

Technology and Supply Chains for Critical Industries

Urban Freight (Working paper 3 of 3)

*Department of
Infrastructure and
Regional Development*

Urban Freight

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Executive summary

PricewaterhouseCoopers Consulting (Australia) Pty Limited and Ranbury Pty Ltd (Ranbury) have prepared analysis of the Urban Freight supply chain on behalf of the Department of Infrastructure and Regional Development (DIRD) as part of the Inquiry into National Freight and Supply Chain Priorities (the Inquiry). This report analyses the key dimensions of the transport tasks being undertaken in the urban freight markets in major Australian cities.

The study analyses at a high level:

- the infrastructure underpinning the typical supply chains for each industry;
- supply chain costs;
- user needs and bottlenecks impacting the supply chain; and
- technology, innovation and changing business practices impacting supply chains in the future, particularly in relation to infrastructure, service requirements and cost.

The Urban Freight Task

Overview

The transport tasks undertaken in the urban freight markets have changed significantly over the past 20 years. Today, urban freight flows reflect the growth in port import and export (IMEX) activities and direct shipping into every major capital city. Urban freight flows are driven by the movement of containers between port, staging depots, distribution centres and empty container parks. The complexity of urban freight supply chains is increasing.

The freight task in urban areas connect a myriad of origins and destinations that vary for different products. As such, the logistics tasks are complex and require tailored solutions to transport the freight most efficiently. As the transport environments get denser and congested, the logistics tasks become slower and more inefficient. Planning is required to address these issues and ameliorate or prevent the congestion and operating constraints deteriorating further or at least mitigating the rate of degradation.

Road Based Supply Chains

The containerised import task is the major Port handling task and the road based supply chain is the dominant option for freight from the port. Supply chain studies undertaken by the major east coast ports all confirm that the destinations of import containers and origins of export containers through the ports are predominantly in the city urban areas. In essence, most containers are transported from the ports to distribution centres and warehouses in the cities as the first landside logistics stage of the IMEX supply chain. The second stage is the breaking down of the container loads for distribution as smaller loads and consignments to a range of businesses (e.g. retail and industrial) and end customers. This task is more likely to be undertaken using rigid and light commercial vehicles.

Rail Based Supply Chains

Port shuttle rail based supply chains for urban freight in Metropolitan areas operate in Sydney and Perth. The Sydney port shuttles (e.g. Minto and Yennora) carry a range of goods, with the Perth service dominated by the haulage of grain from CBH at Forresterfield to the Port of Fremantle. Congestion is a major driver of the use of rail in lieu of road services. However, without strategically located rail facilities within the urban areas, it is difficult for rail to participate in urban supply chains.

Supply Chain Costs

Supply chain costs in urban freight environments are driven by the products to be transported, specific tasks being undertaken, origin and destinations and the extent to which the task is impacted by external factors such as congestion. As a result the costs tend to be driven by the time taken for various delivery tasks rather than the distance travelled. The efficient operation of the road networks and access associated with the first and last mile are pivotal to supply chains in terms of reliability and costs.

Supply Chain User Needs and Bottlenecks

The urban freight supply chains are complex and multi-faceted with a myriad of tasks spread over many origin-destination (OD) routes. The supply chain needs of each end user are bespoke and reflect the specific circumstances of their individual operations and transport tasks. In addition, there is substantial interdependency between supply chain user needs. A material failure or weakness in one component of the supply chain has consequential knock-on effects for end customers.

Efficiency through cost and capacity optimisation are critical elements of the urban freight supply chains. Key influencers to supply chain efficiency include:

- providing solutions for complexity of the supply chains and streamlining the number of stages required to deliver freight to customers;
- aligning required supply chain infrastructure and capacity for various tasks and volumes, and maximising asset utilisation across the supply chain to reduce unit costs for end users;
- investment in right sized transport capacity and facilities that can optimise the transition of freight from import configurations to customer delivery task configuration;
- efficient fleet utilisation and the management or minimisation of congestion factors and impacts;
- managing community impacts associated with a noise, congestion and safety issues;
- the potential impact of complex competition regulatory regimes in decision making; and
- managing planning controls and processes to ensure corridors and industrial precincts containing major supply chain facilities are protected from residential encroachment.

The impact of technology on the supply chain

In the urban freight environment there is a range of technologies and systems that have been developed or are under development that will facilitate the improved productivity and efficiencies in various freight logistics tasks.

New technologies, which may be applicable in the future or have been partially implemented or being considered within the urban freight sector include:

- tracking and traceability systems using technology that can monitor the movement within the various supply chains;
- supply chain automation systems impacting, ports, vehicles, warehousing and freight planning systems; and
- innovative urban freight facilities that can streamline and facilitate the efficient movement of freight in densely populated areas.

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1 *Introduction*

PricewaterhouseCoopers Consulting (Australia) Pty Limited and Ranbury Pty Ltd (Ranbury) have analysed the urban freight supply chain on behalf of the Department of Infrastructure and Regional Development (the Department) as part of the Inquiry into National Freight and Supply Chain Priorities (the Inquiry). This work is intended to assist the Inquiry in informing the forthcoming National Freight and Supply Chain Strategy to ensure:

- the cost of freighting Australia's agricultural and resource commodities and general freight to destination markets does not undermine the global competitiveness of these industry sectors; and
- the cost of freighting imported goods domestically remains low and does not undermine our standard of living.

This analysis will focus on the import and distribution tasks given the dominance of imported goods through international supply chains in to Metropolitan areas. There are also a significant range of tasks that occur within the boundaries of the major cities that relate to goods and commodities transitioning through the cities that are not the focus of this assessment. They include products such as:

- bulk products (e.g. oil, resources, chemicals, agriculture);
- movement of fuel, garbage, and building materials (e.g. cement, aggregates, fill, spoil, pre-cast and steel structures); and
- containerised exports (e.g. grains, dairy products, fruit and vegetables, wastepaper, pulp, paperboards, fibreboards, miscellaneous manufactures, stockfeed and meat).

1.1 Study objective

This study is an input to the Inquiry process and is intended to identify, at a high level, critical issues in supply chains for the urban freight sector. The study analyses:

- the infrastructure underpinning the typical supply chains for each industry;
- supply chain costs;
- user needs and bottlenecks impacting the supply chain; and
- technology, innovation and changing business practices impacting supply chains in the future, particularly in relation to infrastructure, service requirements and cost.

Data in this study is drawn from the following sources:

- ABS (2014), Survey of Motor Vehicle Use
- ABS (2017), Survey of Motor Vehicle Use
- Bankwest (2017), Road Freight Transport Industry 2017
- Barwick, A (2015), Retiming Deliveries London Pollution Study Group
- BITRE (2014), Freightline 1 – Australian Freight Transport Overview

- BITRE (2016), Information Sheet 80 - Traffic on the National Network 2013/14
- BITRE (2017), Waterline 60 Statistical Report
- BITRE (2016), Why short haul intermodal rail services succeed
- Freight Transport Association/J Sainsbury PLC, Night-time Deliveries Wandsworth Trial
- GHD (2011), NSW Infrastructure Capability Assessment – Transport Baseline Report
- QTLC (2013), Supply Chain Perspectives
- Office of National Statistics (2016), London 2016
- Port of Brisbane/QTLC (2013), Import/Export Logistics Chain Study – Summary Report
- Port of Melbourne (2009), Container Logistics Chain Study – Summary Report
- Transport for London, Master Base Map
- Transport for London (2012), Roads Taskforce Thematic Analysis
- Transport for London/University of Westminster, Allen J., Browne M. and Woodburn A. (2014), London Freight Data Report - 2014 Update
- Transport for London, Rethinking Deliveries Summary Report
- WestTrans, Freight Strategy
- various industry body websites
- submissions to the Inquiry
- stakeholder consultation (see Table 1).

Table 1: Stakeholder consultations

Stakeholder	Discussion focus
Woolworths	User needs and bottlenecks

1.2 Report Structure

Following this introduction, the report is structured as follows:

Section 2: Freight Logistics Task

This section provides a high level overview of the freight task followed by analysis of the stages associated with the urban freight task dominated by the road transport sector. It focuses on the import supply chain that feeds a broad range of products into all the major Australian capital cities. It also provides an overview of the extent to which rail based supply chains also provide play a role with respect to urban freight. This section is completed with the international London Case Study.

Section 3: Technology and innovation

This section provides a summary of the key technological advances applicable to the urban freight supply chains and the potential impact of these changes.

Section 4: User needs

This section provides an outline of the user needs for urban freight supply chains.

Section 5: Bottlenecks

This section provides an outline of bottlenecks in the urban freight supply chains.

2 Urban Freight Task

This section analyses the urban freight task in Metropolitan areas, including both road and rail based supply chains. It provides an overview of urban freight and logistics in Metropolitan areas and analysis of each freight movement within a road based urban freight supply chain. It also analyses rail based urban freight in Metropolitan areas, focussing on Sydney and Melbourne.

2.1 Freight Logistics Overview

The Urban Freight Task in Australia has changed significantly over the past 20 years. Historically, urban freight flows were driven by Australia's strong south eastern manufacturing focussed on Melbourne and serving domestic markets. Accordingly inputs, whether Australian or internationally sourced, were transported into Victoria and many commodities were subsequently transported to other capital cities on major south north and east west corridors.

Today, urban freight flows reflect the growth in port IMEX activities and direct shipping into every major capital city. Urban freight flows are driven by the movement of containers between port, staging depots, distribution centres and empty container parks, reflecting:

- a major reduction in manufacturing in south east Australia;
- increased global sourcing of products with increased consumption of consumer goods; and
- containerisation of many products resulting in significantly higher unit throughput at ports.

Tables 2 shows that the major IMEX urban freight tasks in Australia are undertaken in Melbourne and Sydney with a relatively even split of twenty and forty foot equivalent units (which dictates factors such as vehicle type, container yield per vehicle and vehicle trip numbers).

Table 2: Capital City Port IMEX Container Terminal Throughput – 2016

Container Terminal Throughput	Brisbane	Sydney	Melbourne	Adelaide	Perth
Total containers handled ('000)	784	1,540	1,561	268	470
Total TEUs handled ('000)	1,168	2,374	2,366	384	702
40 ft container (% all containers)	49%	54%	52%	43%	49%
Total number of container ships	934	1,058	1,078	409	508
Total containers lifts ('000)	771	1,525	1,543	265	467

Source: BITRE Waterline 60 – 2017

Table 3 indicates that the urban freight task is dominated by the movement of fully loaded import containers, followed by empty export containers, then fully loaded export containers.

Table 3: Capital City Port - IMEX Import/Export TEU Throughput - 2016

Container Terminal TEU Throughput	Brisbane	Sydney	Melbourne	Adelaide	Perth
Total TEUs exchanged ('000)	1,175	2,362	2,652	380	706

Full import ('000)	528	1,184	1,226	140	339
Empty import ('000)	71	10	111	48	23
Full export ('000)	327	479	859	159	206
Empty export ('000)	249	688	456	32	138

Source: BITRE Waterline 60 – 2017

The complexity of urban freight supply chains is increasing, driven by:

- population growth, urban densification and growing congestion of urban road networks;
- diversity in urban form within Metropolitan areas (e.g. urban sprawl and urban densification within a single metropolitan area) requiring multiple unique supply chain solutions; and
- changing end users and users' needs associated with e-commerce delivery requirements and the growing business to consumer distribution channel which requires a unique supply chain solution.

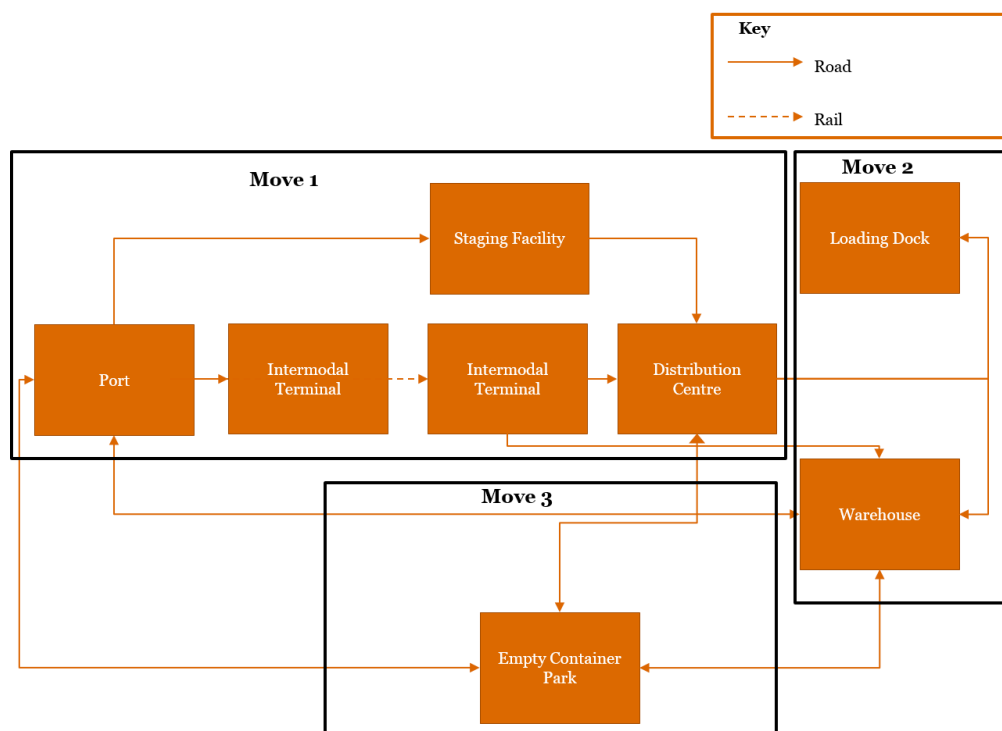
2.1.1 Freight Movements

Urban freight supply chains involves multiple stages determined by customer/user requirements. Staging at each position in the supply chain is driven by user needs in relation to:

- destuffing and repackaging or direct delivery;
- transit time thresholds and replenishment cycles;
- efficiency and cost; and
- process risk and reliability from origin to destination.

Whilst the urban freight supply chain is generally unique for each user, the most common freight moves are illustrated below in Figure 1.

Figure 1: Common Freight Moves by Mode, Urban Freight Supply Chain



Source: PwC Analysis

As shown, these include:

- Move 1 - Transport of high volumes of freight from Port or Processing Facility to Distribution Centre (DC). Mode based variation in the first move include:
 - Movement directly to warehouse by road
 - Movement via a staging facility in receipt windows are not aligned at the Port and DC in road based supply chains. This rarely occurs in a port shuttle network where receipt windows are aligned at Port and Inland Port
 - Pickup and delivery leg (PUD) both at Port/Processing facility to originating intermodal terminal then again from destination terminal to DC or warehouse. PUD can either be taken by Internal Transfer Vehicle or Heavy Vehicle dependent on whether Port terminal is on or near dock and DC or warehouse is co-located at terminal
- Move 2 Transport of freight consignments from Depots, DCs or Warehouse to business establishments and retail stores/outlets by road. Consignments would be either full loads (FTL), part truckloads or consignments that would be pallet loads or less.
- Move 3 Empty Container Repositioning – Move from DC/warehouse of empty containers to empty container park (ECP) for storage and rehire or export or to Port for export. Trip distance can be substantially reduced when ECP is incorporated at intermodal terminal – particularly where co-located activity is concentrated. This move is not considered in detail in the report.

While not always required, an additional transport leg from stores or businesses to final domestic customers / consumers may be necessary.

2.2 Road Transport and Logistics

2.2.1 The first move – container to distribution centre

All capital cities rely on the distribution of freight from Ports for import freight, or processing facilities for local product in the metropolitan region, to the major transport and distribution hubs. The data in Table 3 shows that all ports predominantly rely upon road transport for this leg.

Table 4: Capital City Port - IMEX by Transport Mode - 2016

Container Terminal TEU Throughput	Brisbane	Sydney	Melbourne	Adelaide	Perth
Total containers handled ('000)	784	1,540	1,561	268	470
Total TEUs handled ('000)	1,168	2,374	2,366	384	702
Number of trucks - VBS/TAS operations ('000)	303	641	605	127	160
Total containers transported by trucks / rail ('000)	532	1,146	1,180	280	332
Containers by trucks ('000)	499	910	1,058	213	258
Containers by rail ('000)	33	236	122	67	73
Balance of containers handled landside ('000)	252	394	503	54	138
Total TEUs transported by trucks / rail ('000)	768	1,647	1,768	393	469
TEUs by trucks ('000)	731	1,300	1,583	306	367
TEUs by rail ('000)	37	347	184	87	102
Balance of TEUs handled landside ('000)	401	727	782	78	233

Source: BITRE Waterline 60 – 2017

This is due to the productivity gain for cargo owners resulting from the continuing increase size and capacity of articulated vehicles working under the Performance Based Scheme (PBS) that facilitates the ability to run higher mass and length vehicles on approved routes. This includes Concessional Mass Limit (CML) and Higher Mass Limit (HML) vehicles. This has resulted in A Double PBS Vehicles (Type 1 Road Train) that can carry up to 4 TEU increasing in numbers performing vehicle haulage tasks in lieu of B Doubles to locations such as the capital city ports.

As IMEX volumes grow so to do the levels of heavy vehicle road traffic as part of the first transport leg from the port to the warehouse facility or distribution centre (DC) within the Metropolitan area. This leg is subsequently followed by an outbound leg from the DC/warehouse to a retail or wholesale customer.

Consumable products are mostly transported in the containerised supply chain given the majority of products are sourced internationally. This includes furniture, electrical goods, machinery, manufactures, clothes, vehicle parts, toys and sporting equipment that tend to be light weight and are transported in larger 40 ft containers (2 TEU). Heavier export products such as cereals and grains, dairy products, stockfeed, processed meat, beverages, etc are exported in 20 ft containers (1 TEU).

Urban Delivery Distribution Patterns - Ports to Transport Hubs

Optimising the urban freight task requires a detailed understanding of the vehicle movements and freight handling associated with all stages of the transport task in each metropolitan area. Different levels of data are available in the different jurisdictions in terms of understanding the extent to which Light Commercial Vehicles (LCVs) and Heavy Commercial Vehicles (HCVs) vehicles use major transport routes and where the freight is cross docked, reconfigured and on forwarded. Additional data that explains the key drivers of transport activity on road networks will help future planning and the design of transport solutions. A review of available data has been undertaken to identify key origins and destinations.

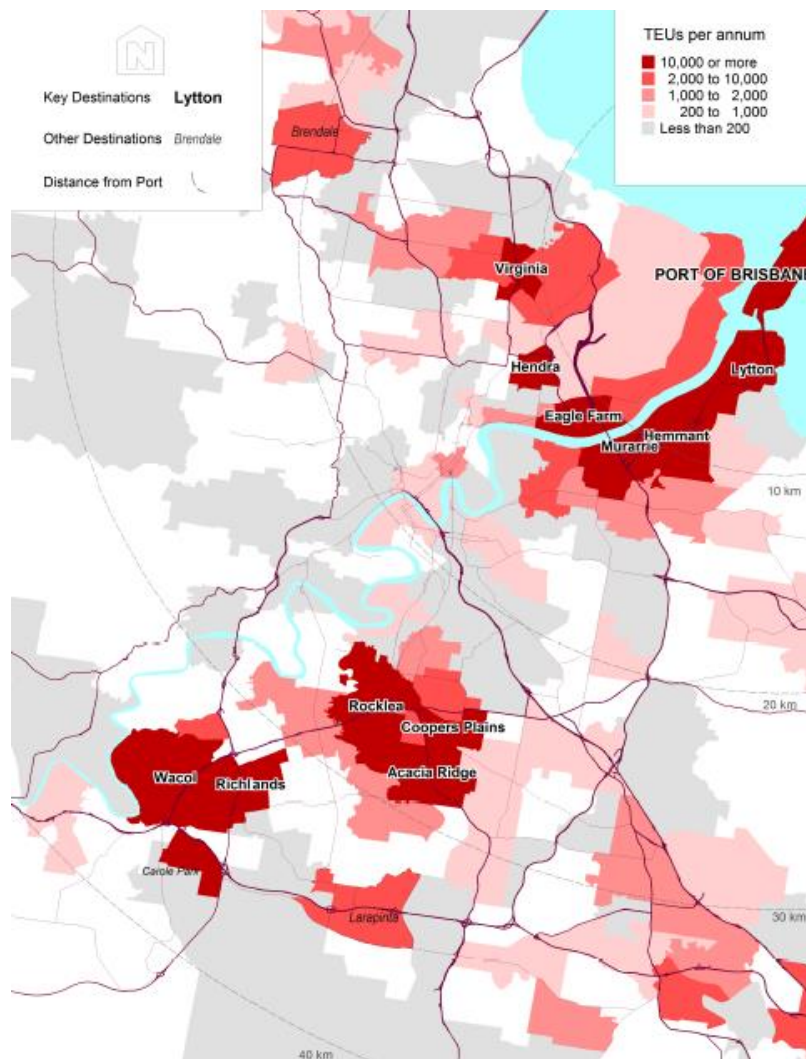
Port of Brisbane - Supply Chain Zone

The Port of Brisbane undertook a major IMEX Logistics Chain Study in 2013. Key findings of the study included (Port of Brisbane 2013):

- 93% of import containers were unpacked and 74% of export containers were packed within 100km of the port. This confirms that there is a concentration of freight handling in urban areas
- 50% of full export containers (152,000 TEUs) were staged at transport yards
- 44% of full import containers (201,000 TEUs) were staged at transport yards
- 27% of full exports containers (81,000 TEUs) were transported directly from exporters to stevedores
- 21% of full import containers (94,000 TEUs) were transported directly to importers from stevedores
- 60% of full export containers and 50% of full import containers remained less than 24 hours in transport yards.

The areas that are key distribution hubs for imports and exports are as follows (Port of Brisbane 2013).

Figure 2: Port of Brisbane Import Container Destinations

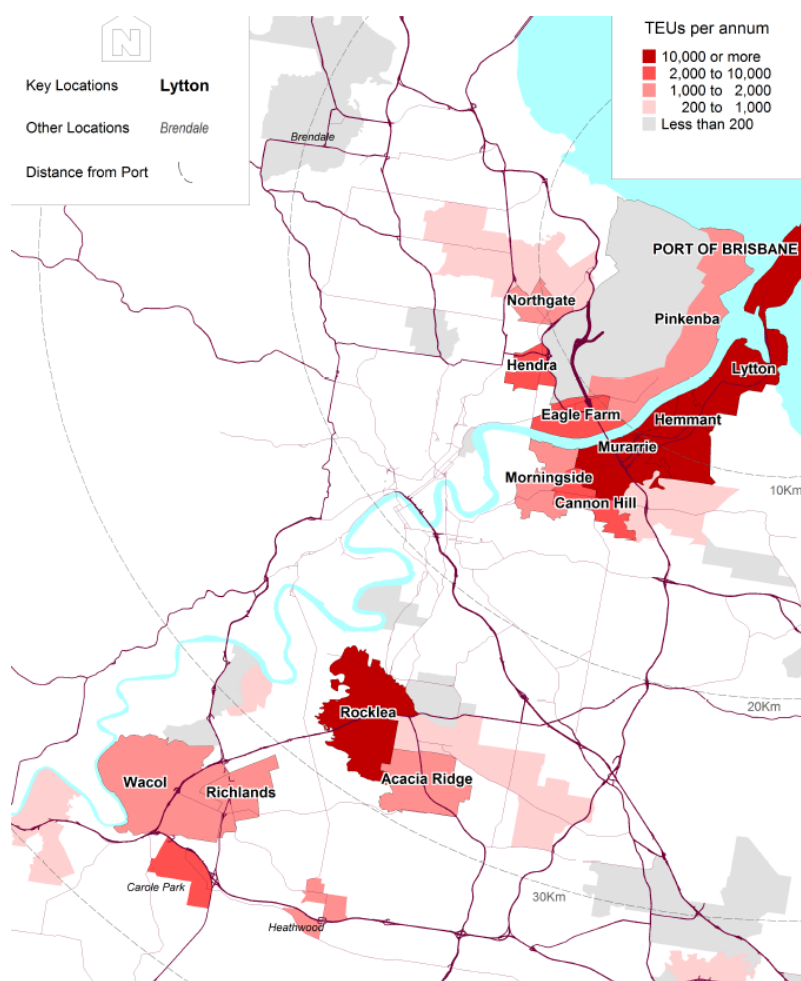


Source: Port of Brisbane – Import/Export Logistics Chain Study – Summary Report 2013

Table 5: Port of Brisbane - Import Container Destination Areas

Area	Destination	TEUs	%
Brisbane	Brisbane - East	122,299	26.7
	Brisbane - South	85,712	18.7
	Brisbane - North	62,101	13.6
	Brisbane - West	2,227	0.5
	Brisbane Inner City	28,711	6.3
Adjacent statistical regions	Gold Coast	32,777	7.2
	Ipswich	50,361	11.0
	Logan - Beaudesert	19,434	4.2
	Moreton Bay - South	11,237	2.5
	Moreton Bay - North	6,625	1.4
	Sunshine Coast	4,076	0.9
Total		425,560	93%

Source: Port of Brisbane – Import/Export Logistics Chain Study – Summary Report 2013

Figure 3: Port of Brisbane Export Container Destinations


Source: Port of Brisbane – Import/Export Logistics Chain Study – Summary Report 2013

Table 6: Port of Brisbane - Export Container Destination Areas

Area	Origin	TEUs	%
Brisbane	Brisbane - East	89,185	29.2
	Brisbane - South	18,267	6.0
	Brisbane - North	7,283	2.4
	Brisbane Inner City	5,014	1.6
	Brisbane - West	537	0.2
Adjacent statistical regions	Ipswich	44,891	14.7
	Gold Coast	35,877	11.7
	Logan - Beaudesert	9,074	3.0
	Moreton Bay - North	14,446	4.7
	Moreton Bay - South	298	0.1
	Sunshine Coast	119	0.0
Total		224,991	73.7%

Source: Port of Brisbane – Import/Export Logistics Chain Study – Summary Report 2013

Port of Melbourne - Supply Chain Zone

In 2009, the Port of Melbourne undertook a similar study to the Port of Brisbane and identified similar trends. They included (Port of Melbourne 2009):

- The vast majority of import and export containers were transported by road.

- 87% of import containers or 713,000 TEU had a destination in metropolitan Melbourne.
- 54% of export containers or 297,000 TEU had an origin in metropolitan Melbourne.
- 91% of full import containers delivered by road had destinations within 50 km of the port.
- 67% of export containers delivered by road had an origin within 50 km of the port.
- The majority of loaded containers are not direct deliveries to/from the port, with 71% of import containers and 54% of export containers are staged through a transport depot in Melbourne.

This is also consistent with the concentration of port freight being handled in the Sydney metropolitan precinct. A NSW Infrastructure Capability Assessment indicated that 85% of the containers being transported to or from Port Botany are packed or unpacked within a 40km radius of Port Botany (GHD 2011).

Study Implications

The implications from the Melbourne and Brisbane studies is that most of the freight movements to or from these major ports have origins or destinations within the capital city regions. Much of the freight is packed or unpacked or staged in close proximity to the ports, resulting in additional freight transfers in the major cities. As the majority of the freight is being transported by road to and from the ports, increased roads trips are required to complete the first stage of the supply chain between ports and DCs / warehouses prior to on-forwarding. The transport of freight from ports to/from regional areas do occur but are a smaller component of the task. Rail freight transport is more likely to be used for freight transfers to regional areas. The stages for this first move are as follows.

1. Port to staging facility to distribution centre

Containerised freight is directly delivered from ports to major DCs and warehouses in major city precincts unless constraints exist in terms of delivery destinations or curfews. Staging of freight occurs mostly when there are restrictions on the ability to undertake the delivery of the container to the customer premises. This is often driven by limitations associated with customer operations, including physical access or business freight receipt hours or specific receipt slot bookings. The Melbourne study identified that approximately 35% of import containers and 34% of export containers are staged in adjacent inner western suburbs such as Footscray or Altona.

2. Port direct to distribution centre

Freight destined for urban locations within the major cities are most likely to be delivered to a major DC in one of the industrial precincts. Most retail DCs that provide distribution to supermarkets and convenience retailers are designed to be high velocity throughput facilities. These facilities are often driven by automated re-ordering systems that initiate replenishment orders on a continual basis driven by in-store sales. The receipt of inbound stock into the high velocity DCs require suppliers to book time slots to discharge freight. Major steps include:

- inbound container or truckload lots of food or consumable products;
- transfer of inbound freight into short term storage areas;
- reconfiguration of products into palletised store lots;
- transfer and assembly of products into store lots/loads; and
- loading of outbound delivery vehicles with store configured loads.

In circumstances where freight customers are not able to accept container load freight, inbound imports can be cross docked at Port based facilities to enable the delivery of products to a more diversified customer base from the Ports. Cross docking capability is provided by a range of port landside logistics providers such as Qube (e.g. Vic Dock) or ACFS (e.g. Appleton Dock) who have facilities at the Port of Melbourne for receiving or forwarding containers from stevedores (e.g. DP World and Patricks). Short distance PUD to a freight forwarder outside the port area (e.g. Linfox, Toll, K&S) located in the surrounding areas (e.g. Dynon precinct north of Footscray Road) are also used when in proximity to the port.

3. Port to Warehouse

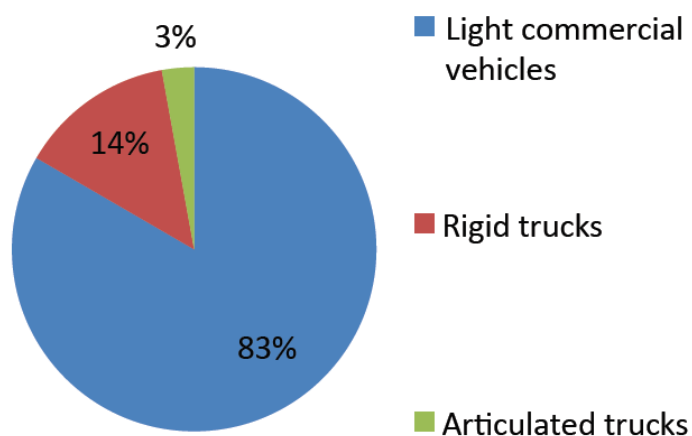
Imported freight that is not high velocity will be transferred from the port to a more traditional warehouse. Containers are trucked to warehouse locations and discharged into storage. These may be facilities run by wholesalers or suppliers to various industries and are likely to be located in industrial areas that have good access to major arterial road networks. Freight is then delivered to customers from the warehouse in smaller PUD full truck loads (e.g. rigid vehicles) or as part of consignment delivery (e.g. palletised) by a metro freight distribution service provider.

2.2.2 The second move – consignments to customers

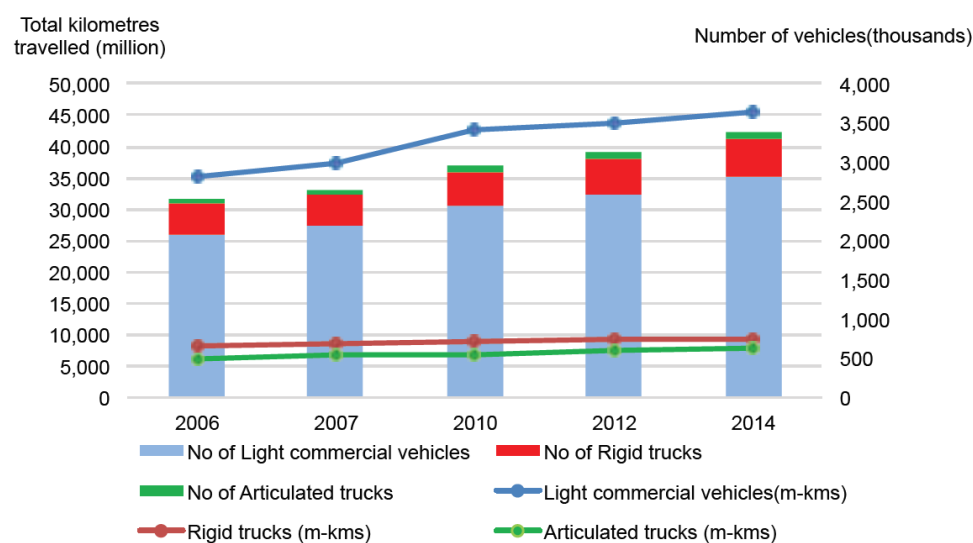
The next leg of freight distribution task across the various capital city networks invariably involves the delivery of freight consignments to a range of businesses operating in a number of industry segments. These major industry segments are retail, wholesale, construction, manufacturing, agriculture, mining, and miscellaneous other smaller segments. (NTC 2016).

The transport of freight across the major cities in this stage, commences to fragment into smaller load tasks tailored for the requirements of receiving customers. Many truck load consignments are still delivered for larger business operators (e.g. retail supermarkets) and industrial businesses. With larger articulated vehicles undertaking primarily linehaul or full truck load (FTL) tasks, rigid and light commercial vehicles (LCVs) are more prevalent for transport of consignment level less than full truckload (LTL) delivery tasks. The national commercial vehicle profile is outlined in Figure 4. Based on ABS Motor Vehicle Survey data from 2014, there were 3.4 million commercial vehicles registered to operate on Australian roads with LCVs making up 2.8 million of the vehicles. The transport task driven by an increasing urban freight task continues to expand (Figure 5). Approximately 70% of all transport operators only have one truck in their fleet and 24% have 2 to 4 trucks. Less than 0.5% of transport operators have 100 vehicles in their fleet (NTC 2016).

Figure 4: Composition of the National Commercial Vehicle Fleet



Source: ABS – Survey of Motor Vehicle Use (Cat.No. 9208.0) 2014

Figure 5: Commercial Vehicle Fleet Trend – No. of Vehicles & Km Travelled

Source: ABS – Survey of Motor Vehicle Use (Cat.No. 9208.0) 2014

While traffic count data is available on the number of vehicles that operate on major corridors, actual metropolitan freight flow data on the movement of freight between critical origins and destination (OD) is not available. To quantify the relative task intensity of commercial traffic compared passenger vehicle movements in the major capital city precincts, the relevant data has been extracted from the ABS Survey of Motor Vehicle 2016. This highlights that while Sydney and Melbourne have a similar total freight km task, albeit with a different vehicle mix, this must be overlayed on the passenger traffic which is 12% higher in Melbourne based on the ABS data as shown below in Table 7.

Table 7: Motor Vehicle Use – Major Capital City Traffic Task – 2015/16 (distance travelled, million km)

Capital City	Sydney	Melbourne	Brisbane	Adelaide	Perth
Passenger vehicles	27,516	30,885	14,901	7,897	13,985
Motor cycles	304	250	186	74	147
Light commercial vehicles	4,875	5,047	4,606	1,313	3,535
Rigid trucks	1,579	1,392	852	273	699
Articulated trucks	459	478	329	111	210
Non-freight carrying trucks	23	41	17	4	16
Buses	502	285	237	85	141
Total	35,258	38,379	21,128	9,757	18,733

Source: ABS – Survey of Motor Vehicle Use (Cat.No. 9208.0) 2017

In addition to the total estimated freight task in various cities outlined above, an indication of the total intensity of traffic levels feeding into traffic networks is outlined in the BITRE Information Sheet 80 on National Road Network Traffic (2013/14). Specific nodes and the annual average daily traffic (AADT) data on various routes are outlined in a series of route assessments. The AADT data includes the following traffic counts (BITRE 2016):

- Brisbane – M1 Helensvale – 145,000 AADT
- Brisbane – Gateway Motorway – 140,000 AADT

- Brisbane – Ipswich – 43,000 AADT
- Brisbane – M1 Pine River – 138,000 AADT
- Sydney – M7 Interchange – 80,000 AADT
- Sydney – Hornsby – 82,000 AADT
- Sydney – George’s River – 85,000 AADT
- Melbourne – Geelong Road – 195,000 AADT
- Melbourne – Metropolitan Ring Road – 70,000 AADT
- Melbourne – Western Ring Road – 97,000 AADT
- Melbourne – Princess Hwy (Berwick) – 93,000 AADT
- Adelaide – Gawler – 24,000 AADT
- Adelaide – Portrush Road – 46,000 AADT
- Adelaide – Salisbury Highway – 58,000 AADT
- Perth – Roe Highway Interchange – 40,000 AADT.

Maps for the major urban arterial roads quantified in the National Road Network Study are attached in Appendix 1.

The freight movements from DCs and warehouses may be the last stage of freight movement where the consumer purchases groceries, consumables or other goods to take them home, or they may be part of a further service offering from a business (e.g. parts) to other businesses or to consumers. This transport leg can be diverse relying on a range of freight delivery service providers, agents or distributors. The configuration of the delivery tasks can range from truck load to pallets to parcel sized consignments.

E-commerce delivery tasks

The increasing trend of business to consumer delivery arising from internet E-commerce business to consumer distribution channels adds another dimension to urban transport task. The delivery of groceries and other goods can potentially add a further additional leg in the urban supply chain, where goods are picked from online orders at supermarkets or other retail outlets and delivered to customers. This has been the recent catalyst for the establishment of local micro/mini DC facilities or fulfilment centres in major urban catchments, that can perform the delivery task that traditional retail stores were not designed to accommodate.

2.2.3 Regulation

Road networks are generally open access common user infrastructure. Road based supply chains are subject to the regulatory framework in each state in terms of as-of-right access to the state road networks and light/heavy vehicle standards. The road transport task is undertaken by service providers on open access road networks that do not charge usage fees beyond registration fees paid to state road authorities and fuel excise collected by the Federal Government.

Registration charges for heavy vehicles are currently determined through the PAYGO Charging System. This system seeks recommendations from the NTC who assess the funding gap associated with future road construction and upgrades and forecast vehicle registration fee revenues. PBS vehicles (HML and CML) must obtain approval of the vehicle design from

the National Heavy Vehicle Regulator (NHVR) and route approval from state or local Government.

Road safety regulation for freight vehicles is governed by the National Heavy Vehicle Law (NHVL). The intent was to ensure that there was a “Chain of Responsibility” to ensure participants in supply chains are all accountable for ensuring safe operations. The current provisions that have not achieved this goal, are to be superseded with changes that will take the effect on 1 July 2018. The NHVL changes are to align the obligations with the workplace health and safety laws and also broaden the responsibility for safe operations to all supply chain participants with a “risk based approach”.

Road operations in the urban freight environments are also impacted by regulatory constraints applied by Councils, relating to freight deliveries to retail stores, food service businesses and consumers. These regulatory constraints often manifest themselves in the form of curfews that limit the ability to spread deliveries around the clock often due to noise related issues. Curfews and other freight delivery constraints force the delivery task into normal business operating hours, often introducing a compounding congestion overlay onto existing passenger vehicle congestion.

2.3 Rail Based Supply Chains

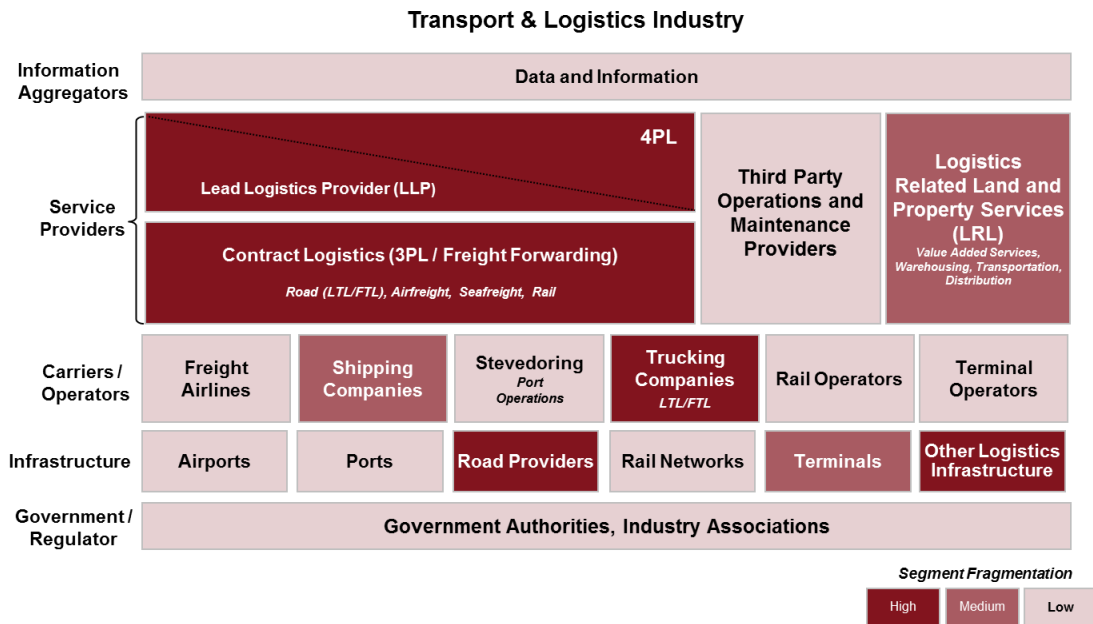
Sydney, Adelaide and Perth have been able to achieve the transfer of containers on rail at the 21% to 24% level albeit not all rail transfers involve metropolitan freight container moves. Sydney and Perth have the highest incidence of metro port shuttles with the prospect of increased rail transfers in Sydney when Moorebank commences operations. Brisbane and Melbourne rail haulage to/from the Ports operates at 6% and 10% respectively with most of the haulage task associated with transporting export containers from regional areas.

2.3.1 Structure

The standard rail based supply chain is characterised by a large number of disaggregated components that vary according to the market segment and types of products being transported within the supply chain. The components that may be substantially fragmented, are shown below in Figure 6. The performance of the supply chain and costs associated with various service providers in the supply chains, inevitably has to flow through to downstream customers and participants across other positions of the chain given its integrated nature. These costs ultimately have to be absorbed as part of the total supply cost and passed on to the end customer or consumer.

The competitiveness of the rail based supply chains and the associated rail freight traffic, is driven by the ability to attract trainload volumes that can operate as a point to point task. The rail supply chain must then be optimised by efficient interactions and interfaces between all the positions within and connecting with the rail based supply chain.

Figure 6: Freight Supply Chains



Source: PwC 2017

The individual efficiency and capacity of any one stage within the supply chain is generally insufficient to drive the overall capability of the chain, if the interdependent components are not operating efficiently or functioning at optimal capacity.

Rail which predominantly provides a linehaul function in supply chains, relies on the contribution of other service providers to undertake complementary roles (e.g. PUD) functions to deliver on the first and last mile. These need to be cost competitive, reliable, efficient, responsive, integrated (either vertical and/or horizontal) and flexible.

Where there are multi-party supply chains (e.g. Port Botany), and bottlenecks occur, there is often an inclination for industry and Governments to apply supply chain co-ordination as an overlay to better manage constraints. This may assist the integration and interfaces within the supply chain to address capacity constraints or single point failure in the supply chain.

2.3.2 Urban freight task by rail

Rail services supporting the urban freight task in the five capital cities include:

- regional IMEX;
- interstate super-freighter services; and
- port rail shuttles.

Regional IMEX

For regional IMEX services, origin/destination terminals are generally located in regional areas outside of the metropolitan area and transported to/from the respective port using the urban rail network and port terminal infrastructure.

Table 8 shows that regional IMEX rail services via the capital cities predominantly relate to the export of agricultural goods such as grain.

As a result, these freight tasks and supply chains are not included in this supply chain analysis. They have been analysed in the working paper 'Technology and Supply Chains for Critical Industries – Agriculture Sector'.

Table 8: Regional IMEX rail services for each capital city

Capital city	Regional IMEX services by rail
Sydney	<p>The regional rail freight task via Port Botany is mainly comprised of export containers, despite import containers having twice the overall volume throughput at the Port.</p> <p>Grain has traditionally travelled to port via established bulk rail networks. In the past five years though, there has been growth in containerisation of grain in the region, for export through Port Botany. This has diverted grain volumes from the established bulk supply chain.</p> <p>Some existing mineral ore production moves by container to the Port of Botany. The majority of existing production moves in specialised containers by rail to the Port Kembla, or by road.</p>
Perth	<p>Exports serviced by rail include agricultural products such as grain, malt and hay. There are limited imports transported by rail including general freight from Asia.</p> <p>A key participant in the urban rail freight task is the Co-operative Bulk Handling (CBH) group which cleans and packs grain at the Metro Grain Centre in Forrestfield adjacent to the rail network.</p> <p>Although the grain is produced in regional areas, this task is a port shuttle service specific to the final leg transporting containerised grain via rail to the Port of Fremantle. This task arises from a combination of the grain infrastructure being connected to the rail network and Western Australian Government financially supporting the Port Shuttle operations.</p> <p>The Port of Fremantle which is still under Government ownership, owns and operates the North Quay Rail Terminal (NQRT). It requires a transfer from NQRT to the berth to complete the export task.</p>
Melbourne	<p>Regional Victorian areas are predominantly export zones accounting for 15 per cent of import containers and 85 per cent of export containers (2009).¹</p> <p>Hence the majority of regional IMEX services transported by rail include agricultural and industrial products delivered to the Port of Melbourne for export including freight exports from the Riverina.</p> <p>Most of the regional terminals in Victoria are located on the broad gauge Victorian Rail Network. Currently, the Victorian Government has commenced the conversion of the Murray</p>

¹ Metropolitan Intermodal Terminal Study 2011', Shipping Australia Limited, p. 18. Estimates were based on the Port of Melbourne 2009 Container Logistics Study.

Basin Rail Network progressively from broad gauge to standard gauge during 2017 and 2018.	
Brisbane	<p>There are regional IMEX services which operate on the narrow gauge line from Central/North Queensland to the Brisbane Multi-Modal Terminal (BMT) at Fisherman Islands. The BMT is a central dual gauge terminal serving the three stevedoring operations.</p> <p>No IMEX rail traffic currently uses the standard gauge rail connection to the Port of Brisbane.</p> <p>The export market involves a mix of bulk and containerised grain and seeds, which is part served by rail with the major share by road. In 2012, approximately eight per cent of export containers were transported from regional areas in Queensland by rail to the port.</p> <p>A large number of packing facilities are located near the regional terminals or at the production/processing locations of the exporters supporting export container transport by rail.²</p>
Adelaide	<p>The modal share of TEUs transported by rail is relatively significant at 22 per cent in 2016.³</p> <p>These containers included export commodities such as wine, containerised grain and minerals.</p>

Regional Super-freighter Services

The interstate intermodal rail services currently provided by Pacific National, Aurizon and SCT are generally not focused on providing services associated with the Urban Freight markets. However, all the major operators have rail terminals that are based in the industrial areas of the major cities.

The freight that is transported to and from the rail terminals are travelling on the urban road networks in each city. Train schedules are designed to meet client requirements such as inbound morning freight availability to facilitate morning deliveries and evening outbound freight receipt train cut-offs for evening and night-time departing services.

There are some slower moving types of freight that do not have short replenishment cycles that are shipped into the larger ports of Sydney and Melbourne and are warehoused in National DCs. These products can be subsequently transported by rail to the smaller states (e.g. Melbourne to Perth) in job or store lots for distribution primarily in the urban areas of the receiving cities.

In terms of urban freight task generation, the total IMEX freight tasks are 4 to 5 times the volume of interstate rail freight tasks.

Port rail shuttles

The role of rail in the transport of urban freight within a city, as distinct from the regional or interstate linehaul tasks, is undertaken by port rail shuttles that undertake cross metro services. Both the origin and destination terminals are located within the metropolitan areas. The freight tasks undertaken mainly include:

- receipt of import containers for distribution to wholesalers, retailers and manufacturers; and
- consolidation of freight (either by road or rail) at an urban intermodal terminal before transporting to the port for export.

Only Sydney and Perth currently have port rail shuttle services operating in Australia.

Demand for port rail shuttles in Australia is impacted by:

² QTLC, 2014.

³ Waterline, Published 2017.

- Relatively short line haul distances which reduce the cost effectiveness of rail – Nearly 80 per cent of international freight moving through the Port of Melbourne has origins and destinations within a radius of about 40 kilometres of the port. The majority of industry is located in the west /south west of Melbourne in suburbs located adjacent to or proximate to the Port including Altona, North Laverton, Brooklyn, and Tottenham.
- Investment in the road network to increase carrying capacity and address congestion – A number of major road projects are underway or have been delivered by State governments. In Brisbane, investments have been made in the Port Motorway, Logan Motorway, Gateway Motorway and Inner City Bypass Upgrade. In Melbourne, these include investments in the western and metropolitan ring roads that have improved connectivity to the Port. New road upgrade projects continue to be rolled out including the upgrade to the Tullamarine Freeway and Western Distributor.
- Increasing productivity in the road sector - Australian road haulage benefits from larger vehicle combinations (length and mass limits) which exceed those in Europe and North America. In more recent times, Governments have increased the size of vehicles allowed (length and mass) on various routes and larger vehicles can be driven to the outer limit of larger vehicle routes and be broken down for the final leg of the transport haulage task. In Brisbane, it is likely that AB triple heavy vehicle combinations will be able to head east of the Toowoomba range and potentially to the port on the motorway network once the new road range crossing is complete.
- Capital cost of establishing or upgrading an intermodal terminal – The establishment of rail terminals in freight generating zones of major capital cities requires the development of a location proximate to industry and connected to the rail network. The development of Moorebank as a rail connected freight hub is an example of the planning required to establish a viable port shuttle operation that can minimise the double handling in the supply chain and enable point to point rail services in a major city.

For additional analysis of the viability of port shuttle services in Melbourne, Adelaide and Brisbane, the 2017 study completed by PwC and Ranbury into the operational conditions required for successful short haul rail services will provide further insight. This study also presented an evaluation framework based on essential operational requirements.⁴

2.3.3 Sydney Port Rail Shuttle

Sydney rail mode share and volume

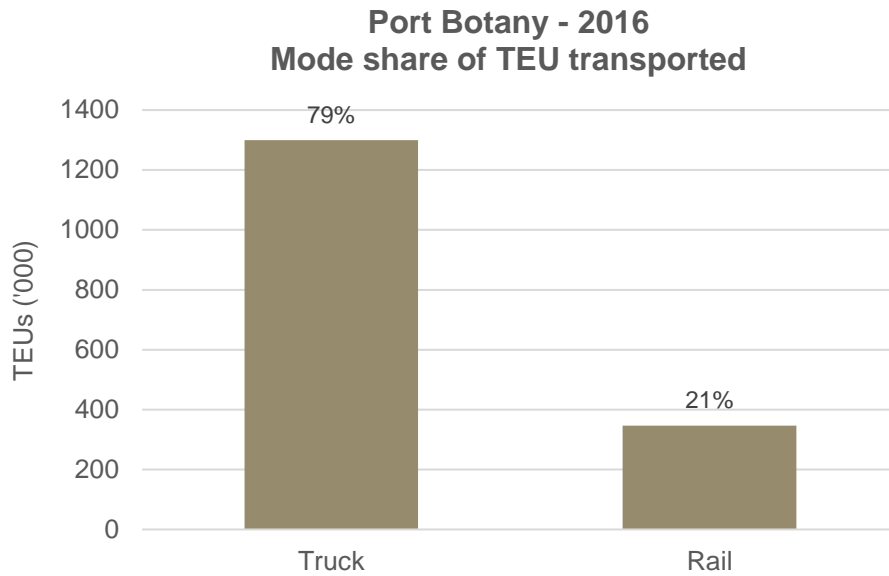
Urban road congestion is potentially the most significant driver to encourage the modal shift from road to rail. According to the Austroads 'Congestion and Reliability Review' in 2016, *"morning and afternoon peaks [in Sydney] exhibit time delays up to 40 per cent"*.⁵ Sydney is one of the poorest performing cities in terms of average speed, reliability and travel time delay peaks.

Rail in this capital city thereby benefits from the relative poor productivity of road haulage and provides a quicker, more reliable and cheaper supply chain solution. Sydney is uniquely positioned; neither Melbourne, Brisbane or Perth are currently subject to this level of congestion, although this situation is likely to deteriorate over time. Hence road transport of containers in these regions are relatively productive compared with Sydney.

⁴ PwC/Ranbury, *Optimising the use of rail in landside port transport networks*, 2017.

⁵ Austroad, *Congestion and Reliability Review*, Research Report R533-16, 2016.

Figure 7: Port Botany – Rail mode share and volumes



Source: BITRE Waterline 60, Published 2017

The NSW government plans to increase the share of containers moved through the port by rail to 28 per cent by 2021.⁶ NSW Ports has set a longer term target to move three million TEU per year by rail by 2045, which represents around 40 per cent of forecast container volumes.⁷

Current focus areas to achieve this modal shift include:

- developing or upgrading intermodal terminals and rail yards at key locations including Enfield, Cooks River and Moorebank;
- identification and reservation of a rail transport corridor to allow the planning and construction of a future Western Sydney Freight Line that can link with the Port without curfews and constraints. Pacific National has previously indicated an intention to establish a terminal facility at St Marys on the planned Western Sydney freight line;
- enhancing rail freight routes including duplication of the rail freight line between Port Botany and Enfield which currently includes a 2.84 kilometres section of single-track. This project is also flagged as a 'high-priority' initiative in the Infrastructure Australia Priority List; and
- improving the efficiency of Port Botany cargo movements through the Cargo Movement Coordination Centre, coordinated by Transport for NSW.

⁶ Transport for NSW, *Strategic Action Program 2 – Network Capacity*, p.120.

⁷ NSW Ports, *Navigating the Future - NSW Ports' 30 year Master Plan*, 2015, p.24.

Sydney terminal infrastructure and capacity

Table 9: Sydney terminal ownership and features

Terminal	Terminal operator	Rail operator	Terminal owner	Freight DCs & w/houses	Multiple operators
Chullora	PN	PN	PN	No	No
Enfield	Aurizon	Aurizon	Port Botany	Yes	No
Moorebank	Qube	Qube	MIC	Yes	Unknown
Yennora	Qube	Qube	Stockland	Yes	No
Minto	Qube	Qube	Qube	Yes	No
Villawood	Toll/DPW	TBA	Toll	Yes	No
Cooks River	MCS	Various	MCS	No	Yes
Port Botany	Patrick- DPW	Various	Patrick- DPW	No	Yes

Source: Terminal operator data, PwC analysis

Table 10: Sydney throughput and short term capacity

Terminal	Volume*	Domestic IMEX	Services per week	1500 m trains	Short term capacity TEU p.a.
Chullora	High	Both	25 +	Yes	600,000 +
Enfield	Med	Both	12 +	Yes	300,000 +
Moorebank	High	Both	TBA	Yes	1,500,000 + ⁸
Yennora	Low	IMEX	5 +	No	200,000
Minto	Med	IMEX	5+	No	200,000
Villawood	Low	IMEX	5 +	No	100,000
Cooks River	Low	IMEX	5 -	No	100,000
Port Botany	High	IMEX	100 +	No	800,000 +

Note: * Throughput of containers (TEU) at intermodal terminals has been categorised as 'high', 'medium' or 'low' based on the following groupings: High – 200,000+ TEU, Medium – 70,000 – 200,000 TEU and Low – Up to 70,000 TEU

Source: Terminal operator data, PwC analysis

Summary of terminal constraints

- Metro terminals face various brownfield site constraints which have an adverse effect on the efficiency of rail operations. An example of this is short siding lengths that drive the requirement for trains to be split into smaller rakes of wagons on the main loading roads to enable load/unload operations and permit internal site road access (i.e. Yennora).
- The new greenfield IMEX terminal development at Moorebank will not face this same site constraint of the smaller inner metro terminals, given it is designed specifically for the

⁸ Based on contractual obligations with Federal Government.

IMEX task to Port Botany. Moorebank is expected to cater for IMEX throughput volumes up to 1,000,000 TEU per annum, and is due to commence operations in 2018.

- Both Chullora and Enfield terminals are focused on delivering interstate rail services and provide limited port shuttle services.
- Yennora and Minto terminals are subject to passenger network congestion and priority, as well as train length constraints.
- Port Botany terminals have length limitations for the various sidings (340m to 680m). Trains regularly have to be split and shunted into multiple dead-end sidings where loading is split between stevedores. This results in delays, blockages in Botany Yard and additional safety inspections.
- There are a number of issues identified at the Port Botany terminal regarding the efficiency of allocating rail load/unload windows to multiple stevedores. Delays can occur when train services carry more/less than that allocated (e.g. size of their loading window) and difficulties in responding to late trains. Transport for NSW is looking to address real-time management of variability through the Cargo Movement Coordination Centre (CMCC).
- Containers transported by rail incur additional lifts and moves dockside to transport containers to the berth.
- If train services have to shunt to split between, or enter terminals, and cannot exit the network, access through Botany Yard is blocked impacting access.
- Surrounding road congestion is a major issue through-out the Sydney region, with the wide geographic diversity of the rail customer base. There are also road access limitations.

Sydney rail infrastructure and capacity

Sydney's metropolitan system is all standard gauge, shared by local and interstate freight and passenger services.

Figure 8 shows that the Southern Sydney Freight Line from Macarthur to Port Botany provides a dedicated freight link from the south for domestic interstate intermodal and Port Botany terminals. The following metropolitan lines are dedicated to freight and managed by the Australian Rail Track Corporation (ARTC):

- Port Botany Rail Line
- Metro Freight Network
- Southern Sydney Freight Line which provides a dedicated freight link from the south to Chullora and onto Enfield and Port Botany as well as a new connection into the new Moorebank terminal.

The Australian standard over the ARTC network (excluding the Hunter Valley coal lines) is 21 TAL at 115 kph and 23 TAL at 80 kph.

The remaining lines are shared with the passenger network and managed by Sydney Trains.

Figure 8: Sydney rail freight corridors



Source: ARTC, 2015-2024 Sydney Metropolitan Freight Strategy, 2015

The Enfield Staging Facility was opened in 2013 to enable the holding or re-sequencing of trains heading to the port terminals or Port Botany Yard. This has helped to relieve congestion on the port-approach tracks. Siding lengths in the Port Botany shipping terminals are constrained. The DP World Australia facilities, for example, are shorter than a standard 600 metre regional IMEX train, requiring train consist breaking and shunting into the DPW terminal, with three sidings of 340 metres each.

Summary of rail network constraints

- Some metro terminals are affected by shared passenger/freight use outside of the dedicated freight network including passenger priority and peak period curfews (e.g. Yennora and Villawood).
- There are operating constraints at Port Botany in and around Port Botany Yard, and for rail access to the stevedore terminals.
- Outside of ARTC's Southern Sydney Freight Line and Metro Freight Network, freight trains are required to travel on the passenger network. Even where the rail line is dedicated to freight, rail access can be inhibited by the need to cross the Sydney passenger track (e.g. Minto).

Cargo Movement Coordination Centre (CMCC)

The CMCC was established in 2014 by Transport for NSW, as responsibility for the Port Botany Landside Improvement Strategy (PBLIS) was transitioned from Sydney Ports Corporation to the State Government. The CMCC helps to coordinate both road and rail based supply chains at Port Botany (refer to Figure 9 below).

[The CMCC] works with road carriers, rail operators, stevedores and related supply chain stakeholders to maximise use of the existing network capacity and continuously improve the efficiency of cargo movement through the port. The CMCC focuses on key supply chain interfaces – ports, roads, rail and intermodal terminals – for bulk commodities (such as grain and coal) and container freight.⁹

The CMCC is a governing body responsible for implementing/monitoring the following initiatives:

- Mandatory performance standards for carriers and stevedores and financial penalties in the event of non-compliance (road based supply chain)
- The Operational Performance System (OPS) which is specific to road freight and used by registered stevedores and road carriers operating at Port Botany. It integrates stevedores' processing data and truck tracking data to provide a record of operations of the landside interface at Port Botany.
- Stakeholder forums including the Port Botany Road Taskforce and Port Botany Rail Optimisation Group with representatives from key supply chain members. These forums consult and provide advice to Transport for NSW to optimise road and rail freight performance.

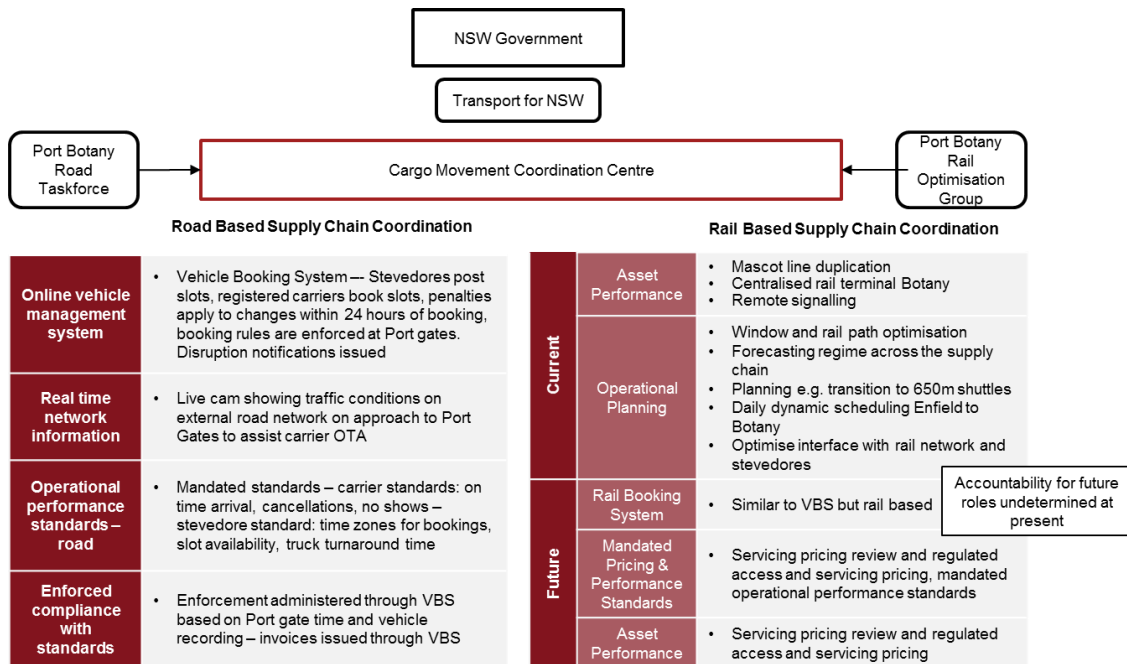
A number of initiatives have been implemented, including the Vehicle Booking System (VBS) in response to road congestion. The VBS is an online vehicle management system whereby stevedores post slots which are booked by registered carriers. Booking rules are enforced at the port gates and penalties apply to changes within 24 hours of booking.

The Port Botany Rail Optimisation Group (PBROG) is currently reviewing three key areas including:

- stevedores productivity;
- number of containers per train; and
- idle time within the port.

⁹ <http://www.freight.transport.nsw.gov.au/cargo-movement-coordination>, Accessed March 2017.

Figure 9: Supply chain coordination at Port Botany (road and rail)



Source: TfNSW PBLIS Presentation (Undated), PwC update to account for changes under Cargo Movement Coordination Centre (formerly the PBLIS).

Supply chain coordination was forecasted to drive \$156 million in efficiency benefits for participants at Port Botany over the period 2011 to 2030, including \$55 million for road and \$101 million for rail.¹⁰

2.3.4 Melbourne

Melbourne does not currently have a cross metro port shuttle in operation. However, there is a likelihood that regional IMEX and port rail shuttles will become increasingly viable as a result of:

- increasing road congestion over time resulting from the proximity of the Port to the Melbourne CBD;
- the Victorian Government has indicated a desire to move the interstate rail operations out of the Dynon precinct adjacent to the port;
- the markets have already been relocated from the port precinct;
- inner land holdings are scarce and are likely to significantly increase in value over time; and
- rail as well as road will be required in the port precinct and planning in the port precinct should seek to address port rail requirements.

Currently, increasing or optimising rail in the port precinct is one of a number of freight and passenger rail projects being undertaken by the Government in Victoria. The Government is also waiting for the delivery of a Rail Access Strategy from the Port of Melbourne.

¹⁰ Strategy& Analysis, Deloitte Access Economics PBLIS CBA Review Stage 1 2012, Sydney Ports Rail Update 2011.

Port Rail Shuttle Network (PRSN)

The Australian and Victorian Governments have allocated up to a combined total of \$58 million (\$38 million and \$20 million respectively) to support the establishment and operation of private sector port rail supply chains moving containers to and from the Port of Melbourne.

This support is intended to be in the form of one-off capital funding to deliver capital works and rail infrastructure on public land. It is anticipated that these funds will be allocated in early 2018 following an Expression of Interest and Request for Proposal by invitation.

In return for Government funding, the private sector entities must commit to delivering minimum volumes of the port container task on rail from 2019 onwards.

Port of Melbourne Rail Access Strategy

Under the terms of the Port of Melbourne lease transaction, the Port of Melbourne operator must prepare a rail access strategy within 3 years which must set out:

- options for rail infrastructure projects for improving rail access for the movement into and out of the Port of Melbourne; and
- a commercial assessment of each identified option including current and projected transport infrastructure requirements.

One of the options set out in the first Rail Access Strategy is for the development of a port rail shuttle. The Rail Access Strategy will be submitted by 2019 and every rail infrastructure option must be capable of being implemented within 5 years after submission.

The Rail Access Strategy has not been finalised. In consultation, the Port has flagged the following key items for consideration:

- Rail terminal options to be developed including potential for a common user terminal.
- There is a potential requirement for rail storage or holding roads for queuing purposes (either near port or on the regional/metro boundary) – this may include holding tracks (in a similar manner to Sydney) and there are options to do this both at Tottenham and immediately to the north of the Port in the Dynon precinct.

2.3.5 Regulation

Rail transport as a mode operates on closed systems managed by below rail infrastructure managers. The network manager facilitates access by rail operators to the multi-user networks. The general freight networks are generally unable to deliver a commercial return on the asset base. This results in the networks being mostly run by State Governments or GOC (Government Owned Corporation) entities (e.g. ARTC). The network managers where required submit an Access Undertaking to state or national economic regulators proposing light handed regulation that results in a non-discriminatory pricing regime and clear access protocols outlining the conditions of access. Pricing aims to cover operating costs and make a contribution to return on capital (asset value) if feasible and usually manifests itself in a flexible floor to ceiling pricing mechanism.

Across the nation, the facilitation of access to metropolitan rail freight networks in major cities and regulation of access are outlined below:

- Brisbane – Queensland Rail / QCA and ARTC / ACCC
- Sydney – Railcorp/IPART and ARTC/ACCC
- Melbourne – ARTC / ACCC

- Adelaide - ARTC / ACCC
- Perth –Arc Infrastructure / ERA.

Rail safety regulation is now centralised under the Office of the National Rail Safety Regulator (ONRSR), who manage rail safety through a risk based regulatory framework. All rail operators, rail infrastructure managers and rail infrastructure construction managers must obtain and maintain accreditation with ONRSR.

2.4 Costs

The freight being transported within the major Australian capital cities encapsulate a range of goods and products that are distributed between a myriad of origin and destinations. In addition, the task varies from parcels, pallets, container/truck loads and train loads of products. Overlaying the physical transport tasks are the overheads associated with the fixed infrastructure that enables the individual transport segments to be undertaken efficiently. These include depots, warehouses, distribution centres and terminals. This diversity results in the cost structures associated with urban freight tasks being difficult to define

The major cost components of the transport tasks fall into groupings of;

- labour;
- fuel;
- maintenance;
- supervision;
- overheads; and
- assets.

The general freight transport market is extremely competitive due to the very low barriers to entry for road operators. The industry is dominated by road transport in the urban areas that operate as small businesses or sub-contractors (Table 10). The sector generally has low capital expenditure, low margins and high throughput. Profitability is driven by volume and scale where aggregation of freight loads determines whether operators can breakeven on any task or load. costs

Table 11: Operating Road Freight Transport Businesses 2014-15

	Operating at the end of FY 2014-15				
	Non Employing	1-19 Employees	20-199 Employees	200+ Employees	Total
New South Wales	6,940	8,212	295	18	15,465
Victoria	6,648	6,285	212	21	13,166
Queensland	5,185	4,680	277	17	10,159
South Australia	1,991	1,222	88	4	3,305
Western Australia	3,124	2,075	152	5	5,356
Tasmania	362	337	21	0	720
Northern Territory	129	122	16	0	267
Australian Capital Territory	146	153	7	0	306
Total	24,528	23,086	1,068	65	48,747

Source: Bankwest – Road Freight Transport Industry 2017

The pricing of transport in the urban environment varies by vehicle type, with city running being driven by time rather than distance as occurs with line haul tasks. The notional cost per hour are in the order of \$70 to \$80/hr for a van or smaller rigid truck that does urban

pick-ups and deliveries, \$100 to \$120 /hr for a semi-trailer delivering containers to from warehouses and DCs and \$150/hour for B-doubles and larger vehicles that are carrying multiple containers between major freight centres such as the port and DCs. The age and quality of the road fleet undertaking an urban delivery task are also relevant in terms of the overall cost and efficiency of delivery.

The operation of the heavy vehicle combinations can be in the form of bulk runs that shuttle a larger number of containers from the ports to freight hubs or DCs for cross docking into smaller loads for delivery to end customers. This was the type of operation undertaken by Qube in Melbourne between Victoria Dock at the port and the Somerton rail terminal when there was insufficient volumes to support a rail service on that route.

Rail port shuttles undertaking urban freight tasks have the additional cost of rail network access charges. These charges levied mainly by Government rail infrastructure managers (e.g. Railcorp or ARTC) may be either a fixed charge reflecting the allocation and use of a train path on the network, or through the application of a task intensity measure reflecting use of the network (e.g. charge per GTK – gross tonne kilometre) or a mixture of both methodologies. The access charges are meant to provide a method of contributing payments for the operating and maintenance of the closed rail network as well as a return on the asset. In an urban rail network, the main task is the delivery of passenger services in the major cities. The charges and contribution to network costs are incremental and represent a small part of the overall train cost of circa less than 5%, and this varies by jurisdiction and network manager.

The operating costs of rail in cities also varies to the extent the loading in containers on Port Shuttle services are dense or cubic and are carried in 20ft or 40ft containers. Operators may charge a base rate and an incremental cost per tonne. The pricing is also determined by the haul distance from the Port to the Port Shuttle terminal.

2.5 Case Study – London

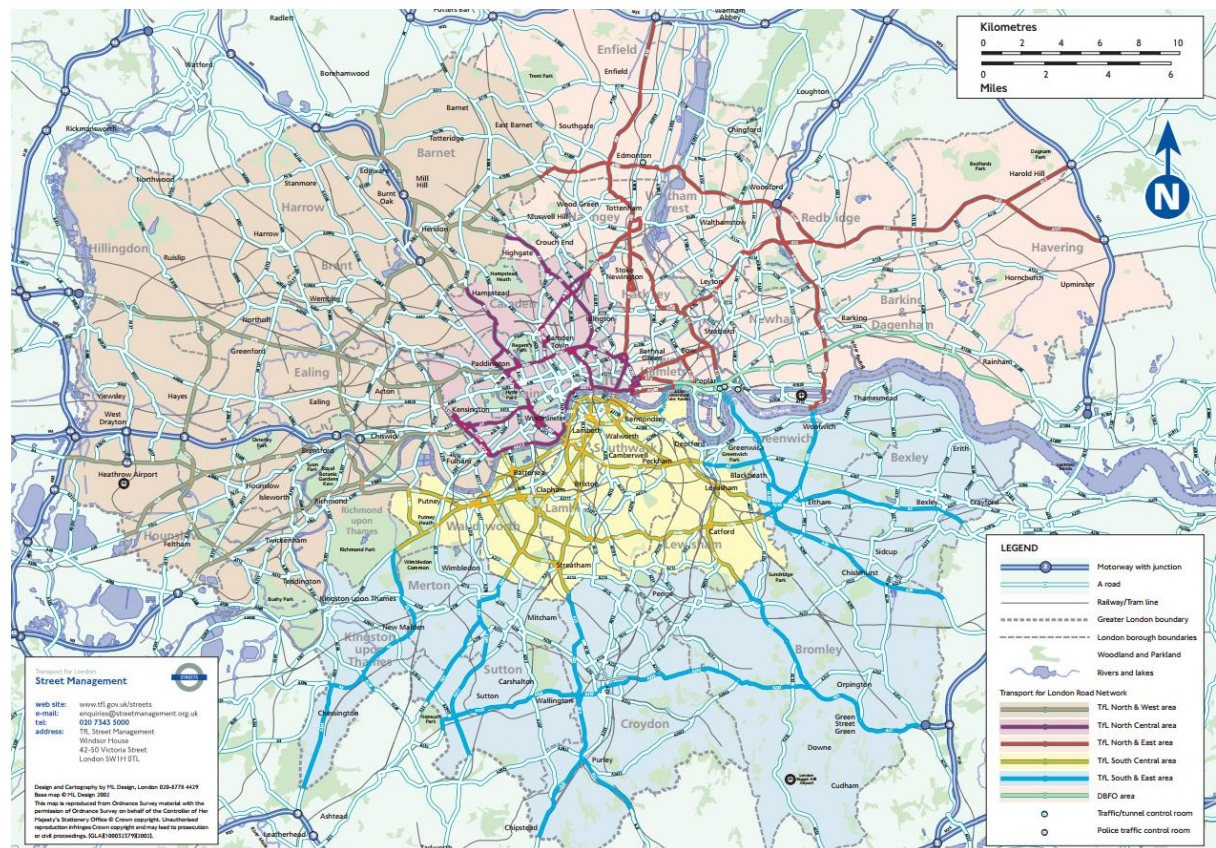
2.5.1 Background

London Statistical Snapshot

- Greater London
- Population – 8.8 million
- Area – 1572 km²
- London Metropolitan Area
- Population – 13.9 million
- Area – 8382 km²

Source: ONS 2016

Figure 10: Greater London Region Map



Source: Transport for London website – master base map

Due to issues arising from congestion, the Government commenced the development of a London Freight Plan in 1999. The intent was to coordinate freight policy across all modes of transport to facilitate sustainable development and balance the demands of the economy, environment and society (Steele & Dumble 2006). To achieve these goals, the Government aimed to:

- improve the efficiency of road freight distribution;

- increase the proportion of the freight carried on rail;
- promote coastal shipping and inland waterways; and
- improve the interchange between modes.

To achieve sustainable distribution the London Freight Plan sought to:

- ensure networks allowed efficient and reliable handling of freight;
- minimised adverse environmental freight impacts;
- minimised the impact of congestion on freight delivery and services; and
- shift freight from road to other modes when if economic and practical.

Part of the plan was to engage with major stakeholder and industry groups. The Freight Plan was reissued in 2004 and 2007.

2.5.2 Modal Challenges

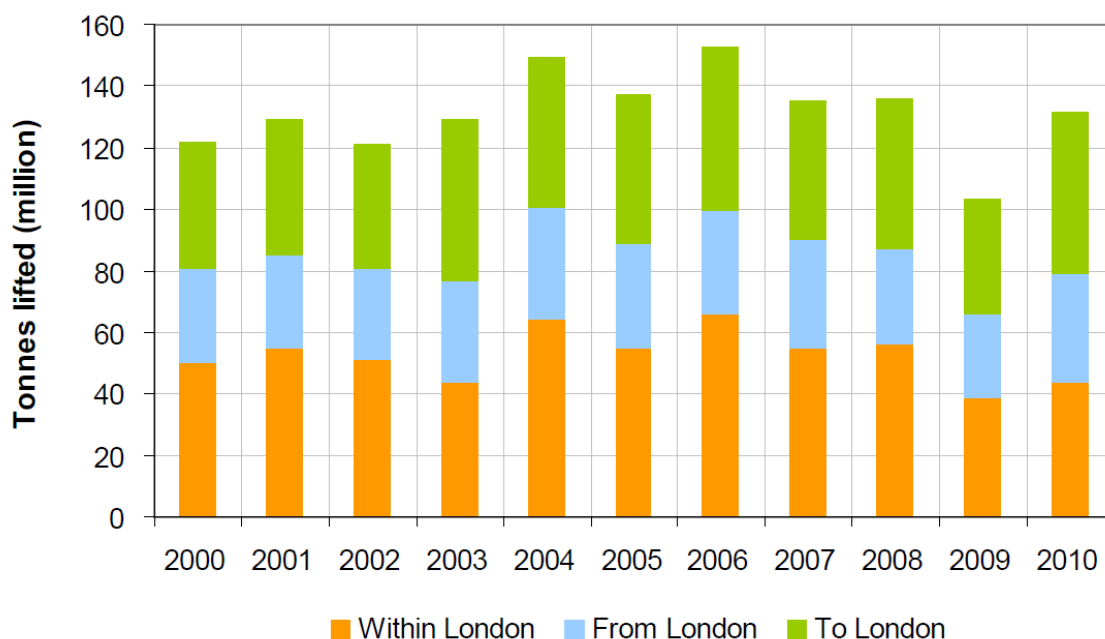
Road Freight (Source: London Freight Data Report 2014)

Most freight in London and the UK is delivered by road. The London Freight Data Report (2014) identified that the road freight mode share was 89% or 131.7 million tonnes of freight transported, with freight accounting for 16% of vehicles and 20% of road capacity. There has been an inter-regional dependency between the London and other freight generating areas (e.g. Ports) with 72% of Heavy Goods Vehicles (HGVs) being for hauls over 100kms (LFP 2007). However, Light Goods Vehicles (LGVs) and Heavy Goods Vehicles (HGVs) only made up 13% and 4% respectively of all vehicle kms on London roads in 2012 (LFDR 2014).

Although the long term projections are for significant increased freight tasks, there has been a downtrend after the GFC returning freight volumes transported to early 1990's levels in recent years (TfL Roads Taskforce 2012).

Approximately 132 million tonnes of road freight travelled on HGVs within the Greater London precinct in 2010. The task comprised:

- 53 million tonnes imported with an external origin and London destination;
- 44 million tonnes had both an origin and destination in London;
- 35 million tonnes had an origin in London and destination elsewhere in the country; and
- HGV journeys were almost equally split between articulated and rigid vehicles.

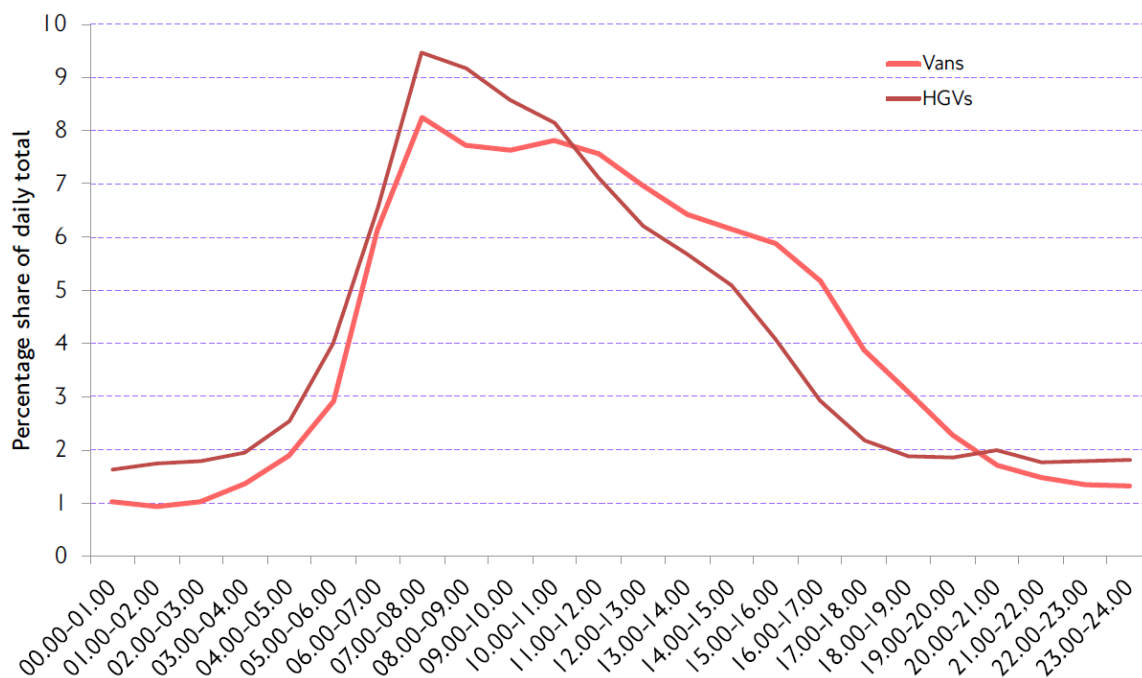
Figure 11: HGVs Journey Tonnages in the London Region – 2000 to 2010

Source: London Freight Data Report 2014

Increasingly, congestion is impacting the reliability of freight delivery in London. There has been a consolidation of freight handling facilities at locations that have good access to the major road networks. There were estimated to be 30,000 transport and logistics workplaces in London in 2013, and 70% of these employed (150,000 staff) were involved with wholesale transport and logistics. Workplaces employing more than 100 logistics staff accounted for only 2 per cent of the businesses in London.

While passenger cars and taxis are the major component of traffic in London with 22.9 billion vehicle km in 2012, Light Goods Vehicles (LGVs / vans) which are less than 3.5 t gross weight and HGVs over 3.5 gross tonnes (rigid/articulated trucks) are the next major traffic generator with 4.8 billion vehicle km. The van and truck traffic is driven by customer delivery requirements and replenishment cycles for freight products. The peak freight vehicle activity occurs between 7.00 and 8.00 am each day and then tails off throughout the day (Figure 12).

Figure 12: Central London Freight Vehicle Access - Average Hourly Traffic Flow 2012



Source: Transport for London – Roads Taskforce Thematic Analysis 2012

The freight that is handled in London is very diverse (e.g. food, consumer goods, office consumables, cleaning services/freight, hotel supplies, hospital supplies, education freight, etc.) associated with multiple different supply chains. Issues that were contemplated and solutions sought included planning of routes, consolidation of loadings, increased out of hour's deliveries and optimisation of alternative modes. In addition, waste products of circa 20 Mtpa are also required to be transported out the region to handling and consolidation facilities.

Rail Freight (Source: London Freight Data Report 2014)

In 2012, 6.7 million tonnes of freight was transport in, out or within London by rail. This equated to 7% of all the freight moved in Britain. The largest freight flow was the inbound segment which was in excess of 5 Mt and the major product grouping was aggregates for construction. These volumes include significant through-volumes that pass through London enroute to/from other regions.

Figure 13: Rail Freight Journey Tonnages in the London Region – 2004 to 2012



Source: London Freight Data Report 2014

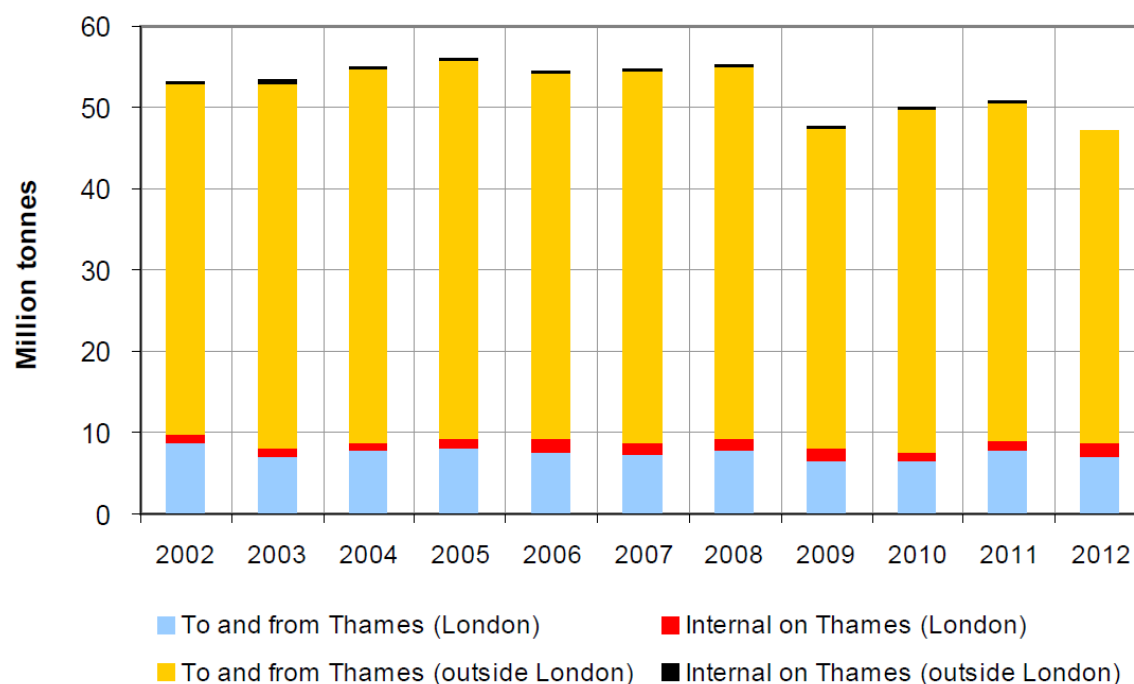
Shipping/Sea Freight (Source: London Freight Data Report 2014)

There are approximately 80 wharves in operation under the jurisdiction of the Port of London Authority (PLA) of which circa 50 are in London and used to varying degrees for freight. While 45 million tonnes of freight was handled at PLA wharves in 2012, only 7 million tonnes of freight was loaded/unloaded at PLA wharves within London. Major products handled across the PLA wharves inside and outside London were intermodal freight, oil and aggregates.

There are a number of major Ports outside of the Greater London area that are servicing London and southern England regions. Major sea ports that form part of the import/export supply chains to the south of England include:

- Folkestone;
- Felixstowe;
- Thamesport;
- Tilbury;
- London Gateway; and
- Southampton.

These ports are not in the greater London region with a concentration in the Essex and Kent regions in the south east. However, the distance from the ports to London are not significant and range from circa 100 km (e.g. Felixstowe) to 40 km (e.g. Tilbury).

Figure 14: Freight handled at PLA Wharves – 2002 to 2012

Source: London Freight Data Report 2014

2.5.3 Major Initiatives

Through the catalyst of the London Freight Plan, there have been a range of initiatives undertaken across the region to improve freight activities and planning.

Retiming Projects

An example has been the establishment of WestTrans which is a partnership of six councils in West London to produce the WestTrans Freight Strategy in 2016. The strategy aims to:

- improve air quality and reduce emissions;
- increase the efficiency of freight activity;
- reduce road network congestion;
- support technology use and innovation;
- improve freight safety; and
- optimise business and economic outcomes.

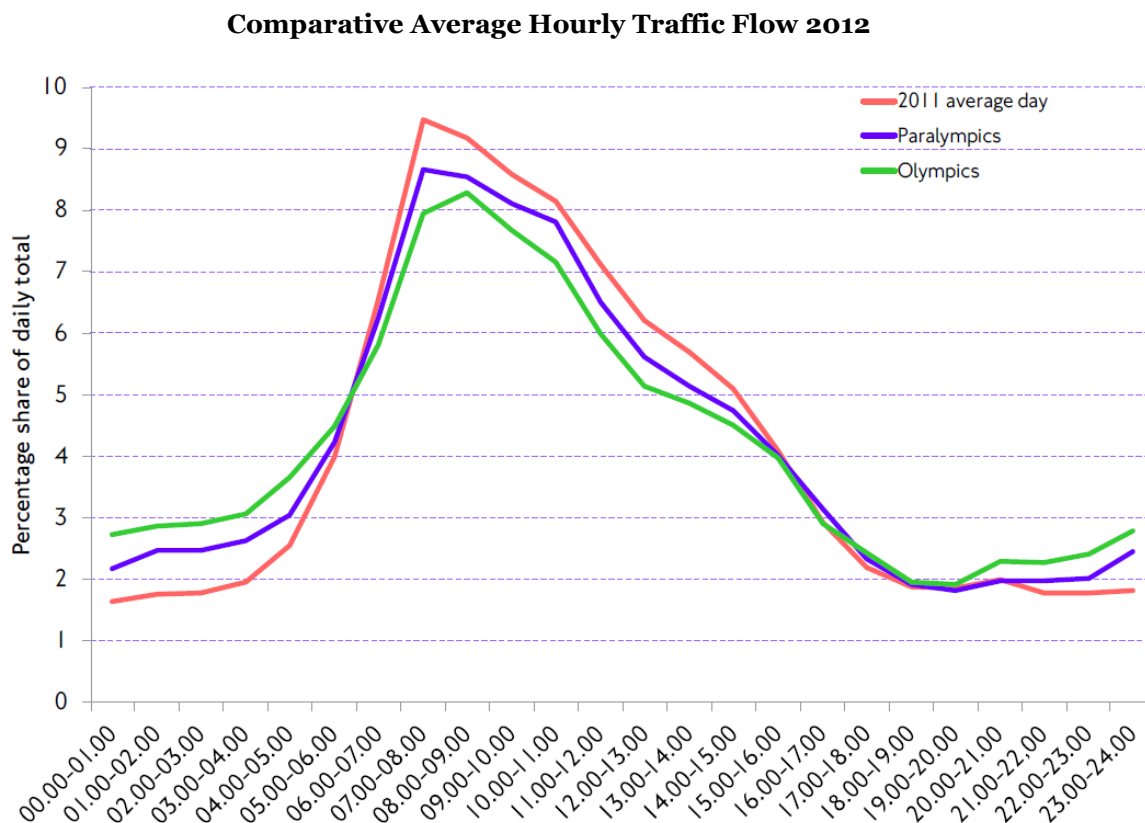
There are 15 initiatives that are being pursued to achieve these objectives. One of the major initiatives of WestTrans and the London Freight Plan is the Retiming of Deliveries. With a global objective of increasing the efficiency of deliveries and reducing the number of freight vehicles in peak periods, the approach has been to have the “*Right vehicle, at the Right Time, in the Right Place*”. Key steps are:

- reducing the number of freight vehicles through reduced demand, consolidation of demand and consolidation of supply;
- retiming outside of peak hours;

- routing more efficiently; and
- revising mode operations.

Congestion issues were able to be addressed during the 2012 Olympics and Paralympics (Figure 15).

Figure 15: Central London Freight Vehicle Access



Source: Andrew Barwick – Retiming Deliveries London Pollution Study Group 2015

Changes were achieved through retiming of deliveries. Transport for London has developed a consortium of business and Government stakeholders to develop and implement plans for delivery of project initiatives. The program developed has four themes (Barwick 2015):

- establishment of the Retiming Deliveries Consortium to lead change;
- undertaking retiming trials;
- match making for retiming options; and
- introducing quiet technologies.

Through understanding opportunities and limitations related to sites, planning conditions, equipment, noise standards and local authority requirements, Tesco for example was able to retime deliveries to circa 250 stores in London.

2.5.4 Sainsbury Wandsworth Supermarket Retiming Case Study

A case study in the potential benefits of retiming was highlighted in a Sainsbury Case study produced by the Freight Transport Association (FTA). Sainsbury's Wandsworth supermarket

was restricted from delivering between 12.00 pm and 6.00 am due to noise abatement notice restrictions from Wandsworth Council. A trial was undertaken to establish a blueprint for noise reduction with local authorities. The trial involved deliveries to the store between 1.30 am and 3.00 am aimed to demonstrate:

- reduced noise;
- improved journey times;
- improved turnaround, sales, and availability of stock; and
- improved fuel economy, emissions and air quality.

Major findings included an 8 to 10 decibel noise reduction from the installation of dock curtains which sealed noise from inside the trailer and on the delivery dock (e.g. transfer of roll cages). Supply chain benefits from the trial included:

- round trip journey time savings of 60 minutes equating to 700 hours being saved p.a.;
- reduced number of journeys equating to a reduction of 700 journeys per year;
- saving of 68 tonnes of CO₂ per year;
- fuel savings of 25,000 litres p.a.;
- earlier availability of products on shelves at opening time; and
- no residential complaints.

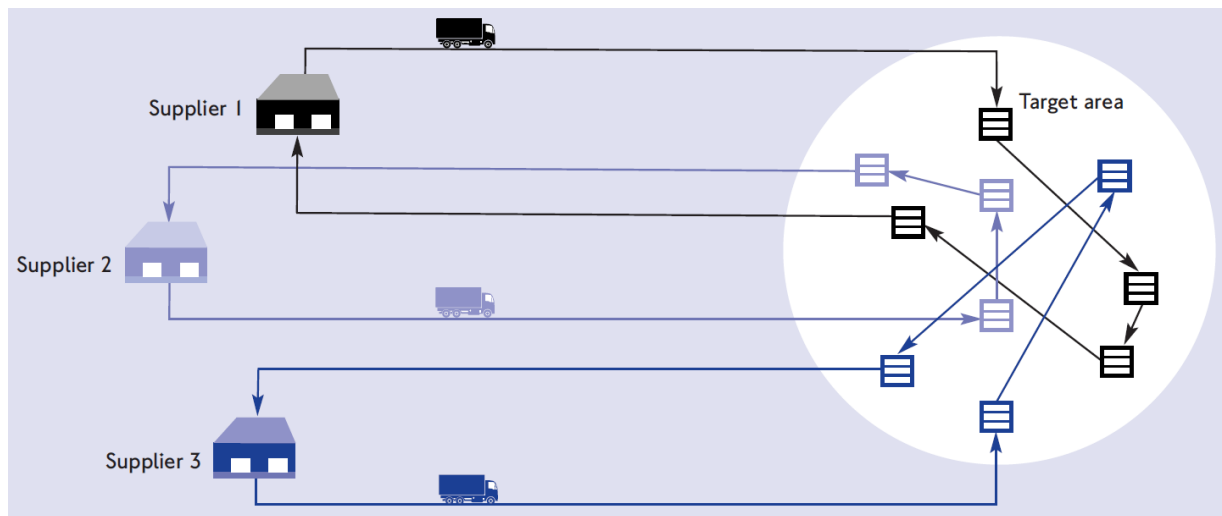
The trial using a “silent approach” philosophy delivered more efficient use of resources as well as balancing delivery time peaks and troughs to reduce congestion, costs and pollution while improving the customer offer.

Consolidation Centres

A major initiative of the London Freight Plan was the introduction of delivery service plans (DSPs) to focus logistics service providers on optimising the freight haulage task across a number of dimensions. An option that has emerged as a core strategy to improve and streamline the logistics tasks in London has been the establishment of Consolidation Centres.

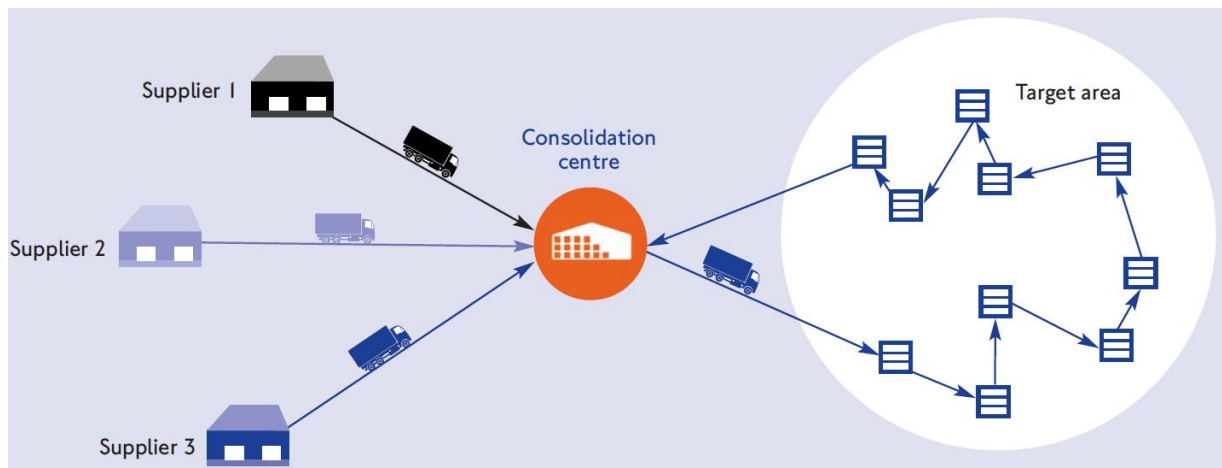
The concept is anchored around the benefits of having fewer larger freight deliveries rather than multiple smaller deliveries over the last mile of the delivery route. Traditionally, freight forwarders delivery tasks that are primarily organised by the suppliers of freight and deliver to multiple end customers in a zone that is congested and constrained in terms of delivery access (Figure 16). In contrast, freight is delivered to an Urban Consolidation Centre (UCC) for final delivery to a number of customers in a defined zone by a single logistics transport provider to minimise vehicle duplication and maximise vehicle capacity utilisation (Figure 17).

Figure 16: Traditional Logistics Service Delivery Pattern



Source: Transport for London website – Rethinking Deliveries Summary Report

Figure 17: Logistics Service Delivery Pattern using Urban Consolidation Centre



Source: Transport for London website – Rethinking Deliveries Summary Report

The development and use of Consolidation Centres has been very successful in some circumstances.

The London Construction Consolidation Centre (LCCC) was established by a number of project partners including, Transport for London, Wilson, James, Stanhope and Bovis Lend Lease to provide construction materials to major construction projects in London (TfL 2008). Estimated benefits of using the LCCC has been a reduction of the number of suppliers' vehicles travelling to the construction projects by 68% for sites with limited space surrounded by congestion (TfL 2008). The LCCC channelled materials to sites, preventing them arriving at the wrong time in the wrong place in the wrong condition.

Another London example is the Heathrow Airport Consolidation Centre. Many terminals were not designed for retail logistics and access is restricted. An offsite consolidation centre was established and it was mandatory to use the centre for receiving retail deliveries. The centre provides a shuttle based delivery schedule with fixed timetable delivering directly to the stores. There are 190 stores that receive 45,000 deliveries p.a. spread over 24 hours per day, 365 days per year. As a result, there was:

- 75% less vehicles delivering to the airport;

- a saving of 35 vehicle deliveries per week and 560 vehicle km per week;
- faster deliveries saving 234 hours per week;
- reduced emissions including CO₂, carbon monoxide, nitrogen oxide and particulates;
- increased delivery reliability in the range of 95% to 99%; and
- reduced logistics costs from elimination of part loads, reduced storage costs and supplier double handling.

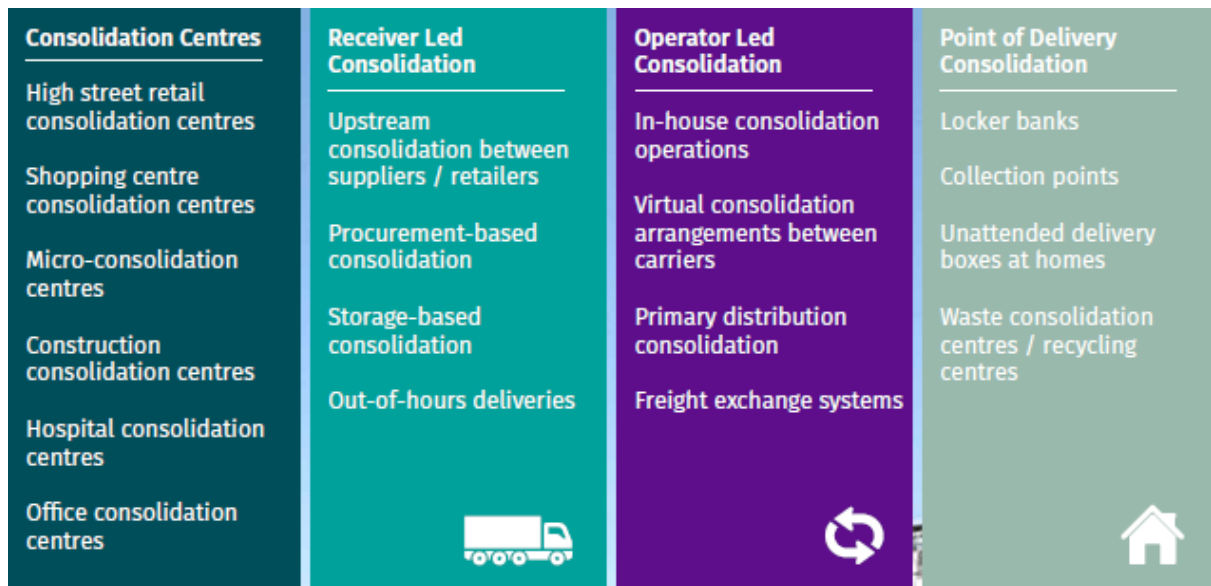
In effect, the large logistics providers and freight forwarders already undertake consolidation and capacity optimisation. They can do this because of the scale of their volumes and critical mass that allows full loads to be directly delivered to customers as a single drop or part load on a fully loaded vehicle. The benefits of consolidation are driven by the ability to streamline existing supply chains.

A whole range of consolidation solutions are possible. They include (TfL website):

- 1 Collective and Collaborative Procurement – Collaborative use of a single or group of suppliers with one or reduced transport service provider to reduce frequency of trips and increase density of loading.
- 2 Increased Order Size – Placement of larger orders to reduce trip frequency.
- 3 Bunching Orders – Consolidate orders into delivery on a predetermined schedule to reduce trip frequency.
- 4 Nominated Carriers – The nominated carrier approach results in multiple suppliers of goods channelling goods through one service provider rather than a different one for different products.
- 5 Upstream Supply Chain – Service providers may share delivery capacity despite competing for customers. It may include delivery capacity, facilities, warehousing, etc.
- 6 Click and Collect – Establishment of local collection hubs for the delivery of products purchase on the internet, avoiding the last mile domestic deliveries.
- 7 Urban Consolidation Centres (UCC) – Delivery of freight to a UCC that then delivers to a clutch of customers in a designated zone using one service provider.
- 8 Micro Consolidation Centre (MCC) – Delivery of freight to a centre much closer to a precinct that has very limited vehicle access. Delivery over the last mile would be provided by a single service provider and small route tailored vehicles (i.e. small van).
- 9 Locker Banks – Delivery of goods and parcels to a centralised lockers in lieu of home deliveries. This reduces delivery variation and trip duration.

The WestTrans Freight Strategy has a large focus on Consolidation as a key pillar of their Freight Strategy. The components scoped for the development of potential actions are outlined in Figure 18.

Figure 18: Types of Urban Consolidation Solutions



Source: WestTrans website – Freight Strategy

As e-commerce retailing continues to grow, combined with higher density urban population centres, consolidation freight delivery solutions and strategies for diverse fragmented transport markets will be essential.

2.5.5 Key Facts and Relevant Issues

- **PUD Services for the last mile** – The continued intensification of major city precincts with increased urban and business development and activity will continue to put pressure on the ability to efficiently transport freight in and out of these areas.
- **Road Efficiency and Access** – Deliveries into the dense city areas is primarily being undertaken by road transport. Access to businesses and residential precincts will be constrained if access is restricted or freight receival areas are not part of planning and development in these areas.
- **Macro and micro freight hubs** – Given many freight movements into the denser areas of cities are less than full truck load consignments down to parcel type deliveries, strategies to consolidate and aggregate the freight volumes to then streamline deliveries into these zones is essential.
- **Port connectivity** - Generally connectivity from Port precincts to inner city areas are poor, with most freight routed through distribution centres. Planning for port connectivity to hubs and consolidation centres would assist the efficiency of freight tasks.
- **Technology** – Increasingly, freight deliveries into dense city areas will have to include out of hours periods. To enable this dimension, a range of automated and silent vehicles will have to be deployed to prevent further congestion and reduce community impacts.
- **Planning and integration** – The requirement to include freight delivery infrastructure into future residential and business developments will be required to optimise the overall operation of supply chains in major cities.

3 Technology

Constant population growth and the urban sprawl in Australia's cities is commanding renewed focus on improving the urban freight and transport networks to allow greater productivity and efficiencies in the movement of goods. New technologies and innovations which have been implemented or are currently being considered within the urban freight network include:

- technology that can track and trace the movement of products along the supply chain;
- robotics and the automation of the supply chain; and
- innovative urban freight facilities and concepts that facilitate greater movement efficiencies in densely populated areas.

This section focusses on the current and upcoming technologies which impact the transportation of commodities from their source to end users

The likely impacts of these technologies on the supply chains and infrastructure requirements is based on evidence from existing deployment where available. The likely impact of these technologies within the Australia context should be verified via stakeholder consultations with industry and government.

Our research and consultation with regard to the impact on urban freight suggest industry is still very much in a proof of concept and piloting stage with regard to the technologies listed, but in the space of Internet of Things (IoT)/sensors and freight management systems, there are some that feel these could be implemented at reasonable scale within the next 5 years. The sections below describe the technologies and innovations currently at the forefront of the freight industry and how they are currently implemented in Australian and International supply chains.

3.1 Tracking & traceability systems

Tracking systems involve technology that is able to transmit information about the location of goods along the logistics chain. For example, Internet of Things (IoT), Blockchain and GPS technology can be used as supply chain tracking systems, which can connect and communicate with suppliers and other supply chain participants. GPS is primarily used as a vehicle locator device as it requires the use of the vehicle battery as a reliable power source. RFID tags are relatively inexpensive, and are most used for tracking assets at a certain location. Blockchain technology serves as the decentralised platform which collects and stores data submitted manually by users and automatically by integrated systems. The security of this data is facilitated by its decentralised and disaggregated functionality which breaks up encrypted data.

3.1.1 Block Chain

Description	Blockchain technology is a decentralised distribution ledger that can hold and record transactions between contracting parties and operates on a user-to-user basis. The technology captures this information and transactions using sensor and signalling inputs along a transaction chain or, more specifically for the Freight sector, along a supply chain. These signals and sensor technology enable traceability of freight vehicles, integrity of product quality through the supply chain and establish accountability and transparency within the freight stage of the supply chain. Blockchain technology is largely being built by users with a need for this decentralized distribution ledger.
Commodities impacted	All commodities.

Take Up	Blockchain technology is mostly in proof of concept or pilot phase with a number of pilots taking place through partnerships between freight providers, businesses and technology solution providers to test the applicability of the technology. Some technology is in small production and this is largely due to the nature of the supply chain of that sector or developer.
Likely impact on supply chain and infrastructure requirements	<p>Blockchain enables verification and certainty around the movement of goods and compliance with contractual obligations as they relate to commercial transactions. Specifically to the freight industry sector, the strong motivators for use of this technology have been driven by:</p> <p><u>Smart contracting</u></p> <p>Blockchain can provide absolute and accurate verification for companies moving goods through freight forwarders. Contracting parties are able to trace their goods and ensure that the goods are secure, moving on time and despatch/arrive according to their contracts. It provides indefensible evidence in the event contractual terms are unfulfilled and allows for renegotiation or revision of terms and payment based on actual services provided, in real time.</p> <p><u>Maintenance:</u></p> <p>The capabilities of the technology allow freight providers to ensure that their fleet vehicles are maintained and in the condition required to fulfil their obligations regarding movement of customer's goods. Sensor technology that can identify those areas needing repair will reduce vessel downtime, creating greater freight capacity in the network that will assist the smoothing of loads. Freight operators can also expect to realise cost reductions associated with less repairs and reduced manual maintenance checks.</p> <p><u>Integrity of goods under logistics providers' duty of care:</u></p> <p>Blockchain with help enable both freight forwarders and logistics providers to demonstrate that the safety and quality requirements of the goods have been maintained whilst under their duty of care. The various nodes of the supply chain can accurately monitor and fully record the movements and environment maintained in the supply chain network. Examples would include the recording of temperature throughout the voyage of fresh/perishable items (i.e. fresh milk) that can verify that it has been kept at or below the required temperature throughout transit. This information can also help identify parts of the supply chain where quality and integrity has failed, enable action to mitigate the breakdown and reduce ongoing wastage of perishable items. With this it can be expected that instances of rejected deliveries will reduce, decreasing backhaul/return trips in urban areas which will improve freight capacity and reduce congestion.</p>
Use case example(s)	<p>Given the integral role of freight movement in the supply chain, Blockchain initiatives have naturally involved freight operators. The following businesses and logistics providers have initiated blockchain trials and pilots, and while the core focus of the blockchain deployment is not on urban freight, it does impact the movement of goods within urban areas.</p> <p><u>DB Schenker, Hamburg Sud and other parties</u></p> <p>DB Schenker and Hamburg Sud have partnered with multiple entities to test the achievability of a blockchain platform for exporting Australian wine to China. It provides visibility over the end to end supply chain and enables verification of provenance, security and contractual obligations across the supply chain.</p> <p><u>Walmart</u></p> <p>Walmart is currently pursuing a US patent for the blockchain technology that will be able to track packages delivered by unmanned drones. If made operational, this technology would create great efficiencies for the end freight of goods especially in densely populated urban areas.</p> <p><u>Fresh Turf & IBM</u></p> <p>This partnership is focussed on bettering parcel delivery through blockchain/cloud based technology. The companies are using blockchain technology to facilitate the tracking of physical storage lockers for shipping and parcel delivery throughout Singapore. It aims to reduce the inaccuracies created by traditional tracking and paper monitoring and inspection processes.</p>

3.1.2 Internet of Things (IoT)/Sensor technology

Description	The use of IoT approaches to tracking technologies has increased with the proliferation of smart devices. Conceptually, IoT traceability systems rely on sensor technology placements across the entire supply chain which can feed into each other when triggered. For example, Radio Frequency Identification Tags (RFID) contain microchips that can identify and respond to radio frequencies. These microchips contain electromagnetic fields which automatically identify and track tags attached to objects. The tags contain electronically stored information. RFID tags can be passive or active, whereby active tags are connected to a battery and can transmit its identity to readers. Passive tags require a reader to send a radio frequency signal first. These readers can then be used to trigger other mechanisms in a supply chain such as coordinate delivery and distribution of the item to which the RFID has been attached. This is unlike traditional barcodes which have to be manually scanned and then fed into a system which may trigger subsequent actions in the supply chains. RFID tracking is demonstrable of how IoT theory can function in an automated manner without human input. Additionally, the use of smart devices such as smartphones in this IoT functionality is predominantly operational in the freight network.
Commodities impacted	All freighted commodities
Take Up	<p>RFID track and trace technology has been established in the freight industry, however, due to growing interest in the authenticity of Australian products in export markets, the technology has an increasingly renewed role in the supply chain and this extends to freight.</p> <p>Smart device IoT technology is also increasingly being implemented in the supply chain network. While emerging in some areas of the freight network, smart device track and trace technology is operational in delivery operations. Mobile devices such as Androids and iPhones can now be used to monitor, trace, register delivery and sign for goods. The integration of these systems across the freight operations of the supply chain is largely in trial phase however some technology solution providers have had success in implementing these platforms.</p>
Likely impact on supply chain and infrastructure requirements	IoT track and trace technology ensures stakeholders in the supply chain have accurate and verifiable records of the source and movement of each individual product. This improves supply chain management and reduces waste in the supply chain. While the capabilities of this technology are still being developed and tested, the ability to input other sources of freight-relevant information such as real time social media traffic conditions, and dynamic delivery routes indicates that this technology will have significant positive influence on the urban freight network and infrastructure.
Use case example(s)	<p><u>National Livestock Identification System (NLIS)</u></p> <p>Currently, track and trace technology is implemented in the cotton industry, with RFID tagging of individual cotton bales for transportation between the ginning facility and spinning mill. Traceability of cotton is required due to the manufacturers having different product specifications. The National Livestock Identification System (NLIS) requires cattle, sheep and goats to be traced with an ear tag that contains RFID technology and this can be traced across the freight network.</p> <p><u>Leopard Systems</u></p> <p>Leopard Systems have developed a freight management system using smart devices which feed supply chain information up into the cloud based platform. The application is integrated to shippers EDI systems as well as capabilities in logistics and transport delivery. It is able to collect and incorporate data across the freight stage of the supply chain.</p>

3.1.3 Global Positioning System

Description	<p>Global Positioning System (GPS) is a supply chain tracking system which can connect and communicate with suppliers and producers.</p> <p>A GPS tracking system uses the Global Navigation Satellite System (GNSS) network. This network incorporates a range of satellites that use microwave signals that are transmitted to GPS devices to give information on location, speed, time and direction of the vehicle a</p>
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	<p>GPS device is attached to.</p> <p>Through the use of GPS, road transport providers have been able to optimise routes, increase truck utilisation, reduce travel time and improve load building and backloading.</p>
Commodities impacted	All commodities
Take Up	GPS is a mature technology which has been deployed for a number of decades. Originally established for use by the defence industry, the technology has been commercialised for use across a number of industries, particularly in road transport to enable the tracking of vehicle location within urban environments.
Likely impact on supply chain and infrastructure requirements	<p>The continued proliferation of GPS technology in trucks and locomotives will enable advancement in the area of freight tracking.</p> <p>Freight management systems (refer Freight Managements Systems section) will rely on the GPS tracking technology to point the location of vehicles so that end users and transport planners can be notified of delays and/or to route transport movements in the most efficient manner. This will support the productivity improvements more advanced freight management systems will deliver such as greater load utilisation and reduced congestion.</p> <p>Tracking systems could result in more efficient asset utilization along the supply chain and more targeted infrastructure investment in road and rail transportation.</p>
Use case example(s)	<p><u>Qube</u></p> <p>Freight transport company Qube uses GPS technology to enable web-based 24/7 real-time tracking. Freight is tracked through the use of Geofence technology that allows status messages to be sent to the online system without driver activation. When the freight carrying the mobile device comes into contact with the Geofence virtual geographic boundary, the software triggers a status message response.</p> <p><u>Australian Rail Track Corporation (ARTC)</u></p> <p>Not all locomotives carry GPS technology, however, the rail infrastructure manager of the interstate rail network, ARTC uses GPS as part of its primary communication system. ARTC is using GPS to implement a situational awareness system that incorporates safe travelling distance technology and real-time locomotive tracking. Currently the use of GPS in locomotives has been for the purpose of rail safe working and communication with train control centres.</p>

NOTE: ARTC's situational awareness system is called Advanced Train Management System. Source: Australian Logistics Council – Using information and Communications Technology to Increase Productivity in the Australian Transport and Logistics Industry July-2010, <http://www.qube.com.au/logistics/technology>, <https://www.artc.com.au/customers/operations/nib/>

3.2 Supply chain automation

3.2.1 Automated port systems

Description	Automated port technology involves the use of robotics to control and manage port operations. These include driverless automated container carriers to move containers around the port and automated stacking cranes for the loading of containers on to the vessel.
Commodities impacted	All commodities
Take Up	<p>Port automation is relatively mature in Australia, as many port terminals around Australia have automated stacking cranes and stevedore operations.</p> <p>A number of terminals have undergone and/or are undergoing automation programs over the last 5 years, such as Patrick's terminal at Botany Bay that completed the installation of automated straddles and machines in 2015.</p>
Likely impact on	Automated port systems is a more efficient way of delivering terminal services. This may

supply chain and infrastructure requirements	<p>reduce supply chains costs as it provides additional capacity required to meet increasing production.</p> <p>The technology will also improve the safety and reliability of terminal operations. It maximises performance and safety, while reducing the impact of external factors such as weather conditions and human error.</p> <p>This overall speed and efficiency delivered within port operations flows through to faster movement in and out for the rail and road operators delivering to the port, smoothing the traffic flow in urban areas where the bulk of Australian ports are located.</p> <p>The impacts of automation on the port function are predominantly positive however port operators are finding that the automation process does limit productivity enhancement because there is no longer capacity for discretionary effort that can occur through the motivation of human workers. Machines can only work to their capacity and cannot be incentivised to work beyond that. Nonetheless, automation does reduce labour costs, and worker safety incidents, and increases efficiencies, driving more constant productivity levels.</p>
Use case example(s)	<p><u>Freight Forwarder:</u></p> <p>Automated stacking cranes are operated from a remote control station in the terminal office area. The remote control station is a duplicate of the trolley-mounted operator cabin, except with the addition of monitors for the camera images of the actual crane's position and movement.</p> <p><u>Victorian International Container Terminal</u></p> <p>The Victorian International Container Terminal also uses remotely operated quay cranes and driverless automated container carriers. Automated container carriers move containers from where vessels are moored to the container yard. These remotely operated cranes and carriers are also operated from a remote control station in the terminal office area.</p>

Sources: <http://www.ictsi.com/operations/victoria-international-container-terminal-vict-melbourne-australia/>,
<http://www.smh.com.au/nsw/sydney-s-patrick-terminal-goes-automated-with-fewer-staff-but-dancing-robots-20150617-ghqc24.html>

3.2.2 Autonomous vehicles

Description	<p>Autonomous transport vehicles which do not require a human operator to function. This includes road freight vehicles/trucks, rail trains, drones as well as passenger vehicles. Using sensor and radar technology these vehicles are able to navigate the surrounding environment without any human input.</p>
Commodities impacted	All
Take up	<p>Autonomous vehicles for point to point transportation are still in conceptual testing phases. The use of autonomous vehicle is largely utilised in closed operational environments, such as mining operations and distribution centres.</p> <p>In October 2016, a driverless truck successfully transported goods 'short-haul' autonomously across the USA. However, the technology required the truck to be on the highway before it could safely be engaged to drive autonomously. The trip therefore necessitated the use of a human driver however, the transport company, Otto is developing the technology such that it is programmed capable for any and every possible traffic condition. Fully autonomous vehicles are projected to be operational between 2020 and 2030.</p> <p>From an infrastructure perspective, in the USA the first steps have been made towards investing in the infrastructure (the Smart Mobility Corridor) capable of facilitating automated transportation and connected-vehicles or road freight trains and drones. In Ohio, the state government is investing \$15 million (USD) to install highway technology including sensors and fibre-optic cables which will increase capabilities for tracking and controlling automated vehicles, traffic conditions, and traffic mobility solutions. Additionally, if the drones wireless concept is successful, this will further relieve the road/rail usage and infrastructure needs of relative government departments and resources.</p> <p>Finally, autonomous air transport has begun conceptually with the use of drones. This concept is however still in its testing phases in the USA and has not yet been commercialised.</p>

Likely impact on supply chain and infrastructure requirements	<p>Autonomous road and rail trains will mean that regulation surrounding driver responsibility (fatigue management, licensing) will significantly reduce. In terms of the impact on supply chains, automation should dramatically cut transport time and costs associated with wastage, delay, recertification, and compliance. Furthermore, the reduction in labour requirements will correlate in fewer instances of worker safety incidents, reduced labour costs (but higher initial capital expenditure) and greater, more constant productivity. However, given these reductions are significant for the transport stage of the supply chain, there are likely to be increases in verification processes and costs for supply chain participants either side of the supply chain.</p> <p>At the Port or end of the domestic supply chain, automation would greatly improve productivity and optimisation of the downstream supply chain. Theoretically, inbound transport consignments could be categorised and scheduled resourcefully to their respective ships and vessels based on variables such as weight, container size, destination, etc.</p> <p>In terms of the impact on infrastructure, the decrease in transportation time (no fatigue management laws and limits on hours spent driving) should result in less road/rail usage because of increased transport efficiencies and capabilities.</p> <p>However, further investment would be required to facilitate the automation of transportation and connected-vehicles or road freight trains and drones. Additionally, if the drones wireless concept is successful, this will further relieve the road/rail usage and infrastructure needs of relative government departments and resources.</p>
Use case example(s)	<p><u>Amazon Prime</u></p> <p>Amazon Air Prime is a delivery service which uses small drones to deliver small parcels. This concept is however still in its testing phases in the USA and has not yet been commercialised. The original drones concept relied on an operator however in January 2017, the use of wireless technology was being tested as a means for creating an entirely autonomous delivery service.</p> <p><u>Mining</u></p> <p>Australian mining companies BHP and Rio Tinto are mature in their use of automated and self-driving trucks and trains. BHP has also publicly indicated it is confident in having autonomous cargo vessels within the next decade and this has been supported by Rolls Royce. Rio Tinto has also announced that it is adopting self-driving trains and drilling rigs.</p> <p><u>Australian grocery retailer:</u></p> <p>An Australian grocery retailer is currently using augmented and semi-autonomous technology across the freight supply chain. There is also prospective consideration of using footpath delivery robots within the next decade.</p>

Source: DIRD (2017), Social Impact of Automation in Transport

3.2.3 Warehouse automation

Description	<p>Automating processes and inputs within the warehouses and distribution centres to better facilitate the movement of goods. The use of consumer technology, autonomous and self-driving warehouse tools is establishing a more cohesive automation functionality at the warehousing freight stage. Augmented reality has capabilities in this area as well. This technology is speeding up the process by guiding human pickers in warehouses to the location of the goods and enabling a faster picking process and faster loading and dispatch of outbound vehicles.</p>
Commodities impacted	All
Take up	<p>Autonomous machinery for point to point transportation in warehouses is mature and largely operational but still developing across some forms of machinery. The use of autonomous vehicles is utilised in closed operational environments, such as mining operations and distribution centres (DC).</p> <p>Uptake of automated picking, packing and putting away processes are becoming standard in DCs. The full automation of DCs where good are not touched by a human at all in the end to end warehouse process requires a high level investment. Many businesses may choose to fully automate a limited number of DCs (where the benefit is greatest) and 'cherry pick' specific technologies within the fully automated DCs to deploy in other</p>

	<p>facilities.</p> <p>There has been an increase in the collaborative use of consumer technological goods for warehouses processes such as using fitbits to track the movement of workers within warehouses. This information is being used to determine efficiencies in worker movement in the picking, packing process and specifically if there any ways to minimise worker effort in this process with regards to goods placement in the DC.</p>
Likely impact on supply chain and infrastructure requirements	<p>The impacts of automation on the warehousing function are predominantly positive. It drives down labour costs, reduces worker safety incidents, and increases efficiencies, driving more constant productivity, as opposed to the pikes and troughs in productivity that occurred when warehouses was operated predominantly by humans..</p> <p>Specifically in urban freight, overall speed and efficiency delivered from DC automation flows through to faster movement in and out for the road operators delivering to and from the facility, smoothing the traffic flow in urban areas where the bulk of commercial Distribution Centres are located.</p>
Use case example(s)	<p><u>3rd party logistics provider:</u></p> <p>A warehouse facility in Hong Kong is also using augmented reality technology to facilitate the picking and packing processes. Through the use of wearable glasses, voice and text guiding technology, pickers are able to more quickly source goods stored in DCs.</p> <p>In Germany, some DCs now have autonomous drones which can fly up and down warehouses and map the availability of goods thereby performing stocktakes and locating their position for pickers and packers.</p> <p><u>Australian wine producer:</u></p> <p>An Australian wine producer has fully automated their warehousing function such that no people now operate in the facility. This is more achievable because of the standard product profile in this industry. In more complex environments, full automation is still in pilot phase with regards to full rollouts in DCs and warehouses.</p> <p><u>Australian grocery retailer</u></p> <p>An Australian grocery retailer has made significant capital investment into developing a fully automated DC in Melbourne. This DC will not require human input to operate the picking, packing, putting away and repacking processes. It is expected to be fully operational by start of 2019. The intention is to limit the full automation of DCs and to select automated processes which can be implemented in semi-automated DCs and operations elsewhere around Australia.</p>

3.3 Digitised supply chain planning

3.3.1 Freight Management Systems

Description	<p>Freight management systems refer to booking, reservation, monitoring, tracking, and allocation systems which enable oversight and management of the freight function in supply chains. The digitisation of these systems is now allowing for better integration between these systems into a multifunctioning platform that provides oversight over the entire freight function from pick up to delivery. In these systems, there are more IoT signals across the freight network that can gather information and track the goods. The integrated freight management systems are now able to work collaboratively in a cloud based environment to gather this data and utilise more advanced algorithms to determine the movement of goods in the most efficient manner. It also allows for efficient planning and allocation of resources within supply chains and helps to improve security around the movement and provenance of goods.</p> <p>As an interim step to full automation and autonomy in freight vehicles, augmented reality is helping to bridge the gap and create greater efficiencies in the driving function of freight and logistics. Moreover, logistics providers are now using personal sensors on their freight drivers to monitor health and safety as well as better engage in fatigue management.</p>
Commodities impacted	<p>All commodities:</p> <ul style="list-style-type: none"> Digitisation and integration of freight systems will enable better customisation of freight and distribution networks, increasing efficiencies, delivery capabilities and reducing congestion in urban areas. Better consolidation and allocative efficiencies

	<p>should also reduce the volume of freight carriers in regional freight corridors.</p> <ul style="list-style-type: none"> • Lag times between demand for additional stock and re-stock should also improve with the analytics technology and data traceability of end to end processes.
Take up	<p>The Internet of Things (IoT) and other models of end-to end traceability solutions are still in conceptual testing phases. There are broader visions of IoT capabilities with the end goal being a “smart city” in which transport, homes, roads, utilities, and other urban systems are all inter-connected and are able to interact to function symbiotically.</p> <p>Within 12 months, a large Australian super market chain intends to have ‘IoT’ smart device integrated capabilities in its freight driving landscape. This will improve their ability to track, allocate and consolidate consignments and implement an Omni-channel delivery function which caters for the customisation needs of their consumers. Another take up in digitised freight systems is the use of real time reservation systems which have evolved from ride-sharing platforms Uber and Lyft etc. to Deliveroo, UberRush and UberEats etc. The rise in these new urban delivery vehicles is transforming the urban freight network, providing greater customisation and efficiency.</p> <p>Regarding the augmented reality technology, logistics providers are fitting personal sensors now to their drivers to better understand the fatigue and health conditions of their workers. This facilitates better compliance with fatigue management laws and also enables management to allocate work on quantifiable data collected.</p>
Likely impact on supply chain and infrastructure requirements	<p>The greatest impacts of IoT technology on freight systems and more specifically urban freight, is evidently its ability to create greater efficiencies in the movement of goods, especially in congested and highly populated areas. Better allocation, customisation and delivery times are all enabled by IoT, integrated systems and more dynamic delivery methods like UberRush and Deliveroo.</p> <p>Supply chain systems will require a technological overhaul to allow for wireless-based tracking capabilities. With the deployment of the IoT (sensors, wireless and connected devices across the value chain and logistics ecosystems on goods, trucks, containers etc.), all components along the supply chain will have to be fitted with IoT enabling technology. To realise the true benefits of these integrated systems, significant investment must be made in deploying the sensor and IoT structure across the freight and wider supply chain network. The long-term impacts on supply chains will have significant benefits on profit-margins (reduced lag times, reduced wastage of transport and logistics) and increased supply and business capabilities (from ‘smart’ systems ability to reorder stock when supplies become low).</p> <p>Additionally, the use of data transfer and analytics technologies would help components of the supply chain to better their service capacity and better allocate their resources where most efficient (e.g. transport providers). In particular, an industry survey recently revealed that eighty per cent of ports surveyed experience significant downtime between busy periods. IoT could be instrumental in increasing port usage year-round and optimise performance at the port end of the supply chain.</p> <p>There would need to be significant investment in the infrastructure of IoT to facilitate a successful implementation of IoT between businesses. For example, without the sensors, wireless and fibre cables network, freight cannot be tracked from pick up to the end destination. This may have economic ramifications in terms of produce wastage, lost capacity in transport facilities and greater road and rail network usage than needed. An added benefit to both the supply chain aspect and infrastructure, is the ability for IoT to monitor asset loads (truck, container, train etc.) to schedule and alert for maintenance requirements. This further improves efficiency costs as only well-maintained transport will be operational on the roads/rail/sea. This should consequently result in less break-downs, greater mobility of transport networks and stronger commerce.</p> <p>Investment in augmented reality is a feasible interim step towards better managing the freight network. This has been outlined in previous sections regarding warehouse automation. The technology is predominantly operational and its capabilities individually will help in better allocation and management of resources (human and technological). When augmented reality is integrated with IoT, the benefits will be quantifiable. The impact will be positive in terms of driving greater efficiencies and capabilities in the freight network.</p>
Use case example(s)	<p><u>Logistics provider</u></p> <p>In South Queensland, a 3rd party logistics provider is now able to operate an Omni-</p>

	<p>channel delivery function, customising delivery vehicles and consolidation processes so that for example, in the one delivery allocation, large pallets of goods can be delivered to a store and single orders to homes in the same delivery.</p> <p>This logistics provider is also increasing the use of real-time responsiveness systems such as UberRush to facilitate fast and lower cost delivery in urban areas. Longer term, the provider would look to the utility of similar real-time response providers in cargo shipping.</p> <p><u>University of Melbourne</u></p> <p>The university is trialling the use of integrated freight network systems in Melbourne. These systems have been operational in Sydney for 12 months and are established in both Europe and Japan. These internet based systems facilitate tracking, monitoring, timing, allocation and registering of loads for transit in urban areas. These systems feed into an innovation explained further below: Urban Consolidation Centre (UCC)</p>
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3.3.2 Traffic management systems

Description	<p>The use of sensor and signalling technology to manipulate the traffic signal systems in urban areas to allow for the more efficient movement of freight delivery vehicles. It allows for greater efficiencies in planning and allocation of traffic and will reduce congestion and delivery times in urban areas. Sensors are placed on freight vehicles which will signal to readers on traffic signals to manipulate the light sequence and allow for the freer flow of freight through congested areas.</p>
Commodities impacted	<p>All commodities</p> <ul style="list-style-type: none"> This technology also has potential capabilities in other areas of transport. For example, public transport would benefit from these traffic management systems particularly in peak commuter times. This would again improve congestion problems in highly populated areas.
Take up	<p>This technology is still in its innovation phase at the University of Melbourne. At this stage, the university is looking at using technology to change the traffic environment rather than changing the traffic infrastructure. There is also further consideration around testing the utility of dynamic freight lanes in urban areas that facilitate more streamlined freight into and out of metro areas.</p>
Likely impact on supply chain and infrastructure requirements	<p>There would need to be significant investment in fitting freight vehicles and traffic signals with the sensor technology to enable the signalling system to function.</p> <p>Once operational, the likely impact on the supply chain would see reductions in delivery times, urban congestion and potentially greater uptake in public transport such as trams and buses because of the greater efficiency in routes and preferential traffic signals.</p>
Use case example(s)	<p><u>University of Melbourne:</u></p> <p>The university has partnered with 17 public and private sector partners on the project to test a 1.2 square kilometre section of the Melbourne CBD to determine where and how the technology would best function in traffic planning, urban freight routes and the public transport network.</p>

3.4 Use of online portals and cloud technology

3.4.1 Terminal booking systems

Description	<p>Online tools and software that streamline port booking systems and container movements.</p> <p>This section looks at 1-stop, which involves the use of online tools and software to reduce port congestion. 1-stop allows for the exchanging of supply chain information where users can directly access vessel schedules, track their containers, lodge Customs documentation, and book times to pick up or drop off containers. It includes a Vehicle Booking System (VBS) that manages terminal capacity with electronic data entry and validation without manually keying in data. The VBS uses a PIN code system to signal each truck arrivals at the port and to alert port workers to collect and deliver the correct</p>
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	container.
Commodities impacted	All commodities
Take up	Globally there are many online portals and software that manages port bookings and container movements. 1-stop is currently implemented at all eight DP WORLD and Patrick terminals in Australia and at the Victoria International Container Terminal.
Likely impact on supply chain and infrastructure requirements	Online tools and software that streamline port booking systems, such as 1-stop, could result in: <ul style="list-style-type: none"> • a reduction in truck queues and turnaround times; • increased reliability and certainty of freight and container movement for freight originators and end users; and • transparent information flow and more efficient allocation and utilization of port equipment. More efficient asset utilisation could result in a decreased need for infrastructure investment at the port.
Use case example(s)	<u>Container Terminal Operators</u> Australia's significant Container Terminal Operators have developed a Port Community System which integrates the communication function between port operators, freight forwarders and logistics providers. This allows for more efficient and complete communication, allocation, booking and movement of goods amongst transport providers.

Source: <https://www.1-stop.biz/>

3.5 Intermodal freight terminals

Description	Intermodal freight terminals are facilities situated at strategic supply chain nodes where intermodal movement allows the efficient transfer of goods from one mode of transport to another.
Commodities impacted	All freight being imported and exported from Australia is via an Intermodal Freight Terminal. Given agricultural commodities are typically produced in regional or inland areas, and intermodal freight terminals are intended to very quickly connect inland areas with Australia's urban supply chain networks and ports, agricultural goods may benefit through intermodal development.
Take up	While not a new supply chain innovation per se, the operationalisation of a number of significant new intermodal developments in Australia is changing the face of domestic import and export supply chains. Application of technologies such as digitised supply chain planning and autonomous vehicles, amongst others, stand to improve the operating efficiency of intermodal hubs in a similar fashion to Australia's ports and other container terminals.
Likely impact on supply chain and infrastructure requirements	Developments at Enfield, Moorebank and Somerton have and will continue to shift greater freight capacity from road on to rail and provide exporters with a cheaper means of transporting their goods to market. Moreover, greater use of rail shuttles for 'wharf cartage' rather than road transport operators will see less congestion on urban road networks.
Use case example(s)	Not provided in consultations

3.6 Trade modernisation

Description	A suite of measures under consideration or in development by the Australian government to re-engineer international trade business process and streamline border regulatory frameworks and leveraging new and emerging technologies such as cloud, artificial intelligence and distributed ledger (or 'blockchain'). These include 'Secure Trade Lanes' and a 'Single Window for Trade, which the United
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	Nations Economic Commission for Europe defines as a one-stop-shop for exchange of information between traders and government agencies.
Commodities impacted	<ul style="list-style-type: none"> all freight either imported or exported from Australia, but particularly freight made up of regulated goods at the border and which requires permission from an Australian government regulator to be exported or imported (for example, prescribed goods under the Export Control Act 1982); and Trans-Tasman freighted commodities.
Take up	<p>Efforts to modernise the trade environment in Australia are in the proof of concept and pilot stage.</p> <p>The Australian government is exploring the implementation of a Single Window for Trade. Examples of Single Window systems can be found in many countries, with New Zealand's 'Joint Border Management System' being a recent and relevant implementation of a Single Window for Trade. As significant assets where clearance from government to undertake the import or export of goods is granted, Single Window systems represent critical ICT infrastructure which can streamline the flow of freight across the border. Where these systems experience issues, such as during the deployment of the Integrated Cargo System in Australia in 2005, they can also inhibit the movement of freight and cause bottlenecks. A move to replace the Integrated Cargo System with a new Single Window for Trade in Australia would likely incorporate the use of innovative ICT architecture and hardware, and may look to incorporate artificial intelligence or leverage industry-led blockchain initiatives. For example, the recently deployed Barbados Single Window employs advanced artificial intelligence in the classification of goods, demonstrating that this technology is becoming more prevalent and cost effective.</p> <p>Governments are also forming partnerships to share data and intelligence on traders in order to better facilitate low risk trade and intervene in high or unknown risk activities. One technological innovation being explored by the Australian and New Zealand governments is a 'Secure Trade Lane' which is designed to "expedite trade and reduce border clearance costs for selected participants." While detailed information on the technical elements of the Secure Trade Lane are not in the public domain, based on our understanding of similar project the technology would involve advanced data sharing between the Customs authorities of Australia and New Zealand and require trusted entities to provide the respective governments with less information less often.</p>
Likely impact on supply chain and infrastructure requirements	<p>Any move by the Australian Government to implement a Single Window for Trade would likely yield significant improvements in terms of border clearance for international traders through the streamlining of business processes and regulatory frameworks. Moreover, the deployment of artificial intelligence would likely disrupt traditional freight supply chain intermediaries such as Customs Brokers and Freight Forwarders where some of the activities previously performed by these entities on behalf of international traders is now automated. In tandem, these types of measures would yield significant increases in the velocity of freight across Australia's border and through Cargo Terminals, Ports and Airports. Conversely, if the implementation of a new system is not carefully managed, it may also lead to the creation of bottlenecks where implementation issues are addressed in a live environment. The faster freight moves from Cargo Terminals, Ports and Airports through to the end user, the higher the capacity of these key supply chain nodes as high container dwell times are cited by Container Terminal Operators as a significant capacity constraint on their facilities.</p> <p>The deployment of a Secure Trade Lane between Australia and New Zealand is likely to impact the flow of freight through the trans-Tasman supply chain. Depending on the number of international traders and volume of freight moving across the Tasman to support their operations, this technological innovation could improve the through-put of Australia's key freight supply chain nodes as well. However, as the Secure Trade Lane is a discretionary supply chain where only certain 'trusted traders' are eligible to ship their freight, the overall impact on the infrastructure and supply chain is expected to be limited.</p>
Use case example(s)	Not provided in consultations

Source: Australian National Audit Office, Customs' Cargo Management Re-Engineering Project, [accessed 7 September 2017], https://www.anao.gov.au/sites/g/files/net3241/f/ANAO_Report_2006-2007_24

3.7 Urban Consolidation Centres

Description	Urban Consolidation Centres (UCC) facilitate the reconsolidation of goods that have been transported from a larger consolidation point to the urban area. These centres serve as the final consolidation and distribution hub from which urban deliveries are made. They create greater efficiencies in terms of vehicle allocation, speed of delivery and customisation of delivery mode. Integrated with these UCCs are technology systems that provide for greater monitoring, tracking, allocation, reservation and registering of loads that are inbound to the facility. These inbound systems are replicated with outbound tracking systems that allow final consumers to have end-to-end traceability of their goods.
Commodities impacted	All commodities bound for urban consumption
Take up	UCCs are operational in Japan and Europe, with some European cities mandating urban bound goods must come through UCCs before final delivery. There is one UCC in trial in urban Sydney, managed by Transport NSW while the University of Melbourne is working on trialling a similar facility in Melbourne.
Likely impact on supply chain and infrastructure requirements	<p>Europe and Japan have enjoyed the greater efficiencies created through UCC implementation. Customised and integrated delivery modes such as micro-delivery vehicles not only reduce congestion but also minimise carbon emissions and costs to carriers (less distance travelled and less vehicle movements from 'smart' vehicle allocation). Through the use of UCCs, smarter allocation of goods bound for metro and urban delivery has resulted in approximately a 70% reduction in distance travelled for large haul freight vehicles.</p> <p>The dynamic nature of UCCs and the technology systems that support them will complement the evolution of end-customer's needs and delivery requirements. This is evident in the surge of real-time, on demand delivery service providers like UberRush, Deliveroo or UberEats. These providers are increasingly becoming the final delivery vehicles for delivery in urban areas.</p>
Use case example(s)	<p>Europe and Japan have well established and operational UCCs that are deriving great benefits to freight networks and consumers in urban areas.</p> <p>While still in trial in Sydney, the University of Melbourne is looking to establish a similar facility to those found in Sydney, Japan and Europe. The university is currently modelling the impact of these systems for Australia and is looking to establish trials in other major cities.</p>

4 *User Needs*

As outlined in Section 2, user needs in urban freight supply chains have transitioned significantly over the last 20 years as:

- Australia's manufacturing base has declined and the nation has become more reliant on imports; and
- population growth has increased in capital cities, within significant densification and intensification of activity in central regions.

In addition to these trends, the freight task that occurs within the major cities is complex and multi-dimensional, unlike resources supply chains that are more linear with a single product supply chain. As a result, the user needs vary according to:

- freight paths through the urban area with consideration to:
 - inbound freight tasks;
 - outbound freight tasks;
 - IMEX tasks into/out of urban areas as well as through traffic (region to port);
 - major freight deliveries (truck/container load) to warehouses and distribution centres; and
 - smaller final delivery freight configurations broken down into components including pallet and consignment deliveries;
- modes being used for freight in the urban areas (road, rail, air and sea); and
- the scale of the tasks being contemplated driven by the requirements of the customers.

Key user needs in urban freight supply chains include:

- cost efficiency;
- capacity; and
- reliability.

4.1 *Cost efficiency*

Cost efficiency is a critical user need in urban freight supply chains given:

- Australia's global competitiveness in export markets is dependent on supply chain efficiency, with transport costs to global markets accounting for a higher proportion of the total cost of production than for many global competitors; and
- a large proportion of Australian imports are products for domestic consumption such as food and beverage, clothing and whitegoods. Inefficient supply chains add to the cost of goods to the end consumer.

Some of the factors that impact the cost effectiveness of urban freight supply chains include:

- congestion and the impact of increasing travel time and vehicle operating costs which has a direct bearing on the cost of road based supply chains;
- quality and functionality of the urban transport infrastructure;
- planning constraints that allow encroachment or impose restrictions on operating hours;
- asset utilisation and cycle times able to be achieved in the urban environment;
- labour productivity and the cost of labour in the urban markets; and
- specialised facilities and vehicles required for the diverse tasks (e.g. refrigerated freight).

4.2 Capacity

Matching the capacity in a supply chain to the market demand is a major requirement for business providers to ensure the delivery of successful logistics outcomes. The task in an urban freight market is more fluid due to the depth and breadth of competition. Supply chain infrastructure and service providers that operate in various market segments are generally available to deliver the required outcomes. Capacity gaps that may exist are incremental in nature and can be solved or supplemented over time.

Urban freight markets are generally serviced by road transport in the majority of market segments. Rail port shuttles are an option where there is an opportunity to connect the port in a major capital city to a freight hub or distribution centre within the city. This is normally driven by congestion impacts or scale effects arising from the point to point volumes associated with the OD route.

In the general freight market segment, fixed infrastructure is normally abundant with more fleet required to extend capacity. The main impediment is the short term nature of contracts with many arrangements being reduced to service agreements that do not encapsulate longer timeframes. Transport service providers have to rely upon their ability to maintain service quality and avoid or effectively manage any service failures.

Some of the key capacity considerations for end users in the urban freight market include:

- rate of product turnover and frequency of replenishment cycles;
- ability to accommodate various stock holding levels;
- ease of access to the store or facility for PUD unloading operations;
- peak period demand impacts;
- size of loads or consignments to be delivered; and
- first and last mile constraints.

4.3 Reliability

In urban freight market areas, there is a very high demand for reliability in supply chains. The ability to achieve DIFOT (Delivered In Full On Time) is a critical benchmarked requirement for most transport operators. The failure to achieve the delivery of critical components (e.g. inputs) of goods or services have severe consequences for customers where delivery failures occur. This is in terms of impact or stopping industrial processes (e.g. manufacturing) or causing stockouts that increase the risk of lost revenue where consumers will shop elsewhere.

Market customers drive the demand for high reliability, generally making it a very important user need. This includes a range of parameters, depending on the particular consignor, customer or product, and include:

- reliability of replenishment cycles of products;
- timeliness and responsiveness to unplanned events and incidents, measured through consignment real time tracking to demonstrate performance accountability;
- ensuring that delivery windows or slots at DCs, warehouses or end customers are met to avoid queuing, rework, double handling and costs;
- ability to maintain asset utilisation and scheduled delivery cycles;
- capacity (route capacity, operating hours, impact of congestion/curfews); and
- accessibility (e.g. by mode, truck size/characteristics, PUD time windows, supplier-customer imposed limitations).

Other considerations include the number of parties within a supply chain, ease of transactions, performance accountability, and degree of control exhibited by parties in the supply chain.

4.4 Issues

In the key urban supply chains, the key logistics operations that form components of various individual product supply chains are impacted by congestion that manifests itself in a range of different forms. This combined with broader system impacts on the User Needs include:

- supply chain route options and the associated congestion impacts;
- replenishment cycle time requirements and PUD travel period embargoes;
- route capability access and unloading limitations including vehicle type and size;
- community impacts associated with a range of issues including noise, congestion, and safety issues;
- geographic coverage including the relative location of consigner/customer and potential impacts on replenishment cycles; and
- consignment sizes and the last mile impacts where route access quality can deteriorate.

5 *Bottlenecks*

The urban operating environment introduces another level of complexity overlayed on the various supply chains operating in the more congested city precincts. As a result, a range of bottlenecks manifest themselves in this operating environment. They are outlined in terms of:

- capacity;
- regulatory; and
- approvals.

5.1 *Capacity*

Potential bottlenecks include a range of limitations including:

- routes that limit the type of vehicle that can operate on the system;
- traffic levels and the resulting congestion arising from commuter and commercial traffic during peak periods and other constrained timeframes;
- system standards (heavy vehicle routes, first/last mile connections, intersections, junctions, axle loads, vehicle lengths);
- limitations arising from operating hours restrictions such as curfews, noise impacts, consignor constraints, and customer constraints;
- warehouse or in-house stock holding limitations; and
- resilience to incidents requiring alternate routing, rescheduling of time slots.

5.2 *Regulatory and/or Approvals*

Some of the bottlenecks outlined under the capacity category manifests itself from regulatory impacts or constraints. These include:

- curfews and access issues arising from noise regulated constraints which can be blanket type restrictions;
- a lack of protection for roads and transport corridors which are major arterial connecting freight precincts with urban demand areas;
- a lack of protection of industrial precincts, freight hubs and transport precincts that facilitate the efficient management and deployment of the urban freight tasks; and
- a lack of loading/unloading capacity in buildings and facilities in high density urban areas that preclude the efficient delivery of the first and last mile of freight.

Appendices

Appendix A Hobart Air Freight Case Study	59
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Appendix A Hobart Air Freight Case Study

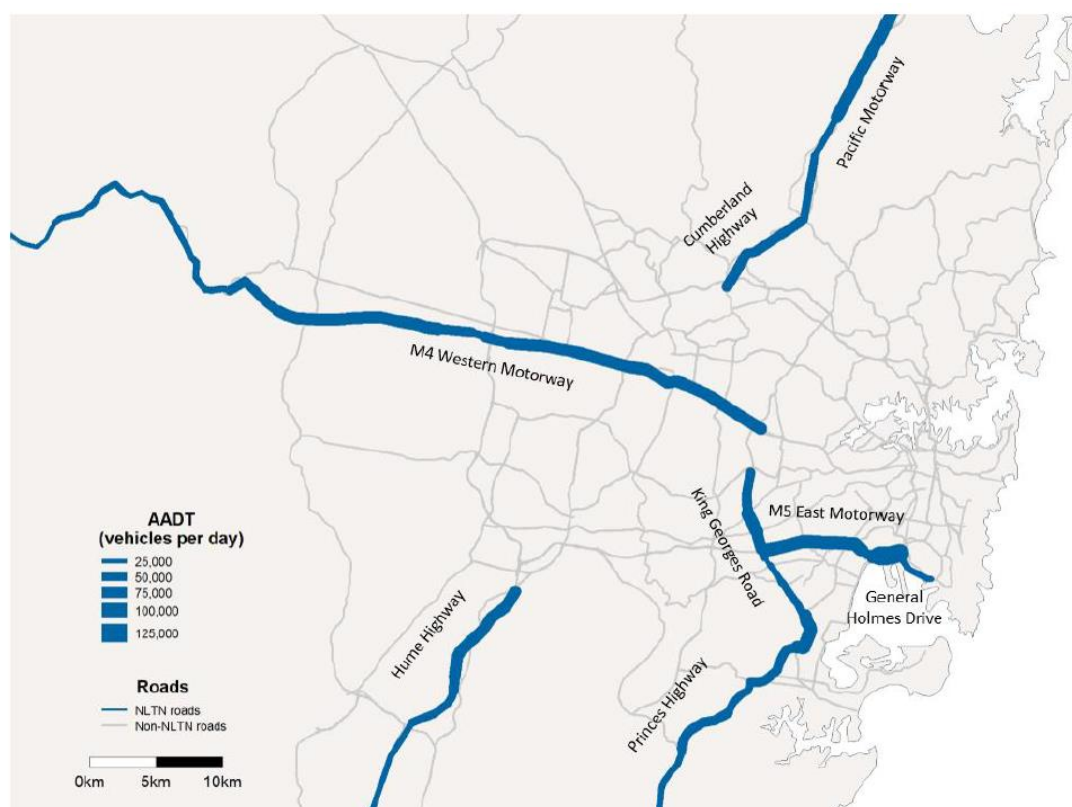
[Attached with this report]

Appendix B Sydney Urban Freight Delivery Case Study

[Attached with this report]

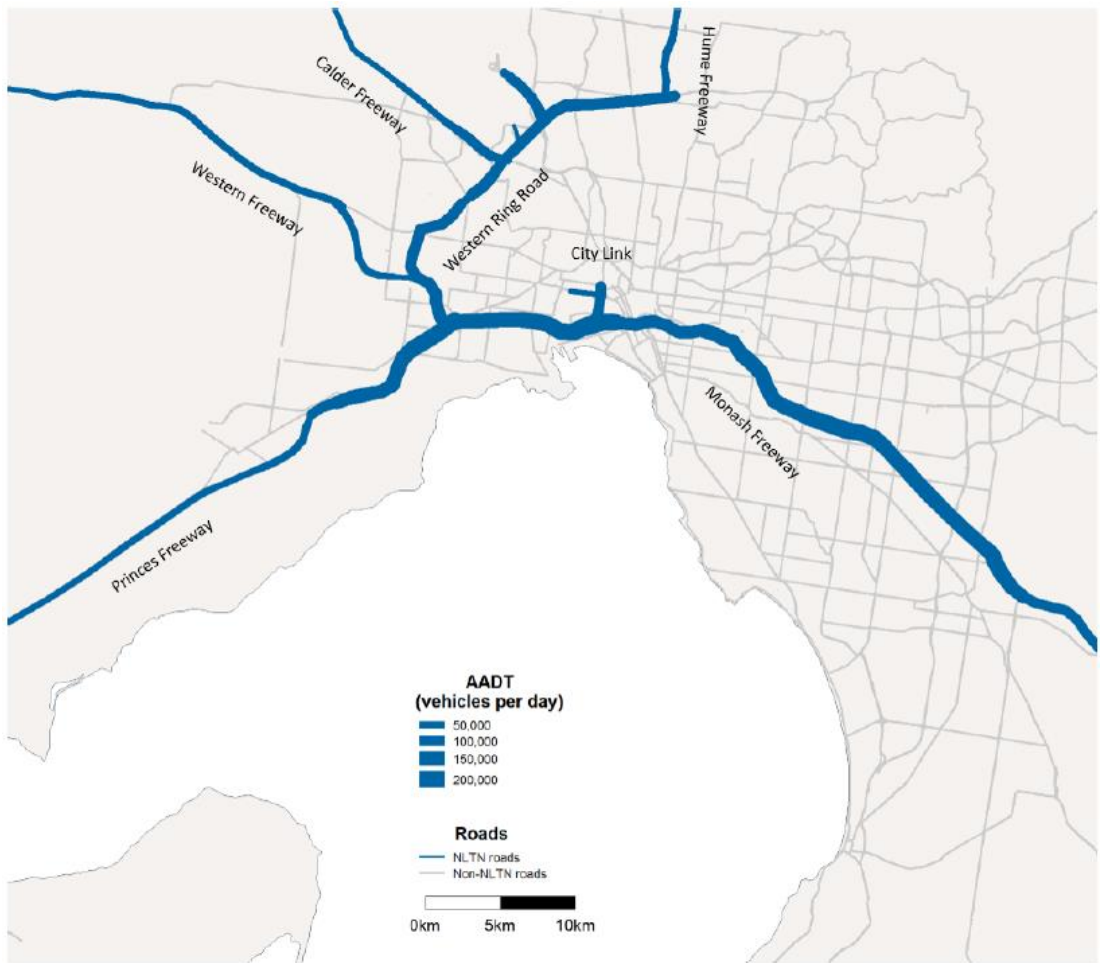
Appendix C BITRE National Traffic Network Maps (Information Sheet 80)

1 Sydney – Major National Road Network links – AADT volumes 2013/14



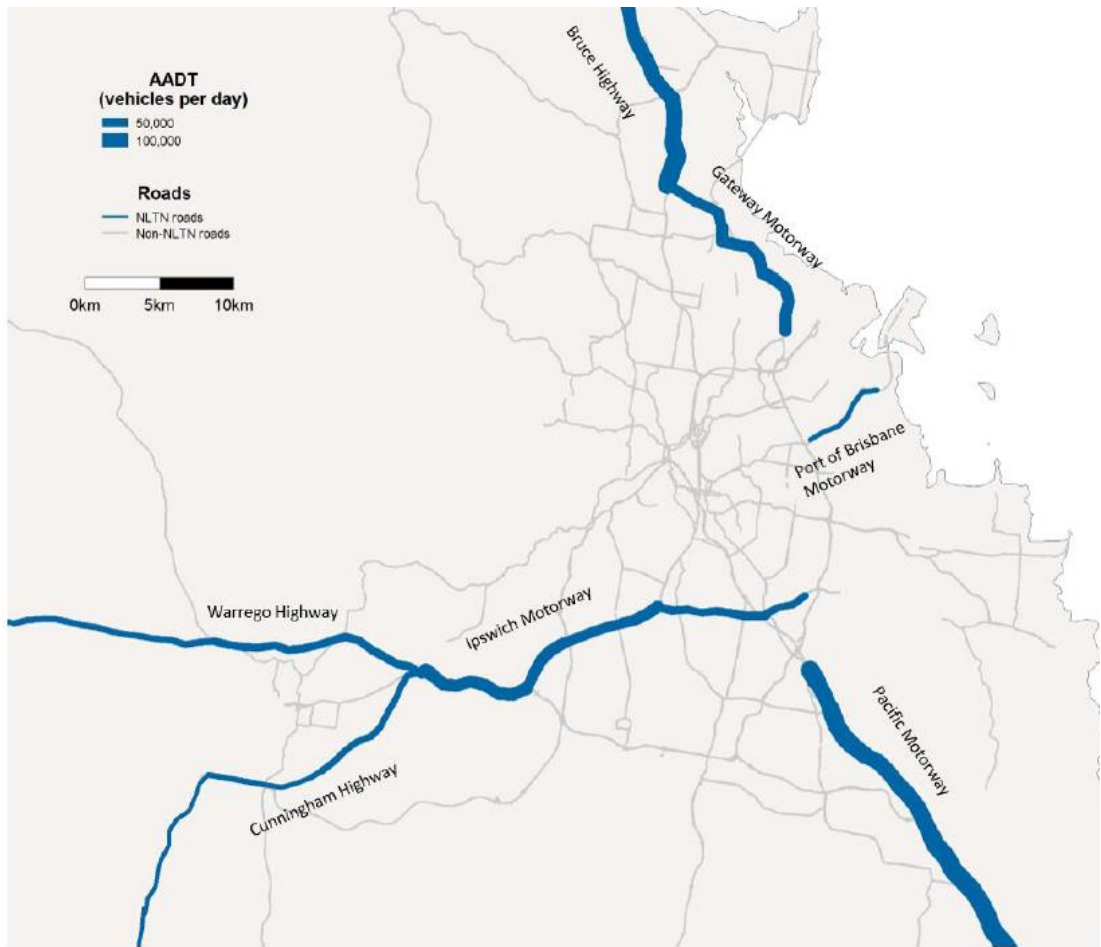
Source: Traffic volumes provided by Roads and Maritime Services, New South Wales.

2 Melbourne – Major National Road Network links – AADT volumes 2013/14



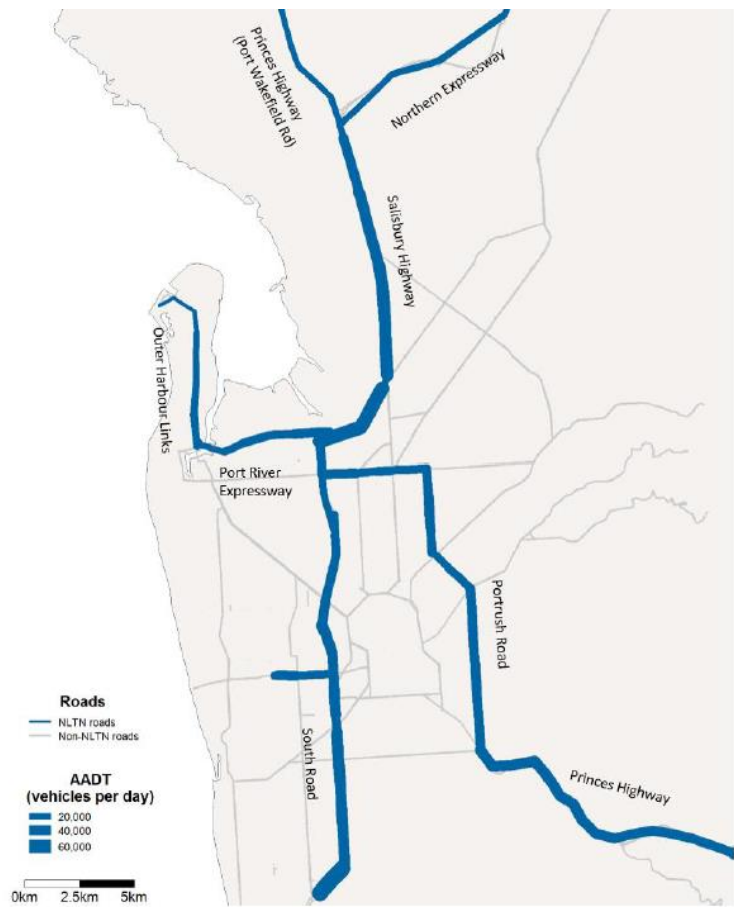
Source: Traffic volumes provided by VicRoads.

3 *Brisbane – Major National Road Network links – AADT volumes 2013/14*



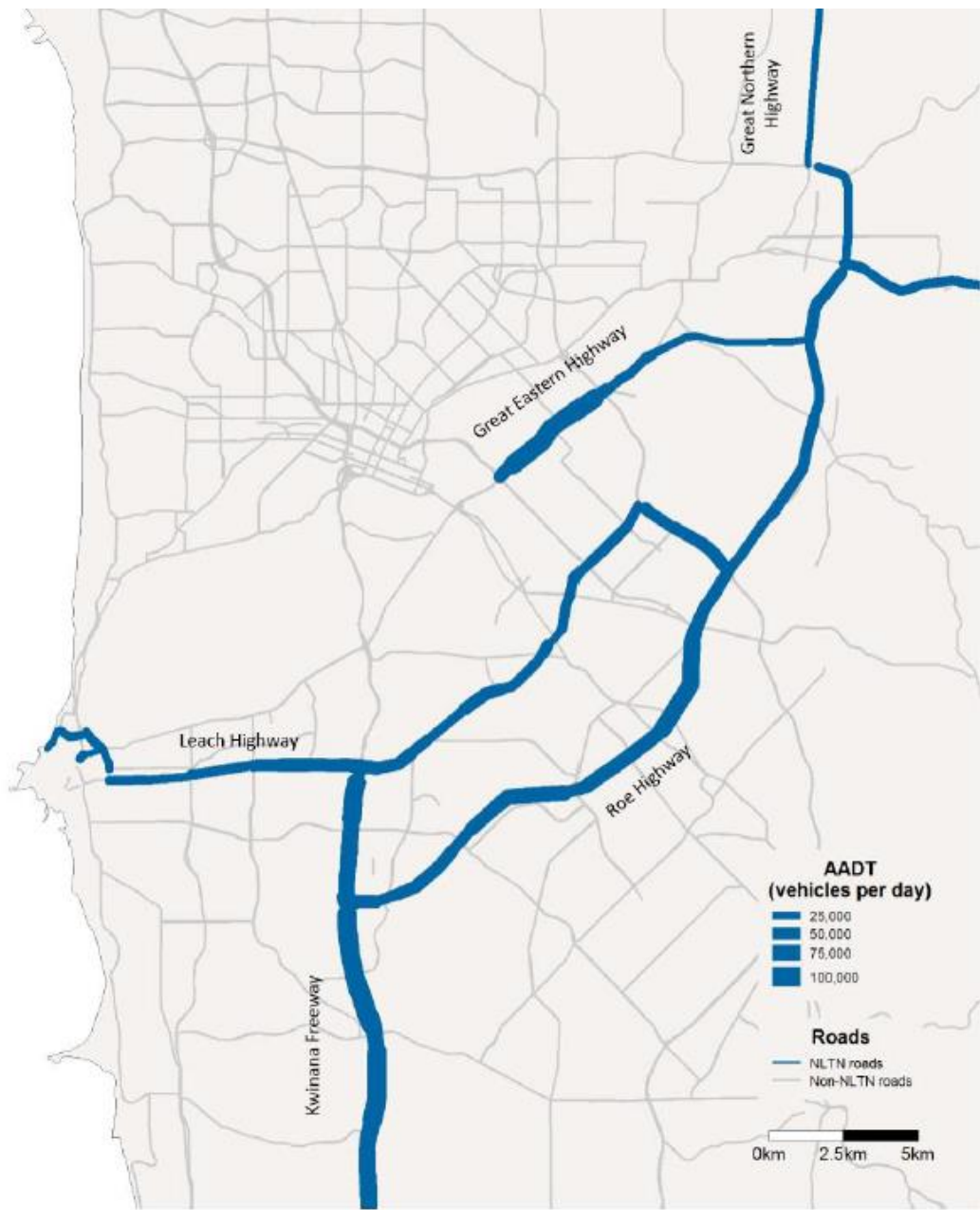
Source: Traffic volumes provided by the Queensland Department of Transport and Main Roads.

4 *Adelaide – Major National Road Network links – AADT volumes 2013/14*



Source: Traffic volumes provided by the South Australian Department of Planning, Transport and Infrastructure.

5 *Perth – Major National Road Network links – AADT volumes 2013/14*



Source: Traffic volumes provided by Main Roads Western Australia.

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