NICTA Comments on the Draft NSW Long Term Transport Master Plan

Dear Transport for NSW,

NICTA thanks the NSW Government for the opportunity to provide commentary on the Draft NSW Long Term Transport Master Plan. It builds on NICTA's earlier input to the NSW Long Term Transport Master Plan Discussion Paper (attached).

NICTA, as Australia's largest ICT\(^1\) research organisation, and headquartered in NSW, is vitally interested in the development and application of ICT for the benefit of the people of NSW. By applying appropriate technology NSW can build a data-driven, connected, and aware transport system with informed travellers which will be safer, more efficient and more able to sustainably manage increasing demand. NICTA's Infrastructure, Transport and Logistics group is focused specifically on how technology and underpinning research can help NSW realise this future.

NICTA has considerable research expertise and practical experience in transport. Over the last six years, NICTA has worked extensively with both Federal and NSW government agencies and with NSW RMS (formerly NSW RTA). Our technology and research has been deployed in joint projects including video traffic detection, roundabout metering and signal control, over-height vehicle detection, structural health monitoring for the Sydney Harbour Bridge and, in conjunction with the NSW Transport Management Centre, incident management.

NICTA has developed and deployed world-leading logistics tools which could potentially improve fleet efficiency by 10% over state-of-the-art and could add $1 billion to NSW GSP over the next decade\(^2\). We established the world's first Future Logistics Living Laboratory here in NSW working with Australia's most important freight stakeholders. NICTA is also exploring optimisation of Port Botany, future Air Traffic Management and is in discussion with CSIRO on a pilot project to quantify the benefits of smart transport technology on liveability in Western Sydney.

At a national level, NICTA holds a seat on the board of ITS Australia and contributes fundamentally to developing an ITS framework designed for Australia. We are also members of the National Managed Motorways Working Group and are working with AURIN\(^3\) on a project to harmonise Australian Household Travel Survey techniques. Internationally we are active in the EU's development of cooperative traffic management systems and global transport forums, and work closely with Germany's Fraunhofer research group on a wide range of transport-related initiatives.

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\(^1\) Information and Communications Technology
\(^2\) Deloitte's Access Economics
\(^3\) Australian Urban Research Infrastructure Network
The draft Master Plan provides a comprehensive framework for addressing the complex transport challenges facing NSW during the next 20 years. The plan frequently mentions the role of technology; we would like to underline areas where ICT may help meet NSW transport needs and where NICTA could contribute its technological expertise to fulfilling this vision. In particular, we would like to assist NSW Transport in further refining the plan so NSW can benefit from the latest developments in Intelligent Transport Systems (including Cooperative ITS), fusion of data from multiple sources, data-driven modelling, large scale network optimisation and the use of computer vision for analysing video.

ICT can benefit the transport system in other ways. High-quality, two-way video and pervasive broadband make large scale teleworking possible. By encouraging working from home, or at a suburban “telehub” one or two days a week, can significantly reduce road traffic and congestion. NICTA is actively exploring such ideas through its investment in the Australian Centre for Broadband Innovation.

NICTA, as an independent, not-for-profit and government-funded research organisation has a record of working with government at all levels and our mission is to use our research, and knowledge of global best practice, for the benefit of NSW and Australia. We look forward to working with NSW Transport to further develop the draft Master Plan, especially in the area of relevant ICT and expertise.

General Comments

By applying appropriate ICT NSW can build a data-driven, connected, and aware transport system which will be safer, more efficient and more able to sustainably manage increasing demand.

Steps to improve transport through ICT

Key steps to apply in realising this vision are to:

- Make better use of data by fusing together existing sources of transport data, including data from new sources such as cooperative ITS, traffic cameras and mobile phones.
- Make the data available in real time, and in a form actionable over the internet, to all parties at no or minimal cost as a matter of policy to encourage an innovation ecosystem around more efficient transport.
- Apply optimisation, data mining and machine learning\(^4\) techniques to the fused data to improve planning, operations and safety.
- Ensure that all transport infrastructure is networked with high capacity broadband and ICT-enabled with appropriate sensors.
- Encourage implementation of the latest ITS in infrastructure and vehicles to improve both efficiency and safety.

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\(^4\) Machine learning is a technique where software can be trained to recognise patterns in data and then use this training to accurately predict future patterns.
• Inform customers in real-time about the performance of the relevant part of the transport system and use this to help with demand management, both direct (through pricing) and indirect through targeted, personally relevant information.
• Encourage using telework to reduce demand on the transport infrastructure.
• Encourage the deployment of the latest fleet logistics solutions to make better use of the available capacity of the transport network.

NICTA has expertise and proven experience that can be applied in each of these areas for the benefit of NSW.

Outcomes from the use of ICT in Transport

There are several outcomes which are enabled or supported by ICT that apply across all transport modes, public and private, and relate to several chapters in the draft master plan:

• Data-driven Planning and operation
• Increased efficiency of transport infrastructure
• Cost Optimisation
• Customer Focus
• Safety Technology
• Reducing and managing demand

We discuss each in turn.

Data-driven Planning and Operations

A large amount of real-time and other data is gathered across the transport system second by second and on longer time-scales. For roads, data is collected from inductive loops, and at toll gates. Quantitative traffic measurements can be derived from analysis of video from cameras. With triangulation, or through cell tower associations, mobile phones can provide passive indications of vehicle and people movement en mass. Smart phones and satellite navigation systems provide precise records of person and vehicle movements through special applications and movement logs respectively, giving direct insight into potentially millions of origin-destination travel pairs across all travel modes. Sydney buses and trains are equipped with GPS units and their precise location is known at all times. Air traffic movements are known precisely. Even feeds from social media such Twitter can be analysed to identify acute problems or to understand customer sentiment.

Taken together, there is a vast amount of information than can give insight into how to better operate the transport system minute by minute, but also to predict future behaviour. In particular, by fusing data across several sources, we can answer questions such as where capacity constraints will emerge in future, how responsive drivers will be to demand management strategies, how to balance demand between commuters and freight operators, how to better adapt traffic control signals to actual demand, or gain insights into how to improve safety or respond better to incidents.
NICTA is working with AURIN on establishing a framework for facilitating this kind of data fusion and analysis for road transport.

NICTA has world-leading expertise in how to fuse and interpret data to provide both analytical insight and predictive ability. NICTA has used these techniques in areas as diverse as traffic incident management, exploration of geothermal power, and determination of maintenance priorities for water mains.

Increased efficiency of transport infrastructure

Section 8.11 the draft Master Plan highlights the role of technology to make more efficient use of existing infrastructure. NICTA supports this view and can assist NSW transport in developing detailed technology responses to NSW’s transport system challenges, and especially in helping develop the Transport ICT and Innovation Strategy described on page 309.

ICT can make transport more efficient in many ways. For roads this may include better control of traffic signals, optimised adaptive speed limits, ramp metering, dynamic pricing to manage demand, control of freight paths using GPS, and the provision of real-time traffic information which may be acted on by humans or machines to choose better paths, different transport modes, or to voluntarily change trip times to avoid congestion and reduce peak demand. Cooperative ITS allows vehicles, humans and infrastructure to signal location, movement and hazards in real time using DSRC technology. While primarily a safety technology, there are also efficiency benefits to be gained by better response to incidents, the improved ability for traffic signals to respond to individual vehicles, and a general platform for tolling.

In a simple example for road, NICTA developed better algorithms for traffic light control at a complex roundabout in Albion Park in conjunction with the then RTA, with simulations showing an 8% improvement in performance. This kind of efficiency increase, applied state-wide, could add billions of dollars to GSP through better congestion management. Any improvement in efficiency translates into an environmental benefit as well through reduced emissions.

For freight and passenger rail, advanced signalling systems, driverless trains and ITS concepts analogous to those used in roads may also be used to drive improved efficiency and to balance the needs of both freight and passenger users.

ICT can also improve efficiency at vital inter-modal terminals through advanced optimisation techniques. NICTA is exploring a project of this kind aimed at optimising the operation of Port Botany and its interactions with the rest of the transport network, beginning with the rail interface. Similar principles could be applied to Sydney Airport, which, as the draft plan notes, places great and increasing transport demands on the network.

Traffic signal control is of special significance in NSW. The RTA pioneered the world’s leading adaptive traffic signal control system, SCATS, in the early 1970s.

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5 Dedicated Short Range Communications
This system has reduced trip times, managed congestion and minimised stop/stops for four decades. Since that time there have been orders of magnitude improvements in computational power, network bandwidth, computer vision to analyse video, numerical techniques for optimisation, and in predictive techniques such as machine learning. In addition, Cooperative ITS technology using DSRC is being deployed and standardised in major markets. DSRC provides additional and useful inputs for optimising both the performance and safety of traffic signals.

Given these advances, NICTA believes there is significant scope for enhancing SCATS through the use of video and other sensors to measure traffic queues and vehicle speeds; and the use of DSRC to both tune traffic signals and provide information to approaching vehicles. The better management of congestion achievable by such enhancements could add billions of dollars to GSP. NSW might also take a leadership position in encouraging the uptake of DSRC in its own fleet of vehicles, or more boldly, in introducing legislation to mandate it in new vehicles, as California does.

In addition to making the transport network more efficient, ICT can also make more efficient use of the existing network. As noted earlier, NICTA’s Intelligent Fleet Logistics software, Indigo, has been shown to lead to efficiency improvements of 10% and, if applied state-wide, would add billions to GSP in improved efficiency. It is especially important to encourage the large number of small freight operators in NSW to begin using this kind of technology.

**Cost Optimisation**

ICT based models, simulations and visualisations can be used to explore different transport futures, provide insight into the impact and performance of particular projects. In general, they can provide information to assess best return on investment, evaluate cost trade-offs between different transport modes and also to determine investment priorities. Further, drawing on more and new sources of data allows improved demand forecasts and consequent benefits from improved accuracy. The same data can also provide fine detail on how much load individual transport users are placing on the network, which may provide a basis for future funding approaches.

Infrastructure requires constant maintenance. Data-driven approaches using existing data, or that from new sensors, can be used to help optimise maintenance schedules by more accurately targeting areas likely to need maintenance, reducing the amount of unneeded maintenance and drawing attention to urgent problems automatically. NICTA has been working with the RTA and RMS on structural health monitoring of bridges and most recently on the Sydney Harbour Bridge, where we use machine learning to fuse sensor data in a way that highlights any structural anomalies.

NICTA is also working with Sydney Water Corporation using machine learning to analyse pipe failure data and provide improved maintenance schedules.
Customer focus

Customers crave information about transport that allows them to make good decisions regarding travel. Equally, reliable transport information is critical to freight performance. With trustworthy data, one may decide to delay a trip because the transport system is simply too busy. Uncertainty about traffic conditions, incidents, arrival times of trains and buses, or whether or not there is room on a bus all cause inefficiency at a user and network level as well as making it hard to manage demand.

Much of the data needed to make good decisions already exists, and vastly more will become available from DSRC, mobile phones and computer vision applied to video from cameras. Data from several sources can be fused together provide a clear view of the performance of transport network, or specific aspects – such as how far away my train is. ICT such as smart phones, intelligent signage, GPS systems in cars and PCs can all be used as channels to provide travellers with relevant, personalised information.

To be most valuable this information needs to be delivered when it is needed and where it is needed (e.g. to your mobile phone while you are deciding whether to drive or take the bus) and it must be relevant and easy to obtain, not hidden many clicks down on a webpage.

It is important that government provide such services, but equally important that the raw, real-time information is made freely available to the innovative community of entrepreneurs who are experts at delivering new services on mobile devices.

Feedback from customers is also an important part of customer focus, and increasingly, social media can be used to gauge public sentiment. NICTA designed its Opinionwatch tool to understand public sentiment of topics using material posted on the web.

Safety Technology

ICT can improve transport safety in two main ways. First, by improving the active safety of vehicles and infrastructure and second, by improved insight from data analysis of accident and incident patterns.

Active Safety

It is well recognised that there is very little that vehicle manufacturers can do to further reduce the risk of injury to vehicle occupants due to a collision. Seat-belts, airbags, electronic stability control and ABS have all contributed to reducing both the crash rate and the severity of injuries and the number of deaths due to traffic crashes.

The next leap in vehicle safety will be reducing the probability of collisions and their severity when they do occur, using low-latency vehicle-to-vehicle communications.
(DSRC) which will warn vehicles of impending collisions and also through onboard radar assisted collision avoidance.

DSRC is the cornerstone of Co-operative ITS (C-ITS), aimed at improving the efficiency, safety and sustainability of the transport system beyond the levels obtainable with standalone systems. With the huge increase in the use of smart devices it is evident that C-ITS technologies will be pervasive in the next few years.

Drivers will be warned of the presence of pedestrians. A sports’ coach could switch on a road side unit to warn drivers that road-side playing fields were in use. Simple systems such as these will save lives. DSRC units in smartphones will act as a safety beacon for pedestrians.

NICTA has already demonstrated a DSRC safety system in collaboration with NSW RTA: TruckOn. TruckOn used a simple vehicle height detection system coupled to DSRC radios to communicate warnings to over-height vehicles. Such a system, if deployed before tunnel entrances and low bridges could save millions of dollars per year in maintenance costs and lost time due to induced traffic congestion when a truck blocks an underpass or tunnel.

Developments by NICTA and others creating low cost “radar on a chip technology” will take the issue of cost off the table as automobile manufacturers seek to achieve “zero fatality” and zero incident targets. Software innovations such as SEL4 – a trustworthy and secure software system developed by NICTA in NSW and deployed in over 1.6Bn mobile phones around the world – could bring transformational reliability and security to increasingly complex safety-critical vehicle systems.

Safety Insights from data

Detailed analysis and data fusion of cell phone, loop, GPS and other data is likely to yield insights in many critical aspects of road transport performance and safety.

NICTA is exploring this type of analysis with the NSW RMS. Such analysis may allow us to predict the time it takes to clear a traffic incident, provide earlier warning that an incident has occurred, gain insight into how congestion propagates outwards from the incident and which links and intersections are sensitive to the effects of a particular incident.

We can also improve our understanding of travel times by understanding the impact of incidents on travel time, developing a more detailed and comprehensive insight into daily travel patterns and determining the reliability and utility of new data sources such as cell phone and floating vehicle data. The results of such analysis can then be used to improve traffic management and safety.

Reducing and managing demand

Increasing demand, especially peak demand, is the root cause of degraded performance in the transport network across all modes. Improved efficiency (most
economically attained through the use of ICT) in each mode assists in dealing with the problem, as does ensuring each transport mode is used to its fullest capacity – for example, shifting load from road use to trains.

At some point however, peak demand will exceed capacity and the only possible response to avoid degraded performance is to either increase capacity, or reduce the peak demand.

Increasing capacity is expensive as it requires capital works and, in Sydney, often requires even more expensive tunnelling. Consequently, reducing peak demand across the transport system is critical in helping NSW meet its future transport needs.

There are three approaches to reducing peak demand that can be enabled by ICT.

The bluntest approach is to use variable pricing mechanisms to alleviate peak demand. The mechanisms to support this are enabled by ticketing technology, DSRC, tolling technology, and video analysis of number plates. In the road system, NSW already employs variable tolling on the harbour bridge, and cities such as London charge a “Congestion tax” (a peak road rental charge). On the rail passenger network the concept of peak versus off-peak fares is well accepted. NICTA can assist in this area by fusing together transport data so it may be visualised and analysed to see where and when peaks are forming and will be forming. We can also explore optimal solutions for spreading the peak demand.

An indirect approach, but one which may have potentially large impact, is to give travellers targeted and relevant real-time information so they can choose best mode or time to travel. Some of this information is available on Google Maps for road users and there is some information from government sources. However it could be improved by being closer to real time, ensuring it is delivered in an easy to use and rapid way (e.g. optimised smartphone apps with minimal keystrokes) and, most importantly, personalised and relevant (i.e., what is my next train and how full is it? Or how busy are the roads on my journey?). NICTA has the capability to fuse data from multiple sources, use machine learning to derive predictive patterns and to help make personalised and relevant information.

Demand can also be reduced by encouraging working from home, or at a suburban “telehub” one or two days a week. This is increasingly viable as high-quality, two-way video and pervasive broadband make large scale teleworking possible. NICTA is actively exploring such ideas through its investment in the Australian Centre for Broadband Innovation.

**Conclusions**

NICTA commends Transport for NSW in developing a detailed vision and plan for improving transport in NSW over next 20 years.

We believe that ICT has a vital role to play in achieving a vision of better efficiency, improved safety, cost-effectiveness and customer focus. First, by understanding how to improve the transport system through insights from data fusion, optimisation
and advanced predictive techniques. Second, through the application of ITS to improve the efficiency and safety of all transport modes. Third, by ICT’s ability to assist in managing and reducing demand and, finally, through its ability to personalise the transport experience for each customer.

NICTA has capability and experience across all aspects of ICT applied to transport and we look forward to working with Transport for NSW to bring these benefits to the people of NSW.

NICTA, October 25, 2012.

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Appendix: NICTA’s April 26, 2012 Response to the NSW Long Term Transport Master Plan Discussion Paper

NICTA thanks the NSW Government for the opportunity to respond to the NSW Long Term Transport Master Plan Discussion Paper. We believe that a safe, efficient and environmentally friendly transport system is vital to the economic and social success of NSW, Australia and the World.

NICTA applauds Transport for NSW (TfNSW) for developing a 20-year vision for the transport networks of NSW that encompass nine different transport modalities. Seeking broad engagement with stakeholders and, importantly, focussing on the customer—whether commuter or container—is a fundamentally transformational approach.

Transport and logistics, like virtually every other sector of the economy, is already being radically transformed by ubiquitous information and communications technology. NICTA has fundamental capabilities to model urban (and regional) transport systems, fuse data from multiple disparate sources, optimise networks and develop tangible outcomes that can be leveraged for benefit of the NSW economy.

NICTA, Australia’s preeminent ICT research centre, has a long term research program in the transportation and logistics sector, particularly Intelligent Transport Systems (ITS). ITS is defined as the application of ICT to surface transportation. The successor of ITS—Cooperative ITS (C-ITS) extends ITS by enabling intelligent transportation systems to coordinate through the use of various communications
modalities and includes such technologies as vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications.

Advances to be realized through C-ITS are not limited to vehicles. Pedestrians and users of public transport will have access to such technology through their smart phones. In such an environment, even a football coach could power up a system warning drivers of children playing in a local park—and possibly even set a speed limit. C-ITS has the potential to reinvent traffic management, making crashes effectively a thing of the past.

During the past six years NICTA has developed a close relationship with a number of sections within NSW Roads and Maritime Services (and its previous incarnation). Our research and development outcomes have been deployed in joint projects ranging from video traffic detection, roundabout metering and signal control, over-height vehicle detection; and structural health monitoring of the Sydney Harbour Bridge.

During the same period NICTA has developed considerable expertise in the ITS area including:

- Establishing the Future Logistics Living Laboratory (FLLL). The FLLL is a global initiative headquartered and run in NICTA’s headquarters at the Australian Technology Park, Sydney. Established with SAP Research and Germany’s Fraunhofer Institute, the FLLL now boasts 25 active industry participants from large corporate and SME sectors, runs quarterly workshops on issues relevant to the sector, and oversees change projects among participants on topics requiring significant collaborative action;
- Dr Glenn Geers is a Director of ITS Australia, a member of the National Managed Motorways Advisory Board, the AusDSRC Steering Committee and the Australian Urban Research Infrastructure Network Urban Transport Lens. He is also on the International Advisory Board of the European Union's Network of Excellence for Advanced Road Cooperative Traffic Management in the Information Society (NEARCTIS) Project. He has been an invited presenter at a number of Intelligent Transport Systems World Congresses and other fora;
- NICTA’s Dr A. Verden and Dr P. Kilby are innovators in freight logistics who have won awards for their Indigo vehicle routing software which has the potential, based on a Deloitte Access Economics study, of adding over $1 billion to the NSW Gross State Product during the next decade.

General Observations

Public Transport

Above all, public transport users desire information. In most circumstances, knowledge of actual bus and train arrival and departure times is of greater relevance than published schedules. Data could be provided through on-platform and at-stop displays as well as mobile applications and websites. NICTA imagines a time in the not-so-distant future when your car will suggest that you park and catch a bus or train instead of driving to reach your destination.
Of course, having transport that runs to time, is 'balanced' to handle peak and off-peak loads; and considers dynamic pricing as part of demand management, is part of the 'future world NICTA expects to see. Ensuring that data is available and modelled is the fundamental first step to improving performance of public transport in a fact-based way. Enormous advances can be made by optimising existing resources to achieve greater capacity and efficiency without sacrificing safety or sustainability.

NICTA has expertise to help make these concepts reality in NSW.

Road Network
There is an artificial separation of the road network into three components: motorways, arterials and local roads. NICTA takes the view that there is a single road network that must be operated in the best possible manner. Right now C-ITS can achieve performance improvements through ramp metering, dynamic hard shoulder running and variable speed control on motorways which must be linked with signal timing and coordination at motorway off-ramps and on arterials. Variable message signs and direct communication to in-vehicle navigation systems, using the best available communications mode, should guide vehicles on the best possible route … or at least give the driver enough time to make a decision on route before being trapped. All motorways must be network-enabled so that roadside DSRC units may be planned for and easily installed when the time comes.

It is apparent that within the next 5-10 years all new vehicles will have an 'always-on' connections to the internet via commercial service providers and to each other by special purpose communication modes such as Dedicated Short Range Communications (ISO CALM/M5 or IEEE 802.11p). The former will handle non-time critical (of the order of 1 second) messaging such as navigation updates, in-vehicle variable speed and message signs, etc., whilst the latter will handle time-critical safety messaging for collision avoidance, etc. as well as providing vehicle position and intent at a rate of ten times per second. For the first time transport engineers and planners will have detailed information of what the transport system is doing 'right now'.

NICTA has expertise to help make these concepts a reality in NSW.

Answers to Strategic Questions
The NSW Long Term Transport Master Plan Discussion Paper poses 18 strategic questions; our 'headline' responses are provided below and in all cases NICTA would welcome an opportunity to engage more deeply and specifically with TfNSW on these topics. This is a dynamic space. In a number of areas NICTA is already engaging with both the public and private sector on opportunities for fundamental improvement.

1-3:
The five objectives highlighted in Chapter 3—customer focus, accessibility and social equity, environmental sustainability, road safety, and economic growth—are appropriate and comprehensive, though of course not mutually exclusive. Without question, transport must be “customer-focused”—be that a commuter or a container. NICTA considers that ‘customer focus' explicitly includes freight movements—it is not the truck (or train) that is essential but the goods that are being carried.

Transportation systems are fortuitous in that three dominant objectives (safety, efficiency and sustainability) lie at the same ‘sweet spot' and will be transformed through application of information and communications technology (ICT). The Discussion Paper makes no direct reference to that area of ICT which is explicitly targeting improvements in urban transport management: Intelligent Transport Systems (ITS). As networks incorporate “intelligence” at every node and for every customer, and as those points of intelligence begin to cooperate, truly transformational objectives may be achieved.

NICTA has proven expertise to help deliver these technologies for the benefit of NSW, for example:

- Modelling complete systems
- Improving flow through networks, e.g., roundabouts
- Multi-modal transport systems, e.g., ports
- Improving safety at pinch points across the road network, e.g., school zones

4: Sydney has a large area and relatively low population density. Priority funding should be given to upgrading ITS readiness of all NSW transport assets. We believe that capacity gain on the existing transport networks is achievable through the use of ITS. Melbourne’s M1 Motorway is an example of road infrastructure which runs efficiently at, or close to, capacity due to the incorporation of ITS through coordinated ramp metering.

NICTA’s modelling capability could assist TfNSW in choosing optimal investment priorities across the network.

5: All transport infrastructure should be connected to a high-bandwidth computer network so that information can be passed efficiently between operators and customers.

6: The road network should be viewed and managed holistically. NSW already has a globally-leading traffic signal control system—SCATS—which is deployed in over 140 cities worldwide. A key priority is to ensure that technological innovations are woven into its core. Control and sensing techniques that take advantage of the greater computing power and network bandwidth now available should be deployed. Such
systems should not be locked to a specific technology and must subscribe to international standards (ISO TC204).

7-8: System-modelling would enable informed decisions on frequency, reliability and modal type (bus or light-rail) to be made on a scientific basis.

10: Transport modes are strongly interdependent. Transport interchange modeling with customer-satisfaction as the optimal outcome will help identify issues such as late trains missing bus connections, variations from scheduled operations, and similar. Deploying communications technology and relatively simple algorithms can help address this opportunity.

11: Addressing the requirements of Sydney Airport and Port Botany is a multi-horizon challenge to which ICT is uniquely equipped to assist. NICTA is already – directly and indirectly – engaged with a broad cross-section of the public and private sectors identifying opportunities for improvement. Solving for these critical components of the Sydney transport landscape calls for a fact-based analysis of the situation with a view to immediate opportunities (‘quick wins’). Further investment is needed to support long-term growth forecasts in commuter and freight needs during the next few decades.

NICTA’s modelling, big data, optimisation and related technologies are critical components of any solution. Already, NICTA is actively engaged in this area through:

- UNSW, Research Centre for Integrated Transport Innovation;
- Total Port Logistics, discussions with Sydney Ports Corporation, NSW Government, Transport for NSW and many industry participants; and,
- Future Air Traffic Management Project with Air Services Australia.

12: Complete modelling of greenfield sites would help to identify transport needs across all modalities.

13-16: Modelling the regional transport networks is vital for ensuring a viable rural economy. NICTA considers ramp metering on the F3, modelling of Port Kembla and
Port of Newcastle supply chains, and integration of regional rail into the freight network to be among the priority opportunities.

17-18:
NICTA has direct and relevant expertise to assist with the NSW Freight Strategy and the NSW Ports Strategy.

Deloitte Access Economics reported in 2011 that one of NICTA’s technologies – the ‘Indigo Solver’ optimisation tool—could reduce the transportation costs of the top 20 fast moving consumer goods companies in the state by around 8.95% or $103m and add over $1Bn to the NSW Gross State Product over the next decade.

Separately, accelerating improvements in the Port Botany supply chain, by understanding total supply chain interactions, modelling key components and optimising or automating critical areas, will best support community expectations for this productivity bottleneck.

Understanding looming capacity constraints in Australian Air Traffic is key to understanding opportunities for Sydney Airport. NICTA is already connected to key organisations globally to understand the opportunities available in context of European and North American initiatives.

Conclusion
The NSW Long Term Transport Master Plan Discussion Paper presents a comprehensive approach to transport planning for the future of NSW. NICTA believes that information and communications technology is a powerful enabler of enduring benefit. Intelligent transport systems and the promise of cooperative intelligence will inform prudent decisions in technology adoption and use, providing additional transport capacity for minimal infrastructure investment.

NICTA looks forward to exploring how we can work in partnership with Transport for NSW in an ongoing manner to research, develop and implement beneficial outcomes for the people of NSW.

NICTA, 26 April 2012

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