

# Network Operation Planning - A new approach to managing congestion

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## 1 Introduction

Congestion is an unavoidable aspect of most urban cities. However, there is a level at which congestion starts to detract from liveability, increases transport costs and affects the reliability of travel for public transport and freight.

There is no single, simple solution to managing congestion. Sustainable management of congestion will require an integrated approach involving greater use of public transport and higher occupancy vehicles, farsighted land use planning, changes in behaviour by road users and businesses, and changes to how roads are managed.

Better management of the existing road network requires a new approach to network planning that ensures the most effective use is made of the limited road space available.

This paper explains the benefits of this approach, the implementation challenges, and experiences in applying the approach to Melbourne's arterial road network.

## 2 The Congestion Problem

### 2.1 What is Congestion?

There is no universally accepted measure or definition of congestion. However, it is apparent from road user surveys that travel time and travel time reliability are the most important factors in determining a road user's perception of congestion.

Typically, congestion is associated with a reduction in the normal capacity of a road due to high traffic volumes, traffic incidents, adverse weather and roadworks. This can be observed where freeways are operating at speeds less than 40km/h or where flow on arterial roads is constrained by downstream capacity. The inability of a signalized intersection to fully utilise the amount of green time allocated to a movement is often the first sign of congestion. Figure 1 illustrates how congestion can be presented on a road network.

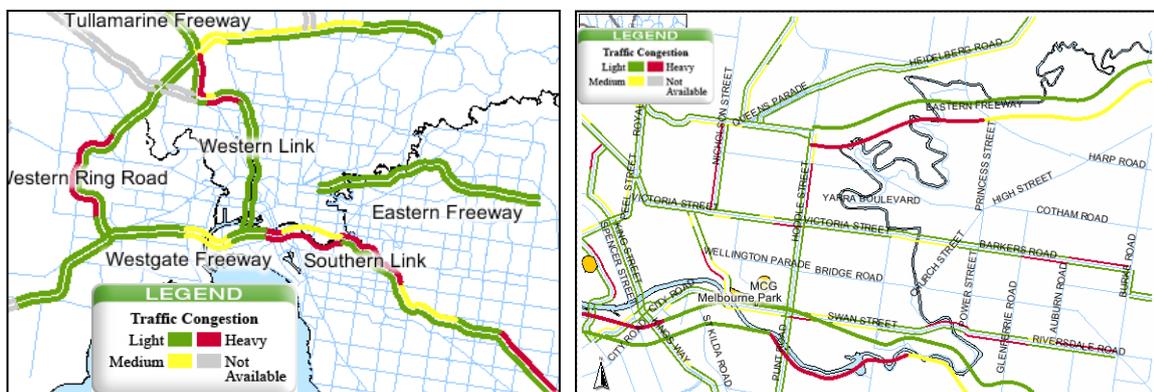


Figure 1 – Typical freeway & arterial road real-time congestion maps

Congestion can detract from the amenity of strip shopping centres, and make it more difficult to access shops and community facilities. Longer travel times also mean that the cost of transporting goods increases. The variability in travel time introduced by unusual congestion also has an impact on the reliability of travel, particularly for public transport.

## **2.2 Congestion Trends**

With Melbourne's rising population level, the demand for private vehicle usage is expected to increase. Even allowing for a doubling in public transport use over the next 10 years, car travel will be significantly higher than it is now. Freight travel is also predicted to increase, particularly in light commercial vehicles. Unconstrained growth in road travel is not sustainable. The total cost of congestion in Melbourne is estimated to be around \$3 billion, and could triple over the next 20 years.

The development of Melbourne's transport network through the last century has matched the predominantly radial nature of trips into and out of the CBD. The freeways, rail lines and tram lines generally radiate from central Melbourne. However, patterns of travel are changing across Melbourne. There are now over 12 million trips made each day in Melbourne (including walking and cycling). The majority of these trips involve travel within and between middle and outer suburbs. Managing the network with a focus on radial movements into and out of the city is no longer appropriate in all instances.

## **2.3 Tackling Congestion**

The Victorian Government's Metropolitan Transport Plan (MTP) sets out 4 strategies for managing congestion:

- Improving the reliability and flow of road-based public;
- Making existing roads operate better;
- Improving service coordination, integration and customer interface; and
- Promoting sustainable travel through better demand management.

Network Operation Planning is a process that has been developed to guide work on making existing roads operate better. This process will:

- Describe how the arterial road network is intended to operate for each transport mode for each part of the day, at both a regional and local level transport (i.e. a Network Operating Plan);
- Identify where the road network does not operate as intended; and
- Define the changes in road operation required to improve performance.

## **3 Network Operation Planning**

### **3.1 Road Use Priority**

The first stage of Network Operation Planning is to describe how the arterial road network is intended to operate for each transport mode for each part of the day. The modes considered include:

- Trams;
- Buses;
- Pedestrians;
- Bicycles; and
- General traffic (including freight).

The priorities assigned to the road network are based on the principles set out in the Metropolitan Transport Plan, which include:

- Public transport has first priority on designated routes on the Principle Public Transport Network (PPTN);
- Freight has unrestricted access across the arterial network;
- Preferred traffic routes will be developed to avoid significant conflicts with abutting land use;
- Improving traffic flow in and around activity centres; and
- Promoting non-motorised forms of transport.

In determining priorities, consideration also needs to be given to the demand for travel across a network. This information is available from the Australian Bureau of Statistics Journey-To-Work data. At a municipal level, this data provides a good contextual background for the development of modal priorities. Figure 2 shows a typical travel demand diagram across a local government area. This type of diagram can illustrate the level of through travel demand, demand into the municipality and demand within the municipality. In this example there is a high east-west travel demand through the area and strong demands into the municipality from the north and east.

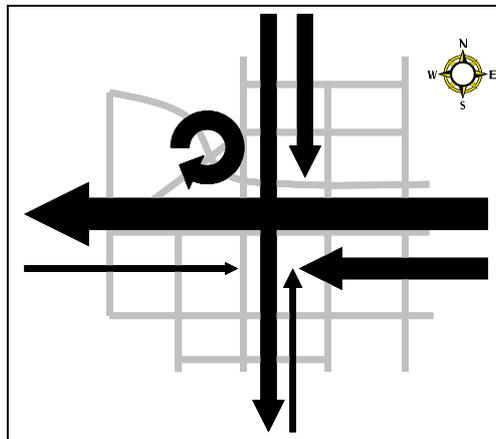


Figure 2 – Typical peak period travel demand

The application of the Metropolitan Transport Plan principles involves the consideration of a large array of data, including travel demand, freight movement, activity centres, abutting land use, public and transport services. The result is a plan showing which transport modes have priority on what roads. Figure 3 shows how a road use priority map can look across a municipality.



Figure 3 – Typical road use priority map

Another key variable in the management of congestion is time-of-day. While a base modal priority can be assigned to each road, this can change for different periods of the day depending on travel demand and abutting land use. In addition, priority is often directional, particularly for morning and afternoon peak periods. As such, road use priority maps are developed separately for each of the following periods:

- AM peak (typically 6.30am to 9.30am);
- High off-peak (typically 10am to 3pm);
- PM peak (typically 4pm to 7pm); and
- Off peak (typically 7pm to 6am).

These maps will usually also indicate a priority direction for the priority mode on each road section.

Road use priority maps form the basis for the overall network operating plan. As such, it is important that the development of these plans be done in consultation with major stakeholders.

### 3.2 Performance Gaps

The next stage of the network operations planning process is to identify where the road network does not operate as intended for each mode and route.

Operational performance is typically derived from travel time. For most of Melbourne's freeway network data is available from vehicle detectors, which enables a quite detailed gap analysis to be undertaken.

The performance of Melbourne's arterial road network can be determined in a similar manner through the use of vehicle detectors present at around 2,500 signalised intersections across the metropolitan area. The data collected in real-time from these detectors can provide a useful network picture of arterial performance.

Data relating to the performance of specific transport modes is not as comprehensive. Good information exists for trams, which is proposed to be extended to the bus system. At this stage data for freight, bicycles and pedestrians is very limited.

The gaps in performance can then be overlaid on the modal priorities to highlight where priority may be adversely impacted (refer figure 4).



Figure 4 – Performance gaps overlaid on road use priorities

### 3.3 Operational Changes

The matching of the performance gaps against the mode priorities, as shown in figure 4, can be used to identify the sections of the road network that need to be addressed to improve the operation of the priority mode. These road sections then become the primary sites for implementing improvements to operation.

The range of operational tools available to improve performance include the:

- control of access onto the road network from abutting land;
- allocation of road space through:
  - management of traffic lanes, and
  - management of parking
- operation of traffic signals and the use of other intelligent transport systems;
- incident, roadworks and event management; and
- information provided to road users to make better decisions on mode, time and route choice.

### 3.4 Implementation Challenges

Network operation planning fits within a broader process that can be illustrated in Figure 5.

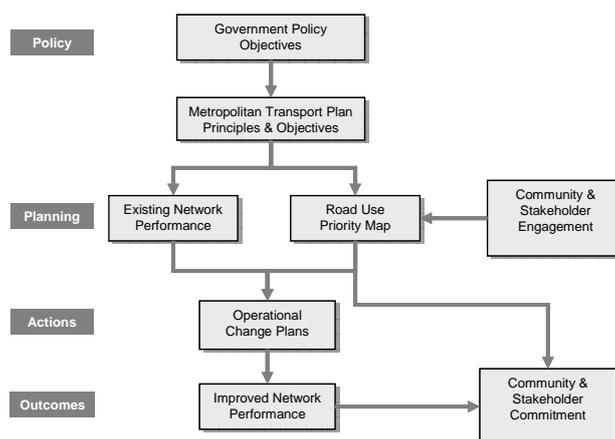


Figure 5 – Implementation process

There has been limited success around the world with the implementation of planning frameworks to manage congestion. This may be due to a number of factors. Network operations is still a new concept both within road agencies and externally. Road agencies have been slow to throw off the road building culture or take a more strategic approach to managing road networks rather than individual sites.

There are few road agencies that have responsibility for both freeways and arterial roads for a network as large as Melbourne's. Usually this responsibility is split between different levels of government as in the United Kingdom. Melbourne also has one of the largest centrally managed adaptive traffic signal systems. These factors put Melbourne in a relatively unique position in which to successfully implement a better approach to managing congestion.

There are significant challenges around gaining community and stakeholder acceptance to the process, and in realigning organisational culture towards network operations. Some of VicRoads experiences, over the last year, with implementing this new approach to managing congestion are discussed in the following section.

## **4 Experiences with Implementation**

### **4.1 Top-Down or Bottom-Up?**

The initial planning work followed traditional approaches to the setting of functional road hierarchies. While this approach was intuitive and logical to the planners involved, explaining the concept and its' application to others proved to be challenging. This was primarily due to the size of the Melbourne metropolitan road network and the subtle differences between a road use hierarchy and a functional hierarchy. There was also a view that roads could be managed to address all needs.

An alternative approach was then developed, based on planning at a municipal level, which would then be aggregated to form the plan across the whole metropolitan area. This bottom-up approach presented many advantages over the top-down approach, including:

- The direct application of the Metropolitan Transport Plan principles can be shown at a local level;
- Many key stakeholder groups are based around municipal boundaries;
- Implementation can be prioritised along municipal lines; and
- Implementation can be tested at a municipal level rather than waiting until planning for the whole of Melbourne is completed.

The major disadvantage of the bottom-up approach is the potential for inconsistencies at municipal boundaries. However, as explained further on in this paper, the inclusion of overlap in the development of each municipal plan, and the inherent repeatability of the process, mitigates this problem.

### **4.2 Public Transport**

The Metropolitan Transport Plan (MTP) sets out a clear direction for public transport priority across the road network. This is based on the premise that sustainable management of congestion can only occur if the ever-increasing demand for travel can be accommodated at a much higher vehicle occupancy rate than the currently 1.2 persons per vehicle.

The capacity of the current transport network to cater for increases in trips is limited for rail and tram without large capital investment. The radial nature of the fixed rail infrastructure also limits the potential to cater for the faster growing travel demand within and between adjacent municipalities. Conversely, the road network presents a vast, relatively untapped resource for public transport and higher-occupancy, more sustainable travel.

Much of the transport debate over recent years has focussed on public transport versus roads. The debate, either consciously or unconsciously, has devalued the contribution that on-road public transport plays.

### **4.3 Organisational culture and external perceptions**

Most road authorities were born out of the need to build new road infrastructure to meet the demands resulting from the post-war industrial and resources booms of the 1950s and 1960s. Building roads remained a strong focus right through to the 1990s. During the 1990s, asset management emerged as a concept to ensure that adequate attention was given to maintaining the road asset in a safe and efficient manner.

During the last 5 years, there has been a growing understanding that cities cannot continue to build their way out of congestion. There is limited land available in inner and middle

suburbs for transport infrastructure, and together with the sustainability challenges resulting from climate change and a desire to improve the liveability of cities, road authorities are re-directing their attention to better managing the assets that already exist.

Network operations is the emerging new urban transport discipline that road authorities need to embrace to meet this challenge over the next decade. Initially, discussions with stakeholders on the concept of network operations were met with some scepticism, primarily based on the 'road builder' perception. However, as the organisational culture changes and the benefits of a network operations approach becomes apparent, there is growing confidence within road authorities to be more open and prescriptive about how the road network should be used.

#### **4.4 Data and systems**

As a result of a near fully instrumented freeway system and a centrally-managed traffic signal system, Melbourne has access to vast quantities of data on the operation of the road network for every minute of the day. To date, this data has been used primarily to run small groups of intersections, and provide automated incident detection and travel time on the freeways.

There is a significant opportunity to improve the management of congestion through more intelligent use of the data already available to us. The derivation of both freeway and arterial travel time information from this data has progressed over the last year, enabling the actual performance of the road network to be measured. But much more needs to be done through collaboration with research organisations and universities to explore mathematical and statistical models that can provide predictive capabilities.

Improved systems and tools, which can more effectively utilise this data, are going to be essential elements in managing congestion.

#### **4.5 Working with local government**

The competing demands of through traffic versus abutting land use mean that the support of local government in network operations planning is fundamental to its success. The guiding principles of the Metropolitan Transport Plan actually bring the objectives of VicRoads and local government closer together. The Metropolitan Transport Plan recognises the importance of activity centres, strip shopping centres, pedestrians and bicycles in a framework that balances priorities with motorised forms of transport.

Many councils are actively reviewing their municipal transport strategies. In working with these councils, it is apparent that the network operations planning process can provide a powerful tool to consider competing objectives.

Experience with the development of network operating plans over the last 12 months has highlighted the repeatability of the process. The Metropolitan Transport Plan principles are strongly embedded in the process, which means that different stakeholder groups can apply the process and get a similar outcome.

Network operating plans also provide a degree of transparency to how the transport network is being managed. This can assist councils in land use planning, and in the management of their own local road network.

#### 4.6 Strip shopping centres

There are a large number of strip shopping centres across Melbourne that have developed along arterial roads. Many have become an integral part of the community culture. But the catalyst for their emergence, i.e. the arterial road, is now seen as an impediment to the sustainability and liveability of the strip shopping centre.

Strip shopping centres present the greatest challenge to resolving the competing demands for arterial road space. Cars, trucks, buses, trams, pedestrians, bicyclists and parking are all in potential conflict. Burke Road, Camberwell and Bridge Road, Richmond, are classic examples in Melbourne. The application of the Metropolitan Transport Plan principles suggests the following priorities:

- Identify alternative arterial roads for through traffic and make them work well to attract traffic to use them in preference to the route through the strip shopping centre.
- Provide priority to buses and trams to the strip shopping centre as a key destination for public transport users.
- Give greater priority and access to pedestrians within the strip shopping centre to promote walking.
- Provide safe bicycle access to the strip shopping centre on roads that will attract more people to use bicycles.
- Provide flexibility in priority across the day as demands change within the strip shopping centre.

These principles will often result in a road use priority plan similar to figure 6.



Figure 6 – Typical road use priority plan near strip shopping centre

One of the unresolved uses of arterial road space through strip shopping centres is for parking. As a city, Melbourne is fairly unique in the level of on-road parking provided on arterial roads. There is a traditional, perhaps mistaken, belief that on-street parking is a “right” and is a commercial imperative for business survival. On-street parking is, in fact, a significant cause of congestion through strip shopping centres. Parking is perceived as providing a safer and more amenable environment for pedestrians and shoppers, but it is also a very inefficient use of an expensive asset.

There is no doubt that strip shopping centres present one of the greatest challenges for network operating plans.

## 4.7 Transit City development

The development of Transit Cities is a key element of the State Government's Melbourne 2030 strategy. Transit Cities are urban precincts designed around key transport nodes to improve the interaction between land use and transport, and promote transit-oriented development. The Metropolitan Transport Plan identifies the need to improve traffic flow in and around Transit Cities, with particular priority to Dandenong, Frankston, Ringwood, Box Hill and Footscray.

The transport challenges for the Transit Cities have all thrown up the same issue; how to reduce traffic on the major arterial through the centre of each Transit City. This remains an issue for each of the Transit Cities. The major reason for this is that the scope of the transport considerations has focussed primarily on the Transit City footprint. The solutions, however, are likely to be found in the road network surrounding the Transit City. The application of the network operations planning process to the City of Dandenong has already highlighted the wider road network changes that may be required to achieve the Transit City objectives. The use of the process for the other Transit Cities is also needed to establish how the road network needs to operate in these areas before the commencement of any traffic modelling exercises.

The Transit City objectives invariably result in road use priorities weighted to pedestrians, bicyclists and public transport. Figure 7 illustrates a typical road use priority map surrounding a transit city. The preferred traffic routes attract through traffic away that would otherwise use routes through the Transit City, and most routes leading into the Transit City are given public transport priority.

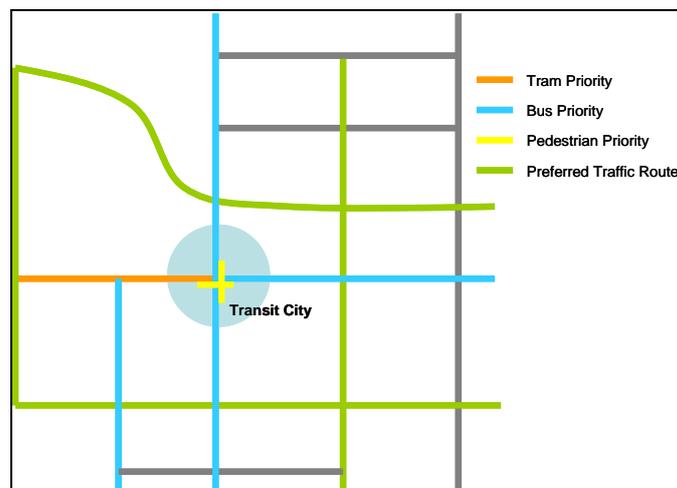


Figure 7 – Road use priority map for a Transit City

## 4.8 Growth Areas

While the management of congestion is generally of greater concern in the inner suburbs in Metropolitan Melbourne, it is important that network-wide planning is undertaken as early as possible to avoid future congestion across all parts of the network.

Transport planning in growth areas has tended to focus on arterial capacity and the need to consider duplicating existing arterial roads to meet the demands of new housing developments. Network operations planning in growth areas can assist in defining future bus and bicycle networks, and guide better land-use planning decisions.

## **4.9 Bicycles**

The Principle Bicycle Network (PBN) was developed to guide investment on bicycle facilities. The network operations planning process aims to identify those sections of the PBN that priority should be given to bicyclists. Increased bicycle use is likely if we reduce the competing demands on bicycle routes and providing priority on safe, high quality routes that link activity centres.

The identification of priority bicycle routes will require a strong local government involvement as the resolution of competing road use demands invariably highlight local roads and off-road paths as safer and more attractive routes for bicycles.

## **5 Conclusion**

Even in the early stages of the implementation of network operations planning, it is apparent that better and more sustainable transport decisions can be made. The plans also provide an integrated approach to managing congestion by drawing together land use planning, access planning, traffic control, transport management and road user behaviour.

Engaging the community and securing their commitment to the plans is one of the key challenges. Additionally, stakeholders need to be assured that changes to the operation of the network will result in better outcomes. This assurance hinges on our ability to model and report the operation of the network, predict future impacts and measure changes in congestion.

The next steps in the network operations planning process involve the finalisation of an aggregated road use priority map for Melbourne and the development and implementation of actual changes to network operation to address congestion management in a more strategic and proactive manner.

## **References**

Vincent, T (2006) Network Operating Objectives, Australian Institute of Transport Planning and Management National Conference, Melbourne

Government of Victoria, Linking Melbourne, Metropolitan Transport Plan (2004)