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The integration of rail and road freight transport and their interface with ports

HoR Standing Committee on Transport and Regional Services

CSIRO submission

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Acronyms used

ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
BTE	Bureau of Transport Economics
BTRE	Bureau of Transport and Regional Economics
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DOH	NSW Department of Health
ICT	Information and Communication Technology
IAP	Intelligent Access Program
ITS	Intelligent Transport Systems
GHG	greenhouse gas
NTDF	National Transport Data Framework
NTDWG	National Transport Data Working Group of the Australian Standing Committee on Transport
NDN	National Data Network
OECD	Organisation for Economic Cooperation and Development
TRB	Transportation Research Board of the USA National Academy of Sciences

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Executive Summary

A National Freight Data Strategy

There is widespread concern about the quality and quantity of freight data available to address questions raised under the inquiry terms of reference regarding:

- The role of regional arterial networks in the national freight transport task;
- The relationship and co-ordination between road and rail networks and their connectivity to ports; and,
- The role of the three levels of Government and the private sector in providing and maintaining the regional transport network.

A National Freight Data Strategy could:

- Develop quantitative estimates of the benefits of better data so that value propositions for data improvement can be assessed;
- Identify existing data sets and supporting information which could potentially be shared between jurisdictions;
- Establish collaborative mechanisms via the National Transport Data Framework or a specific freight data initiative;
- Develop new methods for harnessing data collected by automated processes;
- Demonstrate application of data imputation and transfer for Australia regions; and,
- Implement new science and technology for automated low cost data development and sharing.

Measures for greater efficiency

Land transport access to ports:

- The city ends of freight corridors to ports are particularly important and congestion is a problem.
- Complex traffic interactions in urban areas mean that there is value in detailed modelling to identify optimal solutions.

Opportunities to improve the efficiency of existing infrastructure are available via:

- Intelligent Transport Systems to improve traffic flows and driver efficiency in both regional and urban areas, with benefits to both the environment and the economy;
- Collaborative Logistics, developed with industry partners for bulk and non bulk freight, applied to the integration of rail and road freight transport and their interface with ports; and,
- E-business for Rail: Identifying opportunities from the rail side for e-business applications and understanding barriers which can be cultural and economic as well as technological.

Research and development to advance these initiatives

- Would cost very little in comparison to the costs of infrastructure provision; and,
- Could offer very large returns on a moderate investment.

National importance of road and rail freight

Finally we draw the committee's attention to a recent CSIRO report, entitled 'Balancing Act', that addresses the importance of road and rail freight transport in the context of triple bottom line accounting within the overall Australian economy.

Introduction

The CSIRO has a 40-year long history of research in land use and transport, developing technologies for use in transport planning and operation, in road and rail, for both passengers and freight. We see the freight transport task as a vital element in the economic development of the nation, but consider it as an integral component of transport overall and not in isolation. In this broader context, it should be recognised that inefficiencies in the Australian transport industry are likely to have a greater impact on the national economy than those of Australia's major competitors. However, there are also major societal costs directly imposed by freight traffic and these should also be taken into consideration. Hence recent research has been directed towards improving rail and road freight efficiencies while reducing their environmental impacts.

This submission addresses the terms of reference of the inquiry as they relate to issues which might be assisted by research and development. We address one set of initiatives that would impact on Terms of Reference 1, 2 and 4, followed by a series of initiatives, which are all relevant to the third term of reference.

Initiatives for Terms of Reference 1, 2 and 4

1. The role of Australia's regional arterial road and rail network in the national freight transport task

2. The relationship and co-ordination between Australia's road and rail networks and their connectivity to ports

4. The role of the three levels of Government and the private sector in providing and maintaining the regional transport network

Towards a National Freight Data Strategy

The diverse set of issues covered by these three terms of reference all have a common thread - the need for data and information to tell us about the past, the future and especially the present.

As the US Transportation Research Board has noted:

"Reliable, consistent, comprehensive and timely data on freight movements are essential for informed decision making in government and the private sector, for both economic and infrastructure investment decisions and for policy." TRB (2003)

While this may at first sight seem to be "stating the obvious", inverting the data description to read "unreliable, inconsistent, incomplete data not available when needed" quickly demonstrates the importance of the statement. There is worrying evidence, from both reported and anecdotal sources, that much of the data used for freight planning and policy match this second description better than the first.

Many organisations in Australia needing freight data for policy, planning or operations, encounter problems associated with the fragmented nature of freight data and the cost involved in locating, accessing and using these data. Indeed almost all recent taskforces or inquiries into Australian freight and logistics have highlighted the issue of sparse data. Moreover given the role that freight transport plays in the national economy, and the forecast doubling of freight demand over the next 15-20 years, the demand for easily accessible, quality and timely data on freight transport is growing.

The need for up-to-date, accurate, and useful transport data and information is becoming more urgent due to a number of factors including:

- An increased demand for triple bottom line assessments;
- Informing policy response to rapid changes in transport demand due to changed business environments such as 'just-in-time';
- The need for data to facilitate long term planning requirements;

- Strategic level project assessments in Austin; and,
- Specific concerns such as the integration of rail and road freight transport and their interface with ports.

At the same time CSIRO researchers have found that users feel data is becoming harder to obtain, especially data needed to support network utilisation and infrastructure investment. Recent rail freight data is particularly scarce following rail privatisation. The BTRE is even trialling the use of data from trainspotters to augment supply. In general, more data is needed, in more detail, and more frequently.

In line with the terms of reference of this inquiry, the CSIRO is alerting the Standing Committee to the potential advantage of a National Freight Data Strategy that provides for the efficient collection, sharing and distribution of publicly-held data, together with processing support suitable for different types of users. Research required to assist this would cover:

- Processes for information sharing between all tiers of government and the private sector to make best use of all available data;
- Leveraging data collected by technologies such as telemetric;
- Modelling for data infill and transfer;
- Automated methods to discover, specify and access both the data and corresponding application tools; and,
- Analysis to show the benefits to Australia of better freight data and better freight data management.

Processes for information sharing

The CSIRO has recently found a groundswell of support for initiatives to improve the quality and quantity of data available for planning and operating freight transport and infrastructure for freight transport throughout Australia.

Aust roads has commenced a study to investigate the potential for freight data collaboration.

Auslink has also highlighted the need for consistency between jurisdictional data sets to enable national comparability. National freight data processes could assist by providing a national knowledge base of freight data, elements of which could be applied to forecasting and modelling across jurisdictions. As a result, a cross-jurisdictional National Transport Data Working Group, set up by the Standing Committee on Transport of the Australian Transport Council proposed a National Transport Data Framework (NDTF) to address the lack of coherent transport data to meet the strategic longer-term requirements of planners, policy makers, infrastructure developers, and management.

Some of the strategic benefits identified for an NTDF were

- Better transport decision making: better data access would allow both better individual assessments and assessment of a wider range of alternatives;
- More informed investment decision-making: via better cost benefit analysis and consideration of externalities through a broad range of data;
- Consistent national approaches to project appraisals; and,
- Reduced risk: Better data will reduce uncertainty in planning and potentially in operations.

The working group's report (NTDWG, 2004), recognising the need and desire of individual jurisdictions to retain control of their own data, recommended that a national data portal be set up to facilitate exchange of information.

The initiative is being pursued via a trial of data sharing. Thus the time is ideal for formal analysis to show benefits to Australia of better freight data and better freight data management.

Leveraging Data Collected from Telematics

While the lack of data for freight operation and planning, is being lamented, an ever increasing amount of relevant data is being automatically collected, as Australian freight vehicles incorporate more telematics, information communications systems for operation, and road authorities implement new Intelligent Transport Systems for traffic management and tolling. If cost and time imposts on the data holders plus commercial

sensitivities, privacy and security issues can be addressed, and payment for use can be resolved, this data could be put to good use.

Examples of current technologies involving automated data collection include:

- Freight tracking systems using bar-codes and electronic tags, with the possible use of GPS
- Vehicle scheduling and routing systems for dispatch, route planning, scheduling
- Automated toll collection systems
- Safe-T-Cam which automatically records the number plates of freight vehicles travelling at highway speeds to check speeds and driving hours compliance.
- Weigh-in-Motion stations while screening heavy vehicles for mass limits enforcement collect information on all heavy vehicles
- Freeway monitoring systems including cameras and counters.

In addition, the Intelligent Access Program (IAP), a voluntary program that will remotely monitor heavy vehicles, using telematics, to ensure they are complying with their permitted operating conditions, will collect detailed operations data. It will be used by owners for managing individual fleets, but could be aggregated to provide data for infrastructure planning and management.

The ITS technologies may be useful at either a local level or system-wide depending on the level of coverage supplied by the system. For example, the Safe-T-Cam network now covers regional NSW and SA and therefore could provide some inter-regional data on freight movements. ITS deployments such as electronic toll collection may be more localised, with data applying to a network link or route only. However all these technologies collect data over time usually 24 hours per day 7 days per week. Thus time series data is available, if cost effective methods for access can be designed.

Modelling for data infill and transfer

Data transfer procedures for imputing data values from values at other places and times are not new, but there have been advances in methodologies leading to new procedures to recalibrate data from one location to another on the basis of small surveys and traffic counts. For example information about the origins and destinations of all freight trips is widely sought for interregional, regional and local planning. New methods can generate this.

Such methods provide incentives for interregional data collaboration to:

- Provide additional perspectives and cross-checks.
- Fill gaps by extending analysis across jurisdictional boundaries.
- Fill gaps by transferring values (and saving on local data collection).

Expert freight modellers believe there is great potential in exchange of freight data information to aid in the development of disaggregate data. Case studies to apply and validate such methods in Australia are needed.

Automated methods for data discovery and access

The NTDF proposed to create a ‘one-stop transport data shop’ allowing comparable data to be accessed automatically on a number of levels to meet the planning needs of federal, state, and local governments and other stakeholders.

Similarly, the National Data Network (NDN) (NDN, 2004) is being developed by the Australian Bureau of Statistics (ABS), in collaboration with other interested agencies, as the portal for Australian statistics and survey-related data and gateway to a distributed library of data holdings relevant to policy analysis and research.

In both, the preferred model is a distributed system, with a small central node serving as a gateway to an array of data holdings which will be dispersed amongst a wide range of holders. The central node will compile information about the available data, called metadata, from the custodian’s site. This node will include a discovery facility to allow users to search and retrieve relevant information about available data based on the metadata repository.

In theory such systems could be implemented by staff personally answering individual requests, seeking information and checking security. In practice automation is needed for cost effective operation.

Automation is used in maintenance of up to date information, via special programs which check for changes in information and make updates, searches and data compilations, and in security controls. Smarter systems reduce imposts of data suppliers' time and increase services for users. Low cost operation makes extension of services simple.

The CSIRO has expertise and experience in automated management of data and metadata. This has been applied to development of the NDN and a proposal for a CSIRO approach to implementation of the NTDF.

In summary, there is widespread concern about the quality and quantity of freight data available address questions raised under the inquiry terms of reference regarding:

- The role of regional arterial networks in the national freight transport task;
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A National Freight Data Strategy could:

- Develop quantitative estimates of the benefits of better data so that value propositions for data improvement can be assessed;
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Initiatives for Terms of Reference 3

3. Policies and measures required to assist in achieving greater efficiency in the Australian transport network.

Land transport access to ports – impacts of urban congestion

There are key Australian ports located in the hearts of urban areas. Road freight from regional areas adds to freight traffic from the urban area on the roads to and from ports. The resulting traffic has produced significant social and environmental impacts which concern communities and local government. At the same time, delays imposed on freight traffic by general traffic concerns business and industry. The CSIRO draws the Committee's attention to some findings from a study led by the CSIRO for the Australian Greenhouse Office and reported recently by the BTRE in their Working Paper 62.

The study looked at the relative impacts of various measures to reduce emissions of greenhouse gases and other pollutants from freight transport in urban areas. The study estimated impacts in fine detail on traffic volumes, speeds and emissions on each road link across the entire Sydney network.

Four findings from the study are of relevance to this inquiry.

- Movement of industry out of the city to the west to be close to the Sydney Orbital will result in extra road freight travel on freight routes used for regional access, as goods were brought to and from ports;
- A relatively small reduction of commuter traffic in the morning peaks, brought about by measures such as increased public transport options or differential tolling to encourage commuter travel earlier or later in the day, would have significant benefits for freight;
- Logistics measures such as use of larger vehicles, greater load consolidation and more efficient scheduling for freight in general can bring about fewer trips and reduce congestion (as discussed below); and
- Traffic efficiency measures can be targeted to reduce congestion on key freight routes such as connections to ports. For optimal results, these

measures should be viewed in the context of the full urban network.

In summary, the city ends of freight corridors to ports are particularly important and congestion is a problem. Complex traffic interactions in urban areas mean that there is value in detailed modelling to identify optimal solutions.

Opportunities to achieve greater efficiency - Intelligent Transport Systems (ITS)

The CSIRO through its National Research Flagship Program is developing science and technologies for more efficient use of current road and rail infrastructure. The Energy Transformed Flagship is directed towards reducing Australian greenhouse gas emissions from energy production and use, without reducing economic competitiveness. Transport research within the Energy Flagship is directed towards developing vehicle technologies for a transition to hydrogen fuelled transport in the longer term and increasing transport efficiency to reduce fuel use and hence emissions in the short term.

Increased efficiency is a “no regrets option” which delivers savings for business in operations, savings for government by better use of existing infrastructure and savings for the environment in reduced emissions. It is particularly relevant for freight transport where the alternative of reducing impacts by damping demand for travel, either intentionally, or as result of supply constraints would affect economic growth.

Intelligent Transport Systems (ITS), the application of Information Communication Technologies (ICT) to assist transport planning and operation offer a number of efficiency improvements:

Improved Traffic Flows: Traffic management systems such as those which respond quickly to incidents and manage route diversions can reduce delays on urban and intercity routes. This reduces travel time uncertainty for business and reduces fuel use. The Bureau of Transport and Regional Economics (BTE, 2000) estimates that fuel used in congestion is double that used in free flow travel.

Improved Driver Efficiency: Research reported by the OECD found a 10-15% reduction in fuel use, and hence emissions, with smoother driving (OECD, 2001)

Improved Task Efficiency: As described further below, the use of ICT in planning and operation for both road and rail freight can provide efficiency gains for shippers, transport operators and infrastructure providers.

There are Intelligent Transport Systems already on the market to improve traffic flow. ITS are being designed to improve drive efficiency, and there are a range of options included some developed by the CSIRO to improve task efficiency. Advances in ICT are rapidly reducing costs and expanding options. ITS can also usually be retrofitted to existing infrastructure and vehicles.

However support for research and development is needed, particularly to improve the uptake of technology and to design solutions for Australian conditions.

European research (Weber and van Zulen, 2000) corroborated by Australian industry experience, suggest that major barriers to ITS uptake are market and institutional rather than technological. Institutional attitudes to all new technologies govern incentives and disincentives via taxing charging and regulation and operating agencies select technologies. Thus methodologies which help government planners and policy makers to appreciate the benefits of ITS can be valuable.

CSIRO is working on operational tools which demonstrate to freight operators and policy makers numbers of cost savings and associated fuel and greenhouse gas reductions from ITS. These also demonstrate the significant advantage of early intervention or “near term” strategies as the effect of GHG emissions on global warming is cumulative.

Nor is global warming the only cumulative environmental impact of road traffic. The impacts on the health of vulnerable populations, such as the young and the elderly, are cumulative (DOH, 2000). So too are the impacts of noise (Bullen et al, 1996) Early intervention can benefit all these areas.

The CSIRO’s results have shown that, in urban areas, ITS could improve traffic efficiency (up to 30% reduction in fuel use), improve driving efficiency (up to 15% reduction in fuel use), improve logistics efficiency (up to 10%) and manage travel demand to reduce fuel use (up to 20%). More significantly available technologies and measures could reduce fuel use in these ways by (5%, 2%, 3% and 9% respectively) if implemented today

(Marquez and Smith, 2004). As the research described below shows, there are also efficiency gains from improving logistics efficiency in regional areas.

In summary, traffic and transport efficiencies produced by Intelligent Transport Systems are valuable for the environment and the economy in both urban and regional areas. New science can quantify the benefits of alternatives options and the advantages of early implementation.

Opportunities to achieve greater efficiency – Collaborative Logistics

The CSIRO, in partnership with industry, is developing new methodologies for the supply chain with the overall aim of improving operational efficiency and effectiveness.

The research aims to describe generic properties of dynamic networks and then use theory, models, analysis and algorithms available to optimise the scheduling, routing and loading of freight.

The research and its implementations have been directed over a number of years toward improving freight efficiencies in both bulk and non-bulk freight. More recently a strand of the research is being carried out within Energy Transformed Flagship to show the greenhouse gas reduction benefits of improved efficiency.

Collaborative logistics research has particular relevance to the inquiry since it allows planning for road rail integration in shipment and addresses inter-modal interchange at road rail and sea rail terminals.

Work over many years with the Dalrymple Bay Coal Terminal has developed and applied CSIRO capabilities in the collaborative supply chain logistic area in the context of coal and other bulk materials supply chains, particularly when it comes to coordination of rail, road and port activities in the coordination of bulk-commodity movements.

Related Operations Research has addressed design of inter-modal freight hubs, less-than-truckload network and operation and systems for improving asset utilisation

Research in collaborative logistics with well developed theory and applications to particular industries, could be extended to apply more generically to the integration of rail and road freight transport and their interface with ports, if support for such extension was available.

Opportunities to achieve greater efficiency - application of E-business technologies to rail

E-business, the use of ICT to improve business operations presents both opportunities and challenges for the rail industry. In principle it offers the promise of “seamless transfer” where the shipper is not even aware of the mode used and a significant amount of long-haul non-bulk freight could be carried by rail. In practice it can lead to “just in time” demand for small consignments where road is preferred. It is important for efficient use of regional infrastructure that e-business opportunities for rail are realised.

The CSIRO, first for the Australian Transport Council and now with industry partners within the Rail CRC, has investigated how opportunities e-business presents for improving rail competitiveness may be realised. The work addresses a range of issues including: the application of international experience to Australia, the implication of international requirements for example, on international freight with new security requirements at ports, and the data and technology requirements along the supply chain as goods flow down a supply chain from “suppliers supplier to customers customer” and information flows in the opposite direction.

At the same time the benefits and costs trade off’s in adopting new systems are required. This work has benefited from socio-economic integration which co-ordinates technology research with social and economic research. This is particularly important where decisions need to consider the very complex features of new technology, staff and customers reactions to them and the economic consequences of adopting the technology now or deferring until later.

In summary, E-business provides opportunities and challenges for rail. Research could have a particular relevance to integrating road and rail freight both by identifying opportunities from the rail side and understanding barriers which can be cultural and economic as well as technological.

National Significance of the Freight Transport Task

Finally, we draw the Committee's attention to a recent CSIRO report entitled "Balancing Act: A Triple Bottom Line Analysis of the Australian Economy" (Foran et al., 2005). This report shows the importance of road and rail freight transport for Australia and sets this in the context of other activities in 135 sectors of the economy. It assembles the following background material of potential interest to this inquiry, with the proviso that, due to the need to assemble a vast range of comparable information, the year 2000 rather than 2005 is reported.

The current road freight transport task is around 135 billion tonne kilometres per year with 77% carried by articulated trucks, 19% carried by rigid trucks and 4% by light commercial vehicles. Crude materials (33%) and live animals and food (17%) are the largest categories carried by weight. The truck fleet has 350 000 rigid trucks and 65 000 articulated trucks with an average age of 12-15 years each travelling 18 000 to 20 000 laden kilometres per year.

The road transport industry ranks 17th out of 135 in terms of value adding within the economy and contributes 1.83% of GDP in this analysis. The sector is a moderate employment generator with a direct requirement for 24 000 employment years and another 20 000 years in the sector's suppliers giving a total of 44 000 employment years. Energy use and greenhouse emissions are larger, but still below six tenths of one percent of the national totals as the additional energy and emissions are allocated to the final demand of the product delivered by the road transport sector.

The rail freight sector was responsible for moving 535 million tonnes in the year 2001 and 140 billion tonne kilometres. The composition of freight by weight was coal (37%), ores and minerals (39%), sugar (8%), grain (4%), other bulk (8%) and non-bulk items (4%). The total rail network extends over 40 000 km (including passenger rail) with 2 000 locomotives and 92 000 freight wagons. The network expanded by 1 420 km with the opening of the AustralAsia freight line from Alice Springs to Darwin in 2004 at a project cost of $1.3 billion. The Australasian Railway Association reports that the rail freight industry includes over 180 public and private companies.

In financial terms, the rail freight sector ranks 41st out of 135 sectors in terms of value adding, and contributes 0.48% of GDP in this analysis. It has direct employment requirements of 8 000 employment years with an additional 6 000 years in the sector's suppliers giving a total of 14 000 employment years. In addition, it contributes 24 000 employment years to downstream sectors such as black coal and iron ore mining. It requires one third of one percent of national energy use and emits one fifth of one percent of greenhouse emissions.

Overall, freight logistics activities represented $57 billion or approximately 9 per cent of Australia's gross domestic product (GDP) in 2000. Of these activities, approximately $31 billion were performed 'in-house' by Australian businesses. The remaining $26 billion represented those activities undertaken by the freight logistics industry as services to the business community, of which $23 billion worth of services were provided by transport logistics suppliers.

Conclusion

The effective and efficient movement of freight is critical to Australia's economy and must be assured in the face of changing circumstances, such as an increased emphasis on global markets, shifts in domestic economic activity, new transportation patterns for improved logistics efficiency, growing congestion on the nation's roads, heightened concerns about transportation security and capacity, and increasing concerns about the environmental impacts of road transport.

To this end, and in response to the terms of reference of the inquiry into the Integration of rail and road freight transport and their interface with ports, the CSIRO asks the committee to consider the following issues when making its recommendations.

The value of a National Freight Data Strategy to provide the quantity and quality of data for addressing the questions raised by the inquiry's terms of reference:

- The value of quantification of the benefits of such a strategy
- The importance of processes for freight data collaboration between tiers of government and the private sector and the

potential for a National Transport Data Framework

- The advantage of developing methods to leverage data collected by automated devices, especially private sector data
- Opportunities to trial data transfer to cover data gaps
- Automated systems can improve the cost effectiveness of data collaborating services

Land Transport Access to Ports

- The city ends of freight corridors to ports are particularly important and congestion is a problem
- Complex traffic interactions in urban areas mean that there is value in detailed modelling to identify optimal solutions

Opportunities to improve the efficiency of existing infrastructure are available via:

- Intelligent transport systems to improve traffic flows and driver efficiency
- Collaborative Logistics applied to the integration of rail and road freight transport and their interface with ports
- Adoption of suitable e-business systems by railways

Research and development to advance these initiatives:

- would cost very little in comparison to the costs of infrastructure provision
- could offer very large returns on a moderate investment

Bibliography

BTE (2000). Urban Congestion - the implications for Greenhouse Gas Emissions, Bureau of Transport Economics, Rep No. 16

BTRE (2004) Modelling Responses of Urban Freight Patterns to Greenhouse Gas Abatement Scenarios, Working Paper 62: Bureau of Transport and Regional Economics, Canberra, ACT. Available at http://www.btre.gov.au

Bullen R, A Hede and T Williams (1996) Sleep disturbance due to environmental noise: a proposed assessment index, Acoustics Australia 24(3), 91-96

DOH (2000). The Health of the People of New South Wales-Report of the Chief Health Officer. Public Health Division, NSW Health Department, Sydney. Accessed June 2002. Available at http://www.health.nsw.gov.au/public-health/chorep/cho2k.pdf

Foran, B., M. Lenzen and C. Dey (2005) Balancing Act: A Triple Bottom Line Analysis of the Australian Economy. CSIRO Sustainable Ecosystems. Available at http://www.cse.csiro.au/research/balancingact/

Marquez, L. and N Smith (2004), “Evaluating ITS Outcome Scenarios Using TRANSCAD”, Proceedings of the 11th World Congress on ITS, Nagoya, 2004

NDN (2004) National Data Network Website, http://www.nationaldatanetwork.org/NDN/index_aboutthendn

National Transport Data Working Group (2004)
The National Transport Data Framework, http://www.atcouncil.gov.au/documents/NTDF.aspx

OECD (2001) OECD Report of the Workshop on Innovation for Environmentally Sustainable Transport Mobility Services and Logistics for Passengers and Freight

TRB (2003). A Concept for a National Freight Data Program, TRB Special Report 276. Transportation Research Board, Washington, D.C., Available at http://trb.org/news/

Weber, K. M., and H. van Zuylen, 2000, European Policy for Technology Innovation in Transport: Finding the Right Role and the Right Options, IPTS (Institute for Prospective Technological Studies) Report, 48, http://www.jrc.es/home/report/report_main.html