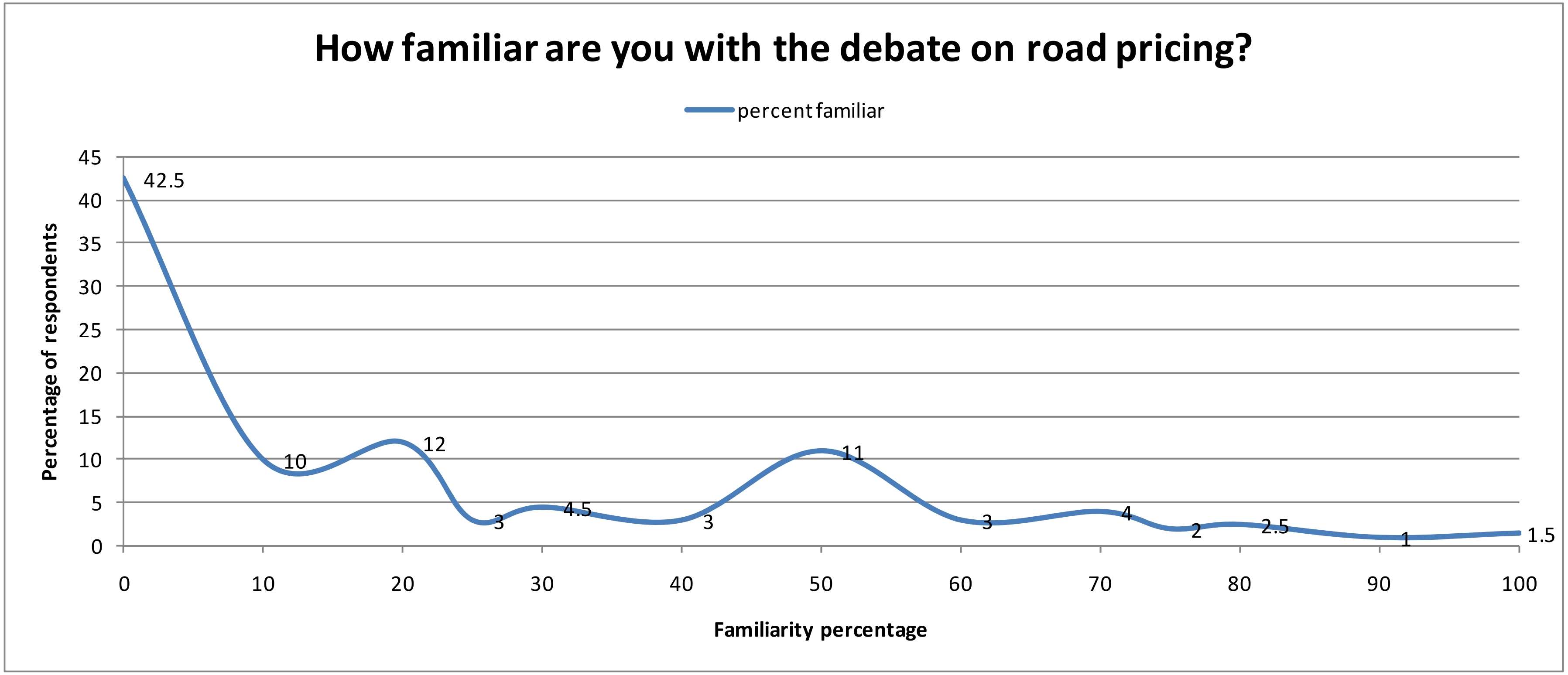
- **There cannot be a congestion toll if there is no public transport**, and the one thing that [we] … have not got is proper public transport,” he says.

(Comment- PT tends to be defined as rail)

Citizen Awareness of Road Pricing Profile



Citizen familiarity with the debate on road pricing



What is Real Road Pricing Reform?

- It MUST involve **dropping some charges** as we add in some new congestion-related charges,
- **AND**
- **importantly** showing how the revenue raised is put back to **useful causes** that can/will be supported by society.

- It is possible to design a system in which many users of the roads are financially **better of** with a congestion charge (and even an emissions-related charge)

- where the cost of using the roads is lower when congestion is absent and vehicles are environmentally cleaner, w**hich will also ensure govt. gets its needed revenue**

How can we start the reform journey for the entire network?

Beginning the Sell: Registration-Usage Pricing Reform Proposal

› **Simple Rule:** begin with what is in place at present and see how that might be modified in line with a longer term objective.

› What if we can modify **the current registration fee** to signal real opportunities for individuals to reduce their road use charges?

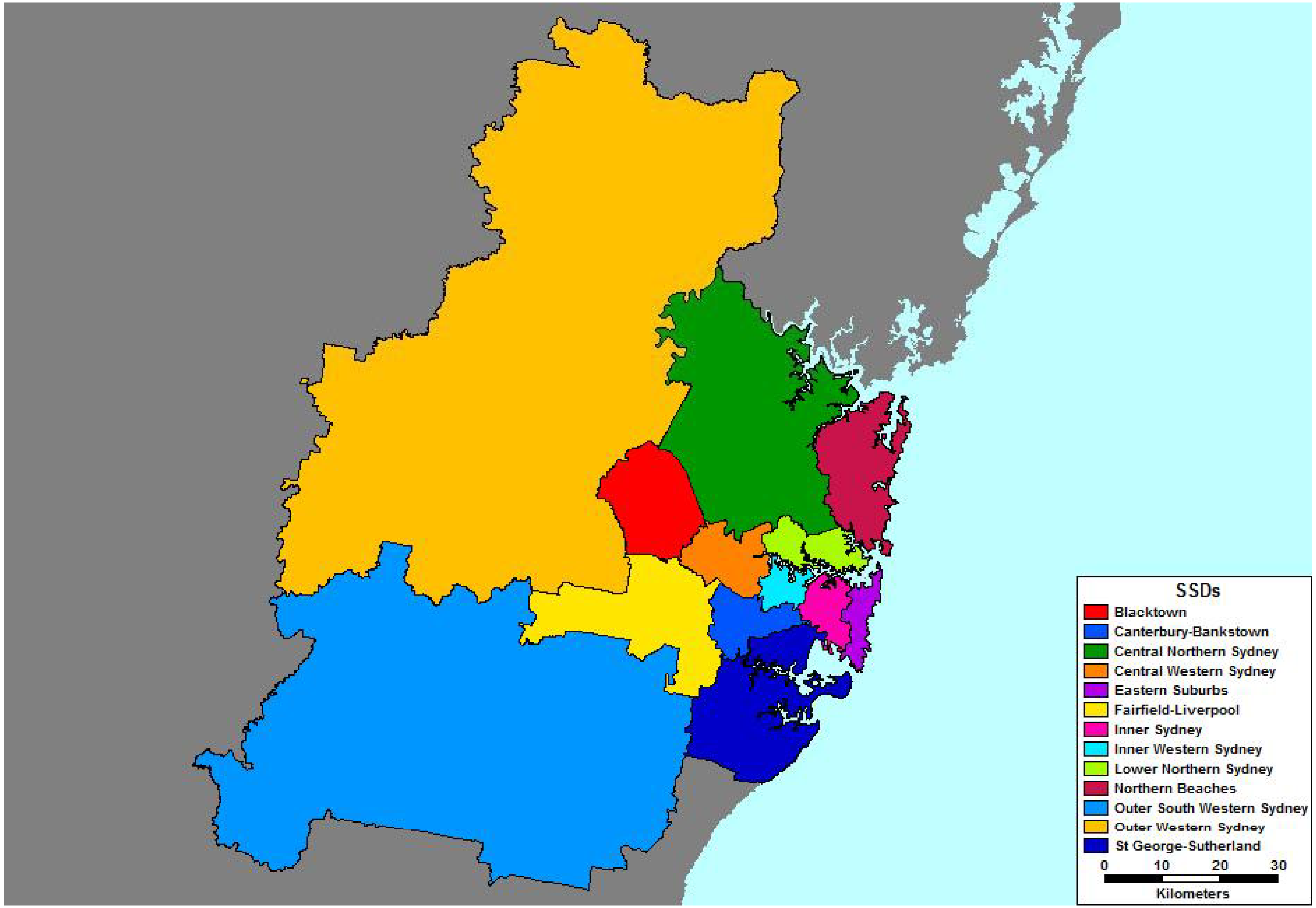
Registration-Usage Pricing Reform

- Start targeting the ***specific*** peak vs. off peak kilometres
- Begin by assuming that all annual kms are peak kms.
- If the driver wants to have a subset of kms recognised as off peak kms, they must purchase an on-board vehicle meter box (OBVMB) that will record the kms by time of day.
- **The off peak kms are not charged**, but peak kms will be charged at either an agreed cents/km. or a fixed peak surcharge for bands of annual peak kms

Registration-Usage Pricing Reform

- The challenge is to identify an appropriate adjustment quantum in the annual registration fee.
- **Full Reform Plan:**
  - **Adopt a simple discount rule** e.g., a flat reduction in the regn fee (e.g., 60%) linked to the acquisition of the OBVMB
  - A distance-based **charge per peak km**
- **With the condition that:**
  - **Treasury is no worse off and**
  - **Drivers in total outlay less money**

SSD's in SMA

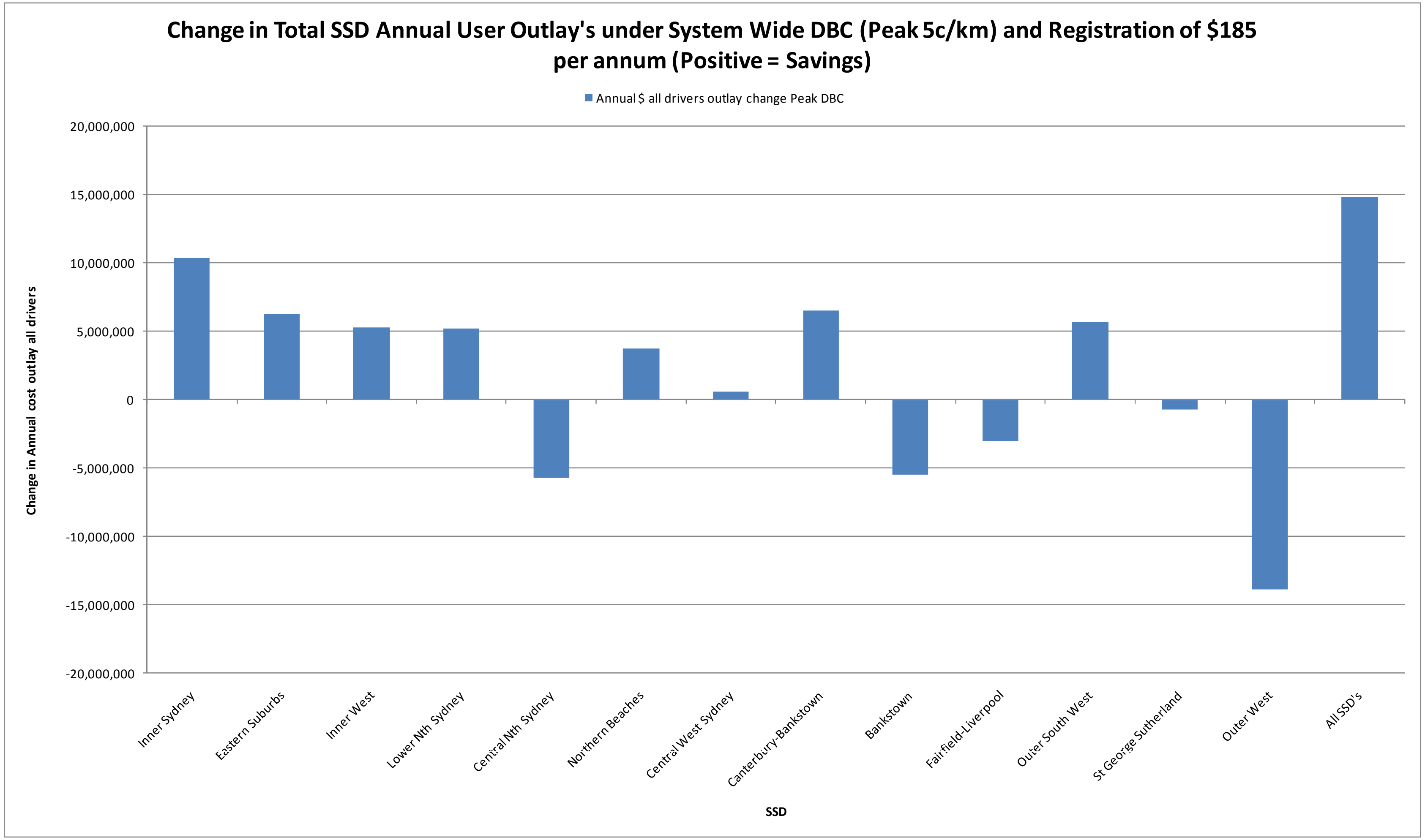

SSDs
Blacktown
Canterbury-Bankstown
Central Northern Sydney
Central Western Sydney
Eastern Suburbs
Fairfield-Liverpool
Inner Sydney
Inner Western Sydney
Lower Northern Sydney
Northern Beaches
Outer South Western Sydney
Outer Western Sydney
St George-Sutherland
0 10 20 30
Kilometers

Identifying a DBC and Discounted Registration Fee that makes Motorists and Treasury Financially No worse off

		ALL SSDs				
		Positive = gain, negative = loss				
		Car driver	Treasury	change in peak km	change in off-peak km	change in total km
Regn fees halved and DBC for peak kms only C/km	2	130	-113	-102	0	-102
	3	88	-64	-154	0	-154
	4	48	-16	-205	0	-205
	5	**9**	**32**	-256	0	-256
	6	-29	78	-307	0	-307
	7	-66	123	-358	0	-358
	8	-102	167	-409	0	-409
	9	-137	210	-461	0	-461
	10	-171	252	-512	0	-512

Hensher, D.A. and Mulley, C. Cost Impacts of Motorists Discounted Registration Fees in the Presence of Distance-based Charges and Implications for Government Revenue, fully drafted 27 September 2012.

Cost Implications for Drivers



Education

Gaining the Necessary Skills: How academia can contribute

Traffic, Transport and Land Use is a good start

› **Partnerships**

- ITLS and the RTA Jointly designed (Paul Forward) ACTTM and Grad CTM articulating to MTM
- Continuing to this day but numbers and quality are declining

› **Briefing sessions**

  - Research Dissemination Program with TfNSW (monthly seminar sessions)

What we Offer at University of Sydney

ITLS Graduate Program

Logistics & Supply Chain Management	Quantitative logistics & transport
	Foundations of supply chain management
	Supply chain planning systems
	Warehouse & inventory management
	Contemporary procurement
	Value chain costing
	Green operations & reverse logistics
	Disaster relief operations
	Global value chain networks
Aviation & Maritime Manager	Airline strategy & supply chains
	Airport management
	Global freight logistics management
	Maritime management & logistics
	Ports management
	Cases in global transport & logistics

Transport & Infrastructure Management	Transport & infrastructure foundations
	Infrastructure appraisal
	Sustainable transport policy
	Strategic transport planning
	GIS for transport & logistics
	Traffic & mobility management
	Public transport
	Decision making on mega projects
	Infrastructure financing
	Infrastructure management case studies
	Transport & infrastructure systems

A Final word on the Academy in General and ITLS in Particular

- "The Key Centre is now well placed to be a major player nationally and globally in providing an intellectual overlay to the debate on societal priorities that can guide the future prosperity and well being of societies. While we see our broad role as engaging at all levels of inquiry, be they the very practical studies to assist government and industry, be it at the strategic, tactical or operations levels, we must not lose sight of our more pure academic ideals of informing the debate in ways that are not constrained by political or commercial interest. This is often a delicate balance, but if we are to make a difference then our role must be one of moving the boundary of debate and decision making rather than reinforcing prejudices and biases that so often result in decisions that are not in the long term interest of a society that we so aspire to be part of."
- Extract of David Hensher's Directors Report for the ITLS Annual Report:
- http://sydney.edu.au/business/itls/news_and_events/news/2014/key_centre_2013_annual_report_now_available

ITLS Video on graduate program

Challenges: What are some key Road Blocks?

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› Challenge #1:

Will we ever be able to attract enough car users out of their cars by any amount of injection of investment into public transport (PT) to relieve congestion on our roads?

› Challenge #2:

If yes to Challenge #1, what sort of infrastructure investment will make a difference?

- Hint: Many large cities are a City of Cities with a complex network that is crying out for connectivity, coverage, frequency and visibility

› Challenge #3:

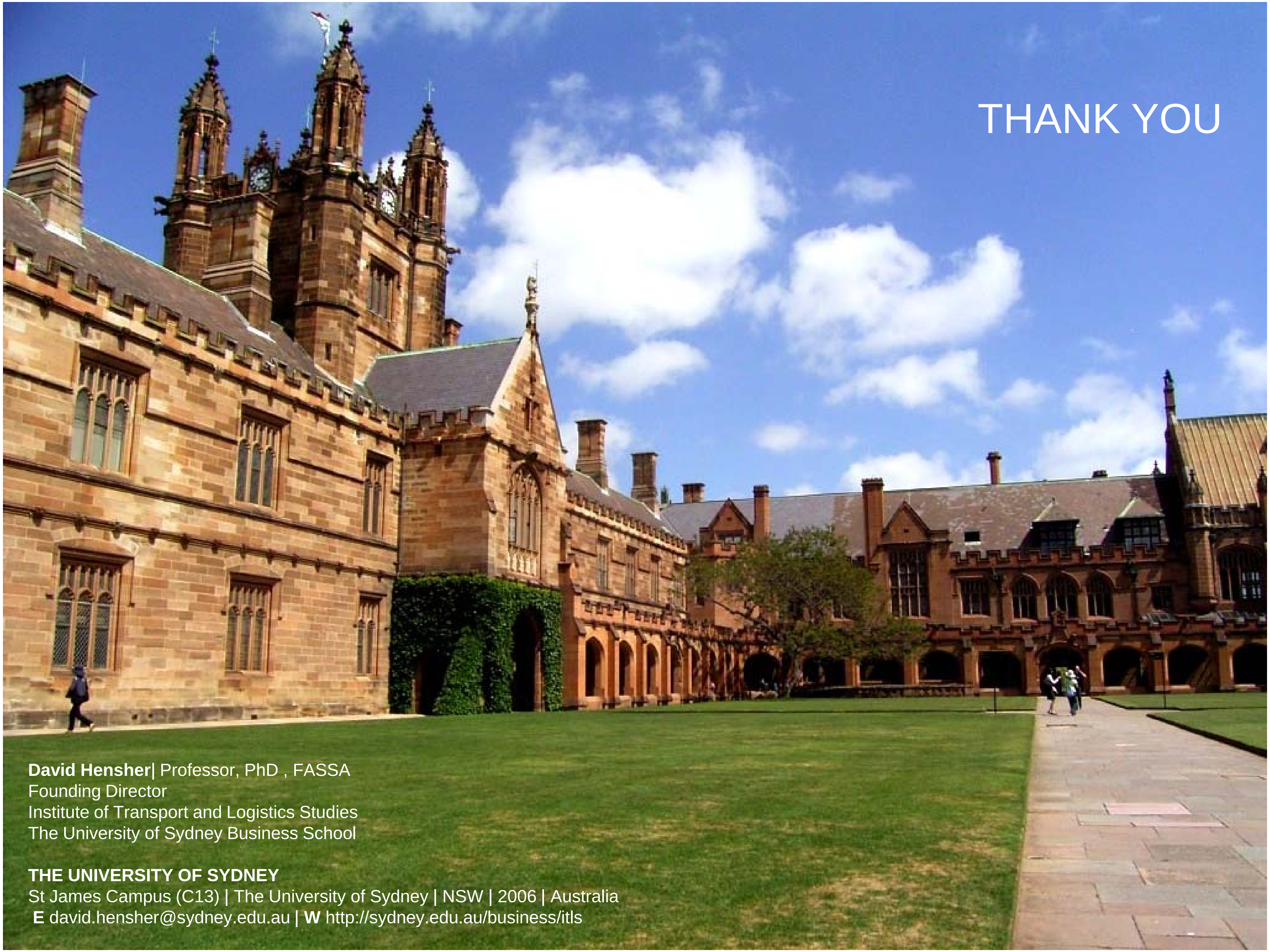
What role should a revamp of the price for using the car play in a (traffic) congestion-relieved future?

- Can we really expect to reduce traffic congestion by investing in PT without a serious reform to road pricing (and I do not mean simply congestion charging)?

›Challenge #4:

What we need to do in sorting out the pricing challenge is to undertake a complete overhaul of the entire charging regime.

How might we initiate this?



THANK YOU

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