THE ROLE OF SMART ICT IN THE DESIGN AND PLANNING OF INFRASTRUCTURE

Submission to the Standing Committee on Infrastructure and Communications

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Abstract:

This submission addresses items b, c and g of the terms of reference, namely:

b) Identifying the new capabilities smart ICT will provide;
c) Examining the productivity benefits of smart ICT;
g) Considering means, including legislative and administrative action, by which government can promote this technology to increase economic productivity.

In particular, we consider the impact that smart ICT can have on the road system and how it can be used to reduce the requirements for vehicular traffic and road infrastructure.

1. Introduction:

Over the past 50 years ICT technologies have had a dramatic impact on the economy. Today technologies such as broadband, mobile Internet, cloud and social have changed the way enterprises operate, disrupted industries such as media and retail and enabled all industries to change the way they relate to their customers and deliver service.

However, the impact of these technologies has not been evenly felt across the economy. Sectors such as government, health and education have not shown the same levels of productivity gains as the rest of the economy. This is now set to change, as a new wave of ICT technologies is set to create unprecedented transformation on a scale that dwarfs even the changes of the past 50 years.

In section 2 of this submission, we briefly outline the key technologies that are emerging and are likely to have significant impact over the next 10 years. In section 3, we postulate the impact of these technologies on road infrastructure and show how appropriate use of digital technology can free up capital and land that would otherwise be required to build new roads to support population growth.

2. Emerging technologies:

By merely examining historical precedent it becomes clear that any technology that is likely to have impact in 10 years' time is already visible today, either in labs or in the market, but often with low current adoption. These technologies that have not yet become mainstream are referred to as 'emerging technologies'. The term 'mainstream' describes technologies that are used regularly by the majority of the population. However, predicting which technologies will become mainstream is extremely difficult as it is dependent on human behaviour.

Four categories of technology are emerging today which have the potential to go mainstream:

2.1. Human interface technologies

As technology progressed over the last 25 years of the 20th century, human beings needed to learn how to adapt to use the technology. Effectively technology was only available to an elite educated few. In the first 25 years of the 21st century, technology has been adapting to human beings to make the technology intuitive and accessible to all.

Speech and natural language recognition are enabling people to talk to technology, using innovations such as gesture recognition, which simplifies the control of devices and screens; eye tracking, (to primarily assist people with disabilities); and even brain interfaces, which are emerging and allow computers to understand and respond to human thoughts.

2.2. Immersive communications

A fundamental shift in TV viewing habits has led to the requirement for a new generation of broadband communications: TV viewing is shifting from broadcast to broadband. By the end of this decade, it is expected that more hours of TV will be viewed on broadband than broadcast.[1]

In order to support widespread viewing of TV on broadband, the technology for broadband needs to change from web-centric to media-centric. Web-centric broadband is able to exploit the 'burstiness' of web viewing (characterised by the short and sudden periods of data activity) to achieve statistical gain in broadband communications (which means that many users can share the same bandwidth at the same time, giving rise to what is called a "contention ratio" for the broadband access). However, video and audio do not exhibit the same level of burstiness and so the contention ratio for broadband access needs to be much less than for web traffic. Because of this lower contention ratio there is a different set of requirements for how media-centric broadband access must be designed. In addition, an increasing appetite for higher and higher definition viewing and multiple simultaneous viewing of different programmes requires a higher peak speed on the broadband links. The National Broadband Network (NBN) is designed to address these requirements.

At the same time as the demand for media-centric broadband is emerging, screen and camera technologies continue to improve rapidly thereby enabling high definition multi-media – or "immersive" - communications which provide an increasingly realistic recreation of reality at a distance. In addition to flat screens, the emergence of headsets for augmented or virtual reality create the potential to recreate the entire surrounding reality at a distance.

Immersive communications have the ability to break the nexus between work and place and thus reshape the distribution of the population.

2.3. The Internet of Things

Sensor technologies are emerging that make it affordable to accurately measure an unprecedented number of physical variables: movement, location, chemicals, biomarkers, infrastructure. The power of these sensors combined with modern wireless communications technologies allows "things" to be connected to the Internet so that they can measure, report and control. This so-called "Internet of Things" (IoT) creates huge opportunity to improve our physical world. In fact, according to a Cisco study[2] less than one percent of 'things' were connected to the Internet in 2012. Gartner predicts that endpoints of the IoT will grow at a 35 percent CAGR from 2013 through 2020 reaching an installed base of 25 billion units, with over half of them consumer applications[3].

Governments will need to have a role in maximising the IoT's benefits for all citizens, while at the same time minimising potential effects[4]. As with the Internet itself, the IoT's technologies will transcend national boundaries, so it will be important for governments to work together to promote international collaboration and governance. To some extent, the IoT represents the next evolution of the Internet, taking a hugh leap in its ability to gather, analyse, and distribute data that we can turn into information, knowledge, and, ultimately, wisdom. This context becomes particularly important in relation to the utilities and resources sector in Australia.

IoT will also impact how infrastructure is management and monitored. New and existing assets will be increasingly connected – today video technology is used to monitor road networks and road analogue monitoring systems. In future smart sensors in roads, rail, bridge and culverts will allow continuous condition monitoring to enable asset maintenance funds to be focused, and where possible, proactively allocated.

2.4. Artificial intelligence and machine learning

The advent of cloud services has led to an abundance of computing capacity which can be used to store and process the information that is flooding in from both human and machine sources. The combination of abundant capacity and abundant data has led to a resurgence of interest in machine learning algorithms over the last five to 10 years. By feeding a machine data, we can teach it to recognise patterns in a manner analogous to human thought processes. Advances in speech recognition have come about mainly through such artificial intelligence technologies.

Machine learning can be applied to many different applications. It can be used to recognise faces and objects in photographs, to detect security anomalies in ICT systems, hazards in transport systems and many similar such cases. The technology enables previously unthinkable capabilities to become possible. For example, in 2004 researchers thought it would be impossible to teach a car to drive itself[5]. Yet by 2012 Google had not only built such a vehicle but proven its viability by having it drive itself over a million kilometres around California.[6]

3. Impact on road infrastructure

One of the most significant opportunities to apply smart ICT is on the road network. We have performed a study[7] to examine the combined impact of the technologies discussed in section 2 on the road capacity requirements for Australia out to 2050. Australia's population is estimated to grow from 23.5 million in 2014 to 37.6 million in 2050. If we continue to build and operate roads as we do today we are likely to need about two and a half times more road capacity in 2050 than we have today, to cater for this population growth. However our study estimates that, using a simple but realistic set of assumptions, the road capacity requirement in 2050 will be roughly equivalent to the capacity existing today. This is due to the impact of technology adoption over the next 35 years which is predicted to lessen the need to build new infrastructure, peaking at about 150 percent of today's capacity (as opposed to a 250 percent increase).

The biggest impact arises from Autonomous Vehicles (AV's). An AV is defined as a computer controlled car that drives itself without the active intervention of a human operator[8]. Other studies indicate an even more significant impact of AV's on urban infrastructure. For example, an OECD study[9] modelled the impact of 'taxibots' (self-driving shared taxis) on the city of Lisbon, Portugal, and came to the conclusion that these vehicles, in combination with a mass transit system, could result in a 65 percent reduction of vehicles in use during rush hour.

4. Recommendations

4.1. Assess potential benefits of mandating use of self-driving cars

We recommend that Australian Governments assess the societal benefits of mandating the use of AVs on Australian roads by a certain date. Any investigation and analysis should include the economic, societal and health impacts from the pervasive use of AVs.

90 percent of road accidents today are caused by human error[10], so autonomous vehicles could significantly reduce the annual road toll. Today, the average annual road toll in Australia is approximately 1,200 people[11]. In addition to the people killed, road accidents cause approximately

50,000 people to be injured seriously enough each year to require hospitalisation[12]. It is legitimate to assume that a fully autonomous road system could avoid nearly 90 percent of fatalities and injuries, thereby saving approximately 1,000 lives per year and avoiding 45,000 serious injuries. To support this conclusion, we can compare this with the death toll in aeroplanes where the chances of dying in an AV will be much closer to the chances of death in an aeroplane than to a car in today's world. The probability of dying in a plane crash is 1.4 percent of the chance of dying in a car accident in the current system.[13] AVs therefore have the potential to relieve pressure on the health system to say nothing of other impacts such as the drain on social and emergency services.

Now that the viability of self-driving cars has been proven, car manufacturers are actively looking to build and market autonomous vehicles. A flurry of recent announcements would indicate that we can expect the market introduction of fully autonomous vehicles in about 2020, but in the meantime car manufacturers are already progressively introducing key aspects of autonomous vehicles –such as adaptive cruise control, lane assist driving, self-parking, collision-avoidance self-braking systems - into their production vehicles.

Needless to say, it will take some time for new fully-autonomous vehicles to diffuse into the market. Consumer Reports says that the average life expectancy of a motor vehicle is about eight years or 150,000 miles (roughly 241,000 kilometres), but that vehicles can remain on the road for about 15 years[14]. However, it may also be possible for drivers to fit existing cars with an aftermarket autonomous driving kit, such as those being tested by Cruise[15].

Because of the significant safety and societal benefits of autonomous vehicles it is not unreasonable to expect that at some point in the 2020s, developed countries could mandate a date by which all vehicles must be capable of being autonomous in order to be registered. This would lead to a more rapid introduction of self-driving cars than could be anticipated from natural diffusion alone. By taking such a stance, not only will Australia save the huge societal burden of road accidents, but also could proactively encourage Australian industry to become a leader in the production, installation and operation of aftermarket self-driving kits.

4.2. Create the regulatory environment to encourage new models of transport

In some jurisdictions, new forms of transport (such as Uber) have been held back because of entrenched interests. As mentioned above, new modes such as taxibots have the potential to significantly improve the urban transport environment and regulation should not impede adoption.

4.3. While it is important for Government to debate the merits of new models of transport to ensure public safety and adequate checks are in place, we believe regulation should not impede the adoption of new transport models given the significant benefits outlined in this paper. Create the regulatory environment to encourage and facilitate telecommuting

Immersive telecommunications technologies create the opportunity to break the nexus between work and place. As the NBN becomes increasingly pervasive, and immersive communication technologies become increasingly affordable, telecommuting becomes a viable prospect for many workers. Encouragement of telecommuting will enhance the economies of regional areas, improve overall citizen lifestyle and provide opportunities for the elderly and disabled to participate more fully in the workforce.

The Government should investigate barriers to adoption of telecommuting which can be both social and regulatory and investigate ways of overcoming the hurdles. For example, OH&S regulations should be adapted to remove any unnecessary burdens from those working in a home environment.

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