



**NICTA Response to the Public Infrastructure
Productivity Commission Issues Paper and Draft
Report**

March 2014

Introduction

NICTA thanks the Productivity Commission for the opportunity to submit a response to the Public Infrastructure Issues Paper and Draft Report.

NICTA understands the importance of productivity enhancing infrastructure development to boost growth and create jobs in the current economic environment:

“As the G20 Finance Ministers and Central Bank Governors in Sydney stated earlier this year, the Council on Federal Financial Relations agreed that productive infrastructure is critical to Australia’s future competitiveness and economic growth.

It is imperative that Australia invests in infrastructure projects that address debilitating bottlenecks and build the capacity Australia needs for the 21st Century.

Infrastructure spending can provide a short-term economic boost by stimulating construction activity, and ensure long-term prosperity by increasing the productive capacity of the Australian economy.

Investing in the right infrastructure can also boost Australian incomes by improving quality of life, and increasing productivity, including by tackling congestion, reducing business input costs and by helping firms better link with their employees and customers.

As Australia’s historic investment boom in the mining sector slows, there is an imperative to support investment and real activity across the country.

The acceleration of infrastructure expenditure is a challenge, given that the fiscal positions of both Commonwealth and State Governments remain constrained. All levels of government are therefore looking at ways to address funding constraints.”¹

As Australia’s largest Information Communications Technology (ICT) research organisation, NICTA consider this policy direction by Federal and State Governments indicates a genuine desire to ensure that any new infrastructure development is optimised for productivity from its beginning to end, and for the public investment consideration process to ensure the best value for money. Fortunately, there is a new and better way to achieve this.

Recent technological advances (or ‘Smart ICT’) over the last three years have created a fundamental shift in how infrastructure should be planned for, built and maintained in the future. New data analytics and optimisation techniques, for example, can now provide unprecedented insight into major projects at critical points.

For the purposes of this paper, Smart ICT² will be a term used to describe a range of tools, techniques and capabilities made possible which can be applied to the various stages of the public infrastructure investment process.

¹ <http://ibh.ministers.treasury.gov.au/media-release/010-2014/> Media release from Federal Treasurer announcing asset recycling partnership between Commonwealth and States, 28 March 2014.

² A range of tools and techniques that include advanced (ICT) such as data analytics, optimisation, modelling & software systems, networked sensors, and integration with mobile devices and new ways of gathering data, such as social media and crowd-sourcing.

NICTA proposes that Smart ICT should be integrated into the design, funding, construction and operational phases of public infrastructure, and that it becomes a standard part of the consideration process for any new investment.

Specifically, in terms of the Inquiry NICTA seeks to address the scope for reducing the costs associated with designing, funding, constructing and operating such infrastructure.

We welcome a number of the findings in the Commission's draft report, including³:

- There are numerous examples of poor value for money arising from inadequate project selection;
- Without reform, more spending will simply increase the cost to users, taxpayers, the community generally, and the provision of wasteful infrastructure; and,
- Data problems beset the detailed analysis of the costs and productivity of public infrastructure construction, and of the effects of various policies. A coordinated and coherent data collection process can address this and improve future project selection decisions.

Infrastructure should not be viewed as simply 'pouring concrete'. Given the fiscal constraints of the economy, investment in public infrastructure needs to provide the best value for public money.

NICTA believes public infrastructure investment can be better informed, funded, designed, constructed and operated by using Smart ICT – which leads to better value for governments, business and taxpayers and greater productivity from the assets themselves. Smart ICT can also optimise the use of existing infrastructure and enable better decision-making about which new infrastructure to invest in the future.

Smart ICT – what is it and what can it do?

Smart ICT is not just sensors and new devices. It includes the latest tools and techniques such as data analytics, optimisation, advanced modelling and software systems.

Areas where smart technology can greatly benefit public infrastructure include:

- predicting future demand for freight and passenger traffic movements in key transport corridors around Australia;
- informing preventative maintenance on major infrastructure such as bridges, road and rail networks;
- optimising rail container handling between port quaysides and inland intermodal terminals to improve goods flow both ways;
- integrating crowd-sourced social media into traffic management operations, improving incident notification, and reducing clearance times and congestion.

³ Productivity Commission draft report summary of issues 13 March 2014
<http://www.pc.gov.au/projects/inquiry/infrastructure/draft>

- assisting managed motorways to operate with dynamically-tuned ramp-metering algorithms, lifting throughput in peak periods; and,
- optimising traffic signalling in urban areas to reduce the drag on productivity caused by congestion.

The following sections include examples of where Smart ICT has improved the performance or reduced the cost of infrastructure across the different stages of the infrastructure lifecycle.

Smart ICT in planning or design

Over the last two or three years, data analytics has come of age. Smart ICT has developed to a degree where it can greatly inform the planning process and find new, unexpected ways to reduce cost through the latest data modelling techniques and tools.

The latest ‘machine learning’ can integrate data from multiple sources, ‘fill in the gaps’ where databases miss records, build ‘non-parametric’ models that don’t need expert opinion to define core operating assumptions, and apply multiple filters to algorithms that can predict with high accuracy what outcomes are likely.

By collecting data from current infrastructure systems (such as transport networks) and building evidence-based data-driven models, infrastructure performance can be more effectively measured and operating inefficiencies identified. Medium-to-longer term large-scale planning decisions can now be made with far greater certainty. Additionally, better integrated decision-making can be made on how major infrastructure facilities – such as airports for example – will affect other infrastructure such as road and rail links, transport interchanges and inter-modal terminals. These can be addressed through new optimisation techniques that factor in real world complexity and operating constraints in ways which have not been possible until recently.

Example 1: Port Botany Rail: Sydney’s sea freight is forecast to more than triple its container capacity from 2M TEU⁴ to 7M TEU in the next 15 years. Currently 86% of containers move through the port area by road. This is unsustainable given Sydney’s current road configuration. Can rail accommodate more container volumes, and if so how does the sector encourage modal shift from road to rail?

NICTA has worked with all key participants in the Port Botany rail supply chain to develop a data-driven dynamic model of freight operations to understand capacity of the existing network and its bottlenecks, with a view to increasing performance. The results would indicate that significant capacity is accessible through operating performance improvements, rather than requiring additional capital investment for constructing new infrastructure.

NICTA’s analysis demonstrated that a potential rail track upgrade estimated to cost up to \$200m could be delayed by 15-20 years through applying a new optimised freight movement schedule.

The same approach can be applied to many multi-party, highly competitive sectors, providing, often for the first time, a fact-based analytic tool that can be used to identify and prioritise improvement initiatives.

⁴ twenty-foot equivalent units

Australia's infrastructure spans greenfields and brownfields developments. Given our dense urbanisation, new infrastructure is often a question of balancing demand growth within existing corridors. Here, data analytics and optimisation provides useful intelligence when prioritising new investments.

Example 2: Dam-wall overflow flood event: Advanced data analysis is particularly useful in anticipating risk and advising on appropriate action in unexpected scenarios such as disaster management. NICTA modelled the flow of water from a potential spill at Warragamba Dam in Western Sydney. This enables authorities to make informed decisions on the optimal evacuation paths of 70,000 residents in flood-affected regions – potentially saving lives. Data comes from multiple sources and is fused together to give an accurate height-based picture of flows, indicating over time which roads become impassable – providing better information for the state emergency services (SES), police, transport managers and other authorities. The modelling specifically informs which residents should be evacuated in which order, with frequently counter-intuitive insights that could literally mean the difference between residents being safely evacuated or not.

Design of new infrastructure should integrate the less visible ICT components: sensors, actuators and networks that will enable data-driven models to continually calibrate an asset for operational efficiency. Thus for infrastructure planners and operators an alternative to lane widening can be to increase freeway capacity through relatively low-cost and fairly easily installed technology that may satisfy demand for a decade or more. In this way, smart ICT can preserve the performance of very expensive transport assets and extend the life (i.e., increase the productivity) of those assets.

Example 3: Managed Motorways: Recent modelling by NICTA of a West Australian freeway expansion project indicated that existing peak congestion can be addressed either by a \$300M addition of an extra lane for 4kms, or by the application of much less expensive smart sensors in the road surface connected to ramp meters (dynamically managed traffic light metering). The latter would see more than a 40% increase in throughput. Melbourne's M1 is already using some of these technologies to optimise traffic flow and shows that the technique works in real systems.

Smart ICT in construction

Data analytics and optimisation can unlock significant value during the construction phase of major infrastructure projects. Project management – prioritising, scheduling and managing the delivery of multiple components, trades and essential services – is an already complex optimisation task. Rarely does a project proceed without some major component being rethought, replanned and redesigned, with knock-on effects across the balance of the project. Complicated construction projects can be managed more efficiently by using Smart ICT to deal with changing externalities and priorities.

Example 4: Sydney Light Rail: The NSW Government's light rail public transport project is looking to improve Sydney's traffic congestion between Circular Quay and Randwick. Closing parts of the route to other modes of transport raises questions about meeting mobility demand within and across the city. Large-scale complex models based on historic and live feeds of data will allow transport decision-makers to visualise where and when congestion will occur and 'hot spots' will emerge.

NICTA has predicted, for example, where & when congestion will occur when a major thoroughfare like George Street is closed, such as for a special event. Data modelling enables transport system managers to evaluate the impact of a range of interventions to the main traffic management system, such as using variable message signs (VMS) to alert drivers of alternative routes, or simulating new routes, e.g. diverting bus traffic to the eastern side of the CBD.

Data analytics can also be used to minimise the community impact from disruptions.. As Sydney's light rail infrastructure will take several years, optimising the construction plan around constraints can help planners understand the impact of street closures on business, vehicular and pedestrian traffic. Modelling street closures can be done well ahead of time to understand the impact on adjacent streets, on public transport capacity and on passenger and freight traffic flows. With visibility of information flows from SCATS (Sydney Coordinated Adaptive Traffic System), PTIPS (Public Transport Information and Priority System), taxi and car sharing companies, congestion bottlenecks can be predicted and measures to mitigate those bottlenecks can be tested to ensure that local communities and businesses have adequate time to prepare for the changes.

Smart ICT in operations

The financial, telecommunications and retail sectors are now regularly integrating data analytics given the volume and complexity of data in their operating environment Infrastructure planners and providers need to do the same. In NICTA's work with many public and private sector organisations, identifying and analysing data to optimise business is increasingly becoming one of the most critical factors to success, providing deeper insight and consequently more informed decision-making.

Another attribute of major infrastructure projects is the need to accommodate changing use and demand profiles through their long life cycles. Managing change in the use of critical infrastructure is a reality of growing cities and growing economies. What was designed in one decade, or one era, may change as the surrounding city changes. As a result, its important to model future states to predict the impact of changing demand profiles on existing infrastructure and maintenance and re-investment decisions.

Maintenance of infrastructure

In many infrastructure projects, preventative maintenance is around 10% of the cost of reactive repairs and maintenance. Predictive tools can help prioritise maintenance spend to those elements most likely to fail, thus avoiding or delaying major capital outlays.

Smart ICT can ensure that infrastructure is operated as efficiently as possible. From automatically monitoring a bridge and reporting its structural health status, to dynamically and optimally adjusting the timing of traffic signals, Smart ICT can ensure that infrastructure can automatically respond to demand and new environmental changes to achieve better operational performance.

Example 5: Water Utilities:

Developing more accurate preventative maintenance scheduling has the potential to save the Australian water industry up to \$700M per annum. Australia's water utilities manage 140,000km of critical water mains, or an \$80Bn water pipeline network. Each year, around 7,000 breaks occur, costing taxpayers roughly \$1.4Bn in reactive repairs & maintenance and consequential damage.

NICTA, in collaboration with several water utilities, has developed a new approach to predict the likelihood of water pipe failure. The software creates a statistical model of each pipe within a network using multiple internal and external data sets including current and historic data related to the age, type, material, and size of a pipe, as well as soil composition, external pressure and other factors. By

using all the available data, enables a greater number of faulty pipes to be identified and repaired before they break, leading to significant cost savings.

Example 6: Sydney Harbour Bridge: Sydney's Harbour Bridge has several thousand structural components each of which need to be monitored and maintained. As with other major public infrastructure assets, the Sydney Harbour Bridge requires ongoing maintenance. Current practice requires bridge inspectors to visually inspect every one of the many thousands of bridge components at least once every two years. As the structure ages, demands on inspectors increase and more frequent inspections may be required.

NICTA has developed instrumentation and data analysis systems that combine to provide detailed structural health monitoring of individual components on bridges. Advanced monitoring algorithms detect irregular movements in the structure, while allowing for inherent movements and the impact of the harsh environment. This information is distilled for the asset manager, who can then schedule targeted precautionary inspections that may result in maintenance work being undertaken. The primary benefits to government and taxpayers are greater efficiency, more productive bridge inspections and reduced disruption to bridge users as a result of more timely maintenance.

Call to Action

Australia's economic success during the next few decades relies on increasing productivity across each sector of the economy. Considering the use of Smart ICT in the public infrastructure planning, development and operation process will enable major projects to be designed, built and managed with greater efficiency and productivity than is currently the case, so result in better value for public money.

Smart ICT will enable better, more insightful consideration of the issues and decision-making at the planning stage, minimise risk and uncertainty during the build phase and provide higher operational efficiencies throughout the life of the asset. As computational power and algorithmic complexity grows, these techniques and tools will provide even greater ability to reduce cost and improve productivity.

The financial services, telecommunications and retail sectors have in recent years adopted new innovative technology and tools (or Smart ICT) to fundamentally transform their business models and processes.

It is proposed that the Commission recommends that the use of Smart ICT be integrated into all aspects of the public infrastructure investment process: planning, design, development and operations.

Infrastructure Australia evaluation criteria for projects should also include consideration of how Smart ICT can be used to optimise productivity in this process.

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About NICTA

NICTA (National ICT Australia Ltd) is Australia's Information and Communications Technology Research Centre of Excellence. NICTA develops technologies that generate economic benefit for Australia. NICTA collaborates with industry on joint projects, creates new companies, and provides new talent to the ICT sector through a NICTA-enhanced PhD program. With five laboratories around Australia and over 700 people, NICTA is Australia's largest organisation dedicated to ICT research and commercialisation.

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