Commercialisation of Publicly Funded Research Roadmap

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1 Executive Summary

The roadmap identifies the policies, strategies and mechanisms applied in Australia to commercialise publicly funded research and development (R&D). It looks at the success of these measures through a number of case studies and recommends specific issues that need to be addressed to improve the commercialisation process.

The roadmap was developed through consultation with a range of stakeholders including Australian universities; Government research organisations such as CSIRO and DSTO and information and communication technology (ICT) companies that originated from publicly funded research. Relevant annual reports, company websites and Government policy documents were also reviewed.

The roadmap shows that over the past decade there has been a broad realisation by Governments to change the research culture within public institution, away from basic research to commercially focussed applied research involving close collaboration with industry. Government policy measures, such as external earning targets, and pro-active initiatives from institutions, such as the development of commercial arms, seem to be having a positive impact on increasing and improving the commercialisation process.

The roadmap looks broadly at a number of public institutions that undertake ICT R&D. It recognises that organisations in the public sector are diverse and face different issues. Accordingly we have divided the roadmap into the following sectors and have identified the major issues faced by each sector:

- Universities;
- CSIRO, research agency with a broad mandate;
- DSTO research agency with a specific missions; and
- Cooperative Research Centres (CRCs) long-term joint ventures.

Australia has experienced a number of success stories, which originated from publicly funded research. The success stories outlined in the roadmap demonstrate that there are a number of ways for public institutions to take their ICT products and services to market. Furthermore it shows that there is no one-size-fits-all approach to commercialisation.

2 Background

The commercialisation process is usually long, involved and rarely successful. As depicted in Figure 1 industry practice has shown that 3000-4000 unwritten ideas may be required to create one ultimate commercial success. Clearly, the process of commercial progression requires that flawed ideas or concepts be recognised early and that the deficiencies in these concepts be addressed or that the flawed concept be dropped or returned to the research stages.

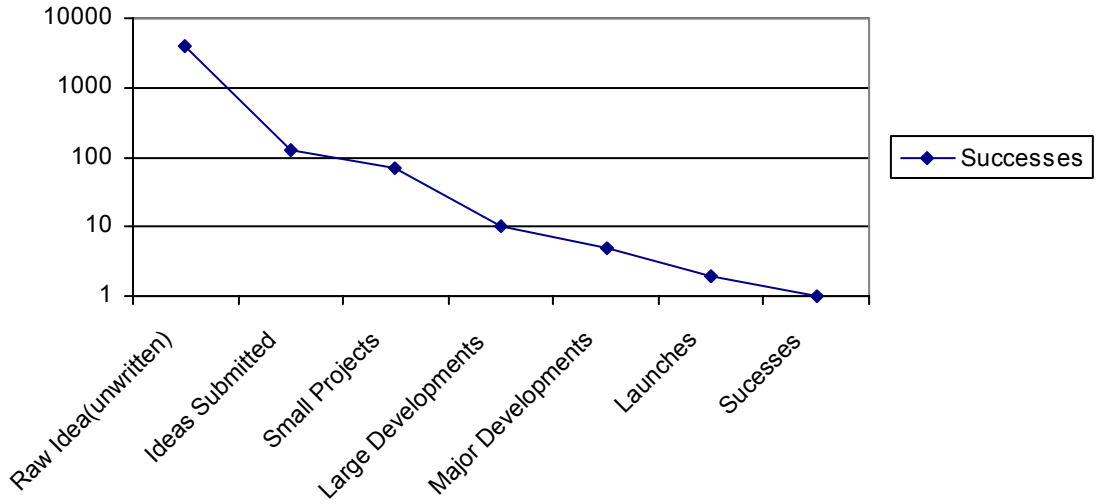

Figure 1: Ideas succeeding at each innovation stage. Source: Industrial Research Unit (USA) benchmark data 1998.

The process of first defining a technology-based idea for innovation and then moving it through various stages of commercialisation progression has many aspects, some of which are peculiar to the individual development. Nonetheless, there are also many common features including:

- Research. Ideas and preliminary concepts emerging from the discovery process can provide the impetus of opportunities that can move into commercial development.

- Pre-seed. Before commercial development decisions are made several things need to happen including clear characterisation of the market opportunity, intellectual property (IP) position, as well as the development of an understanding of competitive market and business issues that will impact the potential of the concept. At this point, one or more Angel Investors or pre-seed fund may also become involved in the evolving technology venture.

- Seed. This phase continues with the process of defining the business opportunity, IP position, staffing requirements, market position, business models and the preferred points of entry to the market.

- Market Development. Whether the final stage of commercialisation is achieved through the formation of a start-up, spin-off, licensing agreement, royalty and equity arrangement, joint venture or transfer of knowledge it largely involves the need to secure investment and enter the market.

In Australia the Government has an important role to play in terms of investing in basic and applied research. Recent statistics from the ABS showed that Government expenditure on R&D (GOVERD) during 2000-01 was estimated to be $2,368m at current prices. This represents a 14% increase over the two years since 1998-99. In relation to ICT expenditure the statistics revealed that:

- Over 25% of total Government expenditure was spend on ICT
- Expenditure on computer software reached $729m (15% of total expenditure) and communication technologies researched $548m (11% of total expenditure)
- Research activity within the ICT field was characterized by pure basic research (2.7%), strategic basic research (12%), applied research (69%) and experimental development (16.3%)

Governments in Australia and overseas are increasingly concerned to increase collaboration and cooperation between universities, government research institutions, agencies and government to produce targeted outcomes from the public funds invested into R&D. Today Australian Governments have an expectation that all publicly funded R&D institutions will provide additional focus on contributing to national wealth through commercialisation.

Recognition of innovation as an economic driver is becoming apparent, Governments realise that technology breakthroughs, which are converted into commercial ideas effectively create new business opportunities, employment and economic growth.

3 Public Institutions

3.1 Universities

Universities constitute 31% of commonwealth R&D expenditure, as well as attracting a large proportion of the ARC funds through Special Research Centres. Higher Education R&D (HERD) spending increased to a new record high of almost $2.8 billion in 2000, an increase of more than $200 million compared with 1998. HERD has been increasing steadily since 1992.

The commercialisation process

Traditionally it is up to individual researchers and universities to propose and manage research projects and to decide whether to adopt a commercial focus or seek opportunities for collaboration with industry. Increasingly universities are being forced attract commercial partners in order to earn essential research income and are establishing commercial arms and programs to assist researchers and students to bring their research to market.

Appendix B provides details on the commercial arms of Australia's major universities with particular relevance to ICT. These commercial arms assist universities in adopting a business approach to the management, finance, investment and development of working relationships with industry. Similarly the CRC program has helped change the research environment, with their focus on industry links, commercialisation and training of post-graduate students. Appendix C provides a list of the major ICT CRC's and lists the university participants involved in each centre.

Australian universities seem to be following their US and European counterparts and moving towards creating new ventures in the form of spin-off or start-up companies rather than licensing IP to an existing business or forming a joint venture with an existing business.[1] This has arisen, as it can be difficult to find enough existing businesses that are willing to invest in public sector R&D and there is a need for universities to obtain income to offset Government funding. The formation of spin-off or start-up companies also has the potential to offer researchers financial rewards

International Benchmarking

In the United States (US) the commercialisation of university research results in more than $40 billion in economic activity, which, in turn, supports more than 270,000 jobs.[2] Within the US universities formal technology development and business incubation programs are common to all universities. University technology transfer has helped to spawn new businesses, create industries, and open new markets. It seems likely that 2002 will see the formation of at least 300 new companies from US universities. One of the earliest success stories is Research Triangle Park in North Carolina. RTP was created

[1] ARC, Research in the National Interest: Commercialising University Research in Australia, July 2000.

[2] Association of University Technology Managers (AUTM), http://www.autm.net/index_ie.html

through the joint efforts of several research universities, numerous business development and government interests, and the availability of millions of acres of real estate. These forces combined to create the critical mass necessary for its formation. Although RTP benefits from more than forty years of operation, its success may be seen as symbolic of technology transfer in the region.

Interestingly within Computer Science the top five institutions are IBM Corp, AT&T, Stanford University, MIT and the University of Illinois.

Australian universities are learning from their US counterparts. A recent example is the Bench to Business initiative developed by the commercialisation arms of four of Australia's leading research universities, Anutech Pty Ltd (Australian National University), the Business Liaison Office of the University of Sydney, the Research and Development Office of the University of Technology, Sydney, and Unisearch Ltd (University of New South Wales), alongside ATP Innovations. The group was developed to exchange information about technologies available from the represented universities and is working to forge stronger links with potential partners in industry and the investment community.

Limited data suggests that the commercialisation performance of Australia's universities is on a par with the United States (US) university average of licenses and spin-off companies; which 1-2 per $100 million of research expenditure. However the best US practice is 5-20 times higher with up to 27 spin-offs per $100 million of research expenditure.[3]

However there are still areas where universities can improve and in order to increase collaboration with industry the Group of Eight, a coalition of Australia's leading universities, recently recommended:

- Increasing the basic level of the R&D tax concession and making the premium rate more accessible;
- Increasing the rate of R&D tax concession for R&D conducted by universities and public science agencies;
- Reassessing the public good benefits of the R&D Syndication Scheme, which stimulated a substantial boost to industry funding for university research; and
- Providing tax incentives for industry investment in research infrastructure wholly or partly for use by universities or public science agencies.

3.2 CSIRO

Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) has divisions in 22 research areas including information technology and telecommunications. Traditionally, the real strength of the CSIRO has been in agricultural and environmental sciences and ranked in the top five world institutions.[4]

[3] PMSEIC, Commercialisation of Public Sector Research, June 2001.

[4] These ranking are based on total citations, which is complied by Science Watch - World Institutional Rankings in Select Fields, by Total Citations, 1991-2001

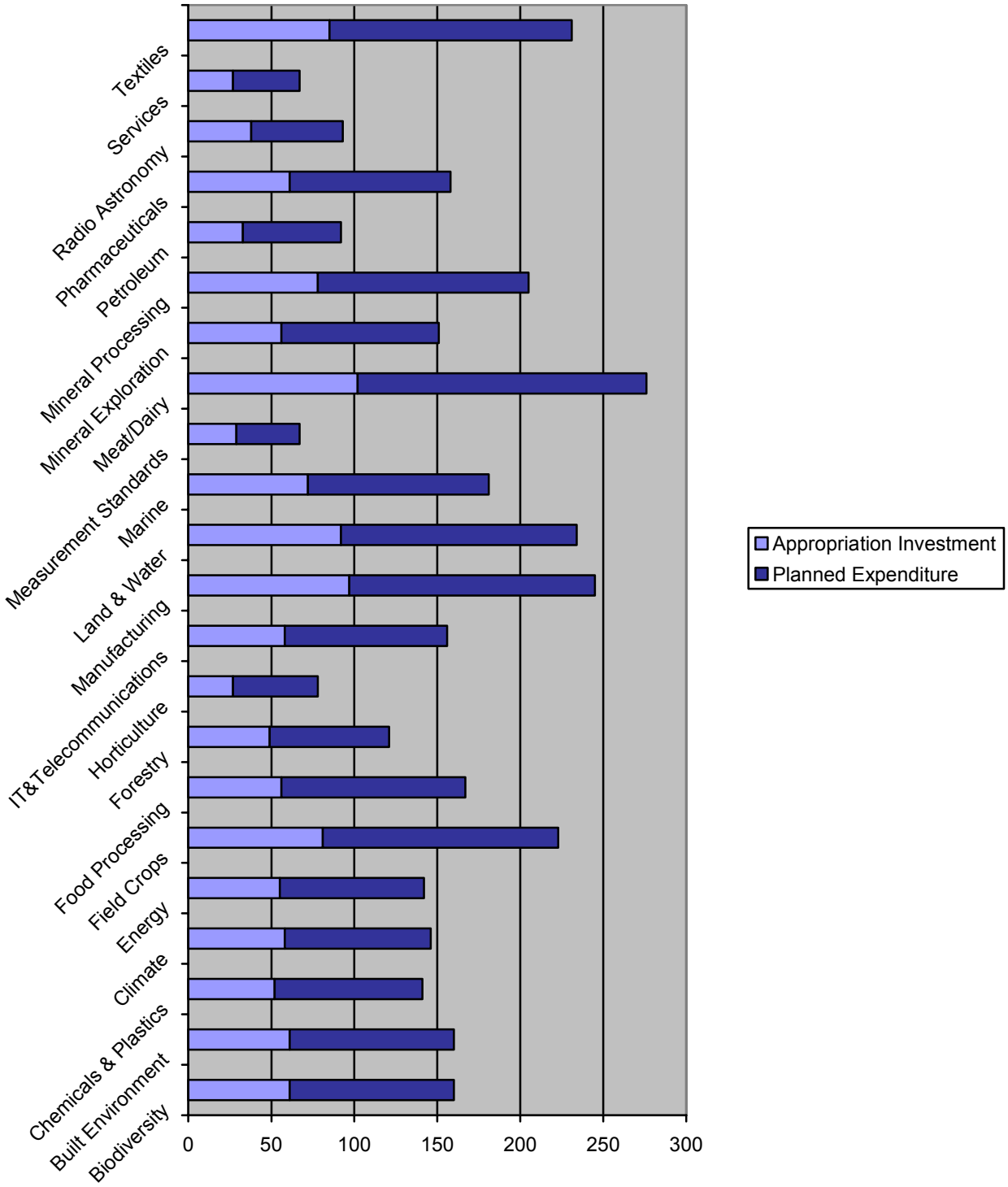

Figure 6. Planned Appropriation Investment and Total Expenditure by Sector 2000-2003, $million. Source: CSIRO Annual Report 2000-2001.

The table above indicates the planned investment for each of the CSIRO's divisions in over 2000-2003. Within the ICT sector the CSIRO has planned appropriation investment and total expenditure (from 2000 to 2003) to be over $155 million.

External Earnings Target

The primary purpose of CSIRO is to facilitate the uptake of science and technology research that benefits Australia. The transfer of technology to users in the private and public sector is central to CSIRO's primary function. Since 1998/99 the Commonwealth Government has imposed an External Earnings Target (EET) on CSIRO as a strategy to encourage more direct collaboration between CSIRO and industry, enhance the commercialisation of CSIRO research and obtain a better return on investment. The EET has been steadily increasing and in 2000-2001, external earnings amounted to $248 million or 32.3% of total funding, with about 14% derived from international companies and agencies.

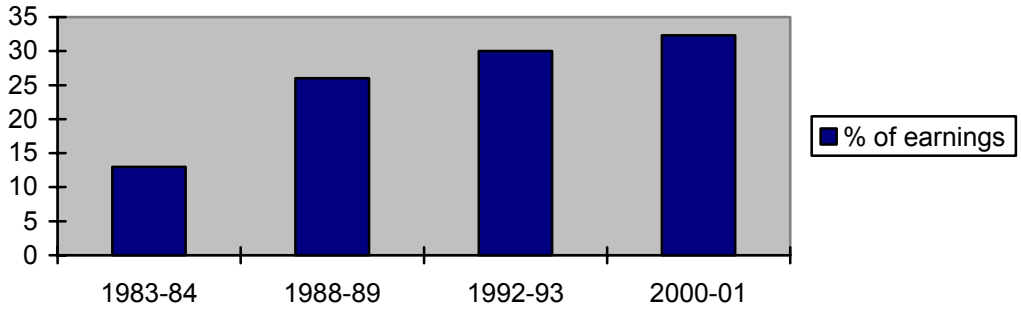

Figure 6: External Earnings as a Percentage of Total Funding 1983-2001

The IT and Telecommunications division within CSIRO has an EET of 35%. Following the arrival of Chief Executive, Dr Geoff Garrett, in early 2001 CSIRO has been working on a new Strategic Action Plan, which will streamline and strengthen CSIRO's commercial activities. The organisation is undertaking initiatives to increase the number of spin-off companies where this is the best commercial path. They are taking a more active role in providing seed funding to projects if there is no initial industry recipient. They are also becoming more involved in getting projects to the investment ready stage through the employment of business planning consultants and by marketing projects to investors and venture capitalists.

Commercialisation Pathways

There are a number of commercialisation pathways used by CSIRO, including:

- Start-up firms;
- Licensing to established firms;
- Sponsored research involving an end user and an ICT-producing organisation;
- Sponsored research directly with an end-user - this may result in a product or new business opportunity or have no product spin-off; and,
- Research advice.

The principal method of technology transfer is collaborative and contract research services for both private and public sector customers. The creation of new business enterprises is a smaller, but growing, component of the CSIRO's overall portfolio. The rate of new company formation from CSIRO has been reasonably consistent at approximately three per year over the twenty-one years since 1980. There has been some variation: there is an average of nearly four per year in the later 1980s and a low point in the mid-1990s of only one or two companies per year. Since 1980 the CSIRO has already generated more than 100 spin-off companies whose combined turnover is now more than $200 million.

The low rate of company formation in this latter period illustrates an important point about enterprise creation in the public sector relating to risk associated with this path, which must be recognised and accepted. Following the failure of a company which CSIRO had formed, and in which it still had substantial equity, the CSIRO Board became averse to the risks associated with new company formation, in part because of their perception about political risk attendant on failure. The general climate, which this created within the Organisation, led to half-a-dozen years of a low rate of company formation.

In 2000 the CSIRO's IT and Telecommunication sector advisory committee urged the organisation to give greater consideration to incubation of spin-off companies and other similar commercialisation models. The committee, which is made up from a number of industry based representatives, believed such approaches are better aligned to the expectations of the marketplace and, more to the point, that such approaches would hold much stronger potential for delivering outcomes that would provide long-lasting benefit to Australia. Some of the ICT spin-off companies are included Appendix B success stories.

Today, the CSIRO Board is supportive of new company formation as a mechanism to transfer CSIRO technology to the marketplace. The impact of this change has been marked, with significant numbers of new companies formed recently. Whilst the initial impetus for formation of a new company usually comes from within CSIRO, it is rare for the full range of expertise, which the proposed company would need to maximise its chance of success, to be available within CSIRO. As the organisation understands in order to succeed it is important that those involved in the proposed company obtain access to the best possible advice.

CSIRO finds a general shortage of entrepreneurial and venture management skills in Australia and this is reflected in an even stronger shortage within CSIRO. In general, the lack of people with entrepreneurial and venture management skills will be the key obstacle to forming a new business venture and to the success of that venture not the availability or otherwise of venture capital. CSIRO has found that to access scarce venture management skills and to minimise risk for the start-up, a strategy of seeking co-investment from external venture management and seed capital firms can be useful. Such a policy of co-investment is common practice in the venture capital industry.

New business creation based on CSIRO technology was, until recently, ad hoc and reactive to champions (both internal and from outside CSIRO). CSIRO is now moving to implement a more systematic and proactive approach to new business enterprise creation. The challenge for CSIRO in doing this is to ensure that all options for technology transfer have been considered and that the creation of a new business enterprise is the most appropriate path. Guidelines, processes and support relevant to

new business creation will need to be better established within the Organisation as part of this more proactive approach.

Some key elements of a systematic and proactive CSIRO program in new business enterprise creation will be:

- The generation of sufficient unencumbered IP;
- Divisional processes to recognise and nurture opportunities; and
- Formation of strong external linkages to access skills and experience not available within CSIRO.

3.3 DSTO

The Defence Science and Technology Organisation (DSTO) is part of Australia's Department of Defence. Its role is to ensure the expert, impartial and innovative application of science and technology to the defence of Australia and its national interests. The organisation has three laboratories centred on their core businesses - military platforms, electronic systems and information. The laboratory headquartered in Melbourne provides support to Australia's major military air and maritime platforms. The first of two laboratories in Adelaide, the Systems Sciences Laboratory, supports the acquisition and operation of the major electronic systems on military platforms and utilised by land forces. The third laboratory, Information Sciences Laboratory, also at Adelaide, focuses on the exploitation of communication and information technologies and their inter-action with human users.

In 2002 the organisation adopted four challenge technology thrusts to drive change in their technology base. Briefly these are:

1. A broadly based program aimed at understanding and reducing the cost of operations of major platforms.
2. Smart materials, with a wide range of defence applications including integrated sensors and processors - leading to the concept of intelligent ADF platforms.
3. Robotics, which expands, to cover broadly based and integrated research program in robotic systems
4. The fourth technology challenge is related to asymmetric warfare.

Engagement with industry

Over the past year DSTO has increased its efforts to engage not only with industry but also with universities and other R&D organisations such as CSIRO. Their external relationship mechanisms include industry alliances, formal licensing agreements and collaborative research arrangements. DSTO currently has 66 licence agreements and 18 industry alliances.

In June 2002 DSTO announced that they have established a Technology Transfer & Commercialisation office (T2CO), which has the overall aim of achieving greater industry take-up of their intellectual property. DSTO believes that as defence and civilian technologies converge, there are going to be increasing opportunities for DSTO

technology to be used more widely than just in defence and related areas. Qualified recruits from the private sector, experienced in technology transfer, IP and licensing, are staffing the new office. They have also recently announced change in the management of the defence patent portfolio. This responsibility is being transferred from Defence Materiel Organisation to DSTO. This transfer should ensure closer links between the inventors and patenting decisions and provide many synergies with the Technology Transfer & Commercialisation Office. While the Technology Transfer Office is gathering momentum, DSTO will be taking a more entrepreneurial approach to downstream product development and working with the pre-seed fund managers to develop the most appropriate model for DSTO.

DSTO's level of commercial outsourcing is also significant. Last financial year they invested over $20 million (9% of their budget) sourcing R&D and technical support from industry, universities and other external organisations. They plan over the next three years to increase this by 50 percent. Furthermore, DSTO have entered into arrangements with DARPA, the US Defence Advanced Research Project Agency, which allow DSTO to contract collaborative R&D activities. This could be to explore military applications of ideas developed by Australian companies. DSTO's initial contract is collaboration on computer network security research. Several other topics are in the pipeline.

3.4 Cooperative Research Centres

In 1990, the Australian Government initiated the Cooperative Research Centre (CRC) Program to address the perceived need to change the prevailing research culture, which produced inadequate update by industry of the substantial government funding to CSIRO and Universities. The objective of the program is to strengthen the long-term collaboration between research organisations and the users of the research, in order to maximise the benefits to Australia and from this investment in R&D. The CRC's have additional objectives in providing post-graduate training and educating potential users to the benefits of research and knowledge transfer.

In 1998 the Government reviewed the CRC program with a mandate to gain greater commercialisation and self-Funding into the program. The review recommended continuing support for the Programme and encouraging more CRC's in the 'information industries'. Currently 63 CRCs are operating and seven of these are in the ICT field. Appendix B provides a current listing of the ICT based CRCs. It has been acknowledged that the CRC system is an effective way of brining University and CSIRO researchers closer to industry and within the seven ICT based CRC there are a number of industry participants involved. The CRC's claim that the program has made researchers more collaborative, more team oriented and more interested in how research and industry interface.

Industry provides approximately 50% towards CRC funding. Thus those that manage the CRC's realise that the ICT industry downturn, especially in telecommunications, could negatively impact the availability of industry investment. Nevertheless the CRC's believe they can play an important role as some ICT company's reduce their R&D projects through the offer of outsourced R&D. DSTO and CSIRO are important participations in the CRC program and are currently active in a number of ICT CRC's and are participating in bids to establish new CRCs.

4 Success Stories

A number of success stories are outlined in Appendix A. The successes cover a wide-range of technologies and there does not seem to be any recognisable technology-based trend influencing success. However there are a number of intangible influences that were prevalent throughout the success stories. The following influences were taken from conversations with those involved in the commercialisation process.

- People at the research institution had the right skills and networks to commercialise the technology
- The company was able to develop relationships with multi-national corporations in the United States
- Once the research team put the business case together and they were able to access venture capital
- It was just about timing, bringing the product to market when there was a potential buyer
- A propensity for networking among firms, academe, and research institutions gave the start-up an upper hand
- The research team developed a long-term perspective and realised that their success was not going to happen overnight
- The researchers successfully integrated into an entrepreneurial culture and were able to continue to refine and develop the technology within the start-up company
- The university transfer office was able to offer flexibility with licensing

5 Issues Arising

We have to recognise it is very rare for a public research agency to commercialise anything. To commercialise a product or service is to take it to market and this is not traditionally the role of the public sector. Furthermore, public sector organisations are not set up to undertake manufacturing, sales and marketing. Rather they transfer their research results to some other organisation, which carries out the commercialisation. So, for example, in a start-up route IP is licensed or sold to a new company and this company commercialises the research. What this highlights is a fundamental requirement for public sector research organisations to partner with others in order to get their research results to market. The partners fall into four broad categories:

- Users (the source of problems or opportunities);
- Product developers (ICT producing firms);
- "Go-to-market" partners which take the product or service to the market place; and,
- Other research organisations with complementary expertise needed to develop the technology.

Several or all of these roles can be performed by different parts of one organisation. A public sector research organisation can interact with these partners in a number of ways, which will strongly influence how the research is commercialised and how effectively and efficiently this takes place.

Within industry, there is much greater use of what could be called a "piggy-back" path. That is, the R&D group has close ties with the product development and/or business groups, and through this mechanism the researchers gain a much better awareness of market opportunity and competitive market position. This closeness significantly reduces the level of risk, and increases the success ratio, compared with publicly funded R&D groups who start at the ideas stage without such close links to an existing product or market channel.

In some cases there is an unrealistic expectation about joint ventures and spin-offs, and insufficient awareness of the scope for licensing or other form of transfer to industry channels. In principle, there is no reason why public sector R&D groups cannot align suitably with industry groups however in practice there are significant barriers. Current barriers to alignment of public funded R&D with industry directions include:

- Culture in the public funded body, both at researcher level, and at management level, few public body senior managers have any experience of industry R&D in practice, so often their positions are unrealistic, and
- Unwillingness in industry groups to expose their business strategies.

Current barriers to industry investing in public-funded R&D include:

- Problem in identifying exactly what is being invested in - a better ability to articulate and manage IP, and the impact it can bring for business, are needed in public bodies;

- Problem that industry managers who have little patience with public body processes and constraints - needs a greater commitment from industry to understand how the public bodies work, and to build links at the appropriate levels;

- Nervousness about the reliability of the public funded researchers to focus on areas that will achieve outcomes for the industry. We need to overcome the impression that Australian public-funded researchers often give that they have a right to do whatever they want - that once the money is received the outcomes are no longer important;

- Lack of experience in industry in managing public funded bodies as R&D suppliers. We need preparedness on part of industry to manage the relationship actively to maintain the confidence of direction and outcomes, and awareness of the risks and costs involved in this

A number of reports and papers have been prepared on the barriers and inhibitors faced by public institutions in the commercialisation process. These reports together with stakeholder conversations have provided the roadmap with some common barriers and inhibitors faced by public institutions, to varying degrees, in the commercialisation process.

5.1 Lack of market focus.

Public institutions may select projects in isolation of any industry or market awareness and often select projects based on researcher skills and institutions infrastructure. There is generally a lack of understanding about industry receptiveness - i.e. what makes it possible or difficult for an industry group to take up particular R&D outcomes. Also public organisations tend to set large-scale priorities, but at the engagement level miss having sufficient understanding of existing businesses to know what targets would be realistic. There is also a naivety on the part of some researchers, who often imagine that industry doesn't have any expertise in the area and propose projects that have clearly had very little thought or practical evaluation. Researchers must get to know an area really well to be able to propose projects that are going to be feasible.

5.2 Lack Management Skills and Experience

In industry, the ability to develop products based on research is a critical process requiring skilled and experienced entrepreneurs who can develop alliances, attract venture capital or internal funding from the ICT industry and bring advanced technology products to global markets. Australia currently has insufficient entrepreneurs to provide this brokerage role in the public sector.

One of the key management competencies, that is seldom visible or addressed, is "engagement experience" - that is, an understanding of what is required to initiate and maintain an effective long-term researcher-industry relationship. Individuals who have successfully worked in both types of organisation, and can manage the internal processes by understanding the barriers and sensitivities etc usually develop this competency.

Public institutions may not be able to build up a good-sized research team to become involved in the project and provide the necessary manpower to successfully undertake a

R&D project. Furthermore, it's not just the size of the research team, but also the right balance of skills and experience, and the ability to work adaptively from both technology and business drivers that can effect the success of a project.

5.3 Lack of Financial Resources

Australian's venture capital industry is not prepared, in the main, to provide new enterprises with seed capital (say $0.5m $1.0m). Rather, they concentrate on funding the growth of firms that are already or nearly profitable and providing them with broad level management support. Universities and the CSIRO are staring to take more risk and have developed funds to provide pre-seed and seed capital where appropriate.

The Government has also announced as part of Backing Australia's Ability, the Pre-Seed Fund program will help the commercialisation of R&D undertaken by universities and public sector research agencies. Under the program, four fund managers, Allen and Buckeridge Asset Management, Rothschild Genesis Fund, SciVentures and Starfish Ventures have been selected to invest more than $100 million in projects or companies spinning out from universities or Commonwealth public sector research agencies. The Commonwealth Government is providing $72.7 million of the capital with the balance provided by private sector investors, universities and public sector research agencies.

Nevertheless the concentration on 2nd or 3rd stage funding by the venture capitalist, rather than 1st stage, is a real and ongoing problem.

5.4 Nervousness Regarding IP Management

Traditionally there had been a lack of expertise in IP management and legal expertise within public institutions. Many public institutions seem to have no experience with the practicalities of managing IP. For example, many insist on shared IP ownership without being aware that many companies have cross-licensing agreements that may preclude complex IP agreements - if not explicitly then probably in practical terms.

The ARC now requires researchers to develop strategies to identify, protect and manage IP generated from ARC research funds. In 2001 the ARC announced National Principles of IP Management for Publicly Funded Research to improve the commercial output from research. Hopefully these principles will assist individual organisation developing their own guidelines to suit their environment. These guidelines will also hopefully assist the ICT industry to understand an institutions IP position.

Industry believes that simplicity is the key when initiating IP agreements in public institutions, because they will inevitably get more complex if the relationship develops and more IP emerges. There often too much focus on broad or sweeping intangible IP managements and protecting everything and not enough on identifying what is genuinely competitive IP, articulating it, protecting it, and then being in a position to negotiate based on it.

5.5 Lack of Industry Expenditure on R&D

Australia's investment in all R&D had been steadily falling until recently. In 2000-01 business expenditure on R&D (BERD) increased by 18% and Government expenditure on R&D (GOVERD) increased by 14%. Despite these improvements Australia's R&D

performance is relatively poor compared to other OECD countries, Australia experiences low gross expenditure on R&D in relation to GDP, due to low business expenditure, high public relative to private expenditure on R&D, a high ration of basic to applied research; and foreign-owned enterprises play a major role in ICT sector R&D

Figure 3 demonstrates Australia's low rate of business expenditure on R&D compared to Europe, Japan and North America. This lower rate greatly lessons the opportunity for interactions between public and private R&D and reduces the options for commercialisation.

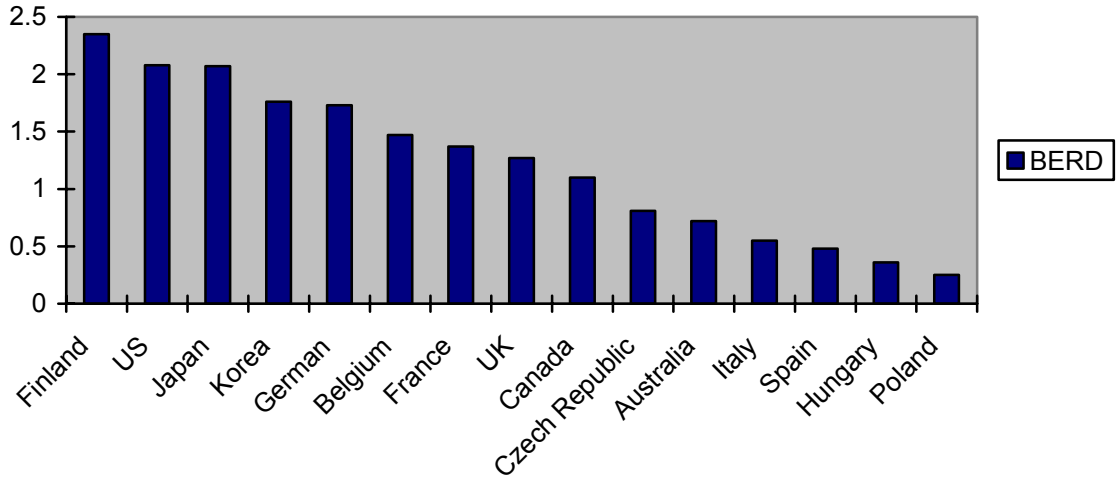

Figure 3: BERD/GDP Rations of OECD Countries. Source: Australian Bureau of Statistics 8104.0 Research and Experimental Development Business Australia, 2000-2001.

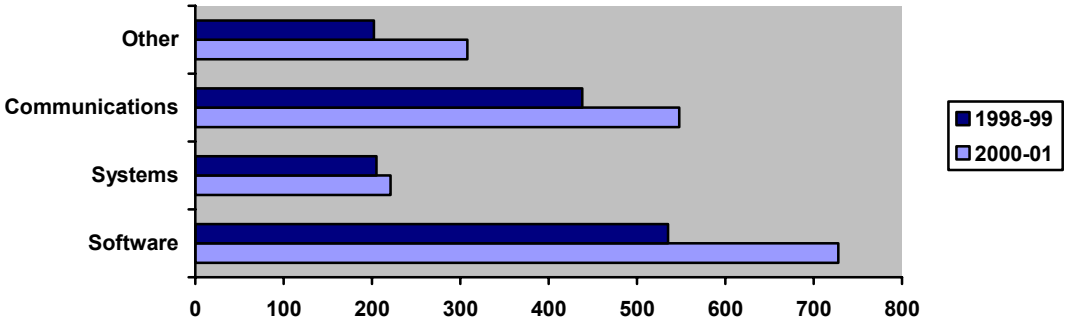

Figure 4: Business Expenditure ($million) by Field of Research Source: Australian Bureau of Statistics 8104.0 Research and Experimental Development Business Australia, 1998-1999 and 2000-2001.

Australia's low business expenditure on R&D directly affects the level of public expenditure as Governments increasingly tie their expenditure to industry contributions. Institutions are claiming that research centres, which relied on external industry and contract research, are shutting down due to the fall in industry expenditure. Recent closures have been the University of Adelaide, Centre for Telecommunications Information Networking and RMIT University, Centre for International Research on Communication and Information Technologies.

July 2002 – House of Representatives Standing Committee on Science and Innovation inquiry into business commitment to research and development. The inquiry will look

at the economic benefits of greater business investment in R&D, impediments and steps that needs to be taken.

5.6 Balancing the Competing Interests

Strengthening Australia's ICT research capabilities in a number of key areas as opposed to being a jack-of-all-trades will assist in providing national and international recognition. The competitive landscape in Australia causes too many of the best people to spend too much of their time competing with each other for shares of the same amounts of money circulating under various changing Government funding schemes. In many overseas countries, researchers acknowledge the results of competitive funding, and get behind the winners so they are able to provide the resources to key projects, some solid work, rather than keeping on trying to get their own projects up.

Furthermore, competition between States to establish research centres in the ICT industry can be counterproductive as it dilutes the effort available to produce a nationally based centre with a critical research core size of optimum commercial outcomes. The development of the ICT Centre for Excellence will hopefully provide some focus in this area.

State and Territory Governments make a minor contribution to the research funding when compared to the Commonwealth government, however as depicted in Figure 5 their contribution is increasing. A number of states have developed specific initiatives, such as the Victorian Government $20 million Technology Commercialisation Program (TCP) and the Queensland Government recent R&D Strategy Issues Paper, which relate to ICT research and development.

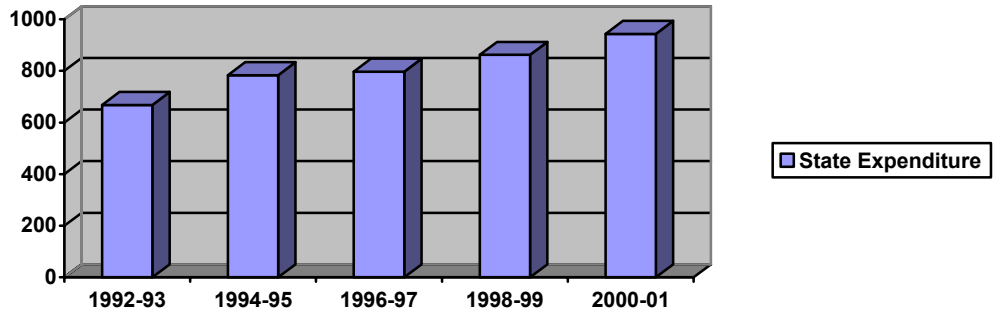

Figure 5: State Government Expenditure on R&D $million. Source ABS 8109.0 Goverment and Private Non-Profit Organisations

In 2002 the Government decided to select four designated priority areas where some $170million of ARC funding is to be channelled. These areas are Nano-Materials and Bio-Materials, Genome/Phenome Research, Complex/Intelligent Systems, and Photon Science and Technology. The total ARC budget for 2001-2002 is $277million.

In early the Government announced through the Department of Education, Science and Training that they are currently looking at setting national research priorities for government-funded research programmes. The Government will announce the national research priorities in October 2002. The review is also part of the Government's policy of improving the efficiency of Australia's R&D spending.

6 Specific Issues to Address

6.1 Coherence

The research and investment environment created by government policies is not always consistent over the long term. The average innovation period is five years and business and investors can find that governments change the rules in the meantime. The average government term is often well short of the 3 year term and changes in government bring with them significant changes to senior public servants destroying consistent, long term programs, policies and relationships with business.

The federal government is currently going through an important process of determining research priorities for public institutions and the ICT industry will only benefit in this process. It is important for Government to demonstrate consistency in the myriad of Government departments, agencies and institutions that influence public policy based on their own objectives and spheres of influence. Furthermore, State and Federal Governments need to cooperate in setting R&D programs and priorities.

6.2 Collaboration

Industry funding is a growing proportion of the R&D carried out in public institutions. The external earning targets instituted by the CSIRO, the CRC program and the ICT Centre of Excellence demonstrate this trend. The success of these institutions in increasing their ICT research and commercialisation prospects is going to depend upon the willingness and capacity of industry participation.

Australia needs to aggressive in developing strategies to attract ICT investment in Australia and within public institutions. A coordinated approach to IP management is also needed if the ICT industry is to invest significant effort in public funded bodies.

The Government should also consider funding approaches for periods when industry investment is low. This funding could be accessible on a competitive basis to industry R&D undergoing downsizing pressures, and to public institution that could utilise spare industry capacity during such periods.

6.3 Capital Markets

Raising capital to finance growth of new technology-based firms seems to be a problem for both public and private projects. Major fund providers are not willing to take the high risks involved in technology based research and early-stage investors are increasingly moving towards later stage investments. Public institutions are increasingly taking more risk and establishing their own pre-seed and seed funding (in collaboration with venture capitalists) to suitable projects.

The Government recently committed $70million to the commericialisation of public R&D through the announcement of four fund managers. Other government initiatives such as the Innovation Investment Fund (IIF), COMET and the BITS program also facilitate access to capital. Another critical component to accessing capital markets is to have strong and well-researched business plans in order to secure the capital available.

Venture Capital consultants should be encouraged; perhaps through a Government program, to work with small companies and public institutions to develop business plans for targeted technologies, to help focus the directions of these groups, build internal skills, and build awareness in the VC industry of potential market-ready technologies. The Government should reassess the tax incentives for attracting foreign capital investment.

6.4 Culture

Unique skills are needed within public institutions to successfully commercialise research. The skills require a balance of industry and research experience to ensure effective management of the research project to the industry environment. The cultural gap between public institutions and universities is being reduced. Public institutions are aggressively developing commercial units and divisions to increase their innovation and entrepreneurial skills. They are also trying to bridge the culture gap through the movement of people between institutions and industry and there are many training courses in commercialisation.

However new cultures cannot be established rapidly and training courses and programs on commercialisation do not substitute for working in the commercial world. Also some of the people in the commercial units of public institutions often tend to be the less successful people from industry, so are not necessarily the best people to entrust the development of commercial relationships.

There should be more proactive programs of management staff interchange between public institutions and the ICT industry. Current secondment programs of 3-6 months are not sufficient for managers to become actively involved in critical parts of either type of organisation's business, and so are not financially viable for industry.

Furthermore, public funded institutions should increase the level of industry awareness and experience in their senior management teams, in order to be able to set effective strategies and provide internal role models for the next generation of managers. They should also improve the recognition and reward differential to high achievers who take risks and are prepared to build the relevant management skills and experience to achieve effective commercialisation.

Appendix A – Success Stories

Listed below are a number of successful stories from ICT related projects, which began as publicly funded R&D projects.

Start-up and Spin-off Companies

BresaGen Ltd established 1982 as a spinoff from the University of Adelaide. Bresa Gen is a biotechnology company engaged in development of human and animal therapeutic products. A global player the company has offices and laboratories in Adelaide, Australia and Athens, Georgia USA. Currently employing over 50 people it has a market capitalisation of $75million.

ResMed was formed in 1989, its primary purpose was to commercialise a device for treating obstructive sleep apnea (OSA). Developed in 1981 by Professor Colin Sullivan and colleagues at the University of Sydney, nasal continuous positive airway pressure (CPAP) provided the first successful non-invasive treatment of OSA. Operations have grown dramatically through the introduction of a number of highly innovative product lines. ResMed revenues and profits have increased steadily during the past eight years, making ResMed a robust and rapidly growing international player.

GroPep Ltd an international biopharmaceutical development company is a spin-off company originally set up by CSIRO and The University of Adelaide in 1988 and became the commercial arm of a CRC. The company listed on the ASX in 2000, has achieved a market capitalization of $100 million and employs over 50 people. CRC partners have retained an equity share in the company.

Platypus Technology took on its present form following the trade sale of Hypertec Pty Ltd, the well-known Australian company that was widely considered to be an Asia Pacific leader in the design and manufacture of memory modules. The Hypertec subsidiary carrying out research and development work on future products was not included in the 1999 trade sale. It is this subsidiary that is now Platypus Technology. Hypertec Pty Ltd established 1979 as R&D company and in 1986 commenced own product sales. Today Platypus is based in New Hampshire, with sales offices in Hungerford UK and Sydney Australia. The company's Research and Development Technology Centre is based in Sydney, Australia.

Mine Site Technologies is an Australian company, established in 1989, that specialises in the conceptualisation, research, development and commercialisation of products for the resource and industrial sectors, particularly the underground mining industry.

Sayso!, Founded in 1990 Sayso! (formerly Syrinx Speech Systems) had grown to become a world leader in commercial speech and voice recognition solution development and delivery. Last year, Sayso! installed 180 lines of speech recognition for online trader ComSec, then gained new management and a new name before going into voluntary administration after a major investor pulled out this year.

Pacific Solar Pty Ltd was established in 1995 to exploit the award winning research of Professor Martin Green and Professor Stuart Wenham in the use of thin film photovoltaic technology. The business raised in excess of $45 million in first round funding to convert the technology to a commercial product. It has since successfully raised a further $21 million and now has an

integrated product which is being adopted by Australian consumers. This technology will now be rolled-out internationally in conjunction with a strategic partner.

OAS Engineering Pty Limited was licensed in 1987 by The University of Newcastle Research Associates Ltd to develop, sell and support computer-based software systems for the management of children's services. The software packages were originally developed for Child Care Centres by Mr Roger Baxter, in conjunction with Kintaiba Child Care Centre at The University of Newcastle and are marketed under the name CRAFT (Children's Records and Financial Transactions). OAS has further developed CRAFT for Family Day Care Centres, Pre-schools and Occasional Childcare Centres.

Biosignal Pty Ltd was incorporated in 1999 to commercially exploit unique anti-microbial and anti-bacterial compounds that will act to inhibit bacterial processes as well as the emergence of bacterial virulence traits. The technology originated from the Unisearch program and has application in a broad variety of markets - from aquaculture paints to pharmaceuticals. Biosignal has sourced collaborative development partners who are leaders in their fields for many market applications. Biosignal to pursue its product development program to the point where the first products are now being sold under trial permit.

Acyte Biotech Pty Ltd is a Sydney-based biotechnology company incorporated during 2000 to focus on exploitation of some particularly effective cell-lines and gene expression cloning for the production of pharmacologically active proteins. It provides specialised development services for the international biopharmaceutical industry. The company was assisted by Unisearch at the University of NSW.

Qucom Pty Ltd is a company incorporated to commercialise the IP arising from the quantum computing research effort centred at UNSW. This work aims to develop computing technology at the atomic level through the creation of few-qubit devices in silicon. The technology has the potential to revolutionise computing particularly in relation to complex modelling and analysis, and is attracting attention worldwide.

grapeVINE was established as a separate spin-out company in 1995 to develop innovative groupware products designed to facilitate management of information and knowledge in large multi-sited organisations. The company was assisted by Unisearch at the University of NSW. The business transferred its operations to the US in 1998 and entered into an arrangement with Netscape to combine grapeVINE's technology with part of Netscape's web-crawler and search engine browsing functions. This led to grapeVINE generating royalty income achieved through sales of the combined grapeVINE/Netscape product. A trade sale of the grapeVINE business was negotiated in 2000 with Sun Microsystems which has seen a staged exit occurring over 2000 and 2001. This exit will provide Unisearch with a return in excess of four times its original investment.

Wedgetail Communications is an IT start-up company receiving a $3.3 million investment from a consortium of investors combining Uniseed and Allen & Buckeridge. The investment will be used by Wedgetail to expand its world market and to promote its suite of products. Wedgetail has developed a suite of internationally leading cryptographic and authentication products specifically designed and engineered for the Java and embedded device environments. Wedgetail Communications was founded in 2000 at the security division of the CRC for Distributed Systems Technology in Brisbane.

Radiata Communications. Early collaborative efforts of scientists working out of the CSIRO and Macquarie University. Designed the wireless chipset which resulted in Australia's biggest

private technology deal Radiata was taken over by Cisco Systems for $US295 million ($494.5 million) in shares in 2000. Though Cisco stock has since fallen to about 80%. Because of the cost advantages, Cisco continued Radiata's R&D activities in Australia and Neil Weste, (Radiata founder) is now director of engineering at Cisco Systems wireless networking business unit in Sydney. In 2001, Sydney firm Radiata Communications Pty Ltd completed development of a wireless local area network (LAN) chipset based on technology and patents licensed from CSIRO. CSIRO will receive royalties from worldwide sales of Cisco products that use this technology.

Fultech The IP in this venture is based on a patented technology for protecting electronic circuits from electrical power surges such as those from lightning strikes. The Uniseed investment is to develop the discrete device ready for sale. The device is a protection switch that virtually instantaneously disconnects vulnerable equipment from the disturbed input power terminal and then reconnects the system after the surge has passed. Fultech is seeking investment to develop an integrated solid state model and to grow its market. Fultech will be licensing this platform technology for manufacture and sale in various markets.

Solar Sailor. A solar and wind powered commercial ferry will soon make its way to Sydney harbour propelled by two UTS-developed electric motors. The electricity generated by the solar panels will be put to work by two UTS designed and built 40-kilowatt electric motors – the latest product of cutting-edge electric motor technology developed by researchers in the Faculty of Engineering in collaboration with the CSIRO.

Magnetica Limited has been established to design, license and manufacture hardware and software systems for applications of magnetic resonance technology. Magnetica is in the process of securing $8m+ equity capital to fund the growth of its manufacturing and licensing businesses. The manufacturing team is currently operating from established premises in South Brisbane, and Magnetica will have ongoing access to the research results flowing from the University of Queensland's Centre for Magnetic Resonance, the birthplace of the existing IP portfolio.

cap-XX Pty Ltd, based on CSIRO research, has developed the world's most powerful supercapacitor. Like ordinary capacitors, 'supercaps' store electricity and charge and discharge rapidly. But supercaps have the ability to deliver high power and can be used in applications such as starting a car. The secret lies in low electrical resistance and the use of a sponge-like structure that provides a large area for storing the charge - 200 square metres for an electrode small enough to fit into a matchbox. Mobile phones, laptops, wireless modems, solar sets and electric cars are among the likely uses. Global sales of supercaps are forecast to grow to well over $1 billion a year and Australia is well placed to capture a large market share.

Viator Systems and the CSIRO developed a new on-line planner called TRIPS (traveller itinerary planning system) which enables travellers and travel agents to tailor an itinerary to personal preferences and concrete factors such as budget, requested activities and destinations. More sophisticated and powerful than current systems, TRIPS combines know-how in artificial intelligence, human-computer interaction, software engineering and operations research.

Licencing

In 1999 the Macquarie Research commercialised proteome technology through a licence to BioRad Australia Pty Lyd. Bio-Rad already has launched a series of new and improved scientific instruments including a leading edge robotic instrument involved in the excision of "spots" from 2D Gels and PVDF Membranes, and delivering them into microtitre plates.

The Centre for Lasers and Applications, at Macquarie University, has developed technology, which improves the efficiency of copper vapour lasers. This technology has been licensed by MRL to a British company for use in their micro-machining business.

The University of Wollongong's Interactive Multimedia Learning Laboratory (IMLL) produced Stagestruck for the National Institute of Dramatic Art (NIDA). Through the software program users can: script their own performances, design sets; use an eight-track system to lay down sound tracks and special effects, choreograph a ballet or opera, cast a musical, or simply go backstage in the world's most famous theatres.

A UK-based company in partnership with UTS will develop leading technology used to track the location of mobile phones, the brainchild of researchers in the UTS Faculty of Engineering. The deal has been negotiated between Cambridge Positioning Systems (CPS) and the UTS technology transfer company Insearch Limited. Insearch and UTS will gain an equity stake in CPS, a fast-growing company at the forefront of mobile positioning. Two of the developers of the technology, will move to the CPS research and development headquarters in Cambridge, England.

RMIT - Multimedia Database Systems. As a result of a recently completed deal, the second-largest supplier of IT to the United States government will sell SIM overseas. Science Applications International Corporation (SAIC) will exclusively sell our technology throughout the US and Europe. RMIT has negotiated for the intellectual property to remain in Australia, with all R&D being contracted back to RMIT Multimedia Database Systems that developed the product. SAIC will establish a SIM division in its Advanced Information Technology Centre located in the Washington area, to market the product in the US and Europe.

In conjunction with the Canadian system integrator Irosoft Inc. RMIT MDS are undertaking a project for the Canadian Department of Justice in Otawa. As part of their Legislation Information Management System (LIMS) project Department of Justice require an integrated XML-based Content Management and Delivery System (CMDS). The main features of the CMDS will be: version control, workflow management, low-level XML component management, extensive search-and-retrieval facilities including "point-in-time" capabilities, Internet and intranet delivery, English and French interfaces and searching capabilities, and remote accessibility of all user-level features from a standard Internet browser.

In June 2002 the Department of Defence purchased a software licence for simulation applications from a small West Australian company, CALTRYX. The software, which will help to build distributed simulations faster and cheaper, was developed with DSTO support.

CSIRO The IEEE completed the specification for its new high-speed wireless Local Area Networks (LANs) standard in 1999. This standard (known as 802.11a) allows data rates ten times faster than the original IEEE 802.11 standard which is now in common usage around the world. The new standard allows for data rates in excess of 20 Mbit/s and operates in the newly allocated 5 GHz band. It incorporates CSIRO's patented solution for high speed communications in the indoor multi-path environment. CSIRO has already licensed its prototype system and the patented technology to a local start-up company developing IEEE 802.11a compliant products. This company employs several former CSIRO engineers.

Technology Transfer and Commercial Partnerships

In May 2002 DSTO signed a 10-year agreement with Tenix Industries for the worldwide marketing of our Starlight computer security technology under the brand name 'Veto'. This is an excellent example of an innovative product being transferred to industry for the benefit of both the public and private sectors. It results from a long process of technology transfer involving the consortium companies early in the product development.

DSTO with BAE Systems are currently in negotiation for an agreement that will facilitate joint investment in innovative products being developed in DSTO, looking again to both the defence and civilian marketplace.

DSTO is collaborating with another Australian SME, Thoughtweb Incorporated, to develop intelligent agent based tools for automating the support to military command and control processes. These tools have wide potential application in the commercial marketplace. This work has come out of a CRADA we have with SUN Microsystems, the second such collaboration which is leading to significant technology developments.

CSIRO ISOLDE is a documentation environment, developed under contract with the US Office for Naval Research. ISOLDE automates the generation of content for the on-line help usually built into software products from the software specifications used to design the product. This eliminates tedious and error prone aspects of producing help systems, makes it easier to update and maintain documentation, and contributes to reducing the time to market for software products. ISOLDE attracted attention from software developers at the 2000 Hannover IT fair and components have now been distributed for testing.

CSIRO is collaborating with Australian industry to commercialise its technology for providing two-way emergency communications (surface to miner and return) in the event of a mining disaster. This is the first time that an integrated two-way system has been achieved anywhere. Many technical difficulties were overcome to enable reliable wireless communications through 200 metres of rock. This patented technology also has the potential to improve general mine safety (remote blasting, disaster recovery etc.) while improving productivity.

CSIRO P@NOPTIC is a new search engine for corporate and government intranets. It improves the accessibility of information within such organisations and information flow to clients, significantly increasing efficiency. P@NOTPIC was developed by CSIRO and the ANU within the Advanced Computational Systems Cooperative Research Centre and incorporates technology that has consistently achieved best practice results in international competitive evaluation.

CSIRO Telecommunications and Industrial Physics and the Australia Telescope National Facility (ANTF) have combined within the Chief Executive's Special Project on Indium Phosphide (InP) MMICs to achieve world-class results in millimetre-wave integrated technology. These include the world's first bidirectional amplifier working at 100GHz, a patented CSIRO invention, and the world's first voltage controlled oscillator working at 100 GHz. Amplifiers constructed by the Project working at 85-115 GHz and 180-205 GHz have exhibited a combination of high gain, low noise and wide bandwidth that is world's best practice. CSIRO has also shown how to successfully apply existing commercially-available design tools to achieve first-pass design success in this high frequency domain.

CSIRO's Internet Marketplace technology is being used to deliver integrated planning and property information via the Internet for the Sydney Information Highway project, an initiative of Sydney's Inner Metropolitan Regional Organisation of Councils (IMROC). CSIRO has

developed an internet marketplace system for the QUeensland Government, which will enable savings of around $350 million over six years in that State alone.

An Australian company is using CSIRO technology to develop a single-chip modem for use in wireless local-area networks markets in the USA, Europe and Japan. The modem and an associated 5 Gigahertz radio chip will play an important role in giving computer users mobility and greater bandwidths indoors and enable the use of rich multimedia applications within buildings without using cables.

CSIRO Mathematical and Information Sciences delivered a prototype on-line image distribution archiving system to the Australian Centre for Remote Sensing (ACRES) in March 1998. The system, which manages a new ACRES product called 'SPOT-LITE', will be implemented by ACRES from late 1998. The images are obtained from the French SPOT satellite and provide earth observation data to resource managers.

CSIRO Telecommunications and Industrial Physics and the Australia Telescope National Facility are developing a new generation of integrated circuits for radio astronomy and telecommunications. Microwave circuit designers have commenced work on an Executive's Special Project, aimed at developing leading-edge millimetre-wave, digital and photonic integrated circuits using a new generation of semiconductor material, known as Indium Phosphide. $A1M fixed-price contract has been signed with TRW in the USA for the manufacture of three batches of these new technology analogue and digital circuit wafers over the next 2.5 years. The first circuits, due for delivery in March 1999, will be ultra-low noise 100 GHz amplifiers and other circuits for use in the millimetre-wave upgrade of the Australia Telescope National Facility.

CSIRO Mathematical and Information Sciences was enlisted by the Australian Taxation Office to participate in their Electronic Commerce project. This project, initiated by the Commissioner for Taxation, developed a blueprint for the ATO's approach to taxation of goods and services traded over the Internet. CSIRO researchers worked with the ATO to provide key advice on technical aspects of the Internet and to assist the ATO in the development of compliance strategies, taking into account the widespread use of developing technologies such as encryption, anonymous messages and globally mobile network connections.

A breakthrough in millimetre-wave high-performance chips is opening the way for cars that will be able to avoid collisions, wireless office communications and advanced surveillance systems. CSIRO engineers and their commercial partner, TRW Inc, have designed and produced several new world-class chips or MMICs (monolithic millimetre integrated circuits) using advanced semiconductor material, indium phosphide. For several years, CSIRO has been working with commercial partners to apply similar chips in wireless telecommunication systems at lower frequencies. CSIRO and TRW have now shown that it is feasible to design accurately, and then mass produce, high-performance chips for future generation products at these much higher frequencies.

CSIRO-led consortium called CeNTIE is developing a new 'super' Internet - hundreds of times faster than the current one. The internet is being designed for tele-health, media systems, information brokering, tele-collaboration and distance education. Another $30 million contributed by the members of the CeNTIE bid will augment a government grant of $14 million. Several end-user companies in the health, media, education and other service delivery industries will be using the network while new features are being developed and added to the system. CeNTIE will use dedicated fibres laid in capital cities and Nortel Networks will provide leading-edge optical equipment for the links between major nodes. Another consortium member, AMCOM Telecommunications, will provide interstate capacity between Melbourne, Adelaide and

Perth. East Coast capacity will be provided by arrangement with another ANP winner, GrangeNet, and this will result in a national backbone from Brisbane to Perth.

CSIRO has worked with the Boeing Company through the Boeing Commercial Airplane Group since 1989 to develop efficient production methods, and materials that are lighter, stronger and cheaper. The strategic research program covers manufacturing systems, advanced high performance materials and studies of the impact of aircraft emissions. Senior CSIRO officers have been seconded to Boeing in Seattle and special web links have been set up to facilitate research and development collaboration and management. The partnership has a significant direct benefit to Australia. Boeing employs 1, 900 people in Australia and has invested more than $500 million in local facilities, plant, equipment and training, local research and development, and technology transferred to Australia. Boeing has also exported $1.3 billion worth of aerospace parts from Australia.

Flinders Technologies is collaborating with Your Amigo Pty Ltd in the development of a more efficient and effective Technology for indexing and searching intranets, extranets and the World Wide Web. YourAmigo is a software company specializing in information search and retrieval products. The core technology is based on concepts originally developed at Flinders University. The Company has attracted a strong private investor base through experienced management, exceptional technology and performance track record. YourAmigo's search products represent a paradigm shift, out-performing traditional spider-based search technologies. Based on unique technology and architecture, our search products are able to provide organizations with a vastly improved ability to seamlessly search their intranets, extranets and web sites. In May 2001, YourAmigo signed a three-year Industry Alliance agreement with Australia's Defence Science and Technology Organisation (DSTO), the largest defense research establishment in the southern hemisphere.

Appendix B – List of University Initiatives

Anutech Pty Ltd – ANU University. Anutech has a technology division, which manages a portfolio of ANU technologies and R&D projects at various stages of development. The Division identifies and matches industry partners with ANU technologies and R&D expertise.

Business Liaison Office – The University of Sydney. Services provided by the BLO in the area of commercialisation include: Advice on intellectual property, evaluation of the best pathways to commercialise technology, Advice on accessing seed funding through Government programs or internal sources, to assist in developing projects to the stage where they are attractive to investors, Introductions to venture capitalists and other investors, Negotiations with investors and licensees, legal & business services in the establishment of companies, Facilitation of approval for the formation of companies within the University, Advice on incubators and Packaging of several technologies for investment.

Illawarra Technology Corporation – University of Wollongong. The corporation's objective is to establish and operate commercially viable offshore programs in key markets as well as build upon existing international operations for the University of Wollongong. The Communications Division focuses on research, development and application of radio based communications systems and their interface to fixed (wired) communication systems. The Advanced Manufacturing Technologies (AMT) Division provides applications of engineering, science and technology for major industries - from general manufacturing, pharmaceuticals, food and electronics to waste management, metals and mining.

Insearch Limited is a commercial company of the University of Technology, Sydney. It was formed in 1976 to generate income for the University, initially by providing consulting and research expertise to business, industry and government. In 1987 Insearch became an educational institution in its own right and today the provision of education services in Australia and overseas is Insearch's core business. UTS has a variety of technologies with commercial potential. UTS takes a flexible approach in partnering with companies and investors to exploit these opportunities. The University is able to partner through licensing or joint venture arrangements, depending on which vehicle is most appropriate. UTS researchers are eligible to apply for grants from the Insearch-UTS Technology Development Seed Fund, which supports proof-of concept projects. The typical project supported by the Seed Fund is a 12-month venture to build a prototype, proof the technical merit or commercial concept of a new piece of intellectual property or develop a business plan.

Office of Business Development – University of Western Sydney. They have developed a commercialisation flowchart, which provides an overview of the commercialisation process. The Office of Business Development can assist students and staff of the university to turn technology or intellectual property into a viable commercial product or service. Their core competency lies in our ability to facilitate technology transfer, licensing and Research and Development contracts to guide invention to reach its full business potential. They run a The Innovative Technology Network is a project, which brings together local business people to learn about, and exchange ideas, on innovation and new technologies. ICT industry partners include BAE Systems.

Macquarie Research Ltd – Macquarie University. The Company manages Macquarie University's patent portfolio and the commercialisation of academic inventions either through licensing or the formation of spin-off companies. Another of Macquarie Research Ltd's functions is to promote an awareness of issues relating to the protection of the University's intellectual property. The company provides administrative support to research projects undertaken by

academics and employs more than 70 full-time/part-time graduate and post-doctoral staff in research teams.

Norsearch Ltd - Wholly owned by Southern Cross University, Norsearch limited was established in 1986 to conduct the University's commercial operations. The primary objective of Norsearch is to provide the University with a flexible and responsive interface with regional, national and international communities. Norsearch's responsibilities include the identification and development of new and strategic initiatives, the marketing of the University's expertise, research and development, the establishment of collaborative arrangements with other organisations and project management. Strength in tourism and environmental science research.

TUNRA Limited was incorporated in 1969 as a company limited by guarantee by the Council of The University of Newcastle, to provide a broadly-based research and specialist education service to industry, commerce and the community. TUNRA is financially self-supporting and does not receive government or University grants or subsidies. TUNRA has access to the extensive facilities available to the academic staff and the University is the sole beneficiary of any surpluses TUNRA achieves on its operations.

Unisearch Limited is your gateway to new technologies and consulting capabilities centred on the University of New South Wales (UNSW) -one of Australia's premier research-based universities. Our long-term investment focus is on technology commercialisation. We provide licensing opportunities for innovative new technologies developed from academic research as well as investment opportunities. Unisearch collaborates with other research institutions on a variety of initiatives, which encourages stronger connections for emerging technologies with industry partners and experienced mentors. We also participate in various programmes with the Australian Graduate School of Management (AGSM) and have a direct link to consultants at the Australian Defence Force Academy (ADFA) through their business development office.

La Trobe Research and Development Park is now one of Australia's largest (over 50 ha), most unique (three-stage) and prestigious Technology Parks. It offers a world class business development environment for start-up, small mature and large technology based businesses and at present is the preferred location for over 30 technology tenants. The Park is an integral part of La Trobe University, one of Australia's largest multi-campus universities, known for excellence in teaching and research in the biological, computing, engineering, health and environmental sciences. The Park and University's management culture encourages synergies and collaboration between Park tenants, the technology business incubator, the University and the regional business community. We can offer the added incentive of tangible support from the State and Federal Governments by introducing new business entrants to key government agencies of assistance.

Melbourne University Private Ltd – Melbourne University. The Ventures Division offers a comprehensive technology commercialisation service to the academic community of the University of Melbourne and others. The Ventures Division aims to assist in the commercial development of research based intellectual property by providing access to development funds, assistance with establishing and managing start-up companies and patent management. Melbourne University Private has a network of Business Development Managers based in key faculties of the University of Melbourne. Their role is to source research activities with commercial potential. The commercialisation of research is largely handled through UniSeed Pty Ltd, a seed-stage venture capital fund jointly owned with UniQuest Pty Ltd, the commercial arm of the University of Queensland.

Monash Commercial Pty Ltd was established in January 2002 and is a wholly owned sunsidiary of Monash University. MonCom is responsible for four clusters of the university's commercial

entities based on research, coursework, services and property. The activities of Montech Pty Ltd are now part of MonCom. They include managing R&D projects and providing contract research and consulting services to industry, business and Government to ensure the rapid transfer of research developments. Monash is Australia's largest university with six campuses in Australia, campuses in Malaysia and South Africa and centres in London and Prato, Italy. The University has ten faculties with an international reputation for research in a number of disciplines, notably medicine and the biosciences, engineering, physical sciences, business, law and education.

RMIT Multimedia Database Systems. Established: 1989. The Multimedia Database Systems Group at RMIT is one of Australia's leading centres of research in electronic document management. The group develops systems (such as the Structured Information Manager) for document management and undertakes consultation within the wider area of database management and information retrieval. The group consists of eighteen full-time staff, ten postgraduate students, and a number of summer students.

Office for Research Griffith University. As part of the University's Office for Research, Research and Business Liaison is the support unit for the commercialisation of research expertise, discoveries and inventions available through Griffith University. In recent years the interactions between academic researchers and commercial interests have increased in number and complexity. Focus in Biotechnology.

Office of Commercial Services - Queensland University of Technology. The Division of Research and Advancement facilitates the interface between QUT and the global community. The Division fosters the strategic development of the University by building and consolidating partnerships between QUT and industry, commerce, government, graduates, the professions and community groups.

UniQuest Limited - The University of Queensland is the technology and consulting company of the University of Queensland. Since 1983 UniQuest has helped commercialise an increasing number of University of Queensland research projects. UniQuest receives over 100 new IP disclosures each year, writes more than 30 provisional patents each year and currently manages 187 patents for promising technologies on behalf of the University of Queensland. Increasingly spin-off and start-up companies are emerging as the commercialisation path of choice for these technologies. To-date, UniQuest, has helped create 40 spin-off companies and has more in the pipeline.

Commercial and Legal Office – James Cook University. The office oversees the corporatisation and commercialisation of new University enterprises and maintain liaison with current enterprises. Aswell as management of university contracts, agreements and deeds from drafting through to execution. It also provides access to legal services and provides business advice (eg Trade Practices Act, Business Plans, Business Diagnostics, Proposal/Tender preparation etc)

INDELTA Pty Ltd was established in 1998 as the business face of the University of Southern Queensland, Australia, the major shareholder and premier international provider of tertiary distance and online learning. The company has formed alliances with leaders in information technology, business, government and education, enabling it to bring together educational specialists, instructional and multimedia designers, and technology experts to develop eLearning and eBusiness solutions. INDELTA was privatised in January 2001 after successfully building a large client base with over 100 projects. The corporate base is in Melbourne, Australia, and the company also has offices and consultancy networks in Toowoomba, Australia; Sydney, Australia; and Florida, USA. After 7 months of operation as a fully commercial entity, INDELTA is

managing 70 active projects and 97 projects have been completed during INDELTA's three-year history.

Flinders Technologies Pty Ltd – Flinders University Since 1987, Flinders Technologies has invested in and successfully developed a number of leading edge technologies and commercialised these with companies around the world. The company undertakes Commercial Assessment of Technologies, Strategic Planning for Technology Commercialization, Innovation Fund Management, Project Portfolio Management, International Deal Management for Technology Commercialization and Technology Transfer.

ITEK Pty Ltd is wholly owned by the University of South Australia. Established by the University of South Australia in 1999, ITEK supports and partners innovative business opportunities from the University and other knowledge-rich organisations or individuals. ITEK is a self-funded organisation, our income being derived from fees for service and distributions from investments. Its aim is to achieve a sustainable business model through the provision of education, mentoring and direction to clients on a case by case basis, establish a best practice management system for supporting start-up businesses and commercialisation activities, develop and operate a seed capital fund with investments between $50K-200K per project and strengthen the local economy via ITEK assisted businesses creating jobs and commercialising critical new technologies.

Adelaide Research and Innovation The University is home base for many specialist research centres and units in a wide range of disciplines. ARI provides industry and government with direct access to the University's expertise and capability through its consulting and contract research services. It also offers advice and support to researchers and their sponsors and partners in technology transfer and commercialisation, including intellectual property management. ARI's Business Development Managers can put you in touch with the right expert or industry partner.

Unitas Consulting Limited – University of Tasmania is the commercial and consulting arm of the University of Tasmania, marketing the expertise of more than 700 professional educators and research specialists from its two campuses; Launceston and Hobart. The office of Unitas Consulting Ltd. is represented at these campuses and concentrates its efforts in three core division's consultancy projects, conference management services and continuing education.

Curtin Consultancy Services Limited (CCS) is the commercial arm of Curtin University of Technology. They facilitate the commercial interaction between Curtin University and external clients by providing services that include: Consultancy, Expert Witness, Materials Testing, Professional & Continuing Education, Training and Development and Contract Research and Development.CCS draws on the expertise and resources of the five Divisions of the University, and runs individual business units aligned to each Division of the university which are guided by the senior staff of those divisions

Murdoch University – Research and Development. Murdoch was created as a research university and since its establishment in 1975 it has earned and maintained a strong reputation for the excellence of its research work. The University has focused its research strengths into eight major areas, which reflect the University's strengths and multi-disciplinary skills with a focus on issues of international significance.

Uniseed Pty Ltd, the $20 million pre-seed venture fund established as a joint venture by UniQuest Pty Ltd and Melbourne Enterprises International Ltd (MEI Ltd), the commercialisation companies of the University of Queensland and the University of Melbourne respectively. In August 2001 the company committed to 13 investments for a total of $5.035 million for the company's first 10 months of operation. These investments are across a range of

technology sectors including biotechnology, IT, electronics and engineering, medical instruments, mining and education and all involved the creation of new start-up companies or licenses. Biotechnology investment represents 51% of the Uniseed portfolio with the remainder covering other sectors.

Appendix C – List of ICT CRCs

Australian Photonics CRC. The research focus is on the control, manipulation, transfer and storage of energy and information using photons - the fundamental particles of light. The goal of photonics research is to utilise the almost limitless capacity of optical fibres to transmit large volumes of information. The Centre has built a strong research base and core competencies and is an acknowledged world leader in photonics research and development. Its research program underpins a growing and maturing photonics industry in Australia. The Centre was established in 1992 and received second round of funding in 1999. They have established an incubator company, Redfern Photonics, which will assist the commercialisation of CRC research through the formation of spin-off companies.

Core Participants: ABB Transmission and Distribution Ltd; AOC Australia Ltd; Allen and Buckeridge Pty Ltd; Australian Photonics Pty Ltd; BAE Systems Australia Limited; Bishop Innovation Pty Ltd; CEOS Pty Ltd; Coherent Australia Scientific Pty Ltd; Ericsson Australia Pty Ltd; Filtronic Components Pty Ltd; Future Fibre Technologies Pty Ltd; Macquarie Photonics Pty Ltd; Nextrom OY; Nufern Inc; Redfern Photonics Pty Ltd; Telstra Corporation Limited; JDS Uniphase Pty Ltd; Tenix Systems Pty Ltd, The University of Sydney; The University of Melbourne; The Australian National University; The University of New South Wales; RMIT University, Defence Science and Technology Organisation (DSTO), Electricity Transmission Authority (TransGrid); TAFE NSW and Australian Electrical and Electronics Manufacturers Association Limited.

Australian Telecommunications CRC. The mission of the Australian Telecommunication CRC is to create technologies for advanced telecommunication services. Its objective is to create commercial opportunities in international niche markets as a way of enhancing Australia's role in the global arena. It will commercialise its research outcomes through its industry partners and through vehicles that will attract venture funding. It will also create processes for the quality implementation of new electronic designs and will establish programs to transfer its technology into Australian Industry. The centre was launched in 1999.

Core Participants: Ericsson Australia Pty Ltd; Open Telecommunications Ltd; Vodafone Network Pty Limited; Agilent Technologies Pty Ltd, Curtin University of Technology; RMIT University; Monash University; Victoria University of Technology; The University of Western Australia and CSIRO, Telecommunications and Industrial Physics.

CRC for Enterprise Distributed Systems Technology. The Centre's mission is to achieve fundamental improvements to Australian organisational competitiveness and efficiency through conducting and exploiting research in enterprise distributed systems technologies. The Centre will build the information technology (IT) infrastructure required to support business activities and interactions within and among distributed enterprises of the future.
The common research challenge that our diverse domains share is IT support for distributed enterprises that is cognisant of and dynamically reflects: the internal structure of the enterprise; information and knowledge used and/or generated by the enterprise; the activities carried out by and among the enterprise (s); the policies and external regulatory framework which shape the activities and business of the enterprise; the relationship of the enterprise to other enterprises, customers and other relevant parties; the pace and manner of the evolution of the enterprise. The Centre was established in July 1999.

Core Participants: Sun Microsystems Australia Pty Ltd; Telstra Corporation Ltd; Mincom Pty Ltd; RSA Security Australia Pty Ltd; CiTR Pty Ltd; Dialog Information Technology Pty Ltd;

Boeing Australia Limited; Fujitsu Australia Limited; Leaders IT Resource Specialists, The University of Queensland; Monash University; Queensland University of Technology, University of Technology, Sydney; Griffith University, CSIRO, Mathematical and Information Sciences; Telecommunications and Industrial Physics; Defence Science and Technology Organisation (DSTO); Defence Signals Directorate, Queensland Government, Centre for Information Technology and Communications and Queensland Department of State Development.

CRC for Satellite Systems. The mission of the Centre is to deliver sustainable advantage for Australian industries and government agencies based on the applications of small satellites. The participants will undertake a targeted research and development program in communication, space science and space engineering. They will carry out an education and training program utilising these technologies, emphasising "hands-on" projects (some in conjunction with the International Space University) which will lead excellent students to follow a career in space and enable Australian industry to exploit commercial opportunities in satellite systems and services. The marketing emphasis will be in the Asia-Pacific region, where demand for these products is growing most rapidly. The Centre's first major space mission is to develop an innovative scientific satellite, FedSat-1, and install it in orbit during 2002. The centre was established in 1998.

Core Participants: VIPAC Engineers and Scientists Limited; Auspace Limited, University of South Australia; Queensland University of Technology; The University of Newcastle, University of Technology, Sydney and CSIRO, Telecommunications and Industrial Physics.

CRC for Sensor Signal and Information Processing. The aim of the Centre is to become an enduring centre of excellence in sensor signal and information processing which services the needs of many sectors of industry, undertakes basic and applied research appropriate to end user needs, educate post graduate students in demand by employers, and provide advanced professional training beyond the reach of any single university. A key strategy in addressing this aim is the spinning off of companies. The centre was established in 1992.

Core Participants: Telstra Corporation Ltd; CEA Technologies Pty Limited; RLM Systems Pty Ltd; Compaq Computer Australia Pty Limited, The University of Adelaide; University of South Australia; Flinders University of South Australia; The University of Melbourne; The University of Queensland, Defence Science and Technology Organisation (DSTO), Electronics and Surveillance Research Laboratory.

CRC for Smart Internet Technology. The CRC's mission is to capitalise for Australia the outcomes of fundamental research and development of the future Internet and global connectivity. The Centre will build the information technology (IT) infrastructure required to improve the ease of use and the management of an Internet that is rapidly increasing in complexity. What is needed is a scalable, robust Internet that is also "smart" in assisting its users. The CRC was established on 1 July 2001 and has not reported any commercialisation success yet.

Core Participants: Motorola Australia Pty Limited; Telstra Corporation Ltd, The University of New South Wales; University of Wollongong; The Australian National University; The University of Sydney and NSW Department of Information Technology and Management.

CRC for Technology Enabled Capital Markets. The CRC will design and build technology in all areas of financial markets (pre-trade, trading, surveillance, settlement and registry) with a view to eventually providing an open architectured full solution that will permit inter-operability among systems (eg. Futures, equities, bonds) as well as being secure and financially scalable. It will initially concentrate on systems for intelligent trading and surveillance both of which require the identification of unusual trading behaviour. This will require a combination of skills including

data management, data visualisation and mathematical based algorithm development. The CRC will also focus on the wider aspects of securities market design including regulation, information mechanism, participants and financial instruments in order to ensure that technology does not get out of step with other key market elements. The centre was established in July 2001.

Core Participants Credit Suisse First Boston, Australian Financial Markets Association, Computershare, SMARTS Pty Limited, The University of Sydney; The University of New South Wales; University of Technology, Sydney; The University of Melbourne, Securities Industry Research Centre of Asia Pacific and ac3.

Appendix D - Australian Research Council (ARC) Initiatives

The role of the Australian Research Council (ARC) is to advise the government on research funding and policy and promote the conduct of research and research training. In 2000 the Government provided $1.6billion for research and research training through the ARC. The ARC makes recommendations to the Minister for Education, Science and Training for the funding of research proposals. The ARC administers those approved proposals.
The ARC also provides advice to the Minister on research matters.

- ARC Centres of Excellence

Announced in 2002 ARC Centres of Excellence will maintain and develop Australia's international standing in the Government's designated research in nano-materials and bio-materials, genome and phenome research, complex and intelligent systems and photon science and technology. These priority areas will be funded through the establishment of new Centres of Excellence concentrating teams of researchers in these areas, and through the ARC's Discovery and Linkage grants to outstanding individual researchers. Funding for grants and centres will be guided by factors including research excellence, potential national benefit and capacity to build scale, focus and critical mass in these areas.

- Commonwealth Centres of Excellence

In its statement Backing Australia's Ability, the Commonwealth Government announced that the ARC would contribute funds towards two world class Centres of Excellence. The Cente of Excellence in Biotechnology is funded jointly with the Department of Industry. The Centre of Excellence in Information and Communications Technology is funded jointly with the National Office for Information Economy.

- Special Research Centre Quantum Computer Technology.

The centre aims to build the world's first silicon-based solid-state quantum computer. Already, there is very strong international interest in the unfolding Australian research. The US Department of Energy is collaborating with the Australian team, and the centre has already held talks with a number of the major players in the US semi conductor industry, including Hewlett-Packard Laboratories and Intel.

- Key Centre for Social Applications of Geographical Information Systems.

The centre, which part of the University of Adelaide, developed one of the world's first 3-D interactive models of a city, Adelaide, based on detailed geographical information systems (GIS). The South Australian Government commissioned the study and saved hundreds of thousands of dollars because expensive and time-consuming site visits were not required and the job was completed much faster. A number of Australian businesses in a range of industries, State and Federal Governments, and countries are showing strong interest in using the centre's GIS models and expertise.

- Special Research Centre for Corporate Change.

The Centre, part of the Australian Graduate School of Management, is studying a number of overseas businesses and developing software models to help existing and new Australian businesses integrate effectively with e-sectors and maximise opportunities and benefits from the electronic arenas. The research is focussing on a number of industries including the finance, music and retail sectors.