



*CRC for Rail
Innovation*



*Paper 6:
Freight
Infrastructure Issues*

DOCUMENT CONTROL SHEET

CRC for Rail Innovation Floor 23, HSBC Building Brisbane Qld 4000 GPO Box 1422 Brisbane Qld 4001 Tel: +61 7 3221 2536 Fax: +61 7 3235 2768 www.railcrc.net.au	Document:
	Title: Paper 6: Freight Infrastructure Issues Project Leader: Peter Sheehan Authors: Ainsley Jolley, John Symons and Bruce Rasmussen
Synopsis:	

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE	CHECKED BY	ISSUED BY
0	30 April 2009	Michael Charles	Chris Gourlay

DISTRIBUTION

DESTINATION	REVISION										
	0	1	2	3	4	5	6	7	8	9	10
Industry Participant for Review	X										

Established and supported under the Australian Government's cooperative Research Centres Programme

Copyright © 2009 CRC for Rail Innovation

This work is copyright. Apart from any use permitted under the Copyright Act 1968, no part may be reproduced by any process, nor may any other exclusive right be exercised, without the permission of CRC for Rail Innovation.

Table of Contents

List of Figures and Tables	ii
Executive Summary	iii
1. Freight Trends and Implications for Freight Infrastructure	1
1.1. The Rising Freight Task	1
1.2. Challenges.....	1
1.3. Logistics	2
1.3.1. Logistics and Information and Communications Technology (ICT)	2
1.3.2. Logistics and Other Technologies.....	3
2. Intermodal Freight Facilities and Systems	4
2.1. Intermodal Freight Transport	4
2.2. Intermodal Facilities	4
2.3. The Situation in Australia	5
3. Advanced Urban Freight Systems	7
3.1. Combi-Road	7
3.2. AGRIT System	7
3.3. MegaRail Heavy Cargo Shipment	7
3.4. Magtube	7
3.5. Tube Freight.....	7
4. Rail Freight Infrastructure Priorities: The Australian Context.....	9
4.1. Corridor Enhancements in the Next 15 Years	10
4.2. North-South Corridor	10
4.3. East-West Corridor	11
4.4. Hunter Valley Corridor.....	12
4.5. Total Cost of Proposed Enhancements	13
5. Proposed American Rail Infrastructure Investment Study	15
6. Conclusion	16
7. References.....	17

List of Figures and Tables

Table 6.1: Performance outcomes for North-South corridor	11
Table 6.2: Performance outcomes for East-West corridor.....	12
Table 6.3: Performance outcomes for Hunter Valley.....	12
Table 6.4: Total cost of proposed ARTC enhancements.....	13

Executive Summary

BTRE (2003) suggested that the road freight task could increase by 3.6% per annum from 2000 to 2020, a rate well in excess of GDP (2.75% a year) and even more rapid than car passenger traffic (1.4% p.a.). This expected growth of demand for freight will give rise to significant problems, ranging from traffic congestion through to environmental pressures.

Continuing technological transformation and the changing nature of demand for freight transport has implications for the infrastructure necessary to make rail a more competitive freight transport mode. In particular, rail transport is often one link in a total, often complex, supply chain. Transport providers are increasingly becoming part of a total logistics function. This is transforming the nature of the transport task and the infrastructure necessary to support it, while the management of goods is being greatly assisted by the application of ICT. The improvements in information technology make increasingly sophisticated logistics management possible.

Rail transport is being increasingly integrated with other transport modes. The quality of intermodal freight transport facilities and systems is one of the most important factors determining the competitiveness of rail as a mode in freight transport. As a consequence, efficient intermodal facilities need to be provided at each major rail head. The demand for intermodal terminals in Australia is likely to be driven by the level of container trade passing through Australian ports and the increasing non-bulk freight demands on the North-South and East-West freight routes.

Rail transport in Australia is hampered by inefficiencies and poor network performance that reduces its capacity to compete with road on important freight links, such as Melbourne–Brisbane. There is a requirement for a significant investment in the physical rail network to overcome these deficiencies. These investments include concrete sleepers, construction of the southern Sydney freight line, passing lanes, double tracks between Seymour and Wodonga, bypass upgrades, increased height clearances to allow for double stacking, grade separation, improved signalling, and communication systems.

ARTC has outlined enhancements for the next 15 years that will significantly improve the quality of rail infrastructure. These enhancements include network wide improvements at a cost of \$563 as well as;

- North-South Corridor – capacity improvements through northern Sydney, a multi-user intermodal terminal at Moorebank, increased terminal capacity in Brisbane, Network Wide Train Communications Systems (NTCS), Advanced Train Management System (ATMS), double stacking and North Coast and Goulbourn to Junee Deviations at an estimated cost of \$4.933 billion.
- East-West Corridor – increased train length from 1500 metres to 1800 metres, double stacking, track upgrade to increase maximum speed, Horsham bypass, NTCS and ATMS at an estimated cost of \$674 million.
- Hunter Valley Corridor – increased train length to 1350 metres to Gunnedah and increased axle load, a new alignment over the Liverpool Range and ATMS at a cost of \$1.791 billion.

Without this investment, rail will be unable to accommodate the growth in the transport task, maintain the cost competitiveness of Australian business and reduce external costs of transport such as emissions, noise, congestion, deaths and injuries. This investment will lead to improvements in reliability, transit times and cost, such that probability of freight modal shift to rail is greatly improved.

1. Freight Trends and Implications for Freight Infrastructure

1.1. The Rising Freight Task

Growth in freight volumes has been driven at rates above by population growth, by high income elasticities of demand and declining freight rates. In this instance, income elasticities of demand measure the relationship between a change in the quantity of freight demanded and a change in real income. For example, if, in response to a 5% increase in income, the quantity of a good demanded increased by 10%, the income elasticity of demand would be $10\%/5\% = 2$. Income elasticities of demand have been around one, and freight rates have fallen as the productivity of freight and logistics has increased rapidly, thereby allowing a reduction in real freight rates (the price elasticity of demand for freight is estimated at -0.75). As a consequence of these two factors, freight demand has tended to increase by about 1.3 times the rate of growth of GDP in Australia. The process of globalisation, which has encouraged longer supply lines, is a major causal factor in the high income elasticities of freight demand. The other major cause has been the move towards more frequent and varied delivery patterns in distribution associated with the development of new logistic systems (BTRE 2003, 2007).

BTRE (2003) suggested that the road freight task could increase by 3.6% per annum from 2000 to 2020, a rate well in excess of GDP (2.75% a year) and even more rapid than car passenger traffic (1.4% p.a.). Australia's population is forecast to grow at between 1% and 2%. Continuing strong productivity growth in freight and logistics, and the persistence of economic growth over this timeframe, could underpin strong demand for freight transport.

1.2. Challenges

The expected growth of demand for freight and, to a lesser extent, passenger transport, will give rise to significant problems, ranging from traffic congestion through to environmental pressures. Substantial investments in transport infrastructure and new technologies will be needed to deal with these problems (NTC 2007).

The major current issues are:

1. The costs of congestion on the road network, if not addressed, will treble by 2020. Congestion is already increasing markedly in Brisbane, Sydney and Melbourne. BTRE (2007) estimates that the social costs of congestion for Australian metropolitan areas will rise by an average of 4.0% p.a. between 1990-2005 to an average of 5.3% p.a. in 2005-2020. Congestion is primarily an urban issue and consists mainly of incremental delay, driver stress, vehicle costs, crash costs, health impacts and pollution.
2. Large sections of the rail infrastructure are deteriorating, and intra-state rail networks lack viability without government support. This would imply a less than optimal choice in available freight logistics services.
3. Restrictions on Australian ports' ability to service shipping needs, and impediments to integrating the shipping and land transport networks.
4. Increasing difficulties in attracting and retaining people in the transport industry with appropriate skills.
5. Growing tension between land uses owing to the erosion of buffers surrounding industrial developments, transport hubs and key freight routes. As household incomes rise, increasing value is placed on outcomes for safety and the environment. Freight and logistics services increasingly have to take these factors

into account. Urban encroachment is a related problem. It occurs as a result of the land use for transport corridors and logistics centres, and the need for buffer zones around such infrastructure. It gives rise to an opportunity cost for other land uses and environmental impacts.

6. Climate change is an emerging issue. As a large contributor to CO₂ emissions, transport will not ultimately escape from adjustment pressures. Issues associated with climate change are addressed in Paper 1: The Australian Transport Sector and Climate Change.

The multi-faceted transport challenge is to simultaneously:

- accommodate or otherwise manage growth in the demand for transport;
- maintain the cost competitiveness of Australian businesses; and
- reduce the external costs of transport (such as noise, emissions, congestions, deaths and injuries (NTC 2007)).

The freight and logistics sector will face new cost burdens in confronting these issues, and can only maintain its competitiveness by continuing to maintain strong growth in efficiency and productivity.

1.3. Logistics

Certain freight transport services are increasingly being embedded in overall supply chain issues. The science of logistics is becoming one key to supply chain development, and logistics providers are becoming the prime movers, with transport providers frequently becoming part of the overall logistics function.

1.3.1. Logistics and Information and Communications Technology (ICT)

Logistics is only effective when there is an adequate supply of information about what is happening at each point in the supply chain, and when available alternatives are well known and understood. The improvements in information technology therefore make increasingly sophisticated logistics management possible. Of prime importance is the development of barcoding systems that enable goods to be tracked and real-time data to be compiled. Developments in mobile communication technology and various means to exchange data with vehicles have substantial impacts to structured processes, in particular, acquisition of data from moving vehicles and freights. With the further developments and the deployment of mobile communication technology, it has become possible to obtain dynamic data of freight and fleet and to grasp the overall perspectives of freight movements on a real time basis. Other ICT developments of major significance include e-commerce, supply chain-related e-business solutions, digital delivery and B2C e-commerce.

There is evidence from many firm-level studies, and from many OECD countries, that ICT use has a positive impact on firm performance. A typical finding shows that Canadian firms that used one or more ICT technologies had a higher level of productivity than firms that did not use these technologies. Moreover, the gap between technology-using firms and other firms increased between 1988 and 1997 as technology-using firms increased relative productivity compared to non-users. This study also suggests that some information technologies are more important in enhancing productivity than other technologies: communication network technologies being particularly important (OECD 2004).

A range of information systems are being deployed through the logistics system, including vehicle routing and scheduling, track and trace, warehouse management, performance reporting and payment processing, as well as their integration into e-business solutions, e-commerce and digital delivery systems.

In wholesaling, ICTs played a part in the transformation of some wholesaling activities from storage-based configurations to 'fast flow-through' systems through the increased use of barcoding and scanning technology, communications and tracking systems, and inventory management systems. Less storage and handling reduces input requirements.

1.3.2. Logistics and Other Technologies

Non-ICT technological change has also offered new solutions to logistical problems. The standardisation of container sizes and the development of groupage services is an important example. Improvements in equipment for intermodal transport, including modified truck trailers and train wagons, and lifting equipment have also been important. Improved efficiency in the intermodality of transport has been of vital importance in enabling the globalisation of supply chains.

Other examples of non-ICT technological change that have boosted freight transport productivity have been, the use of longer trains with higher axle mass limits and, of course, the containerisation of non-bulk shipping cargoes. For bulk freight efficiency gains include improved loading/unloading speed and capacity automation as well as longer trains.

2. Intermodal Freight Facilities and Systems

2.1. Intermodal Freight Transport

The quality of intermodal freight transport facilities and systems is one of the most important factors determining the competitiveness of rail as a mode in freight transport. FTLIAA (2002) argues that the growth of multi-modal transport services in Australia will improve the integration of rail and road freight services, and the integration of rail into the logistics network, thus improving the sophistication of Australia's freight logistics industry.

Intermodal freight can be defined as the use of two or more modes to move a shipment from origin to destination. An intermodal movement involves the physical infrastructure, goods movement and transfer, and information drivers and capabilities under a single freight bill. An intermodal facility is any site or facility along the supply chain that contributes to an intermodal movement by providing efficient transfer of goods from one mode of transport to another. Facilities may range from transfer points that provide a limited set of services, to purpose-built terminals or hubs, designed for transfers, storage, distribution and a host of associated services.

The intermodal freight sector in Australia consists of two subsystems; one servicing import and export (port-oriented) movements and the other supporting interstate freight movements. In many ways, these operations are independent of each other, but some terminals cater to both port-oriented and domestic movements.

The concept of logistically linking a freight movement with two or more transport modes is centuries old, but the focus since the mid-twentieth century has been on containerisation. More recently, there has been a focus on logistics and global supply chain requirements, which has set the stage for continued intermodal transportation growth. Although trailer and container traffic is frequently foremost in mind when intermodal transport is discussed, it is important to note that many other commodities can in fact be intermodal shipments. For example, all grain moves off the farm by truck before being connected to those movements that will continue by water or rail, and a significant portion of grain transported by rail goes to water transportation. Many other bulk or semi-bulk commodities such as fertilisers and building products move intermodally.

2.2. Intermodal Facilities

The facilities that enable intermodal transport to function are intermodal terminals with their requisite facilities, container ships and other structures (such as double-stack unit trains, exclusive roadways for linking port traffic with major highway facilities and rail spurs). Intermodal movement with air cargo occurs also, but despite being valuable and important it is a small volume or mass task, and requires little infrastructure provision outside the airport itself. Such facilities are costly to provide and, as a consequence, economies of scale are important. As a result, such facilities are difficult to build and consequently can become barriers to entry or access, thereby limiting competition and capacity. Rapid growth in international trade has facilitated the realisation of scale economies in transport, as has the development of larger container ships and the concentration of trade in fewer ports. The worldwide spatial distribution of production activities and trade has encouraged the growth of transport by multiple modes as distances increase. The most important multiple modes were rail and water, truck and rail, and truck and water. Intermodal freight is increasing at a faster rate than freight moved by single modes (USDT 2001).

The unit handling costs associated with the extra handling implicit in intermodal transportation are reduced the longer is the distance covered by rail modes. To facilitate

the realisation of economies, the trend in intermodal transport arrangements has been to consolidate terminals in a hub-and-spoke-system. This provides economies in improved switching productivity, dedicated trains with better service, and reduced train costs as the density increases.

The infrastructure needs of intermodal terminal facilities are:

1. Rail sidings sufficient to handle the maximum length train for the line; facilities for storage and handling of perishable goods; co-locating road-to-road cross-docking activities to facilitate the dispatching of consignments into smaller loads for local delivery; co-locating at the site train support functions such as wagon storage, fuel, and maintenance, cleaning and crew facilities; and providing customer support services that reduce cargo handling and increase supply chain efficiency. Such facilities require considerable amounts of land, and that raises problems because preferred locations are likely to be in already built-up areas.
2. Outside the facility, B-Double minimum standard road access, road access for suitable heavy vehicles, signalling, power, sewerage, water, stormwater treatments, buffer land, landscaping, security, wireless broadband, telemetry services and optical fibre cabling.

It is these front-end development costs that make greenfield terminal developments very challenging commercial prospects. For intermodal hubs that play a role in international cargo movements, linkages with both the commercial ports and the interstate rail network become essential requirements for sustainability. The capacity to shuttle short haul cargoes to and from the hubs in peri-urban locations will relieve port terminal space constraints. For example, the Altona and Somerton in the Melbourne metropolitan area intermodal hubs operate port rail shuttle and interstate rail services for customers. They could have the potential to support substantial increases in freight volumes moved by rail.

The ability to articulate seamlessly with domestic freight routes for larger shipments will distinguish several “superhubs” as the major sites in the port hub network. The superhubs will be capable of receiving direct from the docks under bond for metropolitan distribution and interstate transport. Goods will be able to be consigned direct to the hubs. The superhubs will also need to be able to service a range of transport operators and freight forwarders and service all port terminals. A second tier of intermodal hubs will supply domestics and regional cargoes or may be proprietary to particular freight forwarders or shipping line operators. These hubs would utilise the intrastate network. Regional hubs will continue to service a mix of domestic and international cargo movements and will act as freight consolidators for hinterlands.

The organisation of intermodal transport requires good logistics and cooperation between all parties involved. The organisation of the interchange points and the handling costs involved are the most critical points here. Examples of these interchange points are ports and terminals, in addition to distribution centres and hubs. At these facilities, many technological and organisational problems have to be solved in order to guarantee an efficient and reliable process.

Information technology systems and international standardisation are prerequisites for achieving the necessary standards in logistical services.

2.3. The Situation in Australia

The search for scale economies combined with the recognition of the important role of business to business alliances has led to a massive consolidation of warehousing and

distribution centres. Businesses have established a number of national distribution centres in Victoria to service not only this state, but also south-eastern Australia. These facilities typically operate on a 24/7 basis and require access for large articulated vehicles. Investors are increasingly seeking sites that are articulated with the interstate rail network. Strategic location and open access are two key requisites for any intermodal hub development in order to attract critical freight mass.

The demand for intermodal terminals in Australia is likely to be driven by the level of container trade passing through Australian ports and the increasing non-bulk freight demands on the North-South and East-West freight routes. The future development of intermodal terminals will reflect these broad parameters of growth in addition to the particularities of the route selected for the proposed North-South inland rail and expansion opportunities for intermodal terminals in the adjacent regions.

Melbourne is the leading container port in the country and the hub of the non-bulk freight systems for the large part of eastern Australia. Its geographic position and issues relating to the difficulties confronted in transport to and from Port Botany in metropolitan Sydney imply that the Port of Melbourne will retain, and quite possibly enlarge on, its key role in the Australian transport system. The current project for the deepening of the channel access to Port Phillip Bay and the Yarra will enable larger container vessels to proceed fully laden to the Port of Melbourne. In the longer run, major growth in the Port of Hastings will be required. Improved rail links to the Port of Melbourne will be needed, and later, rail links between Hastings and Cranbourne and north to the Hume corridor will be required (VFLC 2005).

3. Advanced Urban Freight Systems

3.1. Combi-Road

Combi-Road is a new concept from the Netherlands for the surface transport of containers. Combi-Road transports containers on standard road semi-trailers along specially designed tracks. These tracks can either be located on or above ground level or below it, in tunnels. The semi-trailers can, if required, remain with the containers right up to the final destination, in order to minimise trans-shipments. The system contains a combined infrared communication and obstacle detection system and electric power supply rails (Arun 2008).

3.2. AGRIT System

The AGRIT system uses specially-designed railroad cars or trains to carry cargoes through conduits. The cars or trains are fully automated and either monorails or double rails can be used. The system is electrified. The best known AGRIT system is the CargoCap system developed at the Ruhr University of Bochum, Germany. It is a system designed for carrying standard EURO pallets and employs streamlined vehicles running on steel rails in tunnels. More recently, researchers at the Texas Transportation Institute unveiled a new design of AGRIT for transporting whole containers.

3.3. MegaRail Heavy Cargo Shipment

The heavy cargo system developed by MegaRail enables standard rail-ship-truck containers to be carried on a system that connects terminal to terminal. It comprises a heavy-duty guideway, standard 40 ft cargo containers with attached end caps to reduce drag, and an automated container ferry. A version of this technology allows coupling into trains. The standard land-sea container is simply lifted on to the ferry and end caps attached to the container. The guideway contains power and signal lines, and communications devices and traction surface assemblies. It can be assembled alongside rail lines and within the rail right-of-way and similarly assembled with respect to pipelines and freeways.

The cited advantages of the system include increasing the capacity of the existing transport infrastructure (highways, railroads, pipelines right-of-way), decongesting highways and railroads and reducing maintenance costs, increasing port capacity, and faster cargo movements (MegaRail 2008).

3.4. Magtube

The maglev train is usually identified as a mass transit passenger transport system that is too large and expensive for many prospective applications. However, a Californian company, LaunchPoint Technologies has come up with an alternative design which uses the maglev concept employing small vehicles, narrow guideway and new suspension and motor technologies that is adaptable for either passenger or freight applications on either open guideways or in evacuated tubes.

The Magtube freight capsule has end hatches large enough to accept standard cargo pallets or Euro pallets. Shipping containers of various dimensions may also be carried. The narrow width of Magtubes, in elevated or subterranean installations, make it compatible with existing rights-of-way such as railroads, highways and power lines. The system is automated, thus saving on labour costs. Magtube has been developed to prototype stage. While cost would appear to be a barrier against using maglev technology for moving freight, the technology is being considered for transporting containers from and to the ports of Los Angeles and Long Beach (USA) and in Switzerland (Fiske, 2006).

3.5. Tube Freight

Tube freight transportation is a class of unmanned transportation systems in which close-fitting capsules or trains of capsules carry freight through tubes between terminals. In the

past, tube freight systems were pneumatically powered, although conventional electrical motors, linear induction motors and mechanical cable drives could each provide alternative propulsion systems. Tube freight systems can be thought of as a small unmanned train in a tube carrying containerised cargo.

Pneumatically powered transport operates in the following manner. The vehicle operates in an evacuated tube and is propelled by the action of atmospheric pressure, the tube in front of the vehicle being evacuated to a low pressure. By means of suitable valving, the vehicle can be brought to rest at a station by compressing the air in front of the vehicle, thus recovering some of the energy expended in accelerating it. If the track leaving the station is also made to descend in a parabolic trajectory so that the acceleration is minimised and on approaching a station is made to ascend, very high speeds are attainable with minimum energy use. Such deep tunnels together with their pumping equipment would be very expensive. Moreover, a total lifecycle energy analysis would be necessary because of the high energy costs associated with tunneling.

Tube transportation systems for common carriage exist primarily as concepts at this time. Their potential advantage lies in their capacity to provide a totally automated freight shipment service from origin to destination. However, there are numerous design and construction issues to be resolved.

The concept of tube freight transportation is attractive for a number of reasons. Such a system can carry high-volume freight through highly congested areas with minimum effect on surface transportation and completely separate for passenger transport. The benefits from reduced traffic congestion, reliability, greater logistical efficiency (each capsule can be dispatched when loaded and does not have to be assembled into a train, and real time information on the location of each capsule can be maintained inexpensively), increased safety, and reduced impacts on air quality and noise would be considerable. All current tube transportation proposals envision the use of electrical power, and are potentially very energy-efficient (Vance and Mills 1994).

One modern proposed system called SUBTRANS developed in the United States uses capsules that are electrically powered with linear induction motors and run on steel rails in a tube about two metres in diameter. The capsules are unconnected and pneumatic pressure provides a buffering between the capsule and the tube. The SUBTRANS capsules are designed to accept pallets. A case study has been conducted into transporting freight containers by pneumatic capsule pipeline for the New York/New Jersey container ports.

Consideration is being given to an underground freight transportation system in Tokyo, Japan. The system would use standard subway clearances between the capsules and the tube such that pneumatic pressure is not developed between capsules. The system proposes to use linear induction traction. Non-standard containers are designed to be moved through 5.5 m diameter tubes (Capsule Pipelines 2000).

4. Rail Freight Infrastructure Priorities: The Australian Context

There are a range of investments underway in track improvements to reduce train transit times including track straightening, duplication, grade separation and expansion of the kinetic envelope to accommodate double stacking, with important changes taking place in several states. Other system efficiencies can occur through improvement in the trains such as higher power, more fuel efficient locomotives and higher-mass, higher-productivity wagons.

The priorities for rail freight track and signal infrastructure in Australia have been identified by the Australian Rail Track Authority (ARTC) in their *Interstate and Hunter Valley Rail Infrastructure Strategy 2008-2024*. This does not include improvement to rolling stock. Nor does it include major new track such as the inland route to Brisbane. ARTC was created in 1997 by the Federal and State governments to form a single point of contact for operators wishing to access the national interstate rail network. As discussed in Paper 5, it currently has responsibility for over 10,000 kms of standard gauge track in Western Australia, South Australia, Victoria and New South Wales. ARTC is responsible for identifying the infrastructure that may need to be developed to improve costs and efficiency. This section outlines the infrastructure issues and priorities identified by ARTC.

The main components of ARTC-owned or administered track can be categorised as the North-South corridor, the East-West corridor and the Hunter Valley. The East-West corridor comprises Perth to Melbourne, Sydney and Brisbane, while the North-South corridor is the Melbourne-Sydney-Brisbane route. The Hunter Valley comprises coal mine tracks that connect to Newcastle. The East-West corridor has proven to be highly successful with rail's share being approximately 80%. The same cannot be said for the North-South corridor with rail's market share steadily falling since the 1960s. The key factors for the lack of competitiveness and hence loss of market share in the North-South corridor include:

- Reliability: the reliability of Melbourne–Brisbane services has been as low as 40% in recent times.
- Transit times: currently rail is unable to compete with road transport in terms of time constraints.
- Costs: while the cost of rail is comparable to road, the service levels are so poor as to keep market share down. Once service levels improve, cost will become more of a factor.

The focus of infrastructure in the Hunter Valley coal network is to ensure that rail capacity is not a constraint for growth in coal exports.

Current ARTC investments:

The current ARTC 5 year program includes significant works in all three corridors. The North-South corridor has the follow improvements scheduled:

- Concrete sleepers: this allows increased speeds;
- Construction of a southern Sydney freight line, this will remove current curfews on freight trains in the Sydney area although restrictions to the north will remain;
- Passing lanes: reduce delays and allow longer trains;
- Double track between Seymour and Wodonga; and
- Bypasses and upgrades: Wodonga, Tottenham, Dynon.

East-West corridor improvements:

- Increased height clearances to allow double stacking; and
- Passing loop extensions.

Hunter Valley improvements:

- Grade separation;
- Bi-directional signalling; and
- Upgrades and passing loops.

Beyond the current 5-year scope of works, the improvements within the strategy are centred on the following characteristics of rail infrastructure:

- **Container Height Clearance:** Since many bridges and tunnels are constructed with passenger carriages in mind, they have curved roofs that reduce in section at the top and do not accommodate rectangular containers. As a result, most sections of ARTC track are unable to cater for double-stacked containers. Increasing height clearances will therefore enable taller containers or double-stacked containers to be carried. Increasing the height clearance from approximately 4 metres on the North-South corridor to 6.5 metres will greatly improve capacity, efficiency and costs.
- **Signalling and Communication Systems:** Such systems are much more cost effective than new infrastructure by achieving greater throughput on current infrastructure. The new control systems require less trackside infrastructure than traditional infrastructure in addition to improving the efficiency of train dispatching so as to enable more flexible operations, decrease the headway between trains and improve safety.
- **Routes and Alignment:** These have a significant effect on train operations. Track curvature is a major determinant of average speed and grades determine the maximum load capacity for the train and hence how efficient operations may be. In addition to improving average speeds and trailing load capacities, new alignments may be a cost-effective way of addressing height clearances.
- **Capacity:** This is a percentage utilisation of practical capacity. The theoretical capacity is determined by the section running time of the longest section and allowances for safety and signal clearances. ARTC uses a rate of 65% for a single track based on historical experience. A double track has a practical capacity close to its theoretical capacity. Capacity also has implications for transit time. The construction of loops, passing lanes and double tracks can be cost effective methods for reducing transit time.

4.1. Corridor Enhancements in the Next 15 Years

Over the next 15 years, ARTC has outlined enhancements that will significantly improve the quality of rail infrastructure, which would lead to improvements in reliability, transit times and cost, such that probability of freight modal shift to rail is greatly improved.

4.2. North-South Corridor

The proposed North-South Corridor enhancements include:

- Capacity improvements through northern Sydney – the corridor between Sydney and Newcastle is recognised as a major constraint on the North-South corridor. ARTC has proposed enhancements that will result in four freight paths for 22 hours a day that would also benefit passenger services.
- New multi-user intermodal terminal at Moorebank – this will remove growth and competition constraints from limited terminal capacity.
- Terminal capacity in Brisbane – this is important to avoid potential bottlenecks.
- NTCS – the Network Wide Train Communications System.

- ATMS – Advanced Train Management System to provide a new train and safeworking system.
- Double Stacking Melbourne to Sydney – this would reduce costs and add significant capacity.
- North Coast and Goulburn to Junee Deviations – this offers reduced transit time and distance in addition to potentially higher trailing loads.

The cost of these works is estimated to be A\$4.933 billion and lead to the improvements detailed in Table 6.1.

Table 6.1: Performance outcomes for North-South corridor

	Melbourne– Sydney#	Sydney– Brisbane*	Melbourne– Brisbane	Brisbane– Adelaide
Capacity (superfreighter pair per week)				
2009	10	8	16	2
2014	36	33	45	3
2019	59	67	64	4
2014	74	92	77	5
Transit time (hours)				
Target	10.4	15.1	28.0	40.0
2009	11.2	14.7	25.9	37.3
2014	10.1	14.2	24.8	36.1
2019	10.1	14.1	24.7	36.0
2014	10.2	15.0	25.7	37.3
Reliability (% freight available on-time)				
2009	55	55	45	45
2014	85	75	75	75
2019	85	85	85	85
2014	85	85	85	85

Note: #Transit time to Chullora in 2009 and to Moorebank thereafter.

*Transit time to Chullora all years.

Source: (ARTC 2008 p33).

4.3. East-West Corridor

The proposed East-West Corridor enhancements include:

- 1800 metre trains Melbourne–Adelaide – at present, the limit is 1500m trains, while longer trains would increase capacity and increase operational efficiencies.
- Double stacking Sydney–Parkes – this would bring about significant efficiencies and add capacity.
- Track upgrade western Victoria and Cootamundra–Parkes – this would increase maximum speeds and cornering speeds.
- Horsham bypass – this would save 15km of travel and transit times by 10 minutes.
- NTCS and ATMS.

The cost of these proposed enhancements is estimated to be A\$674 million and lead to performance improvements detailed in Table 6.2.

Table 6.2: Performance outcomes for East-West corridor

	Melbourne– Perth	Melbourne– Perth Express	Sydney– Perth	Sydney–Perth Express	Melbourne– Adelaide	Adelaide– Perth	Sydney – Adelaide
Capacity (superfreighter pair per week)							
2009	11	2	6	5	3	5	4
2014	11	3	6	5	7	5	8
2019	14	3	7	6	12	6	15
2014	16	3	8	7	17	7	19
Transit time (hours)							
Target	58.0	50.0	74.0	50.0	12.0	42.5	28.0
2009	55.7	47.7	54.3	52.3	11.6	41.1	22.6
2014	55.3	47.3	53.8	51.8	11.5	40.8	21.4
2019	55.7	47.7	54.4	52.4	11.5	41.2	31.4
2014	56.5	48.5	55.3	53.3	11.8	41.7	21.8
Reliability (% freight available on-time)							
2009	75.0	80	80	80	55	80	55
2014	75.0	80	80	80	55	80	85
2019	75.0	80	80	80	55	80	85
2014	75.0	80	80	80	55	80	85

Source: (ARTC 2008 p39).

4.4. Hunter Valley Corridor

The proposed enhancements in the Hunter Valley include:

- Trains of up to 1350 metres to the Gunnedah basin.
- 30-tonne axle load to the Gunnedah basin
- A new alignment over the Liverpool Range leading to 1650 metre trains from grade improvements.
- Adopt North American rolling stock outlines.
- ATMS.

These works are estimated to cost A\$1.791 billion and provide the performance benefits detailed in Table 6.3.

Table 6.3: Performance outcomes for Hunter Valley

Hunter Valley corridor 2008	ARTC sectors	Speed/axle load	Cant deficiency	Maximum train length	Container height clearance	Signalling system	Distance
Newcastle - Muswellbrook	Port Waratah - Muswellbrook	21 at 115 km/h					123.4 km
		25 at 80 km/h					
		30 at 60 km/h	75 mm	1,650 m	3.916 m	ATMS	
Muswellbrook - Ulan	Muswellbrook - Ulan	21 at 115 km/h					146.6 km
		25 at 80 km/h					
		30 at 60 km/h	75 mm	1,650 m	3.916 m	ATMS	
Muswellbrook - Narrabri	Muswellbrook - Werris Creek	21 at 115 km/h					127.1 km
		25 at 80 km/h					
	Werris Creek - Narrabi (RIC)	30 at 60 km/h	75 mm	1,650 m	3.916 m	ATMS	149.5 km
		21 at 115 km/h					
		25 at 80 km/h					
		30 at 60 km/h	75 mm	1,650 m	4.220 m	ATMS	

Source: (ARTC 2008 p42).

4.5. Total Cost of Proposed Enhancements

The cost of the components of the proposed rail system enhancements are shown in Table 6.4. The largest investment (A\$4.9 billion) is to address the deficiencies of the North-South corridor. The proposed works include duplicating the Seymour–Tottenham line, thereby increasing the capacity of the Sydney–Newcastle link and clearing the Melbourne–Sydney line for double stacking. Individual works on the other corridors are more modest: A\$1.8 billion for the Hunter Valley and A\$674 million for the East-West Corridor. In addition to network wide improvements of A\$563, the proposed enhancements total A\$7.961 billion (2008 dollars).

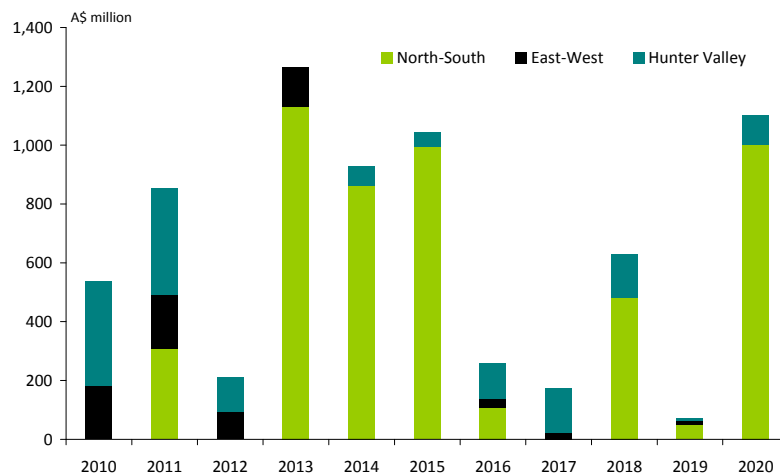
Table 6.4: Total cost of proposed ARTC enhancements

Corridor	A\$ million
North-South	4,933
East-West	674
Hunter Valley	1,791
Network-wide	564
Total	7,961

This does not include any provision for the inland route between Melbourne and Brisbane nor a bypass of the Adelaide Hills.

Expenditure on the proposed works is scheduled over 10 years as shown in Figure 6.1. It shows, however, that many of the major works in the North-South corridor will not be completed until 2015.

Figure 6.1: Total cost of proposed ARTC enhancements by year of expenditure



Source: Author estimates based on ARTC (2008).

These works are focused on track works. None of the proposed investment addresses the issue of the development and improvement of intermodal facilities, such as identified by the ARTC at Moorebank and deemed to be important for efficient connection between road and rail freight in particular. Nor is there any specific provision for improved communications systems also identified in this paper as being important for traffic management. These are being addressed as part of existing enhancement projects.

Following consideration of the ARTC submission by Infrastructure Australia (IA), a number of priority rail projects were listed for further analysis by IA. These include: East-West Rail freight corridor (\$554 m), Hunter Valley Corridor Rail Strategy (\$1.68b) and the North-South Rail freight corridor (\$7.2b) (Infrastructure Australia 2008).

5. Proposed American Rail Infrastructure Investment Study

By way of comparison, a National Rail Capacity Study was commissioned by the Association of American Railroads to estimate the rail freight infrastructure improvements and investments needed to meet the US Department of Transportation's projected demand for rail freight in 2035. Measured by tonnage, this demand is expected to increase by 88% by 2035.

To meet the projected demand, a total of US\$148 billion was deemed to be needed. This included works such as:

- expanding capacity;
- restructuring urban freight terminals and services;
- meeting economic needs; and
- addressing community impacts (Cambridge Systematics 2008).

6. Conclusion

Rail freight infrastructure enhancements are driven by a need to compensate for the years of underinvestment in the basic rail network and to provide for the introduction of new technologies to improve the efficiency of rail freight services. Substantial increases in transport demand and climate change adaptation will require upgraded transport systems. As a result, substantial investment in rail infrastructure and other elements is required. These developments include new intermodal facilities to improve the efficiency of the connection between rail and other (road and shipping) modes, and new communications and signalling systems to increase network capacity and reduce costs. A review of possibilities for technological improvements is provided in Paper 9.

As indicated by the ARTC submission to Infrastructure Australia, the largest cost however is to increase the physical capacity of the network through line duplication, the construction of passing lines, and clearing the rail corridors to permit double stacking. ARTC's estimate of the 2008 dollar cost of these works is about A\$8 billion incurred over the decade 2010 to 2020.

While these investments are essential if the rail network is to have the capacity to accommodate a modal shift, in the context of climate change mitigation, further investment is required to reduce the greenhouse gas emissions of rail transport. This requires progress on the adoption of the new technologies discussed in greater detail in Paper 9 to make rail transport more fuel efficient.

7. References

- Australian Rail Track Corporation (ARTC) (2008). 2008-2024 Interstate and Hunter Valley Rail Infrastructure Strategy, Adelaide.
- Arun Projects B.V. (2008), "Combi Road", Delft, The Netherlands, at: <http://www.arun.nl/combiroadeng.html>
- Australian Greenhouse Office (2007), *National Greenhouse Inventory, Analysis of Trends and Greenhouse Indicators 1990 to 2005*, Canberra.
- Bureau of Transport and Regional Economics (BTRE) (2003), *An Overview of the Australian Road Freight Transport Industry*, Working Paper 60, Australian Government, Department of Transport and Regional Services, Canberra.
- BTRE (2007), *Estimating Urban Traffic and Congestion Cost Trends for Australian Cities*, Working Paper 71, Australian Government, Department of Transport and Regional Services, Canberra.
- Cambridge Systematics (2008), *National Rail Freight Infrastructure Capacity and Investment Study*, Association of American Railroads.
- Capsule Pipelines (2000), *Capsule Pipelines: Cached text 2nd International Symposium on Underground Freight transportation by Capsule Pipelines*, <http://www.capsu.org>
- Cooper, P. (2007), "Energy Saving Hybrid Trains", in IET 2007.
- Fiske, O.J. (2006), *The magtube low cost maglev transportation system* LaunchPoint Technologies, Inc., Goleta, California, USA.
- Freight Transport Logistics Industry Action Agenda (FTLIAA) (2002), *Freight Logistics in Australia: An Agenda for Action*, Prepared for the freight logistics industry by the Industry Steering Committee of the Freight Transport Logistics Industry Action Agenda, and endorsed by the freight logistics industry and its stakeholders on 26 March 2002.
- Goodall, R. (2007), "Research Challenges for Rolling Stock", in IET 2007.
- Institute of Railway Technology (IRT) (2008), "Research Capabilities", Monash University, Melbourne, at: <http://www.eng.monash.edu.au/railway/research>
- IEA (2008), *Energy Technology Perspectives: Scenarios and Strategies to 2050*, OECD and IEA, Paris.
- Institution of Engineering and Technology (IET), Conference 11 October 2007: Rolling Stock – Implications for the Future, www.theiet.org/events/2007
- Infrastructure Australia (2008), *A Report to the Council of Australian Governments- Advising Government on Australia's Infrastructure*, Australian Government
- MegaRail (2008), "Unique Solutions to Critical Traffic and Pollution Problems", Fort Worth, Texas, at: www.megarail.com
- National Transport Commission Australia (NTC 2007), *Discussion Paper on NTC Strategic Directions 2008/09-2010/11*
- OECD (2004), *The Economic Impact of ICT: Measurement, Evidence and Implications*, Paris
- Randall, P. (2007), "Rolling Stock – What do we really want", in IET 2007.
- Sjöstedt, L. (1994), 'Sustainable Mobility' in *A Systems Perspective on Policy Issues Addressed by the 10th CAETS Convocation* in Zürich, SA: 42.E International, Warrendale, USA and SATW, Zürich.
- SKM (2004), *New Technology for Rail*, Final Report to Department of Planning and Infrastructure, Western Australia.

The Economist (2008), "A special report on the future of energy: The end of petrolhead", June 21, pp. 17-18.

Tschirner, P. (2001), 'Intermodality: A Contribution Towards a Sustainable Development and Environment Protection', Austria.

US Department of Transportation (USDOT, 2001), *Transportation Statistics Annual Report 2000*, BTS01-02, Washington D.C.

Vance, L. and M. Mills (1994), *Tube Freight Transportation*, US Department of Transportation, Federal Highway Administration.

Victorian Freight and Logistics Council (VFLC, 2005), *Freight Forward: An Industry Perspective on Transport Infrastructure Requirements in Victoria*, Melbourne.