Science and Technology-Led Innovation in Services for Australian Industries

Report of the PMSEIC Working Group

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PMSEIC Working Group on Science and Technology-Led Innovation in Services for Australian Industries

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The situation

- Services are critical to the prosperity of the nation – employment (85%), GVA (78%) and community well being
- Services are growing rapidly internationally and are an increasingly dominant and pervasive feature of advanced economies
- Knowledge-intensive services are an important area of growth (particularly for developed nations)
- Services innovation is a critical, but often unrecognised, contributor to productivity, economic growth and the competitive advantage of firms and nations
- The contribution of science and technology (S&T) to services innovation is poorly understood, a serious deficiency given the growing global services revolution

Complications

- Australia’s growth in services is slowing, in particular that of knowledge-intensive services
- Services imports to Australia are increasing
- Developing nations are becoming increasingly skilled with significant capacity to grow their services industry
- Given our population size, the ability to be competitive across the board is limited
- The importance of services and services innovation to the Australian economy is often not recognised
- Our R&D/education sector – as one key underpinner for innovation – is relatively poorly connected to our services sector

Our conclusions

- Services innovation incorporates both innovation in our service industries and innovation achieved through services (in any organisation/business sector)
- Science and technology-led services innovation can occur through one or more of the following avenues:
  - development of an underpinning product or platform
  - knowledge used to develop and/or transform services
  - the method of delivering a service
- Significant services innovations in the 21st century will develop through the interaction of science and technology innovation and customer-driven process, organisational and managerial innovation to create novel solutions to market opportunities and to transform businesses
- Australia can capitalise on the global services revolution through opportunities stimulated by science and technology-led services innovation including:
  - using services to enhance the competitiveness of existing industries where Australia traditionally held a competitive advantage, and
  - capitalising on niche opportunities where Australia has inherent competitive advantage/domain knowledge and where there is a distinct national or global need or problem to be addressed

The questions

1. Can Australia meet the challenge/threat to its future prosperity posed by the national and international revolution in services?
2. Can Australia capitalise on the opportunities presented by science and technology-led services innovation to help meet these challenges?
Recommendation 1:
Establish science and technology-led services innovation as an important priority of Australia’s National Innovation System

Services innovation should become a major national innovation priority as an outcome of the national innovation system review. Consistent with this, the following actions should be undertaken:
- Expand the measurement, by the Australian Bureau of Statistics, of services and services innovation to accurately benchmark their contribution to Australia’s economy.
- Review the extent to which current government innovation programs satisfy the needs of services.
- Raise awareness of the importance of services innovation through a system of high-profile awards.

Recommendation 2:
Strengthen the connections between services business and our science and technology base

- Realign priorities and funding to stimulate strategic collaborative research between service enterprises and S&T research organisations that are at the intersection of ICT and service activities.
- Support the establishment of services science research programs.
- Provide incentives to enhance consultancy-type activity between public sector R&D institutions and services industry.

Recommendation 3:
Address the growing skills shortage in Australian services industries

- Provide incentives for education facilities (vocational and university) to provide graduates that meet the requirements of services industries through the establishment of cross-disciplinary courses that encompass ICT, industrial engineering, mathematical sciences, design, business management, social sciences and marketing.
- Provide incentives and the education framework to enable services industry employees to regularly update or expand their skills.

Recommendation 4:
Stimulate services innovation through Government ‘raising the bar’ as both a customer for, and provider of, services and through the establishment of national support infrastructure

- Appropriately amend industry policies to remove infrastructure bottlenecks and create a market pull for services innovation. This should include:
  - Government procurement requirements and services standards geared towards building national capability.
  - Government playing a leading role as a service provider and customer.
- Establish the supporting infrastructure required to carry Australia’s services innovation forward into the 21st Century. This should include a strategy to create market conditions for the integration of broadband with technologies such as satellite imaging, GPS and sensor networks.

Our recommendations in brief

- Building on our strengths
- Developing new opportunities
- Connecting better to our S&T base

By fostering science and technology-led services innovation in our areas of natural competitive advantage, Australia can compete in a rapidly changing, globalised knowledge-based economy.

Proposed response
1: Introduction

Australia is now a service economy. Services account for 78% of Australia’s Gross Value Added (GVA)\(^1\), 85% of employment and 21% of exports (Australian Bureau of Statistics, 2006; Box 1). This reflects a global trend in which the services sector is rapidly becoming the greatest contributor to economic activity (Wolf, 2005) – currently worth around $2.5 trillion in exports\(^2\) (World Bank, 2007). Many people see the growth in services as the next major revolution in the world economy.

“The shift towards services is not simply a US phenomenon, or a developed nation’s phenomenon…the shift to services represents the single largest labor force migration in human history.”

~ Jim Spohrer, IBM, 2007

It follows, therefore, that the ongoing success of Australia’s services sector will be critical to the future well-being of the nation.

In conjunction with the change to a service economy, we are witnessing a seismic shift in the way the world does business. The boundaries between products and services are increasingly blurring. Customisation and personalisation are becoming increasingly important, and the international outsourcing of non-core activities is rapidly being embraced. Skilling, particularly of low-cost economies, has been central to this trend.

The recognition of the importance of services and services innovation to the global economy has initiated a burst of activity on both the global and domestic scenes. A range of studies has recently been published by governments, the OECD and the European Union (see Appendix A). The body of knowledge is growing and with it, the sense of urgency. Additional details on the global and Australian trends in the services sector are provided in (Box 1).

Despite their economic significance, service industries are often widely viewed, erroneously, as relatively low-skilled and non-innovative. Because much of the innovation in services is characterised by responsiveness to the demands of markets and customers and to improvement in business systems and processes, rather than radical new discoveries and technologies, it is often poorly recognised and unappreciated. Not surprisingly, the role that science and technology actually plays in services innovation is even less well understood. Yet the world is experiencing a science and technology revolution that is enabling innovation to occur in unprecedented ways, changing the way we operate, think and innovate in all sectors, including services.

How Australia meets the challenges and opportunities presented by this new business paradigm, particularly in regard to services innovation, will influence not only Australia’s future position in the world market, but also our ability to deliver effective, state-of-the-art domestic services.

With this in mind, and with a recognition of the broad nature of the topic, the Prime Minister’s Science, Engineering and Innovation Council proposed two working groups to investigate innovation in services.

This report delivers the findings of the first of these – the Working Group on Science and Technology-Led Innovation in Services for Australian Industries. As indicated by its title, the Working Group was convened to focus its attention specifically on the role of science and technology in services innovation and how best this could be used to enhance the performance, both nationally and internationally, of Australia’s services businesses. In order to do this, however, the Working Group needed to consider some of the broader, underlying issues and trends regarding services innovation. Furthermore, as it progressed in its deliberations, it became clear to the Working Group that the interaction of science and technology-led services innovation with other modes of services innovation is of increasingly critical importance to the future of Australia’s services sector.

1.1 The Terms of Reference

1. Identify where science/technology stimulated innovation has and might play a role through the provision of whole of life services in creating a competitive advantage for Australian industries.

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\(^1\) Gross value added is a standard measure used in national accounts. It is in simple terms revenue less non-labour costs of inputs.

\(^2\) This figure is based on 2005 World Bank data. It is regarded as a minimum figure as the classification of services used by the World Bank does not include energy or construction services, and as with many statistical data sources does not capture many services activities classified under other sectors, such as manufacturing.
2. Identify the barriers and stimulants to the interaction and mutual understanding between researchers, industry and service providers, critical to the development and take up of improved services.

3. Determine the roles for Government as an integral partner to encourage services innovation in our industries.

Towards meeting these terms of reference, the Working Group investigated the character of services innovation and how it contributes (now and in the future) to creating competitive advantage, as well as the particular distinctive contribution from our science and technology base and how to improve this.

In putting together this report, the Working Group consulted a range of industry and academic experts. These are listed in Appendix B.

1.2 What do we mean by “services”?

There are many definitions of services. In simple, layman’s terms (see also Box 2), services can be described as “…a provider/client interaction that creates and captures value” (IBM, 2007) and/or activities that “…deliver help, utility or care, an experience, information or other intellectual content. The majority of the value of that activity is intangible rather than residing in any physical product” (Australian Services Roundtable, 2006).

“We are all in services… more or less”

~ James Teboul, 2006

The majority of statistical analyses on service trends and service innovation refer to service industries (see Appendix D for service industries recognised by the Australian Bureau of Statistics). In doing so, there is recognition that these do not incorporate the full range of service activities in economies, but rather the industries sectors where the main (>50%) focus of activity is on services.

Services industries cover a wide range of business types (Figure 1) – from the corner shop through to highly knowledge-intensive services such as global communication networks.

In general, knowledge-intensive services encompass two types of activity – professional services, such as finance and legal services, and those services with a strong link to/or utilisation of science and technology, such as mining, health and ecosystem services.

Figure 1: Service industries gross value added

Source: Australian Bureau of Statistics, 2006
Box 1: Services and the economy

International economy

The service sector is the greatest contributor to OECD economies, averaging 70% of industry gross value added (GVA*; Figure B1.1) and 70% of total employment (Wolff, 2005). Employment in services dominates developed nations (Figure B1.2) and is growing rapidly in developing nations - China has experienced an increase of over 191% over the last 25 years (Spohrer, 2007; Appendix C). Overall the international trade in services has been growing steadily, with strong growth experienced in many OECD countries from the 1990s (ranging from 6 to 10% between 1990 and 2001). This reflects a global trend in which the services sector is rapidly becoming the greatest contributor to economic activity – currently worth $2.5 trillion in exports.

Australian economy

In 2005-06, service industries accounted for 78% of Australia’s total industry GVA¹, 85% of employment, 57% of investment and 21% of exports (Figure B1.3; DITR, 2007b). The service industry GVA grew 13.4% between 2000 and 2005. In 2005-06 the largest service industry in Australia was Property and Business Services (13.8% GVA), followed by Finance and Insurance Services (8.3%; see Figure 1 in main text; ABS, 2006). In terms of exports, Travel Services dominated (54%), a significant component of which was Education Services (23% of total services exports). Transportation (20%) and Other Business Services (12%) were the second and third major contributors (ABS cat. 5368).

Figure B1.1: Services as a % of Industry valued added*

![Graph showing services as a percentage of industry valued added from 1970 to 2000 for Australia and other OECD countries.](source: OECD, STAN Indicators, 2005)

* OECD data used for this graph does not include construction, gas and electricity

Figure B1.2: Sectoral employment trends in developed countries. USA data

![Graph showing sectoral employment trends from 1800 to 2000 for Agriculture, Goods, Services, Manufacturing, Mining, and Agriculture.](source: Spohrer, 2007)

Figure B1.3: Percentage contributions by industry 2005-06

![Pie charts showing percentage contributions by industry for 2005-06.](source: DITR, 2007b)

International trade - Australia compared to the world

<table>
<thead>
<tr>
<th>Service</th>
<th>Australia</th>
<th>World</th>
<th>OECD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports</td>
<td>US$31 billion¹</td>
<td>US$2,498 billion²</td>
<td>US$1,898 billion²</td>
</tr>
<tr>
<td>Balance of payments (per capita)</td>
<td>US$1,398</td>
<td>US$1,876</td>
<td>US$6,066</td>
</tr>
</tbody>
</table>

Australia’s international trade in services balance in 2004-05 recorded a deficit of $1.5b, a turnaround of $2.0b on the $0.5b surplus recorded in 2003-04 (ABS, 2006). The composition of Australia’s services exports contrasts with other high-income economies in that it has high proportion of tourism exports and relatively lower proportion of knowledge-intensive services exports (DITR, 2007a).

1 Revenue less non-labour costs of inputs
2 2005 figures derived from OECD STAN database. This figure does not include energy and construction services.
Box 2: Services simply put

Services can be simply defined as:

- “Anything you can't drop on your foot”\(^1\), or
- “Anything you can't put in a box and ship”\(^1\), or
- “People doing something for other people for value”\(^2\).

There is a spectrum of services, spanning the interface with products to clear separate activities.

<table>
<thead>
<tr>
<th>Products only</th>
<th>Services offered are primarily for product support</th>
<th>Products primarily provide hook to attract more core business in services</th>
<th>Services only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eg: smart food wrapping • flat screen TVs</td>
<td>Eg: aircraft maintenance • fast food outlets • cochlear implant</td>
<td>Eg: mobile phones • credit cards</td>
<td>Eg: aged care • pathology testing • weather forecasting • Google • internet banking • financial advice • workplace safety training</td>
</tr>
</tbody>
</table>

\(^1\) John Harvey, IBM  
\(^2\) Ravi Nemana, University of California Berkeley

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Box 3: From products to services - the transformation of IBM in Australia from a manufacturing exporter to a services exporter

**IBM as an Australian exporter of transformed manufactured goods**

In 1975 IBM announced its intention to build an electric typewriter manufacturing plant in Wangaratta, Victoria. Over the next 27 years this plant would export more than $6 billion of manufactured goods from Australia.

In 1984 Wangaratta became one of only three of IBM’s first manufacturing locations for personal computers worldwide. By 1996, it had made IBM the largest exporter of elaborately transformed manufacturing goods by any company from Australia, with revenues exceeding $600 million, over $400 million of which was exports.

Five years later, Wangaratta closed its gates for the last time. By 2001, like many other Australian manufacturing operations, it had become a casualty of the economies of scale and labour arbitrage available in the growth economies of Asia. The closure of the Wangaratta plant marked the end of manufacturing in Australia by IBM, but it was also the beginning of a dramatic transformation at IBM as the organisation moved itself from being a manufacturing exporter to a services exporter.

**IBM as an Australian exporter of IT Services**

In the late 1990s IBM recognised that the sector of the IT market that was growing most strongly was IT Services. IBM IT services exports rose 190% from 1995 to 1998 ($70m to $203m), and Australian IT services exports rose 256% ($176m to $626m). However, increased capacity to provide IT Services to the wider Asia Pacific market was required to take advantage of this export opportunity. This trend was occurring in the context of a global market undergoing an increasing consolidation and commoditisation of IT Services.

Australia was seen by IBM as being well-placed to be a major regional delivery point for IT Services in the Asia Pacific. It had advantages in language, with strong English capabilities (of attraction to the American market), as well as high capabilities in Japanese (of attraction to the Japanese market). It was also seen as being competent in the services sector, with good customer service skills and with lower labour costs relative to Japan and America.

IBM’s Asia Pacific Technical Support Centre was established in Brisbane in 1999, providing technical support for IBM’s Japanese market. In conjunction with this, IBM began to increase its services activities in Australia in other areas and significantly increased the number of Australian staff with regional headquarters responsibility (from 48 in 1999 to 564 in 2007).

By 2007 IBM in Australia was providing world class, export competitive IT Services. From 1998 to 2006 IBM increased IT Services exports by over 800%, with revenue rising from $203m to $576m and staff numbers from 457 to 1420.
The knowledge-intensive services are particularly relevant to this report because they are regarded as those that use more R&D, more technology and more highly skilled workers in comparison to other service industries (Working Group of the Smart State Council, 2006). They are considered to be especially important in the creation of more high-value jobs in mature economies. In addition, the continued global expansion of the knowledge economy combined with increased economic globalisation are likely to raise the importance of knowledge-intensive service activities in contributing to innovation (OECD, 2006a).

Finally, it is important to note that growth in services has often occurred through the transformation of traditional manufacturing industries into services. This is an increasing trend, and is exemplified by the transformation over the last decade of IBM from the largest exporter (by revenue - $400m) of transformed manufacturing goods from Australia to one of Australia’s leading service exporters (revenue in 2006 of $576m; Box 3).

1.3 How well understood is the importance of services to the Australian economy?

Results of a focussed, albeit limited, market survey commissioned by the Working Group and undertaken by MRA (Figure 2) indicate that the Australian public does not have a good understanding of the importance of services to the Australian economy, and hence are likely to undervalue its contribution. The majority of respondents (53%) believe that mining makes the greatest contribution to the Australian economy. Services rated second, at 22%, on par with manufacturing at 21%. Only 17% of respondents correctly identified the actual contribution of services to Australia’s GDP. Interestingly, Australians have a better recognition of services as being the largest employer of Australians (52% of respondents), although a significant number ranked manufacturing higher (42% of respondents). However, only 24% of respondents correctly identified the proportion of Australia’s labour force engaged in services.

Figure 2: Results of a market survey carried out by MRA on the importance of services to the Australian economy.

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3 Market Research Australia
1.4 Services underpinning growth

The importance of the services sector’s contribution to economic and productivity growth is increasingly recognised (Business Council of Australia, 2007; Australian Bureau of Statistics, 2007). The OECD, for example, suggests that improving the performance of the services sector is important to enhancing aggregate economic growth (Wolf, 2005). It has also been argued that productivity improvement and employment growth are strongly linked in services, with more staff required as businesses expand. This is in contrast to manufacturing where employment declines as the industry develops due to economies of scale and mass production (Working Group of the Smart State Council, 2006). Indeed, Hughes and Grinevich (2007) concluded that the forces driving productivity growth in services are pivotal to the overall acceleration of labour productivity growth.

In Australia, the services sector accounted for around almost two-thirds of the 2% per annum labour productivity increase between 1990 and 2002 (Pilat, 2005). The services sector has made the greatest contribution of all the sectors to labour productivity growth since 1993 (Cobbold and Kulys 2003). Importantly, a study by Hughes and Grinevich (2007) identified three services sectors (finance, wholesale trade and other business activities) as the main contributors to productivity growth acceleration in Australia between 1980 and 2004. In addition, they found that communication services played a significant role in generating productivity growth acceleration within this period, from 1980 to 1992 and from 1992 to 1998. They identified a similar pattern of services domination of productivity growth acceleration in the USA. Significantly, they argued that the increase in productivity in services has been closely associated with the development and application of information technologies, which in turn have necessitated the development of a range of complementary investments in management and other organisational assets. This corresponds with the findings of the Working Group of the Smart State Council (2006) which concluded that productivity growth in the services sector is mainly attributable to the adoption and adaptation of new technologies, especially those related to ICT.
2: The role of science and technology (S&T) in services innovation

2.1 The nature of services innovation

"Innovation is ideas successfully applied"
~ John Bessant, Innovation Summit, Melbourne, 2007

Delineating the role of science and technology in services innovation is not straightforward largely because innovation itself has not been historically recognised as a key driver of productivity growth in the services sector (Europe Innova, 2007; Tether, 2005).

Outputs from services businesses generally do not have an independent physical existence. Service innovations, therefore, tend to be intangible and difficult to record. They can also be difficult to consistently reproduce, with service businesses frequently adapting and reforming their activities to meet different customer requirements (innovation through continuous change).

"…modern economies are both service economies and economies of innovation. Paradoxically, they are not regarded as economies of innovation in services….It is as if services and innovation were two parallel universes that co-exist in blissful ignorance of each other."
~ Faiz Gallouj, Innovation in the Service Economy: the New Wealth of Nations, 2002

This historical perspective is now beginning to change (Europe Innova, 2007; Howells, 2000; Metcalfe and Miles, 2000; OECD, 2006a). Two modes of services innovation have been identified (after Hauknes, 1996, 1998):

- Innovation in services industries – where innovation is either applied to an industry regarded as service-based, or results in a new-service based industry (such as water monitoring services, internet service providers and hairdressing – see section 2.2.2); and

- Innovation through services (in any organisation/business) – where the application of a service (such as a mobile phone network) results in innovation in an industry generally not classified as services, such as fisheries (see section 2.3 and Box 7).

Science and technology by no means underpin all innovation in the services sector. The non-technological (sometimes called ‘soft’) part of innovation has been identified as being particularly important for services (Hauknes, 1998; Tether, 2005). This involves, for example, new business models, operational processes, human skills and organisational improvements.

On the other hand, science and technology can be shown to play a critical direct or indirect role in many services, particularly those regarded as being knowledge-intensive services. Good examples of this are health, mining and environmental services.

A distinguishing feature of service businesses is that they tend to innovate by adopting, rather than creating, new knowledge and technologies. Customer relations are also more crucial to services innovation compared with innovation in manufacturing. Service companies must maintain a flexible approach to innovation, constantly changing to meet customers’ needs. Social science, therefore, has the potential to be an important contributor to services innovation into the future.

The distinctive nature of services means, that while science and technology driven innovation is still important, its role in services is different to that in manufacturing. As a consequence, services innovation often occurs through creative combinations of technological and non-technological approaches that involve the social as well as the physical sciences (Tether, 2005). In fact, it is being increasingly argued, both nationally and internationally, that the most significant innovations in the 21st century will develop through the interaction of technological and non-technological innovation (DEST, 2006a; Hughes, 2007; Tether, 2005). This is illustrated in the following sections.

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4 Governments (including the Australian Government) commonly use the Oslo manual definition of innovation (OECD & EuroStat, 2005): “An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.” More simply put, innovation is about doing things in new ways as well as doing new things. It is as much about extrapolation and re-engineering as it is about ‘invention.’

5 The proposed second PMSEIC working group will explore in detail the role of non-technological innovation in creating a competitive advantage for the services sector.
2.2 Types of science and technology innovation

Science and technology-led services innovation is important not only through the direct application of discoveries, but also by enabling the uptake of innovation and discovery made elsewhere (Griffith et al, 2004). This is particularly true for ICT, which is frequently associated with innovation in other domains (DCITA, 2005).

The OECD (2006a) have identified four ways in which knowledge-intensive services affect innovation processes.

- **Renewal services** – where they are directly related to innovation, e.g. R&D and strategic management consulting.
- **Routine services** – where they contribute to improvement of maintenance and management of various subsystems within organisations, e.g. accounting.
- **Compliance services** – where they assist organisations to work within the legal framework and various other regulatory regimes, e.g. auditing and some legal services.
- **Network services** – where they facilitate communication, knowledge exchange and flexible resource allocation, e.g. informal personal networks and production related networks.

Given that knowledge-intensive services include those with a strong link to/or utilisation of science and technology, this analysis can also provide an indication of the ways in which science and technology can affect innovation processes.

With this in mind, the Working Group recognises that science and technology-led services innovation can occur through one or more of the following avenues:

- development of an underpinning product or platform
- knowledge used to develop and/or transform services
- the method of delivering a service

These are discussed in the following sections, with relevant illustrative examples.

In addition, science and technology-led innovation can have an indirect influence on services, such as the benefits that Australia’s ability to combat SARS has had on tourism.

2.2.1 Development of an underpinning product or platform

Many services are founded on the development of an underpinning scientific/technological product or platform. This is particularly the case for knowledge-intensive services but, in reality, it is difficult to identify a service that is not in some way dependent on products and/or platforms developed through science and technology. The development of the Internet, for example, has not only transformed the way many traditional services operate (see sections 2.2.2 and 2.2.3) but has also spawned a diverse range of new, web-based services. An excellent example of this is Google, a company that has grown from a web search engine innovation developed in a PhD thesis to become one of the world’s largest companies with a market capitalisation of over $215B. One of the keys to Google’s success has been the adoption of a business model of rapid uptake, development and application of scientific and technological innovation combined with an interactive relationship with their client base. This latter has in itself been enhanced by the web, allowing users to experiment online with their services (such as Google Earth), simultaneously improving these services and building loyalty.

The application of advances in genomics and neuro-informatics to transform health services is another good example of the important role of science-led services innovation.

In many cases the development of a scientific or technological product initiates a manufacturing business which subsequently is transformed into a service provider. The mining industry has many good examples of this. Mine Site Technologies (http://www.minesite.com.au), for example, was founded to market and sell a mine safety device (the Personal Emergency Device) developed in partnership with CSIRO. The company has since grown to become...
a mining-services company, providing installation and ongoing maintenance services to support its emergency communication products.

It has been argued that a new set of platform technologies are emerging that will enable businesses to innovate more rapidly, efficiently and accurately, having the same economic and social impact as the development of machine tools had on the industrial economy in the mid-19th century. Collectively referred to as “Innovation Technology”, they include eScience, virtual reality, simulation and modelling techniques, and rapid prototyping (Gann and Dodgson, 2007; Box 4).

2.2.2 Knowledge required to develop and/or transform services

The transformation of existing services and the development of new services have been made possible through knowledge advancements in science and technology. For example, mathematics and risk analysis has been an important driver of innovation in financial services, leading to the development of options trading, derivatives markets and the effective management of financial risk (see Box 5). Weather forecasting services have been vastly improved in recent years through developments in satellite technology and supercomputing. Energy services have been significantly enhanced not only by scientific advances in energy production (such as solar power) but also by technological advances enabling nationally networked energy provision (the National Electricity Market).

The application of scientific and technological knowledge has also led to significant innovations in services not generally regarded as knowledge-intensive. For example, the innovative use of digital imagery and IT by a hairdressing business in Bangalore, India, has led to its transformation from the archetypal ‘non-tradeable’ service into one that is potentially tradeable. The appointment commences with the business producing

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**Box 4: Innovation Technology and new science and technology-led services**

Innovation Technology comprises three main types of technology platform:

1. eScience, or Grid Technologies, which have their basis in high-volume data transmission, scientific computing and the internet. These include software that allows shared diagnosis and analysis of data by teams working in different locations and in different parts of the research and development process. They involve ‘middleware’ that allows visualisation of merged data sets to improve the shared understanding and operation of virtual research organisations.

*Example: eScience* is being used by Rolls-Royce to draw more effectively on the wide-ranging expertise in a number of university research centres to improve engine performance and safety.

2. Modelling, simulation and visualisation technologies, which evolved from CAD (Computer-Aided Design) systems and benefited significantly from developments in the computer games industry. Simulation enables design and development teams to explore options and test combinations of ideas in a virtual environment. This reduces the cost and time involved in combining different components and elements in comparison to traditional design and development processes. It also enables more stakeholders, including customers and regulators, to engage in earlier stages of product and service innovation.

*Example: Virtual reality is being used in the fashion and clothing industry to help improve our choices as consumers. Some stores are creating avatars with our body shapes to examine virtually what we would look like in particular clothes, so that we can quickly (and honestly) assess the results of our selections. Our clothes can then be manufactured using thousands of data points from our body shapes (rather than the traditional two or three) to ensure a perfect fit. Simulation and modelling allows rapid and accurate predictions on the effect of various congestion charge prices on traffic flow, extending the imagination of policy-makers and making it more likely that they will make better decisions based on better information.*

3. Virtual and rapid prototyping systems, some of which have emerged from CAM (Computer-Aided Manufacturing), enabling firms to explore options about how to produce products and services quickly and cost-effectively, assessing their commercial viability.

*Example: Rapid prototyping is allowing architects to engage clients, engineers and public authorities more deeply than in the past with their designs, by greater iteration around virtual and rapidly fabricated models, allowing them to produce innovative buildings that both deliver on their required function and delight with their form.*

and emailing a digital image of the customer’s scalp to a designer, who then transmits back to the shop a range of customised hairstyles. The result is increased client satisfaction, with access to a top designer, and increased efficiency and value-add for the business (Walters et al., 2007).

2.2.3 The method of delivering a service

ICT has played a pervasive role in transforming the way services are delivered. E-business (electronic business), for example, has enabled services industries, such as finance (Box 5) and tourism (Box 6), to use technology to redesign their business processes to value add for clients, improve efficiencies and increase the speed of transactions, reduce costs, enhance business partnerships and expand business markets (DEST, 2006a). The development of the internet and the technology for secure internet transactions has, for example, transformed the way the banking system delivers its services to its client base, with electronic banking now widely utilised. The internet has also had far reaching effects in the retail industry, enabling, for instance, businesses of all sizes to readily access and deliver to international markets, as well as leading to the development of new, solely web-based retail business. Wotif.com is a good example, providing a new model of travel accommodation services centred around web-based service delivery to customers (Box 6).

**Box 5: Business models in Financial Services – the integration of science and technology with business model innovation**

**Credit Card Based Loyalty Programs.** Besides their impact on the way we perform financial transactions, credit cards have enabled the development of new businesses through “loyalty programs”. Air Canada has spun out its loyalty program (Aeroplane) which is a $2B business in its own right. The Qantas frequent flyer program is estimated to have generated a $100M pre-tax profit and is to be spun out as a separate entity in 2008 (Sydney Morning Herald, 2007).

**Financial Engineering** (the mathematical modelling of risk) has created huge new businesses and enabled the development of novel financial products and business models. For example, the development in 1973 by Merton, Scholes and Black of the “Black-Scholes model for pricing options” (Wikipedia, 2007) has led to a multi-trillion dollar industry of trading derivatives (PBS, 2000) where the traders manage risk by “dynamic hedging” using the Black-Scholes formula.

**Innovative use of Information Technology** has led to new businesses and business models in finance. For example the Commonwealth Bank created a new business and new business models with CommSec which was a disruption to traditional stock-broking businesses. By providing secure, cost-effective trading in a scalable way, CommSec rapidly gained market share in a highly profitable way.

**Box 6: Wotif.com – technology transforming the hospitality industry**

What if you could get a hotel room cheaper by waiting to book it? That simple question led to the creation of Wotif.com, an innovative new way of booking accommodation. As a date draws near, hotels will often lower the rates for their unbooked rooms rather than have them sit empty. Wotif.com allows consumers to take advantage of this by offering the best last minute* deals from hotels in 35 countries.

The creation of this service was not the end of the story, however. The technical team became unsatisfied with the lack of new development and features in the application server that the site had been using. So they partnered with Sun Microsystems to improve this through the development of an open source application server.

The Wotif.com site currently supports around 10,000 concurrent sessions, with almost one million users making over 110,000 bookings each month.

* bookings no more than 28 days in advance (which allows them to get the best rates from hotels while still allowing consumers some planning time).
2.3 Science and technology-led innovation adding value to traditional industries

Science and technology-led services innovation can also be used to enhance the performance of non-service based industries. This can occur through the utilisation of services (such as outlined in section 2.2) in which science and technology has an important role and/or through the direct application of scientific/technological knowledge (science as a service). A good example of the former is the Indian fishing industry, which has transformed its operations by accessing mobile phone services (Jensen, 2007; Box 7). Indeed, the fishing industry in general has significantly improved its operations by utilising science and technology services such as satellite communications and global positioning systems (after Smith, 2006; Box 7).

As with services industries, traditional industries can be transformed by utilising innovations in science and technology, often with associated ongoing scientific/technological services (science servicing industry needs). This type of innovation frequently occurs where there is a close interaction between industry and the science and technology R&D base.

Box 7: Science and technology services transforming fishing industries

Science and technology have transformed fishing industries around the world, from small scale enterprises in countries like India, to high level industries such as those operating out of Australia.

Mobile phone services transforming the Indian fishing industry

The use of mobile phone services has been used to transform the fisheries industry in southern India. Fish is the dietary staple in this region. However, historically fishermen and traders generally only had knowledge of the price of fish in a small number of nearby villages or towns. The cost of fuel and the lack of storage capacity limited the geographic range of markets at which fisherman could sell their catch. The consequence was a highly inefficient industry, with oversupply at some village markets (and an associated dumping of fish) and undersupply at others.

The introduction of a mobile phone service between 1997 and 2001 enabled fishing boats and traders to coordinate sales. This resulted in a significant improvement in the distribution of fish to markets in this region, as well as a decrease in related price variations. It also eliminated the dumping of fish (which previously averaged between 5 and 8 percent of the daily catch). This increased efficiency in the market led to the profits for fisherman increasing by 8 percent and the price for customers falling by 4 percent. Furthermore, even though it was mainly the larger fishing enterprises that adopted mobile phones in the region, the smaller enterprises still acquired benefit due to the improved functioning of the market.


Science and Technology and the Australian fishing industry

The Australian fishing industry has utilised science and technology innovations to become one of the most productive and sustainable fishing industries in the world.

The use of sonar and sounding equipment has provided the ability to accurately locate schools of fish and in turn better position fishing gear and increase harvests. When used in conjunction with Global Positioning Systems (GPS), digital charts and personal computers, fishing operations can build a highly detailed three-dimensional model of their fishing grounds over time. When further integrated with information on catches, weather, time and tide, such systems can incorporate much of the information and experience an operator gains over time.

The development of various satellite systems has provided fishers and fisheries managers with a variety of significant advancements and tools. The widespread availability of GPS receivers has allowed previously inaccessible areas to be precisely targeted, and the positions of fishing spots or topographic features to be accurately marked. Inexpensive and accurate positioning has allowed the development of computer systems that associate depth, bottom type, catch and time information with location to provide onboard fishing-information systems.

Remote-sensing and remote-imaging satellites and associated services produce a wide range of oceanographic and biological information useful in research and as a tool for locating fish schools. Near-real-time imagery of ocean temperature is used by tuna longline fleets to identify temperature fronts associated with high catch rates of tuna. Existing and future remotely-sensed imagery has substantial potential benefits for fishing fleets in both the inshore and offshore environments, but remains largely unused by industry in Australia.

For example, aquaculture has benefited from innovative developments in computer imaging and pattern recognition technologies for monitoring (including 3D measurement systems), as well as advances in nutrition technologies, genetic research, sonar and robotics. Broadband internet access and environmental services are contributing significantly to improved outcomes for Australian agriculture (Box 8). The food industry has been transformed by science innovations leading to, for example, improved understanding of the chemical composition of food materials as well as their physical, biological and biochemical behaviour. Scientific advances in understanding human nutritional requirements and the nutritional factors in food materials has also been extremely important, as has knowledge of the microbiology of foods and the interaction of food components with each other, with atmospheric oxygen, with additives and contaminants, and with packaging materials (after Smith, 2006).

2.4 Services Science: Integrating science and technology-led innovation with other innovation modes

From the previous section, we can conclude that science and technology are fundamental to the success of many services, by providing the product, platform or knowledge to develop or deliver the service. Further, as discussed in 2.1, as we move into the 21st century the most significant innovations will arguably develop from creative combinations of technological innovation with innovation in organisational design, business models and operational processes (DEST, 2006a; Hughes, 2007; Tether, 2005). This is exemplified in the many applications in the financial services (Box 5) and the creation of Wotif.com (Box 6), where innovations have occurred through the transformation of business models by taking advantage of an existing technology.

The growing appreciation of the importance to the services sector of combining technological and non-technological innovation has led to the concept of Services Science.

The key concept of Services Science - sometimes referred to as Services Science, Management, and

Box 8: ICT and environmental services transforming agricultural practices in Australia

The agricultural sector in Australia is increasingly using ICT and environmental services to improve farm management and productivity.

Broadband internet is having a real impact on the methods and business operations of farms. It is being used as a research tool for pricing equipment, accessing weather and climate information, checking dam and river water levels, and communicating with supply chains. For example, the Barrington Beef Co-operative, a collective of farmers from the Gloucester and Barrington areas in New South Wales, is using broadband technology to source new markets and to increase the speed of communications and information exchange. This in turn has significantly improved their competitiveness (DCITA, 2007).

Figure B8.1: Modelled change in annual Australian precipitation by 2030

Agricultural production in Australia is becoming increasingly dependent on the provision of world class environmental services, including weather forecasting, climate modelling, and soil moisture and crop performance modelling. These services are enabling farmers to improve their planning and management decisions, thus facilitating better production and environmental outcomes. The Bureau of Meteorology, for example, provides a range of vital weather and climate forecasting services that improve the ability of farmers to make management decisions into the future. A number of other bodies (including CSIRO, Research and Development Corporations and State and Commonwealth Government Departments) also provide environmental monitoring and prediction services that are of enormous value. The Australian Bureau of Rural Sciences, for instance, offers a range of internet enabled environmental service tools (www.brs.gov.au/tools), such as the National Agricultural Monitoring System. This contains a range of climatic and production information for dryland/broadacre and irrigated industries in over 600 regions throughout Australia.
Engineering (SSME) - is to integrate the disciplinary knowledge and approaches of computer science, engineering and design, business strategy, mathematical sciences, social science and law in order to enhance services innovation in a way that could not be achieved through these disciplines working in isolation.

“Today, services research is the fastest growing part of IBM research – the number of people focused on service[s] innovation has increased by more than a factor of ten over the last three years, and now accounts for more than 15% of our 3000 researchers in IBM research.”

~ Jim Spohrer (IBM, 2007)

Services science can be defined as the interdisciplinary study of systems that use technology and shared information processes to help people and organizations interact to create value, meeting human and organizational needs more efficiently, effectively, and in a sustainable manner. Service systems govern how people and organizations interact, ideally for each others’ benefit. Such systems are complex, including: (1) technical interfaces and architectures requiring engineering and networking expertise, (2) operations, compliance, and supply chain strategies requiring management skills, and (3) insight and analytical tools from social sciences to assess how people act within such systems and to act on that knowledge (after University of Cambridge Institute for Manufacturing and IBM, 2007). Box 9 provides instances of the role of services science in various industry sectors.

To understand the emergence of this discipline, it is worth considering an extreme example of the complex interplay between the various skills that a professional in the services economy may be required to draw upon.

A consumer services business that uses online delivery may have to consider a number of issues in launching a new service offering. On the technological front these issues could be about changes that may be necessary to the online infrastructure to securely and cost effectively deliver the service, and whether the size of the market justifies the cost of such changes. Consideration may have to be given to how the new service offering fits with the overall business strategy and if there are any synergies that could be exploited with other service offerings. Knowledge of the consumer behaviour and preferences will often play an important role in determining the level of personalisation possible in the service offering. Often the degree of personalisation possible will be dependent on technological feasibility. It will also be determined by the nature of consumer preference data that can be collected. This will have to take into account the privacy laws in force in the jurisdiction of the business.

The deployment of the above combination of skills from technology, business strategy, social sciences and law is not new. Many companies have had to draw on expertise from a combination of such disciplines to grow their businesses. What is new is the interplay between such skills and the speed at which such skills have to be deployed for increasingly narrow market segments and often by small companies.

These service offerings can have short life spans, often being replaced by new service offerings. The combination of speed, narrowness of the market segment and the ephemeral nature of service offerings is creating a demand for professionals with an interdisciplinary understanding of these skills.

As with the emergence of any discipline, new research issues are being identified and addressed from a variety of angles. For example, a Cambridge-IBM report (University of Cambridge Institute for Manufacturing and IBM, 2007) identifies the foundations that have been laid by existing disciplines for services science. This report also addresses some of the knowledge gaps that exist.

In recognition of its growing importance, there have already been moves by international governments to establish Services Science in national research and education agendas, with the aim of enhancing national competitiveness in services, particularly knowledge intensive services. Notably, the United States government considers this new discipline to be so important that congress recently passed legislation addressing this issue (Box 10).

In Australia, the concept is also gaining traction. Several universities, many in close collaboration with
IBM, have embraced the concept of services science (Appendix E). For example, Sydney University, through its School of IT, has initiated a ‘Services Science Management and Engineering’ (SSME) course within its Masters of IT program that includes modules in Services Management, Service Modelling, Services Marketing, Services Governance and related business/technology subjects. Several of these modules were based on pre-built SSME courseware developed by IBM. The university is currently expanding its SSME program to provide a Graduate Diploma and a Major in Services Science Management and Engineering. Other Australian universities initiating courses with SSME content include: Deakin University, RMIT, University of Wollongong, University of NSW, University of Melbourne, Macquarie University, University of Technology, Sydney (UTS) and Queensland University of Technology (QUT).

In addition, analysis of ARC grants awarded over the past four years (2004-2007) indicates that there has been a 12.5% increase in the number of projects that combine science, management and engineering research (which can be used as a proxy for current research activity in services science), and a corresponding 88% increase in funding. While this increase is in the right direction, and in the case of funding appears to be large, it is actually from a very small base (0.36% of projects funded and 0.23% of total funding) and, given the importance of services to the national economy, more needs to be done. This is the subject of one of the recommendations in this report.

Box 9: Services science in different domains

**Commerce** – service systems drive competitiveness and productivity for virtually every sector, from banking to retail to manufacturing firms. Services science seeks to optimize these systems and drive innovation in new services, business processes, and business models.

**Defence** – services science impacts multiple defence issues, including how the military collects and shares information to make battlefield decisions and to execute them.

**Transportation** – services science aids the development of intelligent transportation networks that ease congestion, speed commerce and facilitate emergency services.

**Healthcare** – services science will reform the way information benefits patients, doctors, hospitals, insurers and public health agencies. It will drive productivity and multiple life-saving improvements.

**Energy** – services science will help reengineer energy generation and distribution, making networks more efficient, reliable and responsive to demand.

**Disaster Relief** – services science promises to redesign domestic and international relief efforts, making them swifter, more effective and in some cases avoidable.

**Education** – services science can help optimize distance and online learning systems, uncovering new models for institutions to serve more students, reduce student and institutional costs, improve learning outcomes, and raise revenue.

Box 10: US Legislation on Services Science

On August 2nd 2007, the US House and Senate voted to approve (President signed on 9th August 2007):

*Sec. 1005. Study of Services Science

(a) Sense of Congress – It is the sense of Congress that, in order to strengthen the competitiveness of United States enterprises and institutions and to prepare the people of the United States for high-wage, high-skill employment, the Federal Government should better understand and respond strategically to the emerging management and learning discipline known as service(s) science.*

(b) Study- Not later than 1 year after the date of enactment of this Act, the Director of the Office of Science and Technology Policy, through the National Academy of Sciences, shall conduct a study and report to Congress regarding how the Federal Government should support, through research, education, and training, the emerging management and learning discipline known as service(s) science.”

* Our bold

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6 The increase in number of projects, however, reflects an overall increase in the number of projects funded by ARC, with the percentage being awarded to combined science, management and engineering research being 0.36% in both 2004 and 2007.
3: How is Australia positioned globally in the services sector?

3.1 The challenge for Australia

Whilst services constitute over 70% of Australia’s productivity and are a major contributor to our export earnings, there is evidence that we are behind other OECD countries in this area. According to the World Bank (2007) Australia captures US$31 billion in services exports, of a global market of US$2.5 trillion in exports (US$1.9 trillion by OECD countries). On a per capita basis, this equates to US$1,398 for Australia, which is lower than the global average of US$1,876 and significantly lower than the OECD average of US$6,066 (World Bank, 2007). Australia’s intensity of trade in services (the ratio of export and imports of services to total GDP) is also very low by OECD standards. For example, the increases in trade intensity for Ireland, Korea, Sweden and the Netherlands have been greater than three times that of the Australian rate of increase (Wolf, 2005 in Business Council of Australia, 2007).

There is evidence that Australia’s growth in services has slowed in recent years, particularly in knowledge-intensive services (Figure 3). The Business Council of Australia (2007) estimate that Australia’s share of global services exports has dropped from 1.45% in 1996 to 1.15% in 2005, equating to a $9.7 billion loss in export revenue over this period. This is in the context of rapid growth in services exports in other countries (OECD, 2006c). Furthermore, developing nations such as India, China and Bangladesh, are becoming increasingly skilled and are expanding the volume and range of their services export markets, including services with a strong science and technology component. Given that these developing nations currently have a low percentage of their population employed in services (see Appendix C), they have significant capacity for growth. Indeed, we are already seeing services exports from these nations into our domestic economy.

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7 Data for 2005. This figure does not include energy and construction services.

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8 It should be noted, that Australia’s exports in services is likely to be underestimated, given the data for services is largely centred around service industries and does not capture those services often categorised under other sectors (such as mining). Nevertheless, the general trends in comparison to international trends remain concerning.

Figure 3: Knowledge-intensive services (KIS) exports within the OECD as a percentage of total services exports

Source: OECD, 2006
Note: The blue shading indicates the range of export performance by OECD countries. Top performing countries include Sweden and Ireland, lowest performing countries include Mexico, Portugal and Greece. KIS has been defined as financial services, computer and information services and other business services.
Australia’s services exports, although increasing, are low in comparison to our mining and agricultural sectors, despite their dominance of our domestic economy (Figure 4). Indeed, there is very little difference between our exports and imports (Figure 5). Currently, our export economy is heavily reliant on mining. This reliance could pose a serious challenge to our future economy should this sector experience a significant down-turn in the future. The manufacturing and agriculture sectors are unlikely to fill the gap. This leaves services, which is already the most important sector in our domestic economy. Using the export data for knowledge-intensive services (Figure 3, and Figure 5) as a proxy for the performance of Australia’s exports in science and technology-rich services, it can be argued that we are failing to capitalise on our strong science and technology base to grow our services markets. It would seem that we are relying on the status quo of a high dependency on traditional services industries, such as tourism. Our recent poor performance in the World Economic Forum Innovation Index (2007), falling from 16th to 19th, provides compounding support to this thesis. Examination of Australia’s innovation by industry (Figure 6) shows that the principal innovation growth has occurred in industries where ICT has been a major contributor, through automation and the more effective provisions and use of information. These industries include wholesale trade, finance and insurance, communication services, utilities and mining (although there has been a drop-back in the latter in the last five years).

An additional cause for concern is the lack of diversification in Australia’s services exports, despite the growing diversification of services industries around the world and in domestic activity. More than half of Australia’s services exports are related to travel, 22% were related to transport services, and 25% to the ‘other services’ category, which are predominantly business related (Business Council of Australia, 2007).

Domestically, Australia is continually facing significant challenges in the effective delivery of high quality services across its large and diverse geography, especially to remote and regional communities. This is particularly true for our health and education services.

**Figure 4: Australian current account balance of payments 1988-2006**

![Figure 4: Australian current account balance of payments 1988-2006](source: Rowthorn, 2007, in Hughes and Grinevich, 2007, p10)
Figure 5: Australian knowledge-intensive services exports and imports compared to total services exports and imports

Source: Australian Bureau of Statistics, Cat. 5302.0

Figure 6: Australian innovation index by industry - five year intervals

Source: IBM and Melbourne Institute

Note: To eliminate distortion caused by applying the same weights to all industries, the Index was forced to equal 100 in 1990.
3.2 The role of science and technology in addressing Australia’s challenges in the services sector

Science and technology-led services innovation, particularly in combination with other modes of services innovation, has the potential to play a significant role in addressing the challenges facing the Australian services sector, both internationally and domestically.

Given their importance to knowledge-intensive services, science and technology have significant potential to increase the level and diversity of our services exports.

The innovative application of science and technology can also enhance the competitive position of other service sectors that are less knowledge-intensive or do not traditionally have a strong science and technology focus, particularly through the interaction with innovations in business models, organisational design and operational processes. The application of mathematical risk modelling to Australian financial services (financial engineering) is a good example of this (Box 5).

3.2.1 Where does Australia have most opportunity for capitalising on science and technology-led services innovation?

Australia needs to recognise it cannot be a player in everything. We therefore need to prioritise new opportunities based on where we have competitive advantage and/or a distinct national need.

The Working Group consider that the following criteria are important for developing successful, sustainable and innovative science and technology-led service opportunities:

- Where we have domain knowledge;
- Where we are either already ahead of the game or, through addressing domestic service needs, are likely to get ahead of the game. This is particularly relevant in regard to providing innovative solutions to challenges that are currently, or are likely to soon affect, international communities, such as climate change;
- Where a strong, high-value global market opportunity exists;
- Where there is exportability. Web services and communications have changed what is exportable. For example, there is significant opportunity for Australia to increase its exports in education and health using web services.

Examples of potential areas that meet these criteria for Australia include:

- solutions to delivery of services in remote communities, such as education and healthcare;
- design and management of infrastructure in tropical and subtropical climates;
- sustainably exploiting our resources (e.g. minerals, oceans, agriculture);
- leveraging our natural biodiversity;
- utilising energy from geothermal sources;
- environmental challenges/services (e.g. water, bushfires, coastal/marine, desert sectors);
- transport and logistics services (e.g. in sparse geographies);
- education and research services.

To elaborate on just a few of these…

Breakthrough science and technology (platform changes) can pave the way for entirely new service industries. For example, Australia’s leading-edge capability in climate change science coupled with our track record in drought adaptation research puts us in a strong position to export climate change mitigation and adaptation science services, particularly in the Asia-Pacific region. It also has the ability to provide competitive advantage in areas such as agricultural production and tourism.

Australia is well-placed to capitalise globally on our world-class medical science base and the expertise we are building in meeting our domestic challenges, such as the imperatives of an ageing population and potential blow-out in health care costs (Box 11).
Indeed, science and technology-led innovation could play an extremely important role in addressing the significant domestic challenges that Australia faces in its service sector, such as transport and logistics over our vast continent (Box 12) and the provision of health and education services to our remote and regional areas. Solutions derived to these issues could in turn generate new services export markets. For example, a breakthrough development in broadband technology has led to an innovative solution to one of Australia’s critical heath service issues – the delivery of high quality care to regional hospitals (Box 13).

Innovations in technology platforms and applications are transforming learning modes and therefore the way in which academics can teach. The internet, for example, has enabled online courses to be offered, which not only increases the accessibility (particularly for distance education) and flexibility for students, but also enables content to be enhanced through the use of hyperlinks. In the future, the outcome of these innovations in technology platforms and applications will be to spawn further innovation in education services leading to individually structured learning programs tailored to each student’s needs (Box 14). This in turn has significant potential to further grow our already strong export performance in education services.

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Box 11: Health care services: a future export industry for Australia?

Over the next 20 years, Australia can expect to see a revolution in delivery of health care services. Medical treatments will become much more personalized and the emphasis will shift markedly towards prevention rather than treatment. Many diseases that are currently life-threatening will become chronic, manageable conditions.

This paradigm shift in health care services will depend heavily on advances in science and technology. For example:

- **Personalised medicine**
  The problem with current drugs is that they do not work for all patients because of differences in genetic makeup. By 2020, each of us will probably have our genomes sequenced – and at a cost of less than $1000! This will mean that we can know in advance our genetic disposition to major diseases and our likely responsiveness to recommended drugs. We will then be in a position to offer patients a tailored, much more effective, treatment approach.

- **New techniques for disease monitoring**
  Innovations in information technology, nanotechnology and social sciences will lead to the development of new methods for monitoring chronic diseases. For example, people with cardiovascular disease may have implanted nano-scale devices for continuous monitoring of blood cholesterol, with results transmitted wirelessly to a monitoring centre.

In rising to this health care challenge on the domestic front, Australia will also have the opportunity to build a raft of new export opportunities in health care services. For example, the number of people in India with diabetes is expected to exceed 70 million in 2025, at a cost of over $30 billion per annum at today’s costs.

Realisation of these opportunities will require substantial innovation in service delivery, such as the integration of complex IT solutions into the healthcare system, as well as the training of a new set of “Services Science” graduates that bring a combination of business, organization and technology integration skills. It will be crucial that government supported programs and policies are well-aligned to the needs of this export opportunity.
Box 12: Transport & Logistics Services

Supply chains are pervasive in modern life – a fact not always obvious to consumers. The Transport & Storage Sector of the economy represents 5% of GDP (comparable with each of mining, education, Government administration and wholesale trade). This sector also underpins other parts of the economy, such as agriculture, manufacturing, mining and wholesale & retail trade. Innovations in transport and logistics have an effect which is multiplied through the economy. Science and technology have a central role in improving the effectiveness and efficiency of supply chains. Here are a couple of examples.

Example 1: Getting the good drop to customers

A successful partnership in the grape-wine supply chain involves Orlando Wines, Progress Software Corporation and CSIRO working together on a system to schedule the production of Australia’s top drops, including the world famous ‘Jacob’s Creek’ wines.

The grape-wine supply chain is, in fact, a large and complex network. It involves more than 150,000 tonnes of grapes of 37 different varieties, dozens of wine growing areas, 500 growers, 600 subcontractors, 23 wineries, and 3100 individual blocks. Blocks are all harvested between late January and early May. To harvest a block all the vineyard, winery, transport and harvesting resources need to be co-ordinated. Errors can be costly. Grapes are highly perishable – 1-2 hours can alter wine quality considerably.

Drawing on CSIRO research, a US company, Progress Software Corporation, produces the software to co-ordinate this network for Orlando Wines. Analytic and decision support technologies aid the selection of grapes to mix and predict when grapes in a block will reach maturity and be ready for harvest. Negotiated scheduling and adaptive supply networks methods are used to optimise the use of resources.

The system adds value by reducing uncertainty and optimising the use of resources. It improves predictions, which in turn has led to better collaboration between staff in viticulture and in operations. The system makes more efficient use of resources operated by Orlando Wines and its subcontractors. And, the best news for tipplers, it results in better quality wine because grapes are harvested at the optimum time and with minimum logistical delays.

Example 2: Coal terminal optimisation

CSIRO is using maths-based simulation to optimise investment in coal terminals, a key component in the coal supply chain.

Coal terminals have many stakeholders and they are expensive to build and run. New hardware (stackers and reclaimers), for example, costs tens of millions of dollars. With increasing global demand for coal, the challenge is to increase the throughput of terminals while optimising the use of existing assets and any investment in new assets. Because 25-30% of shipments are blends of two or more types of coal, one aim is to increase blending flexibility at terminals.

Simulation is often used to model different investment scenarios at coal terminals, but the research has been able to go further and simulate whole supply chains, including the detailed decision-making that occurs within them. This allows assessment not only of infrastructure but also of the detailed operational policies and the interactions among the different companies involved in the supply chain – each of which plans and operates independently.

For addressing these complicated systems, CSIRO uses agent based modelling and optimisation techniques based on its research into negotiated scheduling.

Image courtesy of CSIRO.
Box 13: Using technology to bring high quality health care to regional hospitals - the Virtual Critical Care Unit (ViCCU®)

The Virtual Critical Care Unit (ViCCU®) is an innovative, science and technology-driven solution to one of Australia’s critical health service issues – the delivery of high quality care to regional hospitals. The system was developed by CSIRO in collaboration with the Wentworth Area Health Service, NSW Health and Telstra, with funding from DCITA. It is designed to revolutionise the delivery and quality of care in regional hospitals. Its initial development has been to enable an emergency intensive care specialist located at one hospital to supervise a resuscitation team located at a peripheral hospital. It is currently in operation between the Nepean Hospital (Sydney) and the Blue Mountains District Hospital. Critical to its function is broadband technology developed by the Centre for Networking Technologies for the Information Economy (CeNTIE) that allows the transmission of several high quality, two-way digital video channels, high quality audio, vital signs data, written notes and medical images. ViCCU® won the Implementation: Telecommunications category in the 2004 AIIA Awards. The technology is currently being rolled out by Telstra.

Image courtesy of Sydney West Area Health Service.

Box 14: Science and technology-led innovation in education services

Innovations in technology platforms and applications are transforming learning modes and thus the way in which academics teach. Technological innovation is spawning a revolution in education services, with interactive learning being enhanced and enabled, staff to student ratios effectively reduced to one-on-one, and the ability to deliver structured learning programs tailored to students’ individual needs.

Future Scenario – OzUni 2011…

Following the successful completion of his HSC, James will start his first semester of a mechatronics engineering degree course at OzUni. Having enrolled and selected his course content and format online, he is keen to attend his first lectures.

James’ lectures are posted online, either on a departmental Wiki or the more formal OzUniOnline learning system. Some lectures are vodcasted, including from international experts located overseas. His tutorials also occur online, with his groups meeting in chat rooms to discuss course content. He uses Wikis to send questions to tutors and fellow students, and uses the OzUni group site in Facebook to access information about issues other students are experiencing.

One of James’ subjects involves lectures delivered across several campuses at the same time. This is enabled by the use of vodcasting and a dynamic screen, on which annotations to the slides are being made in real time by the professor, who is actually located at another campus. A group currently doing their international field-work semester in Singapore is following the same lecture. Similar electronic boards are used to display student notices in the OzUni Union area.

Many of James’ laboratory classes are conducted virtually and online, through the use of e-Labs set up at the OzUni campus in Second Life. The use of an interactive avatar program by the university means that James can access many of these laboratory classes in his own time.

With all these innovations for self-directed learning available, James can choose when to be on campus, fitting this in with his part-time work. However, he is also concerned to test whether he is on the right track. Apart from his academic advisor from Student Services, OzUni also makes available Peer Assisted Student Support (where later year students conduct online catch-up tutorials on request) and a Skype network to a pilot Tutorial Call Centre in Ulladulla.

By now successfully into his second year, James wishes to apply for his first industry placement, a requirement of his degree course. The university provides software to enable him to produce an e-portfolio, which includes interactive, multi-media documentation of his course achievements. As he progresses through his degree, he will build on this portfolio.

James’ friend Tony, an indigenous business student from Walgett, is also pleased with his OzUni experience. Coming from a rural community, attending OzUni block mode lectures several times a year allows Tony to remain at home to work the rest of the time, while learning interactively using the latest web technologies, keeping in contact with his OzUni classmates, lecturers and tutors by computer with the help of PebblePad personal learning and Facebook. While the digital divide used to be a barrier, problems of broadband access in remote areas of Australia were solved long ago, with ICT hardware now more robust and resilient. And the $200 wind-up laptop also facilitated broader participation in Tony’s and other indigenous communities.
The following features characterise a vibrant science and technology-led innovation culture in services:

- a strong innovative and entrepreneurial R&D base, both by the public sector and by relevant industries;
- linkages (location and networks) between researchers and the companies delivering services;
- good networks for the early adoption/uptake of innovation developed elsewhere (local and overseas); and
- entrepreneurial staff skilled in the area of services science and in the management of innovation.

Australia has a good foundation in some, but not all of these factors. There is a tremendous opportunity, therefore, for Australia to grow its service exports, particularly in services with a strong foundation in science and technology-driven innovation. However, given our population size, our ability to be competitive across the board is limited. We therefore need to target our effort to where we have competitive advantage.

### 4.1 Australia’s competitive advantages

Australia has a number of interlinked areas of competitive advantage.

We have a track record of innovation coupled with a reputation for punching above our weight in science and technology R&D (Barlow, 2006). The Royal Flying Doctor Service is an excellent example of this (Box 16). We have strong science and technology skills and domain knowledge, particularly in the public sector, in a range of areas including ICT, mining, infrastructure, environment, health, agriculture, and entertainment technology. This, coupled with good government and public sector R&D schemes, has created a strong capacity to provide science and technology-driven innovation both within existing services, and through the formation of new services markets.

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**Box 15: Animal Logic – an Australian success story in digital and animation services**

Animal Logic is one of the world’s leading visual effects and animation companies, with offices in Fox Studios, Sydney and Los Angeles, California. The company was founded in 1991 by Zareh Nalbandian and Chris Godfrey, who both came from the traditional film industry and saw the growing opportunities in the area of providing digital animation services to the television and film industries.

Animal Logic’s core business began in the design and production of high-end visual effects for commercials and television programs, providing a platform for successful expansion into servicing feature film work including Babe, The Matrix, Moulin Rouge!, Hero, 300 and the 2006 release of Australia’s first digital animated feature, Happy Feet. Animal Logic did not find its formula for success overnight; it was tried and tested over a number of years through the experiences gained from its successes and failures. Once proven, Animal Logic had the foothold needed to seize major opportunities in the global market place.

Animal Logic has over a short number of years built a reputation as one of the world’s leading design, visual effects and animation companies. This presents Australia with a unique opportunity to build upon this capability and create a world class innovative digital animation services industry.
We have significant expertise in providing high quality products and services with efficiency on delivery and cost. In other words, our businesses have a reputation for reliability and value for money (see Box 15). Mirroring this, we have a customer base that is educated and receptive to scientific and technological innovation.

Fundamental shifts in the competitive behaviour of successful Australian service firms have been reported, with firms reinventing their business offerings to better serve customer and market needs. This in turn has enabled them to command premium prices and capture value from business activities that competitors find difficult to imitate (Kennedy, 2007). In particular, three patterns of innovative competitive behaviour by Australian firms are cited:

- new hybrid business offerings lending products and services for customer problem-solving and generating new mixes of technical, managerial and collaboration skills in the process;
- proficiency as technology integrators, rather than just being either technology makers or technology takers; and
- competing by distinctive knowledge management or by sustained incremental innovations that result in tacit intangible attributes in business offerings unable to be matched by rivals.

Our population is relatively technologically aware and savvy, with 58% of Australian households connected to the internet (predominantly in the capital cities; ABS 2007d). Overall we have good infrastructure, although there are serious gaps in technology infrastructure in regions outside of our capital cities.

Geographically we are well placed to be a key provider to rapidly growing Asia-Pacific markets. We have a sound understanding of regional challenges and our proximity provides the advantage of being close to market and hence raises our attractiveness as a regional base to multi-nationals (e.g. the successful establishment of IBM service centres in Australia, Box 3). In addition, our positioning in the same time zone (Perth time = Beijing time) gives us an edge over our competitors in, for example, Europe and North America. We also have an advantage in language, with native English speakers (the language of global ICT and business) with a good level of education, as well as being a multi-cultural, multi-lingual society.

Box 16: Royal Flying Doctor Service

The Royal Flying Doctor Service (RFDS) is a story of how medicine, aviation and radio were innovatively combined to bring a comprehensive health care service to communities living in remote regions of Australia.

Established in 1928, and developed on a national basis in the 1930s, the service was the first comprehensive aerial medical organisation in the world. It remains unique to this day for the range of primary health care and emergency services it provides, and for the huge area of sparse population and climatic extremes over which it operates.

The service was founded by Reverend John Flynn who, whilst working in remote areas of South Australia and following the idea of a young Victorian medical student – Clifford Peel, saw the potential in the developments of flight as a reliable means of transport and radio to address the critical need for emergency care in remote areas of Australia. Early supporters who enabled the development of the aerial medical service, that was to become the RFDS, included: the industrialist HV McKay (manufacturer of the Sunshine Harvester), Hudson Fysh at Qantas, and Dr George Simpson, a young Melbourne doctor who had heard Flynn speak many years before.

Today, the Royal Flying Doctor Service of Australia has grown into one of the most respected organisations in the world. Covering an area equivalent in size to Western Europe, it now operates from 20 bases, 24 hours a day, 365 days a year. It operates as a not-for-profit charitable service providing aero-medical emergency and primary health care services together with communication and education assistance to people who live, work and travel in regional and remote Australia.

The RFDS has extended its activities to operate in areas often just one hour’s drive out of most capital cities in Australia. With the improved condition of roads and facilities in the outback, the Service is also becoming more involved with the ever increasing number of tourists visiting Australia’s remote locations.

Source: www.flyingdoctor.net  Image courtesy of RFDS Central Operations
We are one of the most stable countries in the world, both politically and economically, and we are a trusted nation ethically and financially. Being a small country, population-wise, we have the advantage of being well- and inter-connected, with short communication chains possible.

Finally, we have expertise in key areas of growing significance to the world. These include addressing issues of service delivery associated with operating across long distances and sparse populations. Good examples of this are the expertise we have developed in transport and logistics (Box 12), and health care (Box 11 and Box 16). They also include providing science and technology services for addressing environmental issues, such as water quality and the impacts of climate change.

4.2 Overcoming barriers

Although there is a tremendous opportunity for Australia to grow its domestic and export market in services with a strong foundation in science and technology-driven innovation, there are some barriers to overcome. Many of these barriers are not confined to science and technology services innovation but rather are ubiquitous to services innovation as a whole.

The Working Group's recommendations are targeted at overcoming these barriers so that we can take full advantage of Australia's competitive advantages and opportunities to develop a thriving domestic and export services sector.

4.2.1 Recognising the importance of innovation in services

As illustrated by the Working Group's market survey (Section 1.3), there is a general lack of recognition or acknowledgement of the importance of services to the Australian economy. This is due in large part to the often intangible nature of services and their operation in an economy set up to quantify success through the production of solid outputs.

There is also a persisting and somewhat widespread misconception (not confined to Australia) that services are not innovative. Coupled with this is a poor understanding of how services innovate. As discussed in section 2, services businesses tend to innovate by adopting, rather than creating, new knowledge and technologies. Largely because they are intangible, the adoption processes used by services businesses to innovate are often not recognised and/or not supported.

Furthermore, the role of science and technology in innovation is often not perceived (and therefore not adequately or widely supported) due to its removed or hidden nature. The result of this is that there is often a poor connection between services businesses and the research and development base.

This inadequate recognition has two important consequences:

a. Australian Bureau of Statistics data are not compiled in a way that allows accurate benchmarking of the economic contribution of innovation to Australia’s services sector

While the Working Group was able to identify many examples of the contribution of science and technology-led innovation to the services sector, we were forced to use ‘knowledge-intensive’ services as a surrogate when attempting to quantify their economic impact. This is clearly inadequate as knowledge-intensive services include a major component of professional services, such as law, that are not science and technology intensive. Furthermore, this inadequacy in measurement of the impact of innovation applies to services innovation more broadly.

From discussions with representatives of the Australian Bureau of Statistics (ABS), the Working Group believes that it is feasible to collect data in ways that better reflect the nature and impact of innovation in Australian services, including the role of science and technology in services innovation, and the contribution of this innovation to economic growth. Much of the relevant ABS information is potentially already available, but is not routinely processed to provide the required analyses. Additional value would be created through collaborative work being undertaken by the ABS with other departments (such as the Department of Innovation, Industry, Science and Research), as well as with government agencies (e.g. the Productivity
The Government supports R&D by industry through a number of avenues, including through the R&D Tax Concession and a number of funding programs. AusIndustry, for instance, manages research and development as well as company development programs, whilst AusTrade offers support to companies for export development. Most of these programs do not discriminate between industry sectors, although there are several that target specific sectors, notably Pharmaceutical/Biotechnology (AusIndustry P3 program) and Energy (Low Emissions Technology Demonstration Fund). The latter has not been accessed by the services sector. Surprisingly for a sector that accounts for approximately 80% of Australian employment and GVA, there is no industry support program specifically targeted at the services sector.

Of the programs offered to all industry sectors (see Table 1), those delivered by AusIndustry had a low to moderate uptake by the services sector (13% to 54% of approved allocations), whilst those delivered by AusTrade had a healthy uptake (76% of approved allocations).

b. The services sector has not received sufficient emphasis in government innovation policies

An examination of Australian government policies relating to the national innovation system reveals limited specific reference to the services sector to date. Nevertheless, there is a growing recognition of the need for specific policies in this sector. For example, DITR has released a Background Paper mapping the Australian services sector trends (DITR, 2007a) while Queensland has undertaken a study on opportunities to grow the state’s knowledge-intensive services industries (Smarter Services: Future Jobs and Growth for the Smart State, Working Group of the Smart State Council, 2006).

To determine the extent to which current Federal Government innovation support programs meet the needs of the services sector, the Working Group has analysed the uptake of industry and public sector funding schemes by the services sector (state government programs could not be analysed in the timeframe available). This analysis was hampered by the inadequacies in data collection identified under point (a) above. Nevertheless, the following general conclusions can be made.

Historically, industry innovation programs have been aligned to the needs of the manufacturing and resources sectors. They are out of step with the growth of the services sector and its importance in our economy.

The Working Group therefore, in Recommendation 1 (to follow), advocates the expanded use of enhanced analytical tools, such as the Australian Bureau of Statistics’ Business Longitudinal Database and Confidentialised Unit Record Files, to better analyse and measure industry trend data. Again, this recommendation is applicable to all services innovation, not just that led by science and technology.

Table 1: Approved allocations to the Services Sector, using ANZSIC codes to classify applicants by industry sector*

<table>
<thead>
<tr>
<th>AusIndustry program</th>
<th>$M approved</th>
<th>% of total program allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Ready</td>
<td>$57.3M</td>
<td>36%</td>
</tr>
<tr>
<td>COMET</td>
<td>$5.9M</td>
<td>54%</td>
</tr>
<tr>
<td>Renewable Energy Development Initiative</td>
<td>$3.3M</td>
<td>13%</td>
</tr>
<tr>
<td>Industry Cooperative Innovation Program</td>
<td>$2.8M</td>
<td>44%</td>
</tr>
<tr>
<td>AusTrade</td>
<td>$16.9M</td>
<td>76%</td>
</tr>
</tbody>
</table>

* Data shows the average figures for 2005/06 and 2006/07 for AusIndustry programs, and 2006/07 data for AusTrade. AusTrade data report the export deals of Australian clients in which AusTrade has provided assistance.
On the other hand, a different picture emerged when AusIndustry categorised Commercial Ready applications according to the applicant’s own assessment of the type of project outcome – services, processes or products (Table 2).

According to this analysis, services are included in only 40 (9.7%) of the 412 successful applications over the last three years.

The Working Group supports the intention of the National Innovation System Review to examine the degree to which the Government R&D Tax Concession and development programs, such as those administered by AusIndustry and AusTrade, support innovation. It recommends that this review include an examination of the degree to which these mechanisms and programs satisfy the needs of services innovation, and whether there is a need to redesign/realign these programs.

This brief, preliminary analysis suggest that the services sector is under-represented in government support programs, and particularly in the public sector. The Working Group believes that this arises in large part because the services sector has not received sufficient emphasis in government innovation policies.

The new Federal Government has taken several positive steps to address this issue. This includes the establishment of a Junior Minister with responsibility for the services sector. The Working Group wholeheartedly endorses the creation of this role.

As part of its pre-election campaign, the Australian Labor Party also proposed a 10-point plan to build the culture of innovation in Australia (Appendix F)9.

Table 2: Number and value of successful Commercial Ready grants in each of the three categories – Product, Process, and Service

<table>
<thead>
<tr>
<th>Basis</th>
<th>Number of applications</th>
<th>%</th>
<th>Value ($M)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>46</td>
<td>11.2</td>
<td>67.81</td>
<td>16.0</td>
</tr>
<tr>
<td>Process &amp; service</td>
<td>2</td>
<td>0.5</td>
<td>0.96</td>
<td>0.2</td>
</tr>
<tr>
<td>Product</td>
<td>300</td>
<td>72.8</td>
<td>297.97</td>
<td>70.4</td>
</tr>
<tr>
<td>Product &amp; process</td>
<td>26</td>
<td>6.3</td>
<td>27.39</td>
<td>6.5</td>
</tr>
<tr>
<td>Product &amp; service</td>
<td>13</td>
<td>3.2</td>
<td>10.96</td>
<td>2.6</td>
</tr>
<tr>
<td>Product, process &amp; service</td>
<td>13</td>
<td>3.2</td>
<td>9.56</td>
<td>2.3</td>
</tr>
<tr>
<td>Service</td>
<td>12</td>
<td>2.9</td>
<td>8.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>412</td>
<td>100.0</td>
<td>423.1</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: A Commercial Ready grant can include one or more of the three categories.

The now established review of the National Innovation System will play an extremely important role in evaluating how Australia can more effectively enable and stimulate innovation in order to increase its productivity and competitiveness in a fierce global market.

Given the importance of services to the Australian economy, and its potential future role in our export market, the Working Group, in Recommendation 1, advocates that a key outcome of this review should be the establishment of services innovation as an important priority of Australia’s National Innovation System.

Recognition of the importance of services to the Australian economy could also be improved through the introduction of a system of high-profile state and national awards for services industries innovation.

**Recommendation 1:**

*Establish science and technology-led services innovation as an important priority of Australia’s National Innovation System*

It is recommended that services innovation is raised to that of a major national innovation priority as an outcome of the review of the National Innovation System.

Consistent with this status, the following complementary actions should be undertaken.

a. Expand the measurement, by the Australian Bureau of Statistics, (using tools such as the Business Longitudinal Database), of data regarding services and services innovation in order to more accurately benchmark their current and potential future contribution to the Australian economy.

b. Review, as part of the review of the National Innovation System, the extent to which the current government support programs that underpin innovation address market failures and barriers in the services sector.

c. Raise the profile and hence awareness of the importance of services innovation through a system of high-profile state and national awards for services industries innovation.
4.2.2 Strengthening linkages between services industry and public sector R&D

“...those [services] firms that do manage to engage in good linkages with Universities, as sources of information and/or as collaborators, are more likely to be dynamic and successful innovators.”

~ UK Council for Science and Technology, 2003

Services businesses with good connections to universities (and other publicly funded R&D agencies), both in terms of collaborative activities and as sources of information, have been acknowledged as more likely to be successful innovators (UK Council for Science and Technology, 2003). Indeed, the need for “...increased and more efficient linkages between science and innovation” was a key finding of OECD Ministers at a meeting in 2004 – recognising that such linkages serve to facilitate the uptake by industry of public sector research and ensure that such research is attuned to social and economic problems (OECD, 2004). This has particular resonance for Australia, where it has been argued that the high number of small businesses in comparison to other developed nations, combined with our geographic isolation, raises the importance of collaboration for Australian businesses’ innovations, particularly those that are new to the world (DITR, 2006). This argument is supported by the data, which indicates that there is a strong association between collaboration and innovation novelty achieved by Australian businesses, with increased R&D intensity being linked to a higher likelihood of ‘frontier’ innovation (DITR, 2006).

Australia, like many of our overseas counterparts, does not yet have good connections between services business and our public sector science and technology base. For instance, in contrast to other developed industrialised countries, only 2% of all Australian business that are innovating collaborate with higher education providers, thereby diminishing the potential for Australian companies to access innovation that is new to the sector, country, or the world (ABS, 2007c).

Two avenues have been identified for improving the engagement between service businesses and the science and technology base (Europe INNOVA, 2007):

i. enabling the science and technology base to become more responsive to the innovation needs of service businesses; and,

ii. making service businesses more aware of the science and technology base and to remove barriers to linking the two.

Public sector R&D has been slow to respond to growth in services. Whilst in time this situation will change and R&D activities will begin to reflect the changing needs of the economy, it is also the case that economies that can accelerate this process will create conditions for services innovation. One major reason for this relatively slow response is that the nature and focus of R&D geared to services has been unclear and is still evolving. However, one trend that is clear is that much innovation occurs at the boundaries of disciplines. Often, this interdisciplinary activity involves interaction between domain knowledge of an industry sector and one or more science and technology disciplines. Some examples – particularly relevant in the Australian context – are:

• Financial services linking with mathematical modelling and risk analysis;

• Insurance linking with climate change science;

• Entertainment (film and gaming, for example) linking with ICT;

• Health linking with medical sciences, ICT and social sciences;

• Transportation linking with mathematical modelling, ICT and social sciences;

• Tourism and recreation linking with ICT, social sciences and climate change science;

• Agriculture linking with climate and weather forecasting, as well as automation for precision agriculture, and with ICT.
Much of the growth in new services in Australia’s traditional industries is underpinned by greater and innovative use of ICT and the information thus provided. Australia has the opportunity to capitalize on this global services revolution by increasing the R&D effort at the intersection of its traditional strengths and ICT.

Also, the newly emerging discipline of services science (or services science, management and engineering) – at the intersection of computer science, industrial engineering, mathematical sciences, social sciences, business strategy and law (see section 2.4) – is beginning to play an important role in services innovation. A proxy for current research activity in services science is the number of research projects that combine elements of ICT, industrial engineering and/or mathematical sciences with, for example, elements of social sciences, business and/or law. Analysis of the research disciplines associated with recent ARC grants, for example, revealed that only a small number of projects were indicated by applicants to combine the disciplines of science, management and/or engineering (SME). Initiatives such as the ARC Centres of Excellence and Research Networks (which are not classified by applicants against discipline codes) are more likely than individual projects to span the SME disciplines, as their structures encourage the formation of cross-disciplinary teams and research programs. A significant increase in the level of such R&D activity will begin to address the innovation needs of services businesses.

Although growing, the linkages between our services industry and the public sector R&D base are not very strong. A measure of the degree of linkage between Australian businesses and the science and technology base is the level of higher education R&D funded by industry. In 2002, this was 5.1% of total R&D expenditure - below the OECD average of 6.1%, but higher than 1995 levels of 4.7% (OECD, 2006b). This is in the context of an overall increasing expenditure by Australian businesses on R&D (BERD), rising to 1.04% of GDP in 2005-06 ($10.1 billion), below the OECD average of 1.53% GDP. Manufacturing and mining accounted for 55% of the Australian BERD (ABS, 2007b). Putting this in terms of collaboration by innovating firms, of the 25% of innovating businesses engaged in collaboration, only 2% were engaged in collaboration with higher education facilities, and only 3% with government organisations (ABS, 2007c). It should be noted, however, that much of this data relates to R&D in manufacturing. However, evidence from Europe has been used to conclude that although the intensity of R&D activities undertaken by service businesses has increased in recent years, their connections with the science and research base remains poor (Europe INNOVA, 2007). The challenge remains, therefore, to increase this connection and enhance the innovation and competitiveness of Australian businesses.

Much of services innovation can be incremental in nature. It often begins with a consultancy project with a university or a public research organisation. For example, a project undertaken by graduate students at Drexel Institute of Technology in the USA, in response to an inquiry made by a local food chain store owner about automated product check outs, led to the development of the barcode, which has revolutionised the retail and other services industries. Such projects also play an important role in exposing businesses to the science and technology base. It is to be hoped that the Federal Government’s proposed Enterprise Connect Program will provide a better framework for connecting companies, including services companies, with the R&D sector. The environment in Australia, however, is not entirely conducive to such linkages as there are not enough incentives for the best researchers at Australian universities to engage in more applied, consultancy-type projects. One reason for this is that – as in many other countries – consultancy does not rate as highly as research in the academic reward and recognition system.

Another reason – that is particular to Australia – is that universities receive block grant funding from the Federal Government for research income generation but not for consultancy-type activity. This creates a natural tendency for universities to favour large, longer-
term research projects over incremental, shorter-term consultancy-type projects. This in turn is inhibiting a potentially important avenue for linking industry with our science and technology base. The UK’s Third Stream Funding (http://www.hefce.ac.uk/reachout/) for universities is a mechanism to provide incentives for connections and knowledge transfer between universities and the community, including consultancies with industry. Funding through this program is delivered as block grants directly to universities. There should be consideration in establishing a comparable program in Australia, either directly through the Department of Education, Employment and Workplace Relations, or possibly through industry and the Department of Innovation, Industry, Science and Research as a feature of the proposed Enterprise Connect program.

The Working Group makes the following recommendation with the aim of encouraging our science and technology base to be more relevant for our service industries and to remove disincentives for engagement between businesses and universities.

**Recommendation 2:**

**Strengthening the connections between services business and our science and technology base**

It is recommended that the connections between Australian services businesses and our science and technology base be strengthened. This should be achieved in three ways:

a. Realigning priorities and increasing the level of research funding (through ARC, CRCs, NHMRC, CSIRO, and other Government programs) for collaborative research between service enterprises and science and technology research organisations that:

   i. addresses problems unique to Australia and whose solution will have global opportunities; and/or

   ii. is at the intersection of ICT, broadly defined, and service activities in which Australia has a competitive advantage (such as mining, agriculture, environmental services, finance, health and tourism);

   iii. stimulates more intensive engagement with service industries, small and large;

   Research programs and agencies should be proactive in identifying opportunities with companies and consortia.

b. Supporting the establishment of services science research programs. For example, the ARC could give consideration to seeding services science research activity via the establishment of research networks, Centres of Excellence, pilot projects and via promotion of the ARC *Linkage Projects* to relevant industry partners.

c. Ensuring that the proposed Enterprise Connect program includes mechanisms to enhance consultancy-type activity between public sector R&D institutions and services industry. Additionally, provide an incentive mechanism for increasing the level of applied, shorter term consultancy-type projects between universities and services industry.
4.2.3 Addressing the skills shortage

Human capital is essential to services industries, because physical capital cannot be substituted for human input to the degree typically possible in manufacturing and resource-based industries. This characteristic of services industries means that as revenues increase, the availability of more appropriately skilled employees becomes crucial.

There is a shortage of people in Australia with the appropriate skills to meet the growing needs of the services sector, in particular the demands placed on the sector by rapidly emerging and changing technologies (DEST, 2006a). Specifically, there is a need for people with cross-cutting skills that encompass ICT, social sciences, business management, and relevant, specific industry domain knowledge (e.g. finance, mining, transport, engineering etc.). This is further complicated by the inability of many facets of Australia’s services sector to attract innovative people. This is particularly true for our small to medium enterprises (SMEs), which often have trouble competing with larger businesses for talent in our small skills pool. The Working Group of the Smart State Council (2006) found that skills availability was the chief issue constraining future growth for most knowledge-intensive services firms.

The growing importance of services and increasing global competition for skills implies that the solution to this problem should be a major priority.

A key aspect of this barrier is a lack of appropriately geared educational programs to provide multi-skilled services graduates. While some educational facilities have begun to address this challenge, there is a need for action to accelerate this process at each level of the education sector – vocational and university (undergraduate, postgraduate coursework and research training). Both university education and vocational training play an important role not only in skills development, but also as major contributors to the innovation cycle. Current and potential actions under each of these are summarised below.

**Vocational Training**

The Vocational Education and Training (VET) system is a very important avenue for providing skills for Australian services businesses. It is vital that this system address the changing needs of the services sector through the development of training programs aimed at interdisciplinary focus on services industries in collaboration with employers. Indeed, a report by DEST (2006a) noted the need for the VET system to establish cross-disciplinary training that encompasses as core elements ICT and business management and marketing. The establishment of Services Sciences courses in VET institutions, including TAFE colleges, would be one very effective way of achieving this.

The Working Group, noting the commitment by the Australian Government to strengthen the Industry Skills Councils (ISCs) through the Skilling Australia for the Future policy, recommends that Service Skills Australia and Innovation and Business Skills Australia could play important roles in encouraging and supporting the establishment of cross-disciplinary VET courses that meet the innovation needs of services industries. This could include recognising, in their skill set development for services industries, the need for cross-disciplinary training that includes ICT, business management and marketing as core elements. It could also encompass supporting engagement of the service industries with CRCs and other R&D organisations.

**University Education**

*Undergraduate Programs*

A number of universities are developing interdisciplinary courses in services science (Appendix E) – often with significant input from industry. Many of these courses involve industry projects or placements as part of the curriculum. While there is a need to promote these courses to prospective students, it is equally important to provide incentives to universities to develop more such programs. One way of achieving this could be via allocating Commonwealth...
supported HECS-HELP places for services science programs. These could be new places or universities could be allowed to reallocate some of their IT places where demand from domestic students has been low in recent times. It is also important that services science (or SSME\textsuperscript{10}) related programs are appropriately resourced. While services science programs will have business and social science components, these will be in the context of technology, and it is appropriate that these programs be treated in the same funding cluster as information technology.

**Postgraduate Coursework Programs**

Postgraduate coursework programs in services science/SSME would be ideally suited to developing high quality skills in a relatively short period of time. These programs would enable graduates and professionals who have expertise in at least one of the component disciplines of services science to upgrade their skills by acquiring breadth and training in the interdisciplinary interplay across disciplines. There is a need to ensure that services science/SSME postgraduate coursework programs are developed in consultation with industry needs. There may also be some need for addressing issues of financial disincentives for services employees to participate in such education programs, and the consequent reluctance of universities to develop suitable courses. This could be partially addressed by making all postgraduate coursework programs in services science eligible for Student Income Support Payments. Another approach could involve encouraging employers to contribute to the tuition fee or to the payment of the loan that a student takes out from the Commonwealth’s FEE-HELP scheme. In many cases, such contributions attract fringe benefits tax, thereby creating a disincentive for employers to assist in the skills upgrade of their employees.

**Research Training**

Growth and importance of services industries to Australia’s economy will also be determined by the ready availability of highly skilled researchers and educators in services science/SSME (see 4.2.2 and Recommendation 2). The current pipeline of students undertaking Higher Degree Research training in services science/SSME is likely to be seriously inadequate for the demand for such professionals. It is also the case that research training in services science/SSME will be more effective if it is done in the context of a problem motivated by industry. This can be achieved if the Australian Research Council were to allocate a number of Linkage Projects Australian Postgraduate Awards (Industry) for services science/SSME annually.

**Accessing international skills and knowledge bases**

Finally, the Australian Government can help ensure that Australia’s education and training system for services skills is world class by using its government-to-government linkages to identify and promote the uptake of world’s best practice in services education and training, as well as facilitate a greater recognition of Australian qualifications internationally. This will assist in attracting the best and brightest to study with Australian providers, in turn promoting services innovation through business, research and study linkages. It will also encourage greater recognition and adoption of the Australian VET system to assist greater intake of skilled migrants to assist in science and technology services innovation.

The Government can also contribute to Australia’s skills development by ensuring that education, employment and migration policies are consistent and mutually reinforce each other. Furthermore, the Australian Government can encourage inwards and outwards student mobility (and formation of the resultant networks) by providing scholarships. For example, in 2007, as part of the Endeavour Scholarships program the Australian Government announced scholarships aimed at bringing India’s brightest to Australia to study. This will be particularly important in ensuring Australian researchers and technical staff remain informed of the most up to date information and methods.

\textsuperscript{10} Services science, management and engineering – see section 2.4
Recommendation 3:
Addressing the growing skills shortage in Australian services industries

a. Provide incentives for vocational training to meet the multi-skill requirements of services industries by delivering cross-disciplinary training that encompasses as core elements, ICT, industrial engineering, mathematical sciences, design, business management and marketing;

b. Enhance the ability of graduates to meet the multi-skill requirements of services industries by encouraging the establishment of cross-disciplinary university courses (such as services science/SSME) that encompass as core elements, ICT, industrial engineering, mathematical sciences, design, business management and marketing. This could be achieved by allocating new, Commonwealth supported HECS-HELP places for undergraduate programs in services science/SSME or by allowing universities to substitute HECS-HELP places in disciplines with declining demand.

c. Provide incentives and the education framework to enable services industry employees to regularly update or expand their skills. These could include making vocational education and postgraduate coursework programs in services science/SSME eligible for Student Income Support Payments, as well as developing taxation incentives for employers to contribute to HECS-HELP loan payments for services science/SSME postgraduate programs for their employees.

d. The ARC to fund a number of additional Australian Postgraduate Awards (Industry) under the Linkage Projects in the field of services science/SSME.
4.2.4 Stimulate services innovation through government policy and development of services infrastructure

In addition to the policy measures outlined in the previous sections and accompanying recommendations, there is considerable scope for Government to stimulate services innovation through ‘raising the bar’ as both a customer for, and provider of, services. The latter includes the establishment of national technology infrastructure to support growth and innovation in services.

In the commercial world, a driver for growth in services innovation is the competition amongst service providers to address consumer demand for better services. This is often in the form of services that are new, fast or more secure. However, in domains such as health, education, environment, communication and security, Government plays a significant role in delivery of services. Often, Government is directly involved in delivering these services or it works with the private sector to ensure the delivery of services. The competitive drivers that exist in the commercial world to continuously innovate to deliver improved services are often not as prominent in these domains. However, if the Government were to mandate an improved service delivery target for each of these domains, a market condition for innovation would be created. These targets (and corresponding, follow-up scorecards) – which would be specific to a domain – would have to eventually be set above global best practice benchmarks for real innovation to occur. While environmental services companies in Australia are innovative, they have not found it easy to compete with European companies that have been driven to innovate because of more stringent environmental benchmarks (Working Group of the Smart State Council, 2006). It can also be argued that California’s Clean Cars Law has been instrumental in making it a global hub for research and innovation in hybrid and plug-in technology.

Thus, the Australian Government is one of the main customers and providers of Australian services, with an expenditure of over $235 billion in 2006-07. Significant components of this expenditure are on social security and welfare ($96.5 billion in 2006-07) and health ($43 billion in 2006-07; DITR, 2007b). Because of our large geography and sparse settlement patterns, there are often issues in relation to the delivery of these services, particularly in remote and regional locations. This is particularly true for health and education. Science and technology-led services innovation has the potential to provide significant pathways for addressing some of these issues. The combination of ICT and health services to deliver high quality care to regional communities (see Box 13) is one good example. Another is the use of ICT to improve the accessibility, speed and delivery of Government services through on-line access.

There are thus at least four ways in which Government can in itself utilise science and technology-led innovation in services, and thus in turn stimulate such innovation. Firstly, it can ensure that its policy framework is designed to stimulate science and technology-led services innovation. This pertains not only to its support programs, such as those discussed in sections 4.2.1 and 4.2.2, but also to areas of policy such as tax incentives and procurement. The latter relates to the second way that Government can stimulate services innovation, that is as an intelligent customer of services. Towards this, it is important that Government procurement be used intelligently to stimulate, rather than prop-up industry. One clear way to achieve this is to gear procurement requirements towards building national capability and optimising opportunities. The standards set through procurement should be high by international standards, even benchmark.
Thirdly, there is significant opportunity for Government to utilise science and technology-led services innovation to address national challenges in services provision, such as in health and education.

Finally, by investing in and developing the appropriate policy frameworks for national services infrastructure, the Government can facilitate accelerated science and technology-led services innovation. This is discussed in the following section.

Development of services infrastructure

Much of services growth is underpinned by ICT infrastructure enabling faster and cost-effective delivery of services. Availability of a nationwide broadband network that is cost competitive is the first significant step towards removing a bottleneck in growth of services. The Federal Government is to be commended for making installation of a nationwide broadband network a priority. However, there is a need to go beyond a broadband network – to link it with other technologies – if Australia is to address the service delivery needs of its sparsely distributed population and if it is to provide an infrastructure for service innovation in its traditionally strong sectors like resources and primary industries that often have a dispersed asset base.

Australia’s geography presents a unique set of challenges for services involving surveillance of a vast coastline, monitoring of land and environmental resources, management and protection of assets and providing logistics support in a number of industries with complex supply chains. While overcoming the challenges of the “tyranny of sparseness” can be burdensome, their solutions can lead to innovations on which new services can be developed. Many of these innovations and services can be exported to other regions with similar geographic characteristics.

A number of technologies can contribute to overcoming the tyranny of sparseness:

- Satellite imaging and remote sensing
- New generation global positioning systems (e.g., GNSS)
- Unmanned platforms (e.g. aerial vehicles)
- Sensor networks
- E-Research and Innovation Technologies

These technologies have evolved to a varying degree in the Australian context. However, most problems of surveillance, asset protection, land and environmental monitoring in sparse regions require these technologies to work together. There has been little attempt to address the challenges that need to be overcome to build a systemic infrastructure that acts as a “glue” enabling these technologies to interact with each other. The need for interaction of the various technologies is best illustrated via an example of monitoring an unusual event somewhere in remote and regional Australia. A satellite image can detect the unusual event and handover to an unmanned aerial vehicle for closer monitoring. The unmanned aerial vehicle employs an advanced global positioning system to fly closer to the event. It may be in a position to collect data about the event or may drop an ad hoc sensor network that could collect data to be picked up at routine intervals by the unmanned aerial vehicle. Modelling and data analysis tools available on an Innovation Technologies platform would then be used to predict the likely effects of the event and the most appropriate response.

Such an integrated platform linked to a nationwide broadband and telecommunications network could provide a cost-effective and on-demand instrumentation of a vast and sparsely populated
land mass for data collection, monitoring and response. Availability of such an infrastructure – that is affordable – could lead to new services (as well as enhance existing services, such as weather and bushfire monitoring services provided by the Bureau of Meteorology) in a number of sectors for sparse regions, including primary industries, natural resources, environmental management, transportation, health service delivery, energy, asset management, critical infrastructure protection and emergency services.

It is unlikely that any one of these sectors could build such an infrastructure platform on its own. However, if such a platform were available, the possibilities for new services are many. As affordable access to broadband has led to growth and innovation in commerce, affordable access to such an integrated platform could lead to unprecedented services innovation in a number of industries in which Australia has traditionally been strong.

**Recommendation 4:**

Stimulate services innovation through Government ‘raising the bar’ as both a customer for, and provider of, services and through the establishment of national support infrastructure

This can be achieved through:

a. Appropriately amending industry policies, removing infrastructure bottlenecks for services growth, and creating a market pull for services innovation. This should include:

   i. Ensuring that Government procurement requirements and services standards are geared towards building national capability and optimising opportunities in the services sector.

   ii. Government playing a leading role in service provision, and as a customer, through the internationally benchmarked identification and quantification of performance indicators for service delivery in domains with significant Government involvement. This should include the setting of appropriate and time-bound enhancement targets.

b. Developing a program to establish the supporting infrastructure required to carry Australia’s services innovation forward into the 21st Century. Specifically, in parallel with the establishment of a nationwide broadband network, the Government should develop a plan for integrating such a network to technologies such as satellite imaging, positioning systems, unmanned aerial vehicles, sensor networks and relevant modelling tools. This plan should include a strategy to create market conditions for such an integration to take place.
It is 2028, and Australia has spent the last twenty years focussed on building a strong and vibrant services economy.

**Services and economic growth**

Knowing that the demand from emerging economies such as China and India for Australia’s raw materials will eventually weaken, and competition from commodity industries will increase, Australia has embraced the services economy.

Australia has leveraged its highly educated population, innovative institutions, open economy and links with Asia to become a regional services powerhouse. This wasn’t easy, as it meant that the country had to come to grips with its changing reliance on primary and secondary industries. However, Australia tapped into the core strengths of its economy to build service offerings around traditional businesses as well as develop new services in niche areas where we have competitive advantage.

Australia’s finance and insurance sectors, equal in size to those in Singapore and Hong Kong, created strong links with research and development institutions to ensure that they took full advantage of eCommerce, trusted information networks and advanced data mining of information about their customers. Australian finance is world-renowned for taking a systems approach to investment, while giving advanced personalised service to clients. Australia is regarded as the world’s leading manager of superannuation and pension funds.

The Australian manufacturing industry has teamed with researchers and the Australian ICT industry to invent new ways of combining services and products together. Many manufacturing companies now identify themselves as services companies, outsourcing the low-value commodity businesses to focus on service delivery. Similarly, our mining industry has continued to focus on selling mining services overseas, using innovative business models to ensure that it captures value from mining operations around the world. Australian mining companies now provide turn-key operations for mining companies in emerging markets where mining and resources experience and skills are scarce.

Australia has also used its experience in agricultural production and addressing environmental issues of global significance (such as the impacts of climate change) to become a world leader in environmental services. Through a concerted R&D program strongly linked with industry, Australia is now the regional centre for all greenhouse and environmental futures trading. It delivers water management technologies and services all around the globe, and is the centre for environmental monitoring and prediction. Australian financial institutions have a global reputation for the most innovative offerings in carbon, water and biodiversity markets.

Acknowledging that it only produced 2% of the world’s intellectual property, and that gaining access to the other 98% was critical to wellbeing, Australia has embraced open source platform development. Many Australian platforms have become standard across the world, which gives Australia a unique edge as key developer and custodian in the delivery of commercial services on top of these platforms.

**Services and the community**

The community has also benefitted greatly through the increased efficiency as a result of this focus on the services economy.

The delivery of on-line government services has dramatically increased the efficiency of the delivery of these services. Government services are now tailored to a citizen’s specific needs, and accessed through central information portals. Interactions between government departments have also increased dramatically, thanks to technology platforms which allow common service delivery.

Health services in particular have been revolutionised though national health technology platforms, allowing customised strategies on prevention to be developed and ensuring efficient service delivery. Citizens now have more and improved access to information about their own health care, stored in private, secure and distributed locations. Australia invested heavily not only into new e-health technologies, but also into the health delivery system as a whole, and Australian health services are some of the most efficient in the world.
This is reflected in reduced waiting lists, lower health insurance costs and better utilisation of Australia's existing hospital infrastructure.

The Australian Government also provided strong incentives for business to embrace eCommerce, through innovative procurement strategies. As the largest procurer in Australia, preference was given to providers who could integrate their services with national technology platforms. These became a critical piece of national infrastructure and were eventually adopted by business to dramatically reduce their operating and transaction costs.

Increasing efficiency in production through services has also resulted in massive resource efficiency. Traditionally, economic growth was coupled with increased waste and emissions – during the 90s and noughties, emissions of carbon dioxide were closely correlated to changes in economic activity. In embracing the services economy, it was recognised that services provide key opportunities to decouple economic growth from resource utilisation, improving the natural environment and reducing the inefficiencies of large waste streams.

Challenges

This focus on the services economy did not come without its challenges, however.

With so much information available about individuals, privacy has become a real concern. This is being managed however, and a new industry around privacy has emerged, exporting privacy services overseas.

An employee in the services economy also requires a range of different skills to one working in mining, manufacture or agriculture. A national services skills program was successful at building the skills of these workers for this new economy at all levels from school to tertiary education. Degrees and vocational training in Services Science, Management and Engineering are now highly sought after, and Masters in Services Administration are now more popular than MBAs.

At the same time Australia was growing its services economy, other OECD countries (from the United States to Scandinavia), were also investing significantly in this domain. However, by focussing on its traditional strengths, on growing niche opportunities where it had competitive advantage, and by ensuring that its services sector was closely coupled to its research and development institutions, Australia was able to raise its standing in the global services market and maintain its competitive edge.

In conclusion

In 2028 the world will have experienced a dramatic shift. Capital, knowledge and labour will flow easily across any physical barrier and the services economy will have an even greater impact on our economy and wellbeing. Australia must choose if it wants to be an active participant and leader in the development of this economy. Of critical importance is how Australia aligns its National Innovation System to best connect services and innovation together.
6: References

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7: Glossary

ABS
Australian Bureau of Statistics. Provides statistical data on the Australian population, economy, environment, industry and research.

ALP
Australian Labor Party. The Leader of the ALP, Kevin Rudd, was sworn in as the 26th Prime Minister of Australia on 3 December 2007.

ARC
Australian Research Council. A statutory authority within the Australian Government’s Innovation, Industry, Science and Research portfolio. The ARC advises the Government on research matters and manages the National Competitive Grants Program, a significant component of Australia’s investment in research and development.

AusIndustry
AusIndustry is the Australian Government’s agency for delivering products, services and information that support innovation, industry, science and research.

AusTrade
The Australian Trade Commission. The Australian Government agency that helps and assists Australian companies to export.

COMET
Commercialising Emerging Technologies Program. COMET is a competitive, merit based program provided by AusIndustry. It supports early-growth stage and spin off companies to successfully commercialise their innovations. More information can be found at: www.ausindustry.gov.au/

CRCs
Cooperative Research Centres. An Australian Government funded initiative to boost world-class research with the aim of turning Australia’s scientific innovations into successful new products, services and technologies, making industries more efficient, productive and competitive.

CSIRO
Commonwealth Scientific and Industrial Research Organisation. Australia’s national science agency and one of the world’s largest and most diverse research agencies.

DCITA
The former Commonwealth Department of Communications, Information Technology and the Arts.

DEST
The former Commonwealth Department of Education, Science and Training.

DITR
The former Commonwealth Department of Innovation, Tourism and Industry.

GPS
Global Positioning Systems.

GVA
Gross value added. A standard measure used in national accounts. It is, in simple terms, revenue less non-labour costs of inputs.

HECS-HELP
HECS-HELP is a loan available to eligible students enrolled in Commonwealth supported higher education institutions.

HSC
Higher School Certificate.

ICT
Information and Communications Technology.
Industry value added
IVA represents the value added by an industry to the intermediate inputs used by the industry. IVA is the measure of the contribution by businesses, in the selected industry, to gross domestic product.

Innovation
As defined by the Oslo Manual (OECD and EuroStat, 2005), “An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations”.

IVA
Industry value added.

KIS
Knowledge-intensive services. In general, knowledge-intensive services encompass two types of activity – professional services, such as finance and legal services, and those services with a strong link to/or utilisation of science and technology, such as mining, health and ecosystem services. They are regarded as those that use more R&D, more technology and more highly skilled workers in comparison to other service industries (Working Group of the Smart State Council, 2006).

MBA
Master of Business Administration.

NHMRC
National Health and Medical Research Council. Australia’s peak body for supporting health and medical research; for developing health advice for the Australian community, health professionals and governments; and for providing advice on ethical behaviour in health care and in the conduct of health and medical research.

OECD
Organisation for Economic Co-operation and Development. Established in 1961, the OECD brings together the governments of 30 countries from around the world committed to democracy and the market economy to:

• Support sustainable economic growth
• Boost employment
• Raise living standards
• Maintain financial stability
• Assist other countries’ economic development
• Contribute to growth in world trade

The OECD also shares expertise and exchanges views with more than 100 other countries and economies.

PMSEIC
Prime Minister’s Science, Engineering and Innovation Council. Formed in 1997 by the then Prime Minister, the Hon John Howard MP, the Council is the Australian Government’s principal source of independent advice on issues in science, engineering and innovation and relevant aspects of education and training.

R&D
Research and development.

SARS
Severe acute respiratory syndrome. A viral respiratory illness caused by a coronavirus. SARS was first reported in Asia in February 2003. Over the next few months, the illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the SARS global outbreak of 2003 was contained.
Services
There are many definitions of services. In simple, layman’s terms services can be described as “…a provider/client interaction that creates and captures value” (IBM, 2007) and/or activities that “…deliver help, utility or care, an experience, information or other intellectual content. The majority of the value of that activity is intangible rather than residing in any physical product” (Australian Services Roundtable, 2006). Following is the official United Nations definition of services, which is recognised by the Australian Government and internationally (including the OECD, the European Commission, the International Monetary Fund, and the World Trade Organization).

Services are not separate entities over which ownership rights can be established. They cannot be traded separately from their production. Services are heterogeneous outputs produced to order and typically consist of changes in the condition of the consuming units realised by the activities of the producers at the demand of the customers. By the time their production is completed they must have been provided to the consumers (United Nations, 2002).

Services industry
The majority of statistical analyses on service trends and service innovation refer to service industries (see Appendix D for service industries recognised by the Australian Bureau of Statistics). In doing so, there is recognition that these do not incorporate the full range of service activities in economies, but rather the industries sectors where the main (>50%) focus of activity is on services. Services industries cover a wide range of business types – from the corner shop through to highly ‘knowledge-intensive’ services such as global communication networks.

Services science
Sometimes referred to as Services Science, Management, and Engineering (SSME – see separate entry). Services science can be defined as the interdisciplinary study of systems that use technology and shared information processes to help people and organizations interact to create value, meeting human and organizational needs more efficiently, effectively, and in a sustainable manner. The key concept of Services Science is to integrate the disciplinary knowledge and approaches of computer science, engineering and design, business strategy, mathematical sciences, social science and law, in order to enhance services innovation in a way that could not be achieved through these disciplines working in isolation (University of Cambridge Institute for Manufacturing and IBM, 2007).

SSME
Services Science, Management and Engineering. A growing multi-disciplinary research and academic effort that integrates aspects of established fields like computer science, engineering and design, business strategy, mathematical sciences, social and management sciences, business strategy, social and cognitive sciences, and legal sciences.

S&T
Science and Technology.
8: Appendices

Appendix A: List of key publications

- **UK (2003, 2006)** –
- **EU (2007)** – Fostering innovation in services.
- **OECD (2005, 2006)** –
  - *Enhancing the Performance of the Services Sector*, 2005.
- **Australia (2004 -2007)** –
- **DITR – contributions to OECD KISA study plus…**
- **DCITA – various papers, including…**
Appendix B: Experts consulted

- Mr Mehrdad Baghai, Managing Director, Alchemy Growth Partners
- Dr Michael Barber, Group Executive, Information Manufacturing and Minerals Group, CSIRO
- Mr Thomas Barlow, Thomas Barlow Advisory Services
- Dr Mark Dodgson, Director, Technology and Innovation Management Centre, University of Queensland Business School
- Ms Jane Drake-Brockman, Executive Director, Australian Services Roundtable
- Dr Jay Hannon, IBM University Relations & Development Manager, Australia/New Zealand
- Dr Robert Morris, Vice President, IBM Research and global head of Services Science research
- Ms Kate Morrison, Director, Volterra Pacific
- Mr Glynn Pritchard, Australian Bureau of Statistics
- Mr Ben Shields, Partner, Strategy & Operations, Deloitte Touche Tohmatsu
- Dr Jim Spohrer, Director of Services Research, IBM Almaden Research Center, San Jose, CA.
- Dr Darrell Williamson, Former CEO Smart Internet Technology CRC
### Appendix C: Global trends in employment in the services sector

#### Table 3: Employment in the top ten nations by labour force*

<table>
<thead>
<tr>
<th>Nation</th>
<th>% World labour</th>
<th>% Agriculture</th>
<th>% Goods</th>
<th>% Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>21.0</td>
<td>50</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>India</td>
<td>17.0</td>
<td>60</td>
<td>17</td>
<td>23</td>
</tr>
<tr>
<td>USA</td>
<td>4.8</td>
<td>3</td>
<td>27</td>
<td>70</td>
</tr>
<tr>
<td>Indonesia</td>
<td>3.9</td>
<td>45</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>Brazil</td>
<td>3.0</td>
<td>23</td>
<td>24</td>
<td>53</td>
</tr>
<tr>
<td>Russia</td>
<td>2.5</td>
<td>12</td>
<td>23</td>
<td>65</td>
</tr>
<tr>
<td>Japan</td>
<td>2.4</td>
<td>5</td>
<td>25</td>
<td>70</td>
</tr>
<tr>
<td>Nigeria</td>
<td>2.2</td>
<td>70</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2.2</td>
<td>63</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Germany</td>
<td>1.4</td>
<td>3</td>
<td>33</td>
<td>64</td>
</tr>
<tr>
<td>Australia*</td>
<td>0.4</td>
<td>4</td>
<td>21</td>
<td>75</td>
</tr>
</tbody>
</table>

Source: CIA, 2007

* The database, from which these statistics were derived, does not include construction, electricity, and gas as services

* Included for comparison
Appendix D: Service industries recognised by the Australian Bureau of Statistics

The following table provides basic statistics on those industries recognised by the Australian Bureau of Statistics as being service industries. Statistics for manufacturing, mining and agriculture, forestry and fishing are included for comparison. It should be noted, that the OECD does not include construction and gas and electricity in their definition of services.

Table 4: Summary for 2005-06 – Industry gross value added

<table>
<thead>
<tr>
<th>Code</th>
<th>Sector</th>
<th>Chain volume 2005-06 ($m)</th>
<th>% GDP</th>
<th>Labour force ('000)</th>
<th>% Labour force</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Agriculture, forestry and fishing</td>
<td>26,854</td>
<td>3%</td>
<td>497.7</td>
<td>6%</td>
</tr>
<tr>
<td>B</td>
<td>Mining</td>
<td>46,335</td>
<td>6%</td>
<td>112.6</td>
<td>1%</td>
</tr>
<tr>
<td>C</td>
<td>Manufacturing</td>
<td>104,174</td>
<td>14%</td>
<td>1070.4</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>Services total</td>
<td>590,942</td>
<td>78%</td>
<td>6705.7</td>
<td>85%</td>
</tr>
<tr>
<td>D</td>
<td>Electricity, gas and water supply</td>
<td>19,862</td>
<td>3%</td>
<td>67.2</td>
<td>1%</td>
</tr>
<tr>
<td>E</td>
<td>Construction</td>
<td>61,961</td>
<td>8%</td>
<td>722.8</td>
<td>9%</td>
</tr>
<tr>
<td>F</td>
<td>Wholesale trade</td>
<td>43,238</td>
<td>6%</td>
<td>480.9</td>
<td>6%</td>
</tr>
<tr>
<td>G</td>
<td>Retail trade</td>
<td>52,520</td>
<td>7%</td>
<td>1378.1</td>
<td>16%</td>
</tr>
<tr>
<td>H</td>
<td>Accommodation, cafes and restaurants</td>
<td>19,855</td>
<td>3%</td>
<td>460.4</td>
<td>5%</td>
</tr>
<tr>
<td>I</td>
<td>Transport and storage</td>
<td>41,214</td>
<td>5%</td>
<td>436.1</td>
<td>5%</td>
</tr>
<tr>
<td>J</td>
<td>Communication services</td>
<td>25,196</td>
<td>3%</td>
<td>138.9</td>
<td>2%</td>
</tr>
<tr>
<td>K</td>
<td>Finance and insurance</td>
<td>64,515</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>L</td>
<td>Property and business services</td>
<td>104,608</td>
<td>14%</td>
<td>1524.5</td>
<td>18%</td>
</tr>
<tr>
<td>M</td>
<td>Government administration and defence</td>
<td>35,145</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>N</td>
<td>Education</td>
<td>39,175</td>
<td>5%</td>
<td>259.7</td>
<td>3%</td>
</tr>
<tr>
<td>O</td>
<td>Health and community services</td>
<td>55,588</td>
<td>7%</td>
<td>751.5</td>
<td>9%</td>
</tr>
<tr>
<td>P</td>
<td>Cultural and recreational services</td>
<td>11,591</td>
<td>2%</td>
<td>208.8</td>
<td>2%</td>
</tr>
<tr>
<td>Q</td>
<td>Personal and other services</td>
<td>16,474</td>
<td>2%</td>
<td>276.8</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>768,305</td>
<td></td>
<td>8386.4</td>
<td></td>
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</table>

Source: ABS statistics (Australian Industry 2005-06, Cat. 8155.0)
### Appendix E: Australian university courses addressing services and innovation

#### Table 5: Australian university courses in services

<table>
<thead>
<tr>
<th>University</th>
<th>Course</th>
<th>Course type*</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian National University</td>
<td>Innovation in Services BUSI8240</td>
<td>P</td>
<td><a href="http://info.anu.edu.au/StudyAt/_NGSM/Postgraduate/Courses_/BUSI8240.asp">http://info.anu.edu.au/StudyAt/_NGSM/Postgraduate/Courses_/BUSI8240.asp</a></td>
</tr>
<tr>
<td>Flinders University</td>
<td>Bachelor of Innovation and Enterprise (Science and Technology)</td>
<td>U/P</td>
<td><a href="http://www.scieng.flinders.edu.au/courses/ugrad/innovation.html">http://www.scieng.flinders.edu.au/courses/ugrad/innovation.html</a></td>
</tr>
<tr>
<td></td>
<td>• Master of Management - Innovation and Change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queensland University of Technology</td>
<td>Bachelor of Biotechnology Innovation</td>
<td>U</td>
<td><a href="http://www.courses.qut.edu.au/cgi-bin/WebObjects/Courses.woa/wa/selectMajorFromMain?courseID=4191">http://www.courses.qut.edu.au/cgi-bin/WebObjects/Courses.woa/wa/selectMajorFromMain?courseID=4191</a></td>
</tr>
<tr>
<td>Swinburne University</td>
<td>Swinburne Master of Entrepreneurship and Innovation (MEI) (including Graduate Certificate of Entrepreneurship and Innovation and Graduate Diploma of Entrepreneurship and Innovation)</td>
<td>P</td>
<td><a href="http://www.swin.edu.au/agse/courses/mei/meiprogram.htm">http://www.swin.edu.au/agse/courses/mei/meiprogram.htm</a></td>
</tr>
<tr>
<td>University of Adelaide</td>
<td>Education Centre for Education and Commercialisation (includes a branch in Sydney - formerly the Australian Graduate School of Engineering Innovation)</td>
<td>Mostly P</td>
<td><a href="http://www.ecic.adelaide.edu.au/">http://www.ecic.adelaide.edu.au/</a></td>
</tr>
<tr>
<td>University of Melbourne</td>
<td>CRC Leadership and Innovation Course: Run annually for 10 years through UMelb</td>
<td>P</td>
<td><a href="http://www.mdhs.unimelb.edu.au/research/R-D/courses.html">http://www.mdhs.unimelb.edu.au/research/R-D/courses.html</a></td>
</tr>
</tbody>
</table>

* Undergraduate (U) or Postgraduate (P)
...continued

<table>
<thead>
<tr>
<th>University</th>
<th>Course</th>
<th>Course type</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Melbourne – Melbourne Business School</td>
<td>• Master of Management (Innovation)</td>
<td>P</td>
<td><a href="http://www.mbs.edu/go/degree-programs/innovation-programs/certificate-in-innovation-management">http://www.mbs.edu/go/degree-programs/innovation-programs/certificate-in-innovation-management</a></td>
</tr>
<tr>
<td></td>
<td>• Postgraduate Diploma in Management</td>
<td></td>
<td><a href="http://www.mbs.edu/go/degree-programs/innovation-programs/postgraduate-diploma-innovation-management">http://www.mbs.edu/go/degree-programs/innovation-programs/postgraduate-diploma-innovation-management</a></td>
</tr>
<tr>
<td></td>
<td>(Innovation)</td>
<td></td>
<td><a href="http://www.mbs.edu/go/degree-programs/innovation-programs/master-of-innovation-management">http://www.mbs.edu/go/degree-programs/innovation-programs/master-of-innovation-management</a></td>
</tr>
<tr>
<td></td>
<td>• Postgraduate Certificate in Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Innovation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Queensland</td>
<td>• Master of Technology and Innovation Management</td>
<td>P</td>
<td><a href="http://www.uq.edu.au/study/program.html?acad_prog=5355">http://www.uq.edu.au/study/program.html?acad_prog=5355</a></td>
</tr>
<tr>
<td></td>
<td>• Graduate Diploma in Technology and Innovation Management</td>
<td></td>
<td><a href="http://www.uq.edu.au/study/program.html?acad_prog=5354">http://www.uq.edu.au/study/program.html?acad_prog=5354</a></td>
</tr>
<tr>
<td>University of South Australia</td>
<td>Masters in Innovation and Entrepreneurship (Graduate Certificate + Graduate Diploma)</td>
<td>P</td>
<td><a href="http://www.unisa.edu.au/cde/programs/postgraduate/gradcert.asp">http://www.unisa.edu.au/cde/programs/postgraduate/gradcert.asp</a></td>
</tr>
<tr>
<td>University of the Sunshine Coast</td>
<td>Innovation, Creativity &amp; Entrepreneurship</td>
<td>U</td>
<td><a href="http://www.usc.edu.au/University/AbouttheUniversity/Noosa/CourseDescription.htm?subjectCode=COR&amp;catalogNBR=110&amp;date=2007-06-18">http://www.usc.edu.au/University/AbouttheUniversity/Noosa/CourseDescription.htm?subjectCode=COR&amp;catalogNBR=110&amp;date=2007-06-18</a></td>
</tr>
</tbody>
</table>

* Undergraduate (U) or Postgraduate (P)
Appendix F: Australian Labor Party ten point plan for the future

Federal Labor has laid out a ten point framework for its innovation policy:

1. Build a culture of innovation and new ideas by strengthening investment in creativity and knowledge generation.

2. Focus incentives for business R&D to promote global competitiveness, delivering the best outcomes for exports and economic growth.

3. Accelerate the take up of new technology, so Australian firms can access the best ideas from around Australia and the rest of the world.

4. Make Australia's innovation system truly international, by supporting partnerships, collaboration and foreign investment in Australian R&D.

5. Use government procurement to support innovative Australian firms.

6. Strengthen publicly funded innovation and research infrastructure and develop multiple pathways for industry to access the knowledge and expertise in universities and research agencies.

7. Strengthen the skill base for innovation, including in maths, science and engineering, and professional training for firms to manage innovation.

8. Develop and implement a set of national innovation priorities, with a broader focus than the current national research priorities.

9. Strengthen the governance of the national innovation system to support higher expectations of government agencies and industry.

10. Review the bewildering array of government innovation and industry assistance programs to reduce duplication and improve effectiveness.

Source: extract from Election 07 Policy Document, An innovation future for Australian industry