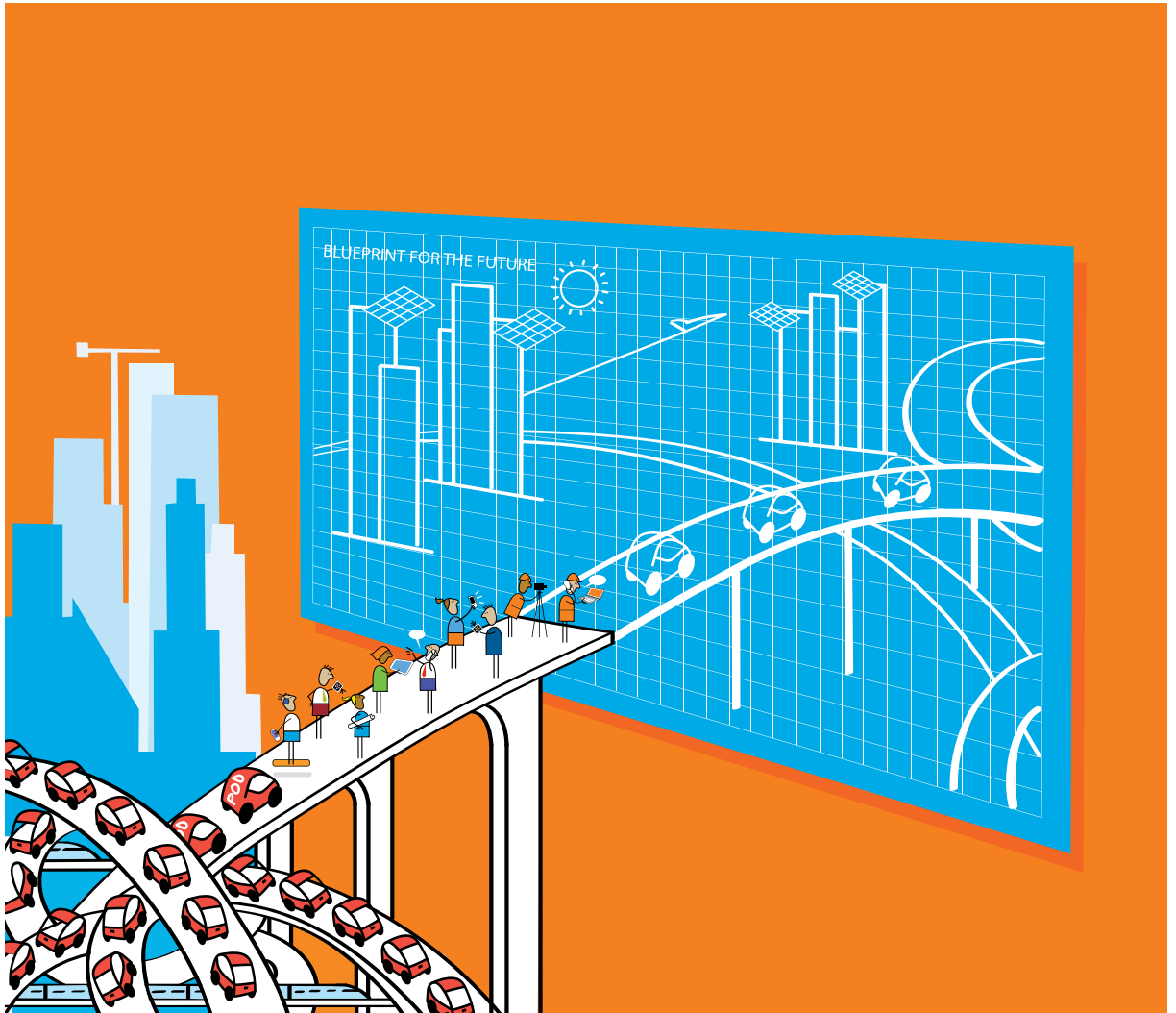# WILL TECHNOLOGY DISRUPT OUR EXISTING AND FUTURE INFRASTRUCTURE?

CHARTERED ACCOUNTANTS
AUSTRALIA + NEW ZEALAND

BLUEPRINT FOR THE FUTURE

future [inc]

A PLAN FOR AUSTRALIA + NEW ZEALAND'S PROSPERITY

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Chartered Accountants Australia and New Zealand is made up of over 100,000 diverse, talented and financially astute professionals who utilise their skills every day to make a difference for businesses the world over.

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Our teams can provide you with specialist advisory, tax, audit, accounting and compliance related assistance through the life your infrastructure projects and programs, or as a fundamental part of your business. KPMG offers you:

A Worldwide Network: KPMG's Global Infrastructure practice includes 3,000 member firms' professionals who have advised on many of the most ground-breaking infrastructure projects, assets and businesses around the world. Our pool of knowledge provides ready access to industry best practices and insights.

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Impartial Advice: Our advice is objective and not biased toward any particular project or financial outcome.

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future [inc] FOREWORD

Technology has changed the challenges of infrastructure. It has become a disruptive – and powerful source of innovation and renewal for the industry. The way that priorities are set and met has been transformed by the collaboration of technology in infrastructure.

As our population grows we are faced with responding to the challenges that arise from this issue. We are also met with opportunities that rapidly arise to create long and short–term solutions. In the last twelve months future[inc] has looked at what we need for continued prosperity in Australia and New Zealand.

Whilst governments and communities can clearly identify what infrastructure should be developed and where, the impact of technology on our future infrastructure requirements is often missing from the conversation. We need to consider why this is. Politicians always say that they want to make lives easier. We need to move beyond the ideas – progress needs to be visible. Our latest future[inc] paper *Will technology disrupt our existing and future infrastructure?* looks at the way that technology will continue to improve and change the infrastructure we have. It also discusses ways technology can significantly change our future infrastructure requirements.

Technology is reshaping national infrastructure requirements. We look at ways it can be embedded into infrastructure assets and the potential it has to alter both demand and supply dynamics. It will also impact how businesses and individuals use infrastructure.

We have already seen the potential of technology in many other areas – but unless we bring technology into our infrastructure planning, we may miss the disruption our current thinking needs.

Join the conversation.

Lee White FCA
CEO, Chartered Accountants Australia and New Zealand

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We cannot be defensive, we **CANNOT FUTURE PROOF OURSELVES.** We have to recognise that the disruption that we see driven by technology, the **CHANGE IS OUR FRIEND** if we are agile and smart enough to take advantage of it.

THE HON. MALCOLM TURNBULL MP
IN HIS FIRST SPEECH AS PRIME MINISTER DESIGNATE ON 14 SEPTEMBER 2015

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Technology has the **potential to disrupt our existing and future infrastructure**. Whilst Australia and New Zealand have both completed extensive studies on what infrastructure should be developed and where, the **impact of technology has not been comprehensively explored**. In our view the conversation on future infrastructure requirements needs to be reframed from "How much more infrastructure do we need to build?" to "How can technology improve the infrastructure we have, how will technology influence what new infrastructure is required and will technology significantly reduce our future infrastructure requirements?"

EXECUTIVE SUMMARY

TECHNOLOGY TRENDS

Technological innovation is changing and will continue to change the way infrastructure is optimised and utilised and how businesses and people use infrastructure. There are five themes that collectively capture the technological trends reshaping national infrastructure requirements:

- **Embedding technology:** Embedding technology into infrastructure assets can have a significant impact on improving asset performance, enabling asset owners to be continually informed of their asset's condition and the use of those assets. For example the Auckland Motorway Alliance implemented an asset management system driven by geographic information systems (GIS) that monitors road conditions. The system has enabled better management of scheduling resurfacing and repairs and maintenance that has resulted in a reduction of unscheduled road closures and extended the life of the asset base.

- **System integration and management:** Optimising infrastructure networks through system integration and management within and across asset classes results in optimal utilisation of existing and new assets. The most obvious case of system integration may be in the design of Intelligent Transportation Systems (ITS). For instance, the US Department of Transportation's Connected Vehicle programme has combined vehicle-to-vehicle and vehicle-to-infrastructure integration into one consolidated platform. This enables various additional functions, such as adaptive signal timing, dynamic re-routing of traffic through variable message signs, lane departure warnings, curve speed warnings, and automatic detection of roadway hazards, to be performed seamlessly.

- **Disruptive technology innovation:** Disruptive technology innovation in infrastructure has the potential to alter both demand and supply dynamics. It has the potential to drive efficiencies and in some cases make existing infrastructure obsolete. These new technologies threaten to disrupt the entire business and regulatory models of whole sectors, such as water and power. For example, PNM the leading electric utility company in New Mexico developed the first solar energy storage facility in the US fully integrated into the power grid. The outcome of the project include reduced energy generation during peak hours, smoothing energy ramp rates and minimising voltage fluctuations and demonstration of a renewable energy source that can be turned on and off. If proven scalable the technology could have far reaching consequences for electricity generation and transmission infrastructure.

- **Technology impacting how people use infrastructure:** Technology innovation will drastically impact how people use infrastructure and therefore what infrastructure is required. For example, the future workspace will be a radically different workspace. As the latest generation graduates from the classroom to the office, they expect upgraded technology to be ready and waiting for them. For this generation of workers, Voice over IP (VoIP), video conferencing and workplace instant messaging are not novelties but necessities. This technology makes it easier for people to work outside the traditional office environment and in locations more convenient to them – avoiding the need to travel in some cases.

- **Technology impacting how businesses use infrastructure:** Technological innovation continues to impact how businesses use infrastructure and therefore what infrastructure is required. For example, intelligent transport systems (ITS) are making freight transportation safer and more efficient by applying data processing, communication, and sensor technologies to vehicles (including trucks, trains, aircraft and ships), infrastructure, and operating and management systems. ITS technologies are new and evolving tools that are already helping national economies achieve their transportation objectives by reducing the number of vehicles on the road and therefore lowering congestion.[1]
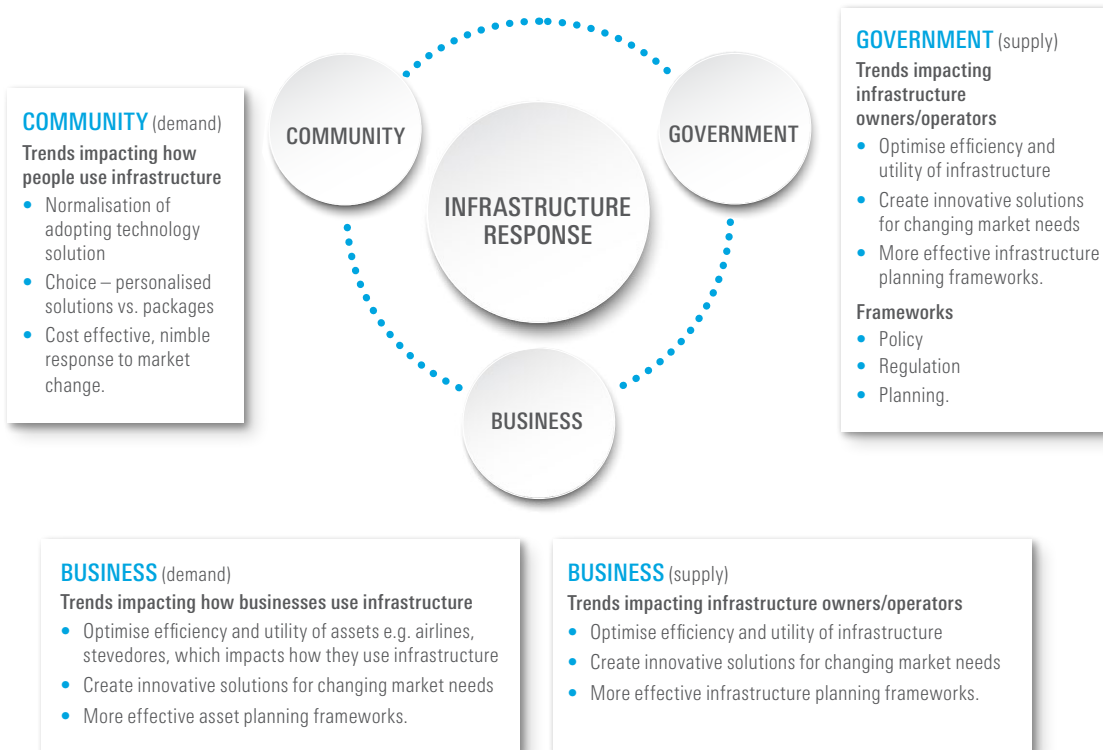
HOW WILL WE RESPOND?

As our populations grow and the world changes around us, opportunities are rapidly emerging to improve efficiency and create solutions to drive better infrastructure outcomes for people, businesses and communities. It is likely that our future infrastructure requirement will be dramatically reshaped. For example the combination of driverless vehicles and the establishment of secondary employment hubs could significantly reduce the number of vehicles on the road and the need for more road infrastructure. Advancements in eHealthcare together with innovative service delivery models will lead to improvements in health solutions that may reduce the requirement for expanding traditional hospital infrastructure. Equally importantly our traditional infrastructure requirements may alter the development of enabling technology to drive this change.

To ensure we embrace these opportunities and optimise our scarce resources it is crucial everyone plays a role in proactively driving the technology agenda. Figure 1 provides an overview of how the community, business and government each have a role in driving the technology agenda. The benefits of change will be realised through a collective response.

FIGURE 1: OUR RESPONSE

COMMUNITY (demand)

Trends impacting how people use infrastructure
- Normalisation of adopting technology solution
- Choice – personalised solutions vs. packages
- Cost effective, nimble response to market change.

GOVERNMENT (supply)

Trends impacting infrastructure owners/operators
- Optimise efficiency and utility of infrastructure
- Create innovative solutions for changing market needs
- More effective infrastructure planning frameworks.

Frameworks
- Policy
- Regulation
- Planning.

BUSINESS (demand)

Trends impacting how businesses use infrastructure
- Optimise efficiency and utility of assets e.g. airlines, stevedores, which impacts how they use infrastructure
- Create innovative solutions for changing market needs
- More effective asset planning frameworks.

BUSINESS (supply)

Trends impacting infrastructure owners/operators
- Optimise efficiency and utility of infrastructure
- Create innovative solutions for changing market needs
- More effective infrastructure planning frameworks.

Changing demographics will change how and where people travel, how they work, how they interact, their housing preferences (type and location) and how they shop. Younger generations expect to be plugged in at all times and to be able to access their information instantly. They are also interested in new ways of doing just about everything. This will impact on their expectations in terms of transport, communications, housing, shopping, health care and education, amongst other things.

How will younger generations' technology expectations impact infrastructure?

Knowledge workers will represent an increasing proportion of the workforce. These new jobs will draw more people to the CBDs. More commuters will utilise the transport network at peak times, travelling to and from the centres of major cities. However advances in telecommuting technologies will push against the surge. Employers will re-evaluate the importance of housing all employees in increasingly expensive CBD offices. Secondary employment hubs, already springing up in the major cities, will take new prominence and take some of the stress away from the CBDs. New technologies allow services to reach satellite cities and regional areas in a way not seen before. These services will improve regional development and quality of living.

Technology will significantly impact government infrastructure policies and programmes. Changes to how services and infrastructure are delivered promise to provide greater choice to users, reduce costs and do more with less.

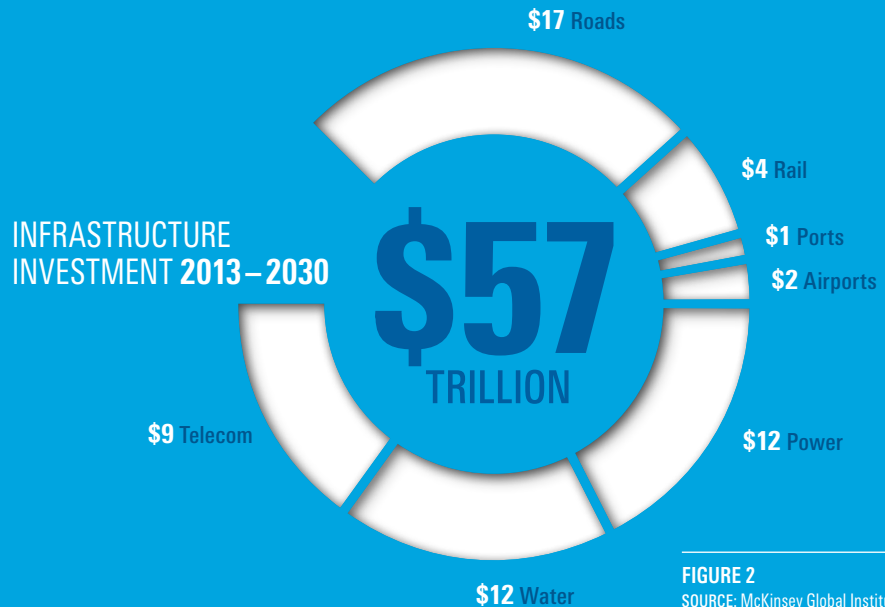## How will future infrastructure projects be prioritised?

New technologies have the potential to disrupt the entire business and regulatory model of monopoly services. The transmission and distribution of electricity using 'poles and wires' is a typical example. Solar generation and battery storage electricity is creating unprecedented uncertainty in the electricity supply sector.

To date, regulatory frameworks for infrastructure services have not been designed to address either planned or unexpected, service or infrastructure obsolescence. New technologies have the potential to disrupt regulatory paradigms too and this is an issue that regulatory policy makers have yet to tackle.

CAN TECHNOLOGY SAVE US?

If we are unable to embrace and adapt to the rapidly changing environment, Australia and New Zealand's productivity and future prosperity will suffer. We are at risk of planning and building infrastructure that is outdated or unnecessary even before it is operational. With the prospect of declining living standards, people will look to alternative locations for opportunity.

The winners will be the countries and organisations that can adapt and lead improvements and innovation throughout the infrastructure asset lifecycle and drive better outcomes with their scarce resources for their communities. The race is on to see who can do it!

INFRASTRUCTURE INVESTMENT 2013 – 2030

$17 Roads
$4 Rail
$1 Ports
$2 Airports
$12 Power
$12 Water
$9 Telecom

$57 TRILLION

FIGURE 2
SOURCE: McKinsey Global Institute[2]

INTRODUCTION

THE INFRASTRUCTURE CHALLENGE

The provision of timely, efficient, effective and economically viable infrastructure is one of the greatest challenges facing the world today. The challenge is framed by a number of realities, trends, opportunities and constraints that will affect our ability to meet this challenge head on.

Australia's population will grow by five million in the next ten years and will double to 48 million by 2060. This results in about 2.5 million new jobs by 2025. In New Zealand, the population will grow 18% by 2033.

These demographic trends will put pressure on transportation and utility networks. Doubling the capacity of water, electricity and digital infrastructure, and waste management will be a major challenge for Australia and New Zealand. New harbours and airports will need to be built and existing ones will need to increase their capacities.

One of the key considerations is the sheer size of the task. The McKinsey Global Institute[2] (MGI) estimates that $57 trillion of global infrastructure investment will be required between 2013 and 2030, simply to keep up with GDP growth.

DOUBLING THE CAPACITY of water, electricity and digital infrastructure, and waste management will be a **MAJOR CHALLENGE FOR AUSTRALIA AND NEW ZEALAND**.
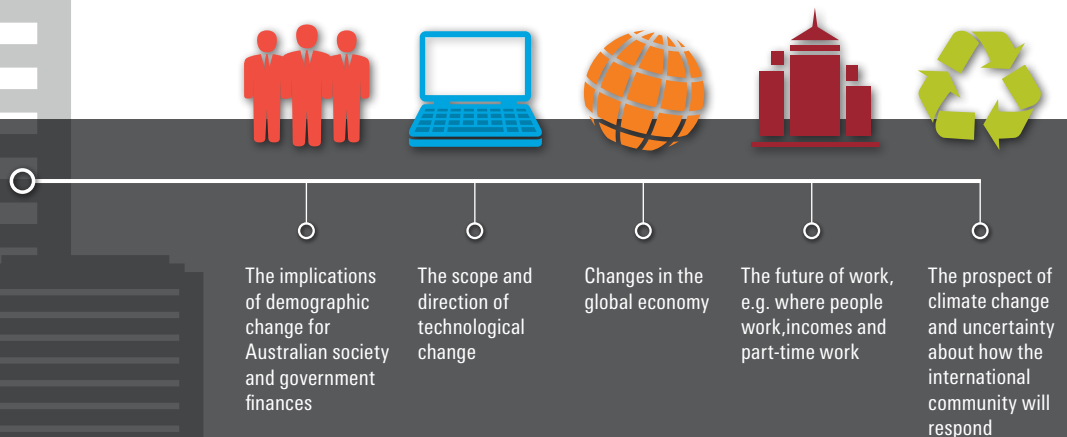
This only covers transport, energy, water and telecommunications. Additional investment is required in social infrastructure (prisons, social housing, health care, etc.).

MGI further estimates that the required annual infrastructure investment equates to $3.2 trillion per year or 3.5% of anticipated global GDP. Infrastructure spending over the previous 18 years amounted to about $2.0 trillion per year, so an increase in the average annual investment of about 60% is required.

New Zealand's government working on addressing the challenge represented 'an inadequate supply of infrastructure,' according to the World Economic Forum Global Competitiveness Report.[3] New Zealand committed $13 billion over the next three years to transport infrastructure alone.[4]

As shown in Figure 3, Australia will need to deal with a number of mega trends in the planning for future infrastructure. Many of these issues are already part of the vernacular in discussions about the future, whether in polite conversation or heated debate about government policy.

| The implications of demographic change for Australian society and government finances | The scope and direction of technological change | Changes in the global economy | The future of work, e.g. where people work, incomes and part-time work | The prospect of climate change and uncertainty about how the international community will respond |

FIGURE 3: MEGATRENDS IMPACTING INFRASTRUCTURE PLANNING[5]

THE IMPACT OF TECHNOLOGY ON THE FUTURE INFRASTRUCTURE REQUIREMENT

In the context of the current infrastructure status quo, a significant breadth of work has been dedicated to what infrastructure should be developed by 2035 and where (e.g. the New Zealand National Infrastructure Plan, the Australian Infrastructure Audit and the Australian Productivity Commission's Report).

However, assessing the collective and cumulative impact of key technology developments on the future of infrastructure has not been extensively explored. There is an inter-relationship between optimising current infrastructure assets and networks, the impact of technology on infrastructure demand and the nature of its use, and our future infrastructure requirements.

While this paper focuses on the application of technology to our future infrastructure requirement, by necessity, it looks at changes to how infrastructure is perceived and used. It follows that future infrastructure requirements are not defined by the question 'How much more infrastructure do we need to build?' Rather, the question needs to be rephrased as 'How can technology improve the infrastructure we have, what is the changed nature of the infrastructure that we need and will technology significantly reduce our future requirement?'

By asking the right question(s), we can address trends such as:

- **Embedding technology:** Embedding technology into infrastructure assets can have a significant impact on improving asset performance, enabling asset owners to be continually informed of their asset's condition and the use of those assets.

- **System integration and management:** Optimising infrastructure networks through system integration and management within and across asset classes results in optimal utilisation of existing and new assets.

- **Disruptive technology innovation:** Disruptive technology innovation in infrastructure has the potential to alter both demand and supply dynamics. Disruptive technology has the potential to drive efficiencies and in some cases make existing infrastructure obsolete.

- **Technology impacting how people use infrastructure:** Technology innovation will drastically impact how people use infrastructure and therefore what infrastructure is needed.

- **Technology impacting how businesses use infrastructure:** Technology innovation is and will continue to impact how businesses use infrastructure and therefore what infrastructure is required.

Rather, the question needs to be rephrased as 'How can technology **IMPROVE THE INFRASTRUCTURE** we have, what is the **CHANGED NATURE** of the infrastructure that we need and will technology significantly **REDUCE OUR FUTURE REQUIREMENT**?'

FIGURE 4: TECHNOLOGY THEMES IMPACTING OUR INFRASTRUCTURE REQUIREMENT

| Embedding technology into infrastructure assets to improve efficiency and performance | System integration and management to optimise the utility of existing and new assets | Disruptive technology innovation applied to infrastructure assets | Technology impacting how people use infrastructure | Technology impacting how businesses use infrastructure |
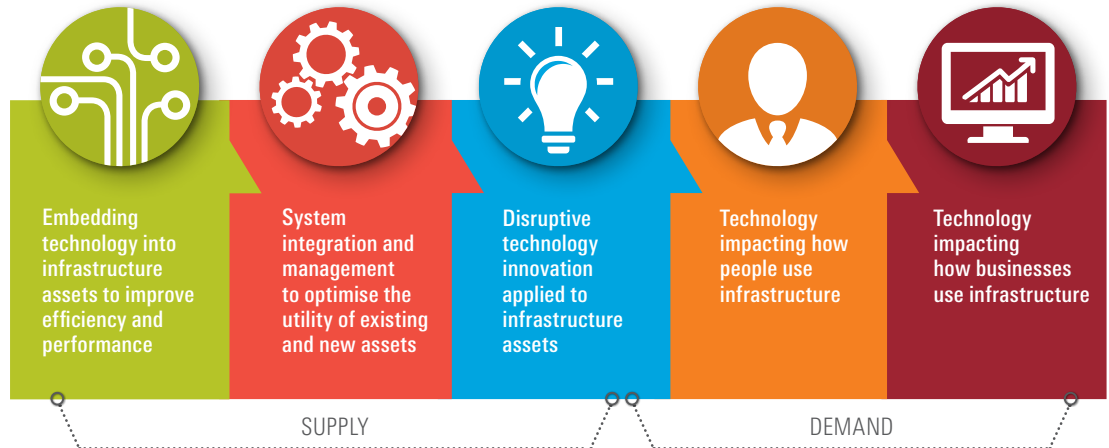
SUPPLY — DEMAND

APPLICATION OF TECHNOLOGY – KEY THEMES

The following chapters explore the current supply and demand technology themes that will influence what we build and how much is required. Supply relates to how technology directly impacts infrastructure, whether it be embedded, systematic or disruptive, and Demand relates to how technology impacts how people or businesses use infrastructure e.g. driverless vehicles have both the consumer and commercial market applications and will impact how people and businesses use infrastructure.

Each of these themes are examined in the light of case studies of current or potential uses of technology. The final chapters explore how we could respond to future technology opportunities as they interface with infrastructure and how this will impact our future national prosperity.

What's immediately clear is that we all need to take urgent action to harness the power of technology and recalibrate infrastructure plans and strategies as the world swiftly evolves. Demographic change, work force mobility and technological change are creating a perfect storm for infrastructure. Without a commitment to understanding how our infrastructure needs have and will change and a willingness to invest in innovative thinking, we will find ourselves pedaling backwards and investing in projects that will be underutilized in the long term.

Our paper calls on communities, businesses and governments around the world to take notice of how the times are changing, why they're changing and what needs to be considered in the response.

GE is working with one the major US railways to install sensors on tracks and locomotives to fine-tune the flow of rail traffic. Initial results show an increase in average speed of about 3 km/hr, resulting in **ANNUAL SAVINGS OF ABOUT $200 MILLION**.[6]

EMBEDDING TECHNOLOGY

IMPROVE INFRASTRUCTURE ASSET PERFORMANCE

Infrastructure – transportation systems, power, water and telecommunications – form the backbone of any country, and determine its growth and economic development potential. Technologically enhanced systems help augment safety, mobility and convenience; improve operational performance; deliver environmental benefits; and boost productivity, economic and employment growth.

A major role for technology is as an embedded technology in hard infrastructure assets (roads, railway lines, bridges, hospitals and schools). This will enable the asset owners to be continually informed of their asset's condition and the use of those assets. On roads and bridges, these sensors can measure attributes such as vehicle speed, the number of vehicles, types of vehicle, stresses (loads, deflections, etc.), weather conditions, and provide the owner with real-time information on the asset's condition and use. In electrical power grids, inline sensors and monitors can be used to assess line losses beyond the normal distance-based losses. They can potentially spot the pending failure of a part or a system, as well as damage to a line from a falling tree. Smart meters can be used to better monitor and predict power usage within small areas or across the system. This can help identify theft of power, and detect power outages before they are reported through other mechanisms. They can also be used to automate the billing process.

The following case studies show how new technologies are already changing road and electricity systems.

CASE STUDY 1
AUCKLAND MOTORWAY ALLIANCE

Auckland Motorway Alliance: Paving the way to improved asset management[7]

BACKGROUND:

The Auckland Motorway Alliance (AMA) operates and maintains Auckland's motorway network. Its primary objective is to ensure that motorists are able to reach their destination safely and quickly at all times of the day and night.

AMA began focusing on the maximisation of asset performance in order to manage demand within budget constraints. To do this, they needed accurate and detailed information about each asset and its condition.

SOLUTION:

AMA implemented an asset management system driven by a geographic information systems (GIS). The system enabled daily operations, planning, budgeting and asset management. This GIS integration enabled detailed tracking of asset conditions by accurately mapping roadway report information. They have 150 distinct layers of information in the system that can be displayed with a variety of base maps, scales and symbols. They accurately measure surface roughness and skid resistance, two indicators of pavement integrity, and enter that information directly into the system. The system better plans for scheduling resurfacing, inspection, or repairs of roadway to minimise duplication of efforts.

RESULTS AND OUTCOME:

The system allows AMA to manage its assets better. The detailed information mapped with visual aids helps AMA minimise their risk and cost by reducing ad hoc repairs. AMA monitors the effect of traffic on the network and compares the network deterioration in the system with the forward work programme. For instance, they were able to combine a resurfacing programme originally scheduled for 2013 and with a revegetation project planned for 2014 on the same section of motorway, which otherwise would have damaged the new surface.

AMA has better managed its budget through asset condition automation by reducing unscheduled road closures and extending the life of their asset base. The GIS tracking helps manage and coordinate road maintenance needs. This decreases the need for unplanned closures which cost around $3,000 each.

AMA is investigating the expansion of the program to up to 27 other motorway maintenance contracts.

CASE STUDY 2
AURIZON'S HIGH-TECH ASSET MANAGEMENT

BACKGROUND:

Aurizon, Australia's largest freight operator, transports more than 250 million tonnes of commodities each year. Growth in its extensive rail network drove Aurizon to optimise the efficiency of their operations and asset management process.[8]

Aurizon's network consists of approximately 580 locomotives, 13,500 wagons and 15,400 route kilometres operated by approximately 7,000 employees. The efficiency and the operational effectiveness of the network depends on regular check and maintenance of these assets. However, these largely manual measures taken to maintain these assets consumed time and resources. Aurizon therefore introduced technological mechanisms to streamline the efficiency, enhance productivity, and develop cost reduction efforts across the business.[9]

SOLUTION:

Aurizon implemented a major process reform programme underpinned by advanced technology.[10] Key solutions of the reform included:

- **Maintenance drones** – Aurizon initiated the use of unmanned aerial vehicles (UAVs) to monitor network infrastructure and overhead electrical equipment which allow the company to obtain high definition inspection information of assets without having any impact on train operations. The use of infrared technology and high-resolution images also mean that the company can more easily access difficult areas, minimise the presence of employees on the rail corridor, and provide data for pre-emptive maintenance activities.[11]

- **Condition monitoring system** – The new technology automates many of the rolling stock inspection and assessment tasks which are currently performed manually in depots. Lasers and cameras along the tracks scan the length of each train analysing the condition of key components such as wheels, brake systems and doors via sophisticated algorithms. The system is designed to send text messages to or email Aurizon's 'rolling stock defect coordinators' with any issues.[12]

- **Freight management transformation** – Aurizon replaced its legacy systems with a SAP freight management system providing an integrated freight and yard management solution. The system has end-to-end visibility across the supply chain process, integrating long and short-term planning with resource availability and customer demand.[13]

RESULTS AND OUTCOME:

Aurizon has seen improvements in its key operating metrics.

- **Maintenance drones** – UAVs are assisting the company reduce reactive maintenance and increase asset monitoring.[14] They provide asset condition information for 2,600km of track of which 80% is electrified. They have improved safety and track time demand. Aurizon is investigating the use of UAVs for surveying and inspecting telecommunications towers, bridges and structures.

CASE STUDY 2 Continued

- **Condition monitoring system** – The system has enabled greater availability and asset productivity, while lowering operating and maintenance costs and has automated the rolling stock inspection. The system provides Aurizon's maintenance team with real-time information and predictive capabilities by consolidating and managing all wayside detection data and automatically generating maintenance work orders.[15]

- **Freight management transformation** – Aurizon has improved planning, scheduling and product tracking. The system has enabled improved on-time delivery and operational decision making. Aurizon's customers have benefited from improved visibility and traceability through a portal allowing them to manage orders and invoicing, view consignment status, and integrated track and trace capabilities enabled for mobile devices.[16]

SYSTEM INTEGRATION AND MANAGEMENT

OPTIMISE THE UTILITY OF EXISTING AND NEW INFRASTRUCTURE ASSETS

In today's connected world, the existence of multiple data silos pose both a huge challenge and opportunity. Infrastructure operators, such as utilities and transportation systems, use multiple systems sourced from various vendors to operate and optimise assets. These separate solutions are still required to communicate with one another. Organisations are now building robust architectures by implementing new technologies that integrate silos with both new and legacy systems. The potential of efficiencies driven through system integration should result in optimal utilisation of existing and new assets. For example, in assessing where to invest in road infrastructure using system data, it could be identified that rather than building a new road a superior economic outcome could be achieved through building a connector between two existing roads. The most obvious case of system integration may be in the design of Intelligent Transportation Systems (ITS). ITS are subject to network effect and scale challenges, thus requiring extensive system coordination – often at the national level – to deploy and integrate ITS. systems. For instance, the US Department of Transportation's Connected Vehicle program has combined vehicle-to-vehicle and vehicle-to-infrastructure integration into one consolidated platform. This enables various additional functions, such as adaptive signal timing, dynamic re-routing of traffic through variable message signs, lane departure warnings, curve speed warnings, and automatic detection of roadway hazards, to be performed seamlessly. The following case studies demonstrate how these systems are being developed and used to optimise infrastructure networks.

CASE STUDY 3

ASFINAG MOTORWAY, AUSTRIA

End to end technology deployment[17]

BACKGROUND:

ASFiNAG, the Austrian road administration authority, exemplifies the global deployment and acceptability of intelligent transport management systems. ASFiNAG, an innovative, user-funded organisation, is responsible for planning, maintaining and tolling the 2,175 kilometres of Austrian motorway, including 340 kilometres of tunnels and 340 kilometres over bridges. A large portion of the road network passes through rugged conditions in the Alps. To better manage the congestion, efficiency and safety of the road network, ASFiNAG needed a better communications and technology solution enabling seamless operations in adverse conditions. Its priorities included:

SOLUTIONS:

ASFiNAG created a smart highway designed to clear traffic jams before they happen. ASFiNAG deployed a bandwidth-intensive video surveillance traffic management system, allowing them to see the road and traffic conditions real-time. The intelligent Ethernet switches support video streaming and emergency voice communication throughout the road network and enables ASFiNAG to focus on the roadways requiring attention. The system is built on a modular platform, which means its capacity can be easily scaled up as communication and surveillance technology improves and requires additional bandwidth.
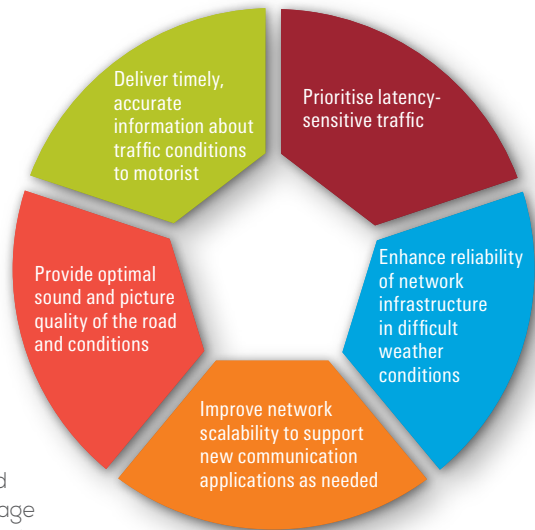

FIGURE 5: ASFiNAG'S SOLUTION

In addition, ASFiNAG adopted 'Internet of Everything' (IoE) to get the data needed to keep drivers safe and moving. Through 70,000 sensors over fibre optic networks, IoE analyses drivers' data to help improve operations. The sensors monitor accident and road and weather conditions across Austria. The data is routed through a central system and across nine traffic management centres.

The system can use their data to better manage the road network. For instance, the system can lower speed limits ahead of slow moving traffic to help prevent a traffic jam. Also, the system can communicate safety or road information to drivers via electronic signs, smart phone apps or free wireless access at rest areas resulting in improved traffic flow and safety.

CASE STUDY 3 Continued

RESULTS AND OUTCOME:

- End-to-end network infrastructure for voice, video and data communication throughout the Austrian motorway system.
- Reliable communication in difficult weather conditions.
- Extended radio signal reach for public safety agencies in difficult areas such as tunnels.
- Streamlining of deployment and operations, reducing total infrastructure costs.
- Improved road utilisation resulting in lower investment in new or expanded roads.
- Enhanced public safety – driven by the internet dispatch and incidence response solution.
- Flexible, scalable designs supporting continued growth, while minimising additional capital outlay.
- Provision of dependable operations in challenging weather conditions.

CASE STUDY 4
LBJ EXPRESSWAY (I-635), TEXAS

Managed lanes and shorter travel times[18]

BACKGROUND:

Traffic management on the LBJ Expressway in Dallas County was a major challenge for the Texas Department of Transportation (TxDOT). Bad traffic flow, increased congestion, longer travel times and poor environment quality were a few of the common day-to-day issues. To address them, TxDOT collaborated with LBJ Development Partners on the LBJ Expressway project. They created an intelligent transportation and communication system that integrated with the redesigned multi-level highway system, with the following elements:

- General purpose toll-free lanes running on the upper level
- Managed toll lanes running on the lower level
- Continuous slip roads on both sides of the freeway
- Elevated direct connector ramp connecting to other expressways.

Project-wide closed-circuit television (CCTV) coverage was a key element and challenge for the project. Having depressed lanes with a column in the centre, along with some significant vertical changes in grade, provided a challenging environment to maintain complete CCTV coverage.

CASE STUDY 4 Continued

SOLUTION:

The intelligent transportation and communication systems is equipped with a regionally supported, scalable managed lanes system comprised of the following:
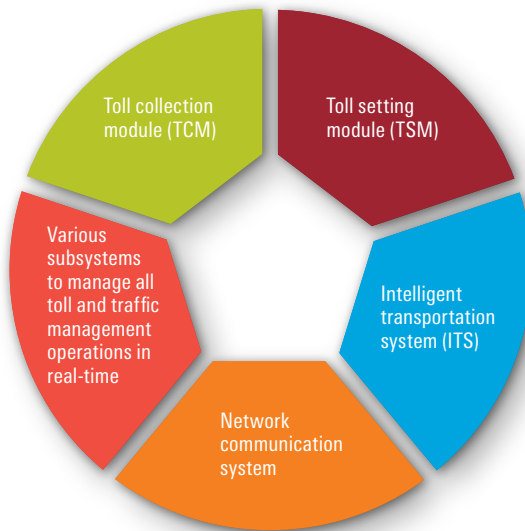
FIGURE 6: TxDOT'S SOLUTION

The system controls toll revenue and maintains a minimum speed of 50 mile per hour within the managed lanes. By using an algorithm to set the toll price dynamically and leveraging data on the number of vehicles in the managed lanes and general lanes, the system can maintain a balance of traffic conditions. Dynamic toll prices are displayed to motorists, allowing them to choose whether to use the managed or general lanes.

The ITS system enables operations personnel to monitor and manage traffic flow and incident response via interfaces to field devices and subsystems, such as the advanced technology vehicle detection system, dynamic message signs, air quality monitoring devices, a roadway weather information system, over-height vehicle detection systems, and digital video recording. The ITS system will display important TCS and TSM information to operations personnel, allow data sharing with TxDOT and other traffic management centres, and enable monitoring of system performance, inventories and maintenance activities on a 24/7/365 basis. Additionally, the new system has the enhanced reporting capabilities needed to comply with highway regulatory requirements.

RESULTS AND OUTCOME:

The LBJ Expressway managed lanes have greatly improved one of the most congested corridors in the state of Texas. The LBJ Expressway project will result in the following benefits:

- More predictable trip times by maintaining a minimum speed in the managed lanes and by adjusting the toll rates as vehicle numbers fluctuate.

- Reduced congestion by giving drivers the choice of continuing on the free, general lanes or avoiding congestion by switching to the additional depressed managed lanes.

- Maximised vehicle throughput for improved traffic and incident management.

- Improved longevity of the roadway through better information on road conditions and maintenance tracking.

DISRUPTIVE TECHNOLOGY

INNOVATION IN INFRASTRUCTURE

Disruptive technology innovation in infrastructure has the potential to alter both demand and supply dynamics. Disruptive technology has the potential to drive efficiencies and in some cases make existing infrastructure obsolete. These new technologies threaten to disrupt the entire business and regulatory models of whole sectors, such as water and power.

The potential key impacts of disruptive technologies on regulated businesses include:

- Changing the nature of demand for services on existing infrastructure
- Enabling services to be provided on new infrastructure.

Disruptive technology has the potential to drive efficiencies and in some cases make **EXISTING INFRASTRUCTURE OBSOLETE**.

Innovative solutions require a simultaneous emphasis on catering to challenges emerging both in the present and future. Successful innovation in infrastructure should deliver numerous benefits:

- The ability to achieve more with fewer resources (people, financial, energy)
- Developing new approaches to overcome the challenges of climate change and ensuring a focus of efforts on the areas of greatest importance and value

- Delivering infrastructure in a timely, sustainable and safe manner
- Encouraging interaction and collaboration across industries, companies and geographies.

The following case studies show how regions are harnessing technologies to improve the supply of various services in an economically viable way.

CASE STUDY 5
PNM PROSPERITY PROJECT, NEW MEXICO

Solar energy shifting and power smoothing[19]

BACKGROUND:
The emergence of renewable energy, such as solar and wind, creates opportunities and challenges for electricity providers. The variable nature of renewable energies, as they are dependent on weather conditions, creates an obstacle to integration with existing power generation and the electricity grid. Fluctuations in renewable energy, such as a week of cloudy days, can cause electricity grid instabilities.

PNM, the leading electric utility company in New Mexico, sought to use solar power storage to overcome these challenges. Solar power storage provides variability management solutions through power smoothing and energy shifting applications.

SOLUTION:
PNM undertook the Prosperity Project to develop the first solar energy storage facility in the US fully integrated into the power grid. The project featured one of the largest combinations of photovoltaic energy and solar panel battery storage in the US.

The project integrated an energy storage solution with a solar energy-generating farm to smooth and shift the volatility of solar power by controlling the ramp rates of solar generation. When solar generation exceeds demand, the batteries store the excess energy for use during peak energy consumption hours. Using batteries for solar integration into the grid makes solar energy more reliable and dispatchable.

RESULTS AND OUTCOME:
The objectives of the solar energy solar facility project are easily being met:

- Reduced energy generation during peak hours from using the battery stored energy
- Smoothing solar energy ramp rates and minimising voltage fluctuations
- Demonstration of a renewable energy source that can be turned on and off.

CASE STUDY 6
LOCAL HEALTH DISTRICT, WESTERN NSW

Telehealth strategy for a large rural area [20]

BACKGROUND:

Western NSW Local Health District (The District) operates across a challenging geography that is larger than the United Kingdom. Over this vast area, the District operates 37 hospitals and more than 60 other service locations. Delivery of clinical services necessitates expensive and time consuming patient transport costing $26m per year plus additional costs to the community in terms of lost productivity. Patient access to regular or periodic outpatient and ambulatory services is also constrained by geography.

Telehealth, one possible solution to these challenges, is the delivery of health-related services and information via telecommunications technologies. The District's current network of telehealth technology is ageing and there are significant infrastructure and connectivity challenges to overcome.

SOLUTION:

In 2015, the District developed a comprehensive Telehealth strategy and implementation plan using a three-phased approach:

- **Phase 1** – Establishment of the 'WNSW Telehealth Platform'
- **Phase 2** – Establishment of the starting point models of care and the incremental addition of new models of care
- **Phase 3** – Establishment of virtual health service capabilities to support provider networks, referral hospital interactions and integrated care pathways.

Centura Health, Colorado's largest hospital and healthcare network, deployed Telehealth programmes in 2011 with outstanding results. [21] Hospitalisation related to heart failure, chronic obstructive pulmonary disease and diabetes were reduced by 62%. Re-hospitalisation rates for patients receiving Telehealth home care (6.3%) were significantly lower than those for traditional home care patients (18%).

Visits for the registered nurse (RN) in a traditional homecare model with similar patient sets is two or three times per week over a 60-day episode of care. The frequency of RN visits was reduced to approximately three visits over the entire 60-day Telehealth care management period. This resulted in cost savings of between $1,000 and $1,500 per patient per episode. By using daily Telehealth monitoring biometrics, the RN was able to closely monitor and take action with early and timely intervention. As a result, around-the-clock Telehealth monitoring became the standard of care.

CASE STUDY 6 Continued

The defined approach provides two major streams of support:

- Technology and business support, such as technical, business and administrative requirements needed to support consumers and clinicians using telehealth within defined models of care, including:
  – The implementation and support of video conferencing carts on hospital wards.
  – The introduction of a scheduling solution to coordinate telehealth activities and support billing, enabling doctors to bill Medicare for telehealth enabled consults.

- Change and adoption support including the encouragement of the uptake and use of telehealth by clinicians and consumers through education on the processes involved, roles and responsibilities, governance and clinical safety considerations.

The following are examples of the models developed:

- Support for earlier specialist intervention via telehealth consults for deteriorating patients in remote hospital sites
- Remote outpatient consults for renal dialysis patients
- Post fracture orthopaedic reviews
- Virtual case conferencing to link patients in their homes with a team of clinicians at a base hospital
- Telehealth consults linking WNSW Specialists with GPs and their patients across the District.

RESULTS AND OUTCOME:

The strategy has the long-term vision of creating 'virtual health service' capabilities. This vision supports a more coordinated approach to providing care across a range of providers beyond the boundaries of the District. For example:

- A more tightly integrated service between the acute care and community services and the primary care services, with telehealth enabling continuous care, key escalation and hand over points.
- More streamlined referral pathways that use telehealth to support the coordination of care between the District's facilities and services and major referral hospitals in Sydney.
- The development and sustainability of provider networks, for example to link Aboriginal Medical Services with the District's services and to bring 'virtual' specialist services into the District that, to date, could only be accessed by patients travelling to Sydney or other major cities in Australia.

The Telehealth strategy has a three year implementation timeframe. Its implementation will have significant impacts on the service capabilities and operational efficiencies for the District including:

- Increasing access to services
- Decreasing the costs and infrastructure requirements of non-emergency patient transport
- Decreasing consumer transport needs and broader lost economic productivity
- Increasing the effectiveness of established 'hub-and-spoke' facility networks and bridging gaps that exist across health service provider organisations.

TECHNOLOGY IMPACTING HOW PEOPLE USE INFRASTRUCTURE

INNOVATION IN WORK FORCE MOBILITY AND FLEXIBILITY

Technology innovation will drastically impact how people use infrastructure and therefore what infrastructure is required.

The concept of work flexibility has been used since the 1990s – with employees working part time, on annualised hours or on periodic contracts. The potential for work flexibility is that more people can work out of cities, therefore lowering the utilisation of and need for more 'city' infrastructure.

Technology, globalisation and innovation continue to play a major social role in the attempted removal of the traditional office concept. New forms of flexible working are emerging as technology gets better and cheaper, with teleworking, hot-desking and virtual offices proving to be the most popular. The impact of globalisation and the growth of multi-national organisations mean that employees can now be located across multiple states and countries. With technology an integral part of work and life, the 'office' is definitely no longer a building. Instead, it is a sophisticated intercommunication system, distributed across global digital networks.

A growing proportion of work can be done anywhere – in any office, at home, on the move and in fact, wherever there is reliable access to digital networks.[22]

Technology is also helping to deal with the potential challenges that home-working

In March 2015, Uber accounted for **47% OF ALL RIDES EXPENSED BY EMPLOYEES** whose companies currently use Certify, the second largest provider of travel and expense management software in North America. This is approximately **TRIPLE THE RATE** from one year earlier according to a study by Certify.[23]

poses. The widespread adoption of messaging tools and presence indicators makes it easy to monitor remote workers' activity and productivity, while helping them stay motivated through regular contact with colleagues. The ability to be flexible with employees' work arrangements can also play a critical part in building successful global teams and doing business across international boundaries.

Creating a radically different workspace from that of a generation ago, is another key driver to accepting and integrating technology. As the latest generation graduates from the classroom to the office, they expect upgraded technology to be ready and waiting

for them. For this generation of workers, Voice over IP (VoIP), video conferencing and workplace instant messaging are not novelties but necessities.

New forms of mobility that provide greater flexibility for moving people between places of residence, work, entertainment and other activities are also being adopted. Uber, Flex and Bridgj are affecting modal share, standard business practices and personal preferences in local transport.

The following case studies demonstrate the potential of how technology could meet the increasing demand for flexibility in all areas of life and service provision.

CASE STUDY 7
CISCO'S FLEXIBLE WORK ENVIRONMENT[24]

BACKGROUND:

Cisco has 75,000 employees across six continents and working in every time zone. The need for round-the-clock connection requires employees to adapt when and where they work. This poses big challenges for employees trying to balance work and

personal commitments. As a result, they rate workplace flexibility as one of their top priorities. Cisco faced the challenge of how to provide employees with work-life balance while maintaining their connected, global operations.

CASE STUDY 7 Continued

SOLUTION:

Cisco redefined the traditional office. Technology and internet connectivity enabled it to offer flexible work practices, such as telecommuting, remote work and flexi-time. The key initiatives or technologies involved:

- Technologies allowing employees to collaborate from virtually anywhere
  - Voice over IP phones
  - Desktop sharing
  - Online conferencing (via WebEx)
  - Instant messaging
  - Video calls
  - TelePresence – virtual reality technology for remote control of machinery or apparent participation in distant events
  - Integrated solutions to access these technologies on any device
- Connected Workplaces with open-plan workstations, privacy rooms, lounges, and recreation spaces
- 1,097 Cisco TelePresence rooms available in 263 cities
- 23,000+ installations of Cisco Virtual Office in employee homes.

RESULTS AND OUTCOME:

In annual surveys, employees repeatedly say workplace flexibility is one of the best things about working at Cisco. Thousands of workers around the world report significantly higher levels of satisfaction, teamwork, and productivity in their connected workplace environments. These benefits help Cisco attract and retain top talent. Its flexible work practices also impact on the environment by reducing the need for air and car travel. The key outcomes are:

- Employees use of collaborative technologies reduces travel, carbon emissions, and travel costs while increasing employee productivity and work-life balance.[25]
- 91% of employees say their managers support their efforts at work-life balance.
- Six-fold increase in use of Cisco WebEx web conferencing over last seven years.

ENABLING INFRASTRUCTURE

Collaboration connectivity is an important element in enabling flexible working conditions. Key to flexible working are technologies such as mobile computing devices, cloud-based applications, video conferencing and even social media. Recent surveys have revealed large enterprises and their employees favour flexible working. At the same time, new technologies that make it easy for employees to securely access the resources they need from outside the office, are becoming available. Established technologies are also maturing into enterprise-ready tools.[26] As a growing trend, flexible working will continue to increase the demand for supporting and enabling infrastructure such as high-bandwidth internet.

CASE STUDY 8
BRIDJ, WASHINGTON, DC

Flexible transit system

BACKGROUND:

In Washington, DC, more than one-third of households do not own a car. They depend on public transport which, with its fixed routes and schedules and the need to transfer within or between modes, is often not well suited to their needs. As in many cities, Washington's transport system has evolved to fit typical commutes from the suburbs to the CBD. With changing development patterns, work arrangements and demographics, the older public transport system is becoming less effective in meeting new demands.

SOLUTION:

To fill the need, Bridj began an on-demand bus service in Washington, DC and Boston[27]. Bridj provides efficient and flexible trips on buses with no fixed stops. Instead, data analysis determines the optimal spot for pick-ups and drop-offs based on the specific needs of the passengers on each bus.

Bridj is able to flexibly deploy their WiFi-enabled buses in neighbourhoods facing higher traffic demands. It compiles and analyses data from many sources, including Google Earth, Facebook, and government data such as travel surveys, the census and municipal records, to see where people live and work. The results are used to create routes that respond to commuters' needs, rather than force them to conform to existing and outdated routes. The more people input their point of origin and destination data, the better the system becomes at providing customised, pop-up routes where people need them. The firm's analysts can also anticipate popular routes – for instance, in advance of a major concert or sporting event.

The efficient use of assets is coupled with an improved customer experience. Bridj uses a mobile application to help commuters book and keep track of their trips. Their buses have plush seats and WiFi connectivity for passengers.

RESULTS AND OUTCOME:

- Bridj is an efficient and viable way to get around a city, especially in areas that experience crowded or non-existent public transport.
- The company offers flexible shuttle routes based on the origins and destinations of the customers on board. It is a huge time-saver for users.
- Bridj has cut some commute times in half through routing and bus-stop optimisation.
- The demand for Bridj services tend to rise in adverse situations, such as a snowstorm.
- A ride on Bridj currently costs somewhere between the cost of public transit and a taxi.

Bridj has also consulted with local government and regulators when commencing its service and has applied for the appropriate licensing for the service that it provides.

There are a variety of views on the impact of Bridj, ranging from concerns of it 'poaching' revenue traffic from struggling public transport systems to plaudits for complementing the existing systems.

TECHNOLOGY IMPACTING HOW BUSINESSES USE INFRASTRUCTURE

EMBEDDING TECHNOLOGY IN FREIGHT SUPPLY CHAINS

Technology innovation is and will continue to impact how businesses use infrastructure and therefore what infrastructure is required.

Commercial and industrial vehicle operations for moving and storing products can be costly and complicated. Intelligent transport systems (ITS) are making freight transportation safer and more efficient by applying data processing, communication, and sensor technologies to vehicles (including trucks, trains, aircraft and ships), infrastructure, and operating and management systems. ITS technologies are new and evolving tools that are already helping national economies achieve their transportation objectives by reducing the number of vehicles on the road and therefore lowering congestion.[28]

The persistent pressure on freight, commercial vehicle and logistics operations to remain efficient and competitive compels them to rapidly adopt ITS technologies. Many now incorporate advanced information and communication devices in both their vehicles and dispatch centres to keep freight moving safely and efficiently.

While GPS location and mobile communication are independent of public sector infrastructure investment, there are additional ITS applications that may benefit from, or even require, state government participation. For example, automated vehicle identification and electronic toll payment technologies usually come under public infrastructure, and travellers of all kinds benefit from such systems.[29]

Intermodal freight and the use of advanced communication and information technology

Technology innovation **IS AND WILL CONTINUE TO IMPACT ON HOW BUSINESSES** use infrastructure and therefore what infrastructure is required.

are two of the most important global trends. Developing these systems requires significant infrastructure and facility investment, harmonisation of operational rules and a standardised information exchange via intelligent platforms.

Some of these technologies, such as traffic control systems, are acquired by government agencies. However, other technologies, such as advanced driver assistance, vehicle

monitoring systems and integrated electronic ticketing, are generally implemented by private enterprise. Many companies also use supply chain management systems to track and manage freight shipments and vehicles.

The application of new technology to freight management is being approached in a variety of ways. The following case studies examine a few of them.

CASE STUDY 9
PATRICK PORTS, AUSTRALIA[30]

Automated container terminals

BACKGROUND:

Container terminals operate a number of disparate systems that typically involve large pools of highly paid labour and are managed through a control centre without a complete picture of the real-time situation. The traditional operations in a container terminal include:

- Vessel unloading using ship-to-shore cranes (STS)
- Container transportation to the storage yard using trailer chassis or straddle carriers
- Stacking of containers in the storage yard using straddle carriers or stacking cranes
- Retrieval of containers for loading to trucks or railcars using straddle carriers or stacking cranes
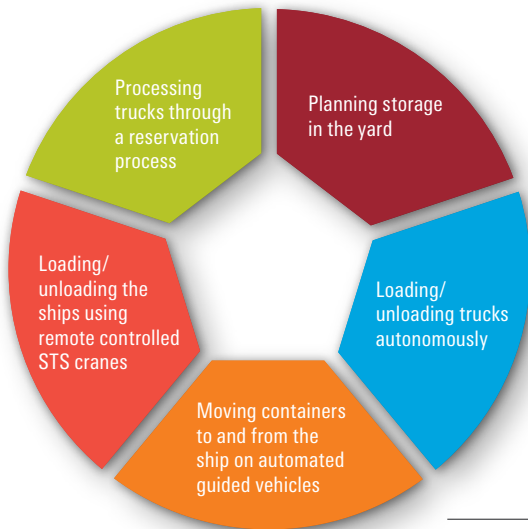- Processing of trucks (inbound and outbound) at the terminal gate.

These independent systems have resulted in the high cost of moving a container from the ship to the exit point of the terminal, the inefficient use of equipment and labour, and congestion within and outside the container terminal itself.

CASE STUDY 9 Continued

SOLUTION:

Developments in sensor and navigation technology have made driverless container-handling machines a reality. The unmanned machine is controlled by a computer or by using a combination of robotic and remotely operated work phases in sequence. These developments follow the systems previously adopted in warehouse automation. The main difference being that the technology required for outdoor conditions has proved to be vastly more demanding.

The new planning and automation technology is integrating the container handling process by:

RESULTS AND OUTCOME:

In Brisbane, Patrick Ports has noted the following benefits from automated straddle carriers:

- Maintenance savings per crane of $500,000 per crane over its life
- A labour cost saving of $40 per container compared to manual terminals
- A reduction of 90% in Workers Compensation claims
- Improved STS crane productivity
- Increased capacity of the container terminal.

In addition, container terminal automation can result in lower illumination at night (automated vehicles do not need bright lights to operate), less noise from operations (automated vehicles/cranes are more precise in placing containers on vehicles, in storage stacks or on the ship) and reduce queues of trucks causing congestion on nearby roads.

FIGURE 7: PATRICK PORTS' SOLUTION

CASE STUDY 10

DRIVERLESS VEHICLES, UK AND AUSTRALIA

Gauging the future of transport

BACKGROUND:

The concept of automated roadways and driverless vehicles has been around for decades. Recent advances in the integration of GPS technology, robotics, sensors and software have made driverless (autonomous) vehicles a reality.

Several companies are exploring driverless delivery systems. Both Amazon and Google have experimented with drones to transport parcels and supplies. In 2013, Australian company Flirtey claimed to have launched the first-ever drone book-delivery service.[31] Google also plans to launch its driverless cars by 2017, after already covering more than 400,000 miles of test drives. Car makers such as Audi, Toyota and Mercedes-Benz, have plans for self-driving cars, and California, Nevada, Florida, and the District of Columbia already have laws allowing driverless vehicles on roads.

The premise is that driverless vehicles will improve safety by reducing the issues of driver inattention, fatigue and inexperience, reduce costs and improve productivity for companies that adopt the technology. Which is why various businesses have put them to different uses.

RIO TINTO'S SOLUTIONS:[32]

Rio Tinto has perhaps the most extensive use of driverless vehicles at its iron ore mining operations in the Pilbara. As part of its Mine of the Future project, Rio Tinto is adopting transportation and mining innovations that increase productivity, reduce costs and improve safety. The key planks of this initiative include autonomous trucks in the mines, autonomous trains delivering ore to port and autonomous drilling. These trucks have now been driven over 3.9 million kilometres and have moved over 200 million tonnes of iron ore.

THE IMPACTS/BENEFITS FOR RIO TINTO:

The autonomous truck program at Rio Tinto's Hope Downs 4 mine has achieved:

- A 14% increase in the effective utilisation of the trucks compared to the best human-staffed mine in the Pilbara
- A reduction of 13% in the cost of operating the trucks.

A safer work environment as a result of sophisticated control systems and removing personnel from the hazardous work environment of the mine.

HOW WILL WE RESPOND?

As our populations' grow and the world changes around us, opportunities are rapidly arising to improve efficiency and create solutions to drive better infrastructure outcomes for people, businesses and communities. It is likely that our future infrastructure requirement will be drastically reshaped. For example, the combination of driverless vehicles and the establishment of secondary employment hubs could significantly reduce the number of vehicles on the road and the need for more road infrastructure. Advancements in eHealthcare together with innovative service delivery models will lead to improvements in health solutions that may reduce the requirement for expanding traditional hospital infrastructure. Equally importantly whilst our traditional infrastructure requirements may change, the development of enabling technology to drive this change is crucial.

To ensure we embrace these opportunities and optimise our scarce resources it is crucial everyone plays a role in proactively driving the technology agenda. Figure 8 provides an overview of how the community, business and government each have a role in driving the technology agenda. It is through our collective response the benefits of change will be realised.
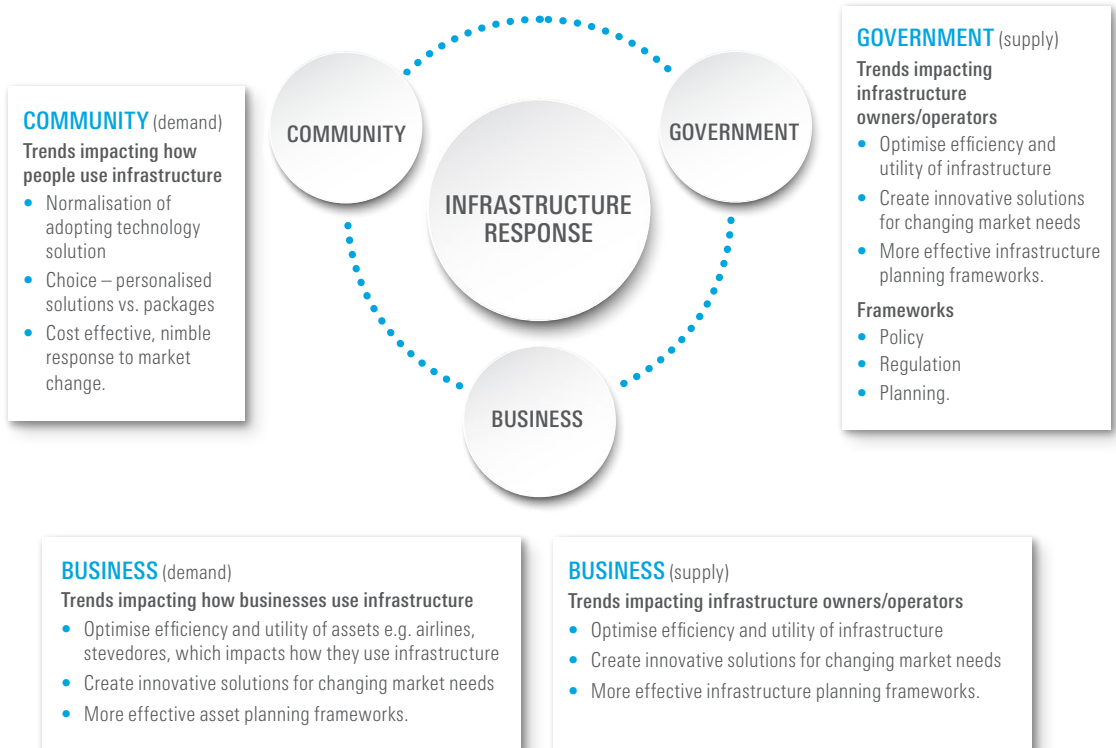
COMMUNITY

Fundamentally businesses and governments are created with the purpose of serving the community's needs. Therefore people are crucial in directly and indirectly driving change in the adoption and evolution of technology solutions to deliver optimal infrastructure development.

Key trends influencing how people will shape the infrastructure agenda through technology are;

1 Increasing populations and changing nature of demographics including expectations of being plugged in at all times and to be able to access information instantly;

2 With the acknowledgment of the demographic shift people want to be able to make lifestyle choices; and

3 Acceptance of technology innovation maturing from 'early adopter' to 'expecting' technology solutions that meet their needs stage.

FIGURE 8: OUR RESPONSE

COMMUNITY (demand)
Trends impacting how people use infrastructure
- Normalisation of adopting technology solution
- Choice – personalised solutions vs. packages
- Cost effective, nimble response to market change.

GOVERNMENT (supply)
Trends impacting infrastructure owners/operators
- Optimise efficiency and utility of infrastructure
- Create innovative solutions for changing market needs
- More effective infrastructure planning frameworks.

Frameworks
- Policy
- Regulation
- Planning.

COMMUNITY
GOVERNMENT
INFRASTRUCTURE RESPONSE
BUSINESS

BUSINESS (demand)
Trends impacting how businesses use infrastructure
- Optimise efficiency and utility of assets e.g. airlines, stevedores, which impacts how they use infrastructure
- Create innovative solutions for changing market needs
- More effective asset planning frameworks.

BUSINESS (supply)
Trends impacting infrastructure owners/operators
- Optimise efficiency and utility of infrastructure
- Create innovative solutions for changing market needs
- More effective infrastructure planning frameworks.

INCREASING POPULATIONS AND CHANGING DEMOGRAPHICS

The population growth in New Zealand and, in particular, Australia will put pressure on the nations' infrastructure. Knowledge workers will represent an increasing proportion of the workforce. These new jobs could draw more people to the CBDs. More commuters would utilise the transport network at peak times, travelling to and from the centres of major cities. However advances in telecommuting technologies will push against the surge. Employers will re-evaluate the importance of housing all employees in increasingly expensive CBD offices.

Could technology drive business office decentralisation and change the trend to ever growing capital cities?

Secondary employment hubs, already springing up in the major cities, will take new prominence and take some of the stress away from the CBDs. However, this necessitates the development of new transport links and services.

Changing demographics will also change how and where people travel, how they work, how they interact, their housing preferences (type and location) and how they shop. Younger generations expect to be plugged in at all times and to be able to access their information instantly. They are also interested in new ways of doing just about everything. This will impact on their expectations in respect to transport, communications, housing, health care and education, amongst other things.

LIFESTYLE CHOICE: REGIONAL DEVELOPMENT

With increased urban populations, increased cost of living and perceived lower quality of life people living in urban centres will want a genuine choice of relocating to regional centres. This could be realised with new technologies that will allow services to reach satellite cities and regional areas in a way not seen before. These services will improve regional development and quality of living. In the process, the hub and spoke model of regional areas may drastically change as well.

Technology will connect those living beyond the metropolitan areas. The expansion of broadband through regional areas will provide high-speed connectivity at affordable prices. Regional areas will increasingly access services previously available only in large cities. Digital imaging and virtual medical procedures will enable high quality, real-time medical services to reach areas where none currently exist. Expert oncologists could review regional patients' scans without leaving their office in the city.

Could technology drive more regional jobs, amenities and investment?

Similarly, the pervasiveness of online classrooms is increasing as broadband connectivity and the quality of online instruction increase. This improved access to quality education will also facilitate regional development. Student commuting patterns will change as schools are designed around virtual instruction, as opposed to traditional forms of instruction.

Governments are investing in court technologies, such as secure videoconferencing, as a way of delivering justice to regional areas. The use of teleconferencing to, for example, take witness testimonies has also raised concerns around the ability to ensure justice. However, technological improvements combined with the cost-savings and convenience may soon balance out these issues. As these technologies become more commonplace, the distribution of courthouses across regional areas will change.

INNOVATION ADOPTION

People's willingness to adopt and demand solutions that meet their needs will dramatically impact the development and proliferation of technology enabled solutions in both the retail and wholesale sectors. Trends driving this progression include:

- **Adoption of technology solutions:** With every generation becoming more adept at using technology, the adoption of technology innovation is becoming and will increasingly become normalised.
- **Solution driven:** People want packaged or tailored solutions that meet their specific needs and provide value for money.
- **Connectivity:** Younger generations expect to be plugged in at all times and to be able to access information instantly.

This is then creating opportunities for businesses to address these unmet needs.

BUSINESS

Businesses are and will respond to people's needs by creating innovative technological solutions and driving efficiencies and utilisation of (infrastructure) assets to ensure cost efficiency.

How will disruptive innovations such as driverless cars, impact our future infrastructure requirements?

For example, car manufacturers may facilitate consumers' preference for user pays infrastructure solutions by connecting on-board computers and improved telecommunications and GPS technologies in vehicles to road user charges. Users will be able to pay for road infrastructure according to how intensively they use it, as well as the time and location of their use. This shift would need to be coordinated and facilitated by government agencies.

Addressing consumer demands of convenience, productivity and safety, the commercialisation of driverless vehicles will occur. It is anticipated that within the next 50 years as the price point drops driverless vehicles will become the norm. According to Google currently people's cars sit idle 96% of the time whilst the adoption of shared, self-driving taxis could have utilisation rates of more than 75%. Therefore a significantly lower number of vehicles would be required

"We know technology and things will transform, but that shouldn't **PRECLUDE US FROM PLANNING** for the future today."

THE HON. DEAN NALDER MLA
WA MINISTER FOR TRANSPORT, SPEAKING AT A CEDA EVENT ON 10 AUGUST 2015

to be owned. An OECD study modelling the use of self-driving cars in Lisbon found that shared 'taxibots' could reduce the number of cars needed by 80% – 90%.[33] A reduction in vehicles on the road will impact the demand for constantly increasing road capacity on specific routes and make some road projects obsolete.

Seeking reliable and cheaper energy solutions consumers may increasingly rely on solar panels and battery technology. Consumers will be able to use their solar panels and charge their battery packs for all their electricity needs, enabling them to completely go off-grid if they want. They could also be able to sell energy back to the grid. This is driving business opportunities and according to Renew Economy editor Giles Parkinson in Australia this new technology will be 'the biggest change in the energy industry in more than a century'.[34]

The decentralisation of the electricity grid may lead to the very high fixed costs of electricity infrastructure being shared by fewer consumers. This will require governments to reform how grid infrastructure is funded, potentially moving from a user pays system to a taxpayer funded, smaller and more efficient electricity grid.

Consumers will be able to use their solar panels and **CHARGE THEIR BATTERY PACKS FOR ALL THEIR ELECTRICITY NEEDS**, enabling them to completely go off-grid if they want.

REVISED PLANNING FRAMEWORKS

Urban transportation networks will struggle with the increased demand, especially given the limited land available for the expansion of road networks and public transport without using compulsory acquisition powers.

What will be the new infrastructure planning frameworks?

There will not be enough roads and parking in CBDs to accommodate a significantly larger workforce even as more commuters choose public transportation or work flexibly. To go beyond the traditional incremental capacity solutions of adding more roads and rail lines – transport system owners, operators, planners and designers will need to consider:

- How best to meet emerging new patterns of demand
- New types of service that are tailored and flexible to the nature of demand
- New business models for delivering service
- The role of technological innovation in the integration of these considerations.

Infrastructure planning frameworks will need to be retooled to address the new reality and options for service delivery. Feasibility studies, business cases and investment planning frameworks will need to be supplemented with new guidance on how to deal with social and economic change brought about by the adoption of new technologies and assess the role of innovation in devising appropriate policy and program responses.

NEW REGULATORY MODELS

New technologies have the potential to disrupt the entire business and regulatory model of monopoly services. The transmission and distribution of electricity using 'poles and wires' is a typical example. Solar generation and battery storage electricity is creating unprecedented uncertainty in the electricity supply sector.

Taking these technologies as an example, they can:

- Change the pattern of supply and demand for energy, and cause excess capacity to arise in the existing network of poles and wires. Large scale, long life infrastructure that is uneconomic to replicate, is usually not readily scalable to meet significant short-term changes in demand. This leads to questions of how the risks and costs of excess or 'stranded' infrastructure capacity should be shared between investors and customers.

- Change the nature of the service and costs that are fairly attributable to different customers. For example, customers who adopt solar generation and battery storage may still require access to poles and wires as a backup supply from other sources of generation. Access to capacity that may not be often used can lead to an increasingly inefficient and costly use of the existing infrastructure. This may in turn increase incentives for customer take-up of new technologies, thus accelerating the inefficiency of, and cost of access to, the legacy infrastructure.

- Cause monopoly service providers to reassess their business models. Owning and operating legacy infrastructure is a means to an end, namely service provision to customers. Disruptive technologies provide alternative means of achieving this and may do so with infrastructure that is economic to duplicate and open to competitive supply. Forward looking, customer focussed existing regulated providers may compete for the supply of services using new technologies, leveraging their positions as incumbent service providers to potential advantage.

How will government infrastructure regulation adapt to new business models?

Traditional regulatory models are not well suited to allocating the risks of rapidly evolving technologies between investors and customers. They normally assume that services are provided by infrastructure that is static and uneconomic to duplicate. Once adopted, disruptive technologies themselves may not require economic regulation. However in the periods that anticipate and effect technological transition, disruptive technologies require regulatory frameworks that can recognise future technological change and provide potentially conflicting incentives both for:

- Investors in existing technologies to accept risks of asset obsolescence and to maintain appropriate investment where this is necessary to maintain quality of services; and

- Effective competition to develop in the provision of services by disruptive technologies.

To date, regulatory frameworks for infrastructure services have not been designed to address either planned or unexpected service or infrastructure obsolescence. Disruptive technologies have the potential to impact regulatory paradigms too and this is an issue that regulatory policy makers have yet to tackle.

WILL TECHNOLOGY SAVE US?

Australia and New Zealand's population growth, legacy investment and maintenance issues and the impact of technology advancements will result in the need for upgraded and redeveloped infrastructure and, in some cases, redesigned business models. The community, business and government will need to embrace innovation and change to meet the infrastructure challenge.

Future infrastructure projects with long term pay back periods must be reviewed now to ensure that precious capital is not being wasted on infrastructure which, through advances in technology, may not be required.

If we are unable to embrace and adapt to the rapidly changing environment, Australia and New Zealand's productivity and future prosperity will suffer. We are at risk of planning and building infrastructure that is outdated before it is even operational. With the prospect of declining living standards, people may look to alternative locations for opportunity.

The winners will be the communities, businesses and nations that can adapt and lead improvements and innovation throughout the infrastructure asset lifecycle and drive better outcomes with their scarce resources. The race is on to see who can do it!

"

The things we need to look at are obviously efficient investment through business but also infrastructure of the future. So if we talk about roads lets **TALK ABOUT ROADS WITH DRIVERLESS CARS** and the infrastructure that gets that going, not building more lanes.

RICHARD GOYDER
WESFARMERS MANAGING DIRECTOR AND CHIEF EXECUTIVE SPEAKING AT THE NATIONAL REFORM SUMMIT, AUGUST 2015 [35]

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