

The logo for National ICT Australia is a circular emblem. It features a dark blue outer ring with a fine, repeating pattern of stylized human figures. Inside this ring is a large teal circle with a smaller teal circle at its center. To the right of the teal circles is a white circle. The text "NATIONAL ICT AUSTRALIA" is written in white, uppercase letters along the top inner edge of the dark blue ring. The text "ANNUAL ACTIVITY PLAN 2004" is written in white, uppercase letters along the bottom inner edge of the dark blue ring. A thin white horizontal line passes through the white circle.

NATIONAL ICT AUSTRALIA

ANNUAL ACTIVITY PLAN 2004

NICTA's MISSION

To be an enduring world-class research institute in Information and Communication Technologies that will generate national wealth

The means by which we will achieve our mission are:

Research by

- Attracting and retaining the highest quality research staff
- Focusing our research efforts toward areas of importance to Australia
- Working collaboratively both internally and with external partners
- Conducting research to the highest standards of excellence
- Being recognised among the world's top ICT research centres
- Providing leadership for high quality ICT research throughout Australia

Commercialisation by

- Building a strong entrepreneurial culture within NICTA
- Fostering open relationships with the Australian business community
- Optimising the economic benefit of NICTA's research to Australia
- Providing a measurable impact on Australian ICT competitiveness

Education by

- Partnering with Australian universities in order to increase the quality of Australian ICT PhD graduates
- Supporting the placement of research students in industrial and research internships as part of their training
- Increasing the number of highly qualified ICT researchers developed within Australia

Linkages by

- Building high quality partnerships with Australian businesses, multinationals, research institutions and universities
- Leveraging the support that has been given to us by our members and by Australian government agencies
- Serving as a focal point for the development of ICT industry clusters



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ABBREVIATIONS

ANU	Australian National University
CU	Curtin University
DSD	Defence Signals Directorate
DSTO	Defence Science and Technology Organisation
ECU	Edith Cowan University
ICT	Information and Communications Technology
ITR	Institute for Telecommunications Research, University of South Australia

NICTA Programs

ERTOS	Embedded, Real-time and Operating Systems
WSP	Wireless Signal Processing
NPC	Networks and Pervasive Computing
FM	Formal Methods
ESE	Empirical Software Engineering
STM	Security and Trust Management
SMLKA	Symbolic Machine Learning and Knowledge Acquisition
SMLSSP	Statistical Machine Learning and Sensor Signal Processing
KRR	Knowledge Representation and Reasoning
ASST	Autonomous Systems and Sensor Technologies
LC	Logic and Computation
SEACS	Systems Engineering and Complex Systems
HUM	Humans Understanding Machines
RIRDC	Rural Industries Research and Development Corporation
SITCRC	Smart Internet Cooperative Research Centre
SVRC	Software Verification Research Centre, University of Queensland
UNSW	University of New South Wales
USYD	University of Sydney
UA	University of Adelaide
UWA	University of Western Australia
WATRI	Western Australia Telecommunications Research Institute

NICTA's mission is to create an enduring world-class research institute in Information and Communications Technology (ICT) that will generate national wealth. NICTA is built on four pillars of activity – Research, Commercialisation, Education, and Linkages – each is supported by specific strategies which express the foundation principles that support the mission.

In 2003 NICTA was focused on the start-up tasks expressed in the Annual Activity Plan (AAP) 2003. These involved recruitment of the first researchers and executive staff; definition of the initial research programs; the development of commercialisation infrastructure; and the commencement of business operations. Some of these initial objectives will remain with NICTA throughout its growth phase, but in 2003 NICTA reached the operating capacity necessary to support an accelerating rate of growth. This makes the year in prospect particularly important since it will test and refine the blueprint.

2004 will see the consolidation of the initial research programs and the addition of two new programs. NICTA's research is to some extent defined by the widely recognised discipline related research themes that have been adopted. While these are important, there is a need for a further organising structure to direct the development of research into areas of national interest. These are NICTA's *Priority Challenges*. In 2004 these will be announced and will begin to shape the development of research projects and alliances.

A rapid area of development over the year will be the growing number of projects. Up to 12 new projects are expected to be launched in 2004 under a contestable funding process that sets aside more than one-third of research funds at each laboratory for research that is within the scope of the priority challenge umbrella and is outwardly focused.

In 2004 commercialisation activities will move from policy development and relationship building to validation of the intellectual property (IP) infrastructure and confirmation of key alliances necessary to support the future transfer of research and research staff to a commercial environment. In anticipation of the need for services by 2005, a set of well structured internal and external services will be in place before the close of 2004. The new PhD study program will be launched after being successfully negotiated in 2003 with both the ANU and UNSW. This ambitious program will put the traditional PhD into a context that embraces technical breadth, networking, development of professional skills, and commercial acumen. Up to 78 PhD candidates will be supported by NICTA in 2004.



NICTA's orientation towards national interest activities and collaborative research will see the formalisation of linkages that have been explored in 2003. In 2004 additional initiatives will be undertaken to open NICTA further to stakeholders. The key objectives for 2004 are delivery of a program for the socialisation of NICTA, particularly SMEs, and to extend outreach to industry sectors and communities that may appear outside the range of NICTA's mission, particularly against the background of the emerging *Priority Challenges*.

It is fundamental to NICTA's future success that it succeeds as a 'best practice' organisation in both its scientific base and in its efforts to extend science to national benefit. To become a best practice organisation NICTA will drive corporate development beyond protocols and procedures to grow a NICTA culture that is consciously:

1. A foundation for world-class scientific excellence.
2. Entrepreneurial in its ambition.
3. Open to industry and community.
4. Collaborative in the national interest.
5. Oriented to rewarding output and performance.
6. Additive to the nation's knowledge capital, not merely acquisitive.

Cultural cohesion will continue to be developed through cross disciplinary project research under the emerging *Priority Challenges* and activities such as bi-annual Program Leader workshops and monthly program presentations to Board members and staff. The redevelopment of the NICTA Intranet site portal will become the main knowledge management tool for sharing across sites.

In 2004 important measurable steps will be taken in the growth of NICTA's identity and institutional culture. A change will occur in the relative numbers of seconded researchers and NICTA-employed researchers. While seconded researchers have predominated in 2003, by the end of 2004 the ratio will be 3:2 in favour of NICTA-employed researchers. Accommodation relocation will also accelerate in 2004. More programs will be moved to sites at Australian Technology Park (ATP) and temporary accommodation in Canberra outside the Australian National University (ANU) campus. A new relationship will begin to develop between NICTA and its partner institutions.

INTRODUCTION


This Annual Activity Plan (AAP 2004) outlines the steps to be taken in NICTA's four pillars of activity – Research, Commercialisation, Education, Linkages – and the supporting institutional activities of NICTA to facilitate its growth. The broad objectives in each of these pillars are, broadly speaking, to:

- develop Australian ICT research capabilities in existing and emerging fields
- exploit for the benefit of Australia the commercial potential of research outputs
- increase the availability within Australia of ICT research skills by providing postgraduate training and attracting ICT researchers from overseas
- become a catalyst for the development of networks and clusters of ICT industry activity.

The current emphasis of NICTA's activity is to accelerate out of its growth phase to a steady state of operations by 2007 when NICTA will have established the capacity to position itself as an open world-class research institution. At this point NICTA will be based on 17 research programs comprising a total of 300 ICT researchers contributing to a long-term research agenda. Each program will have passed through a demanding cycle of establishment, focus building, review and refocusing. They will each be a recognised leader within their research community for excellence in research and its application.

Research will be managed to support the formation and closure of focused project teams as the prime movers for delivery of outcomes and engagement with research partners. A portfolio of 50 projects will have been formed under the direction setting influence of up to four exciting and relevant *Priority Challenges*. Projects will bring scientific excellence to bear on community, industry and national imperatives. 60% of NICTA's research budget will be committed to projects while 30% will be applied to its programs and the remaining 10% to significantly new ideas.

By 2007 NICTA will be considered a major partner by three key industries such as Health, Education, Finance, Mining, and Transport. Along with one of its partner industries, NICTA will have delivered a solution of consequence to the Australian people. Interaction with the venture capital community will be taking place on a regular basis. The outcome from this sense of partnership will be 10 economic impact events such as licensing, spin-off or partnership that add to Australia's ICT business capacity. NICTA will be known for its landmark ICT clusters that provide collocation opportunities for ICT firms and for the virtual cluster of firms organised around its programs that are committed to business success founded on research.




In 2007 45 students will graduate under NICTA's enhanced PhD program. The education infrastructure and resources will support up to 100 outstanding PhD candidates each year. Each will be working towards extensive expertise in their field but also pursuing the breadth of technical understanding essential to the realisation of Universal ICT. Their education will be further enhanced with commercial awareness and an appreciation of the value of professional networks. Programs will be in place to promote ICT as a career to young people with the ratio of women to men growing towards 1:4.

From a start-up in 2003 NICTA has emerged as an organisation that is well on the path to achieving its growth objectives. It will be apparent from this activity plan that some of the challenges that confronted NICTA in the first year of operations are still evident and will likely remain so throughout the period of development to steady-state operations. The most fundamental challenges for the growth period are staffing and the recruitment of researchers, culture building and institutional identity.

In general research recruitment in 2003 has been within expectations although there have been some set backs in the recruitment of individuals. The uncertainty over NICTA's long-term funding has been a factor in individual decision making by prospective research staff. The perceived greater personal security of a university position compared to the limited term offered under the current NICTA funding deed is understandably a compelling argument in some cases. Certainty is essential for research recruitment and growth.

Creating an entrepreneurial research environment remains an ongoing challenge as does finding the balance between strategic discipline-based research and more short-term project-focused research. The mechanisms to achieve both are outlined in this document at some length. Much of the driving force to build the culture that NICTA aspires to will come from management tools such as contestable project funding and the development of conceptual pointers for research collaboration such as the *Priority Challenges*. These are being implemented as quickly as they can reasonably be pursued, but not at the risk of distorting the fundamental scientific objective or national interest mission.

It is understandable that there should be a desire for NICTA to establish itself among a group of world-class research institutes as rapidly as possible. Significant effort has been invested in bringing NICTA to its present state and that alone would seem to justify the pursuit of international acknowledgment, but building identity on the global stage is a function of research output and success in commercialisation. It is a highly ambitious challenge for a start-up institution to firstly position itself for recognition



and then to offer itself in comparison against established world-class institutions in a five-year time frame, particularly when the institutions cited for the purpose of comparison have been established over three or more decades or have incomparably larger budgets.

The terms under which NICTA has been established offers scope for a longer-term research agenda to be formulated. It also introduces a new basis on which industry and research can approach one another. More significantly it offers the opportunity to work for national benefit and not solely for the benefit of members or shareholders.

The research environment that NICTA is working towards will not be won without the passage of time and effort. At this stage NICTA has only completed its first calendar year of operations. However, it has been an important foundation year that has seen NICTA move from a start-up to an organisation with the capacity to realise its mission. It has also set the tone for its research activities and collaborations with other parties. In summary, 2003 has been a challenging year which now sees NICTA well placed to accelerate in 2004 and remain on track for steady-state operations by 2007.

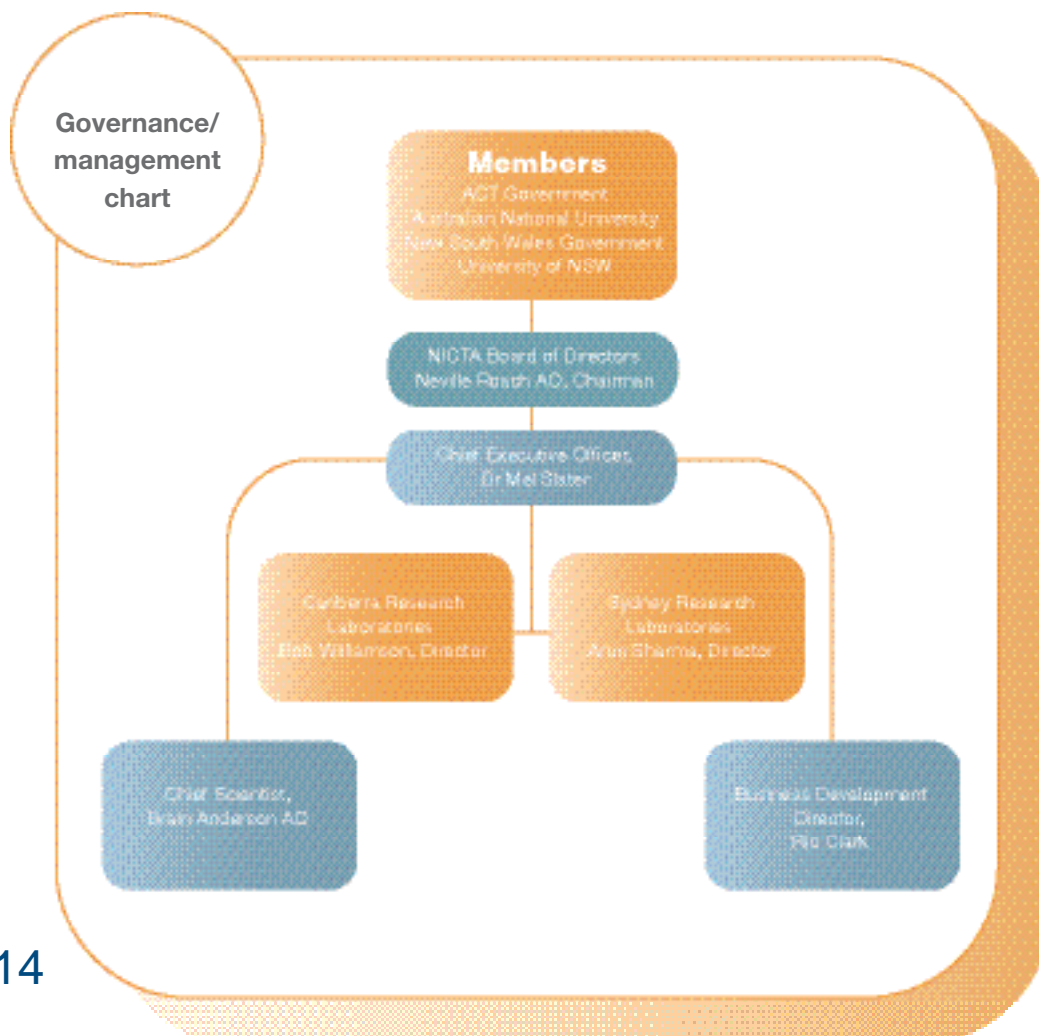
Dr Mel Slater
President and CEO
National ICT Australia Ltd


GOVERNANCE

NICTA is founded upon the contributions of its Members: the Australian National University; the University of New South Wales; the State of New South Wales; and the Australian Capital Territory. The University of Sydney is an alliance member.

The Members have specific rights of consideration and approval of the financial statements of the Company for the preceding financial year and consideration and acceptance of the Annual Activity Plan as to its compliance against the objectives of the Company.

The Commonwealth of Australia is contributing \$129.5 million over five years to the establishment of the Centre as part of the *Backing Australia's Ability* initiatives, under the ICT Centre of Excellence Program. The main participants in NICTA will contribute almost \$100 million, in cash and in-kind, over the same period.





As a limited liability company, NICTA operates independently of the consortium Members. It is governed by a Board of Directors, chaired by Neville Roach AO. The Board is assisted by three sub-committees drawn from its own ranks, but which are supplemented by others as required. These address important corporate functions of:

- governance and remuneration
- audit and finance
- evaluation.

In addition NICTA has the benefit of two external advisory groups with senior international membership. These are the:

- International Scientific Advisory Group (ISAG)
- International Business Advisory Group (IBAG).

Under their influence NICTA's strategic research and commercial initiatives are put under constructive scrutiny from leading internationally respected figures.

Two research laboratories are in operation. The NSW laboratory is based on two facilities in Sydney, one at the NICTA headquarters at the ATP and a major research facility located on The University of New South Wales (UNSW) campus at Kensington. The Canberra Laboratory is temporarily located on the ANU campus.

Dr Mel Slater, former Vice President of the global software group, Americas, for Motorola, is President and Chief Executive Officer. Professor Arun Sharma (former Head of the School of Computer Science and Engineering, UNSW) is Sydney Research Laboratory Director, Professor Robert Williamson (Research School of Information Sciences and Engineering, ANU) is Canberra Research Laboratory Director, and Professor Brian Anderson AO is Chief Scientist. Mr Ric Clark is Business Development Director.

RESEARCH MANAGEMENT

4.1 OBJECTIVE, POLICY AND STRATEGY

NICTA's objective in research is to develop a capability that is at the highest international standard and scale. Research is guided by NICTA's overall vision of Universal Information and Communication Technology. Under this vision the objective of NICTA's research is to contribute to the development of research that will make ICT universal, ubiquitous, usable, reliable and affordable.

The primary strategies that NICTA employs in support of research are:

1. Attract and retain the highest quality research staff from Australia and overseas.
2. Focus the research efforts to build critical mass in selected areas in ICT where Australia can make a difference.
3. Work as an integrated whole with strong collaboration between research laboratories and with external partners.

4.1.1 Staged Growth


In broad terms NICTA's research growth is based on a set of defined growth objectives over five years that will take the organisation to its steady-state operations.

2004 is a significant stage in this growth strategy. It represents the transition from policy and procedure development in 2003 to an implementation and growth phase. Table 1 provides a survey of key corporate level research related milestones and shows the anticipated outcomes for 2004 in relation to the wider objectives leading to NICTA's steady-state operations in 2007.

Table 1: NICTA Research Activity Outlook

	2001	2002	2003	2004	2005	2006	2007
Company	End company re-organized	Consultancy established Funding Deed signed	First members meeting NICTA launch US/IO MCA UNSW ANU MCA Chief scientist Operations & HR managers	ACT Launch US/IO MCA Director business development	ACT Laboratory Director confirmed		
Research Staff			Program leaders recruited Program reviews confirmed	Seconded researchers recruited First ten researchers recruited	ACT Researchers productive	First graduate research students enrolable	Program leaders employed by NICTA
Research Agenda			Inherited research activity		3 priority challenges determined and in effect		Phase 2 research focus generated
Research Programs			Initial programs identified Program input established	One new program added	Formal program and project evaluations Three new programs added		17 programs in operation
Research Projects			3 projects 10 projects suited	12 projects added	12 projects added	12 projects added	Portfolio of 30-50 projects*
Research Linkages			First formal Research connections established outside Sydney and Canberra Research and Commercial Collaborations established		Infrastructure led bid development First deliverable deliverable	Outreach Foundations established for research interaction across Australia NICTA research journal established	
International Context			ISAO established First ISAO meeting held	ISAO recommendations begin to have a meaningful impact on research programs	Emergence of research adaptability of international opportunities	International paper awards Recognition of initial research focus Research benchmark arrangements	
Research Commercialisation			First IP covering Research output streamlining process	Research output covering process Commercialisation infrastructure specified		Commercialisation infrastructure established	Commercial impact process established Economic spin products institutionalised

(* Portfolio range will be affected by completion rates)



During 2004 the expansion of NICTA's research capabilities will be carried out at two levels: corporate research management (section 4) and program activity (sections 5 & 6). Corporate initiatives will establish the operating conditions necessary to support efficient and effective research into the future. This will chiefly refine the research organisation structures, apply key decision making processes to research activity, and institute research review procedures. In combination these are expected to take research activity beyond the base level inherited from the partner universities.

4.1.2 Research Organisation

NICTA research is currently organised around three structures referred to as Themes, Programs and Projects.


Themes serve to define the broad boundaries of NICTA's strategic research. There are five Themes:

1. Infrastructure Technologies.
2. Intelligent Systems.
3. Software Engineering.
4. Human-Machine Interaction.
5. Foundations.

There is no management structure associated with the Themes. They are important because they help to locate NICTA's research within the breadth of ICT research and allow the basic operating units to be conceptually grouped. As NICTA moves to its full operational level the role of Themes as an organising principle will diminish and be supplanted by the more outcome-oriented *Priority Challenges*.

Programs deliver the four core NICTA activities: research; research training; the creation of intellectual property for commercialisation; and research and commercial linkages. Programs are the basic departmental structures for research management. Although they are not permanent they are enduring and can be expected to operate for 8 – 12 years.

NICTA has 12 programs that provide its strategic research focus in defined fields. It is largely through the program structure that NICTA researchers relate to the wider ICT research community in discipline-based research that is long term, strategic and world class. Programs also generate specific research projects, often based on the application of their strategic research and collaboration with other public research interests and companies.



Projects are focused research activities with a leader, budget, timeline and deliverables. They are of short duration, typically <1 – 3 years. They are also oriented towards collaboration between programs and with external public and private sector entities. It is largely through project activity that NICTA researchers relate to industry and the community through the application of research expertise to specific problems.

4.1.3 Research Management Objectives in 2004

Research Management Structure

Research management within NICTA is the responsibility of the Research Management Coordination Committee (RMCC). It comprises the Chief Executive Officer, Chief Scientist, Director Business Development, Research Laboratory Directors, and Finance Manager. The RMCC meets regularly to assess project proposals and coordinate research and commercialisation activity. It is also responsible for annual program reviews.

The International Science Advisory Group (ISAG) exists as an important advisory forum on research. The ISAG has been established to bring NICTA's research under constructive scrutiny by international experts. In 2003 the ISAG challenged NICTA to consider organising some of its research effort around *Priority Challenges*.

The ISAG will have two key tasks during 2004. The first will be to review and verify the progress made towards defining and disseminating, throughout NICTA and the wider community, the *Priority Challenges* to be adopted as organising principles for research. This will occur in March when the ISAG will convene for its second meeting. The second key task for ISAG will be its input to program and project reviews.

As well as the formal review processes, the ISAG members will interact informally with Program Leaders at the ISAG meetings to provide direct advice and suggestions to Program Leaders. A list of ISAG members is provided at section 14.3.



Objectives in 2004

NICTA's strategy for 2004 will extend research activity beyond setting up the research programs to the introduction of measures that will enhance their focus as organised research units. Consequently, while the research strategy in terms of program activity will be largely in the domain of the Program Leaders and Laboratory Directors the corporate research management objectives are to ensure that:

- programs are populated with NICTA employees to complement seconded researchers
- *Priority Challenges* are established within the organisational structure
- quality projects are developed in support of *Priority Challenges*
- the methodology for program reviews is in operation.

4.1.4 Program Staffing


In 2003 each program was founded through the secondment of staff from the partner universities. In line with the milestones for 2003 a total of 15 research staff were recruited to NICTA along with program administrators and research assistants. The level of success in recruitment of staff varied between programs for a variety of reasons. This resulted in some programs reaching only 25% of their expected steady-state complement while others exceeded 50% of projected staff levels.

The fundamental objective for research growth in 2004 is for recruited researchers to be predominant over seconded staff by a ratio of 3:2. This is based on the planned recruitment of 53 research staff over the year that will take recruited researcher staff from 33 in January 2004 to 86 by the end of 2004.

4.1.5 Priority Challenges

Priority Challenges will be introduced as a management strategy to more tightly cluster projects around imperatives founded on challenges of national significance or interest. The *Priority Challenges* are intended to give direction in the development of research projects.

As organising principles they will express something of how NICTA will be open and responsive to challenges in the community and nation. The concept was developed in response to advice from the ISAG provided in September 2003. While they do not have



any direct allocative mechanism associated with them, the *Priority Challenges* will aim to stimulate the thinking of NICTA researchers and collaborators about the application of their research in project activity.

Priority Challenges will necessarily be defined through consultation and consensus. As an aid for thinking about the challenges, a set of criteria has been developed. Ideally, they will:

- have an impact for Australia which is meaningful and apparent to the community
- support National Research Priorities
- be sufficiently broad to be a productive source of projects
- have the potential to deliver a worldwide impact
- span programs and sites within NICTA and be inclusive of other institutions
- inspire outcomes that are achievable within the life of the *Priority Challenge*.

Based on these criteria the *Priority Challenges* can be expected to have a lifetime in the vicinity of five years. They will be ambitious, but aspirational, and not so grandiose as to fail to deliver results within the term of the challenge. Importantly, for NICTA their introduction will be institution building and will strengthen ties across programs, between research laboratories and with outside institutions.

The first *Priority Challenge* will be established early in 2004 with several others to be announced during 2004.

The National Research Priorities


The vision of Universal ICT makes NICTA alert to the possibility of service to the community through the application of ICT. At this early stage of its operations NICTA has not explicitly turned its energies to addressing the National Research Priorities. Many projects that will be carried into 2004 or considered for commencement in 2004 will serve the objectives of the National Research Priorities.



Table 2 below shows the distribution of activity discussed in sections 5 and 6 that reflects alignment between NICTA research activity and the National Research Priorities.

Table 2: National Research Priorities

Program	Frontier Technologies for Building & Transforming Industries	Promoting and Maintaining Good Health	Safeguarding Australia	An Environmentally Sustainable Australia
ERTOS	Embedded Systems			
NPC	Ambient Networks Rural Sensor Networks		Adaptive Media Access Control	Cane toad monitoring Sensor Networks for bush fire monitoring
ESE	Statistical Process Control			
STM				
SMLKA	RoboCup	Robot rescue	Project Lear	
SMLSSP			Dynamic Planning	
KRR			Negotiation Axiomatics and Belief Merging	
ASST	Autonomous Road Vehicles	Medical Imaging		
SEACS	Advanced adaptive optics			



By their nature some programs will be in a position to respond to the National Research Priorities through project development, while others, such as the foundation programs, will have less opportunity to address them directly but will often provide important fundamental contributions as part of a collaborative effort. NICTA as a whole will respond to the National Research Priorities through its *Priority Challenges*.

4.1.6 Quality Projects


In 2004 a management process will be introduced to further enhance project development through the use of contestable funding. This will provide an important incentive in project planning by setting aside approximately one-third of the overall research expenditure (35-38% in 2004) at each laboratory as two equal contestable funding pools available for projects:

1. Aligned with NICTA's *Priority Challenges*.
2. Inclusive of external organisations, especially industry.

Contestability will be an important element in developing an enterprising research culture, but it will be somewhat different from the ARC processes. The competition for funding will remain merit based, but it will include a degree of engagement between project bidders and Laboratory Directors to shape bids in the direction of wider objectives of *Priority Challenges*, commercialisation and national benefit.

New project proposals will be subject to a formal process of assessment by the RMCC. The initiation of projects will be based on a detailed set of project criteria to support informed decision making and risk management. Projects proposals will have to satisfy assessment against criteria under the headings of:

- Proposed Partners
- Alignment with *Priority Challenges*
- Scientific Challenges
- Suitability for Research Training
- Proposed Outcomes (Deliverables)
- Funding justification
- Timeline including initial milestones
- Proposed IP arrangements
- Proposed budget.



All projects will be required to have a client or client surrogate (who may be part of the project team) who will have a say in whether the proposed deliverables are in fact being delivered. Large-scale and long-term projects will have major internal reviews under the supervision of NICTA's Chief Scientist or Laboratory Directors.

4.1.7 Program Development and Review

NICTA commenced operations in 2003 with 12 programs staffed by researchers seconded from partner universities. This arrangement was sufficient to provide initial direction to the research effort, provide a platform to begin recruitment of researchers and provide graduate research supervision. During 2004 existing programs will refine the focus of their research and continue to expand as new researchers are recruited.

NICTA's growth is based on the founding of new programs. Concept proposals for a new program are reviewed by Program Leaders and Laboratory Directors in a workshop environment to identify possible research directions, strengths and weaknesses. Any proposal for a new program proceeds from the Laboratory Director to the RMCC for endorsement.


Program evaluation is based on consideration of:

- **Scientific Excellence:** Magnitude of the challenge, contribution to knowledge, global impact and researcher pool
- **Benefits:** Commercialisation outcomes, collaboration prospects, research training prospects, intersection with National Research Priorities, national benefit and project generation
- **Operational:** Budget, location, linkage potential, impact on other programs.

In 2004 a new program on *Security and Trust Management* will commence in the Canberra Research Laboratory, with extensive linkages across several existing programs. Subject to the successful review by the RMCC of a feasibility proposal a further Sydney-based program in *Databases and Services* will also commence.

Formal Review of Programs

The Board has established an Evaluation Committee to manage major program reviews. The Evaluation Committee will consider the reviews and recommendations of specialised committees of external experts and make recommendations to the Board. Programs may be terminated on the advice of the specialist review committees.



NICTA's Constitution specifies that the committee consist of 6-8 members drawn from the following groups:

- the ICT industry (including one from an Australian SME)
- the ICT research community
- a person from the venture capital or technology commercialisation community
- a person appointed by unanimous agreement of the members.

The proposed Membership of the Evaluation Committee is:

- Chair (External to NICTA; yet to be announced)
- Graham Goodwin (ICT research community and Board member)
- Brand Hoff (ICT Industry – SME and Board member)
- Brian Anderson (Chief Scientist; ICT research community)
- David Skellern (Technology Commercialisation & Board member)
- Mel Slater (CEO NICTA)

A further person may be appointed by the Members to the evaluation committee.

Annual Monitoring of Programs

Programs will also be subject to an annual review that may result in adjustments to some activity. The review will assess the performance of each program in terms of:

- impact
- clarity and consistency of vision
- contribution to the four pillars
- project activity
- operational context
- overall initiative and entrepreneurship.

A review involves a five step procedure:

1. Program Leaders provide documentation of annual performance to Laboratory Directors.
2. The Laboratory Director reviews the documentation.
3. A presentation is made to senior management and the Board on program outcomes.
4. A summary of outcomes is presented to an ISAG meeting.
5. The Laboratory Director provides feedback to the Program Leader.



4.2 MILESTONES

The expected outcomes from the perspective of corporate management of research for 2004 are that NICTA's research culture will be oriented towards entrepreneurship through the influence of contestable funding while remaining strongly compatible with research excellence and collegiality. The Milestones leading to the scenario are:

01 January – 30 June

1. Formulation and announcement of *Priority Challenges*.
2. Allocation of 35% of research funding through contestable funds.
3. Review of *Priority Challenges* by ISAG

01 July – 31 December

4. NICTA Research Staff in the majority over seconded staff.
5. Completion of Annual Review of programs.

4.3 STRATEGIC OUTLOOK 2005 AND 2006

By the end of 2005, it is expected that the initial programs will be sufficiently staffed to provide NICTA with the critical mass of researchers that will see the beginnings of substantial research outcomes and which will allow NICTA to operate near capacity by 2007.

In 2005 – 2006 substantial outcomes from projects will be evident in the form of research papers, conference proceedings and the first deliverables from research collaboration with external partners should be in evidence. Formal program and project evaluations will be in operation providing a full complement of review mechanisms to maintain a leading edge to NICTA's research activities.

The assessment process for two to three new programs will have been completed allowing for their introduction in 2006. There will be substantial activity in a range of collaborative research partnerships with other research institutions. Alongside domestic standing, it is expected that research acceptance will have been established at international conferences. At the same time as NICTA's research capability is maturing, the processes for the commercial scanning of research for commercialisation opportunities will have been developed, trialled and institutionalised.

In 2006 the first graduate research students should have completed their enhanced study programs adding to the potential pool of research talent available to NICTA.

By the end of 2006 the development of a Phase 2 Research Focus will be underway to determine the need for new directions in research. As the research base matures it will allow for new investments in research support to be made such as the establishment of a NICTA Research Journal and the setting up of Outreach Foundations for research interaction across Australia.

THE RESEARCH PROGRAMS

Programs support NICTA's engagement with global ICT research of the highest calibre. As discipline driven groupings they are responsible for contributing to the four pillars of NICTA. Programs are also expected to be involved in projects to encourage research collaboration with other public research interests and companies. Programs are expected to typically endure for 2 – 3 review cycles after which time it is expected they could be significantly changed or closed.

NICTA researchers are located within programs according to their discipline expertise. A merit-based career path is in place based on four ranks of researcher (from postdoctoral to a level analogous to full professor): Researcher (Level B), Senior Researcher (Level C), Principal Researcher (Level D) and Senior Principal Researcher (Level E). A table of NICTA research staff showing individuals, levels, affiliations, fractional appointments and recruitment origins is provided in section 14.1.

To support their activities the 12 programs are allocated base funding using a block grant mechanism. The magnitude of the budget for a program is a function of both the strategic importance – scientifically and in terms of benefit to Australia – of the area and the overall performance of the program, in particular the degree of and quality of a program's contribution to projects.

The existing programs are at various stages of development. The negotiation of Research Resource Agreements and recruitment variations are factors in the different outcomes. But, more significantly, the apparent differences between programs arise from the complexity of building their respective theoretical and applications focus. The technical content, collaboration opportunities and development paths for the programs are significantly different. This is reflected in both the variations in their outcomes for 2003 and the anticipated opportunities for 2004. While some show an abundance of potential opportunities for productive projects, others, by the nature of their discipline, provide more fundamental research output and will support other research efforts rather than their own product opportunities.

Table 3: NICTA Themes and Programs

Theme	Program	Leader	Location
Infrastructure Technologies	Embedded, Real-time and Operating Systems	Gernot Heiser	Kensington
	Wireless Signal Processing	Rodney Kennedy	Canberra (& Kensington)
	Networks and Pervasive Computing	Aruna Seneviratne	ATP

Table 3: NICTA Themes and Programs continued

Theme	Program	Leader	Location
Software Engineering	Formal Methods	Ron van der Meyden	Kensington
	Empirical Software Engineering	Ross Jeffery	ATP
	Security and Trust Management	TBA – New program	Canberra
Intelligent Systems	Symbolic Machine Learning and Knowledge Acquisition	Arun Sharma	Kensington
	Statistical Machine Learning and Sensor Signal Processing	Bob Williamson	Canberra
	Knowledge Representation and Reasoning	Norman Foo	Kensington (& Canberra)
	Autonomous Systems and Sensor Technologies	Richard Hartley	Canberra
Foundations	Logic and Computation	John Slaney	Canberra
	Systems Engineering and Complex Systems	John Moore	Canberra (& Kensington)
Human-Machine Interaction	Humans Understanding Machines (Visualisation)	Peter Eades	ATP

The remainder of this section provides a survey of each research program in turn as they are grouped under NICTA's research Themes. It addresses the research focus of each, its anticipated activity and outcomes for 2004, the prospects for collaboration with other institutions, industry at both a domestic and international level; and finally research staff recruitment status and targets. The project work for all programs is grouped together in section 6.



5.1

Infrastructure Technologies




Theme:	Infrastructure Technologies		
Programs:	Embedded, Real-time and Operating Systems		
	Wireless Signal Processing		
	Networks and Pervasive Computing		
Research			
ERTOS	WSP	NPC	
Microkernel technology for embedded systems	Wireless Theory	Pervasive Applications	
Reliability of Embedded systems	Advanced design and Analysis tools	Network Infrastructure	
Linux OS	Demonstrator Systems	Instrumentation	

Infrastructure technologies are the ‘nuts and bolts’ that all other Information and Communication Technologies build upon. As a research discipline Infrastructure Technologies pose myriad possibilities for strategic research that have arisen from the advances in microelectronics.

NICTA will achieve its mission by focussing on topics within the Theme that are particularly relevant to its research vision. Three commencement programs were identified as of special significance.

1. ***Embedded, Real-Time and Operating Systems*** will conduct research into the embedding of ICT that is reliable and trustworthy within other technologies.
2. ***Networking and Pervasive Computing*** research will pursue the tremendous advantages to be gained from interconnecting diverse Information and Communication technologies.
3. ***Wireless Signal Processing*** will research new theory, advanced design and analysis tools, and demonstrator systems for physical layer wireless communications that are needed to support high rate digital data to small mobile terminals at low cost and long battery life.

Future program activity related to this Theme may extend to problems arising in *Database and Enterprise Systems* in the areas of web databases, hidden databases for embedded devices and databases arising in bioinformatics. *Circuit and System Design* is another prospective program which could be founded around the many challenges remaining in system level design.



Both of these prospects offer potential gains that could be won through research of the scale envisaged for NICTA in its steady-state operations.

5.1.1 Embedded, Real time and Operating Systems (ERTOS)

Research Focus

The *Embedded, Real-Time and Operating Systems (ERTOS)* program aims to develop technologies and methods that support the implementation of highly-reliable yet inexpensive embedded systems.

In the long term the program will provide methodologies, frameworks, components and tools that support the development of embedded systems where correctness or safety properties of the whole software stack can be mathematically proven.

Program Activity

The short- to medium-term research in the program will support reliability and reduced cost through work on small components with small, well-defined interfaces; encapsulated by a very small yet highly efficient microkernel (small modules within an operating system that implement the basic features of the system and can be flexibly configured). This involves developments in operating systems, programming languages and compiler techniques.


Present program research is centred on the development of microkernel technology for embedded systems. The focus is presently on the demonstration of well-performing componentised systems on top of a microkernel. Running device drivers as user-level components has a high potential for enhancing system reliability, but it is particularly challenging due to the critical performance requirements of many drivers, particularly in real-time systems. During 2004 the program will undertake:

- the design of a component framework for microkernel-based embedded systems
- a prototype implementation of a number of core components.

These will substantially support the specific goal for 2004 of demonstrating acceptable performance of user-level device drivers.

Other activities to be undertaken are the investigation of fine-grained protection mechanisms for high-performance component systems, memory management on modern architectures, and combining language and operating-system techniques to achieve secure execution of mobile code.

Given the status of Linux as the dominant OS for new embedded systems developments, the program will maintain its Linux activities as Linux will be required to support most potential receptors in the short term. This includes support of a complete



Linux system on top of the microkernel. Finally, research staff will provide support for nine PhD candidates during 2004.

Network and Linkage Activity

The program has identified a number of opportunities for research and project collaboration. Existing collaborators include HP, IBM, STMicroelectronics, Dresden and Karlsruhe Universities. Anticipated collaborators include Queensland University of Technology, the Australian Centre for Field Robotics and Intel Research.

Potential receptors are companies operating in the embedded space, particularly SMEs. The program will establish links as opportunities arise, although in the short term this will not be trivial, as companies expect complete tools and development environments. The program is developing a rudimentary environment but will accelerate development for any collaboration that has the potential to provide either significant research challenges or impact.

The depth of Linux expertise available in the program is a good basis for building collaboration with clients who are not yet ready for a microkernel-based system, and will help later migration to such a system.


Staffing

The program is based on a complement of five research staff contributed by or contracted from UNSW. In addition Researchers have been recruited from Germany and the Netherlands. A research engineer, research programmer and systems programmer are also in place. This places the program within 40% of its expected steady-state research staff level and provides a strong base for the planned activity in 2004. However, recruitment into the program is expected to face some challenges because people with the right skills are few and highly valued. Specific requirements for the program are Researchers with core low-level system background and with specific expertise in real-time systems, power management and compilers.

5.1.2 Wireless Signal Processing (WSP)

Research Focus

The *Wireless Signal Processing* program aims to develop the underlying technologies that will enable high rate digital data to small mobile terminals at low cost and long battery life.



To achieve this objective the program will pursue the development of new theory and advanced tools directed at physical layer wireless communications. The program will carry out research in:

- study of fundamental performance limitations of wireless telecommunications systems – especially mobile and ones requiring adaptation
- information theory related to wireless communication
- multiple antenna diversity systems such as MIMO systems and smart antennas
- multi-user systems and multi-access technologies
- adaptive algorithms for equalisation, timing recovery and decoding
- coding for wireless channels
- wireless and mobile channel modelling;
- confluence of wireless physical layer communications with packet-based network layers.

Program Activity

The priority objective in 2004 is to build a national research network that will establish critical mass in Australia's wireless research capacity. A considerable effort will be made by program researchers to establish an Australian Research Network that will link strong Australian-based researchers working in areas compatible with the program. The goals for mid-year are to have:

1. Identified the strongest Australian university groups to form the basis of a Research Network.
2. Established a student exchange with Australian universities in the Research Network.

Subsequent staged developments that are planned for the Network are a series of wireless workshops and research collaboration at a project level.

Program research will be active across all the areas within its research focus and will be the subject of publications throughout the year. A basic research effort into information theory and communications theory is planned with the Institute for Telecommunications Research, University of South Australia. Program researchers will also be contributing to the Australian Communications Theory Workshop (AusCTW) through papers and as editor of workshop publications.

Three graduate courses will also be developed and taught by program researchers in 2004:

1. NICTA Overview Course – *Wireless Communications* (Mar-Apr 2004).
2. NICTA Advanced Course – *Turbo Receiver Design* (Apr-May 2004).
3. NICTA Advanced Course – *Continuous Wireless Communications* (July 2004).

Research staff will provide supervision for seven PhD candidates during 2004.



Network and Linkage Activity

In the first quarter of 2004 the program expects to finalise mechanisms for interaction between WSP and WATRI based around joint projects, researcher exchange, and student exchange. By mid-2004 the program will have reviewed potential linkages with industrial clients in Australia and established the first project with a first preferred client by mid-2004.

A network of international linkages will be established over 2004 with leading institutions in North America and Europe, including University of California, Davis; University of Ulm, Germany; and Swiss Federal Institute of Technology, Zurich (ETHZ).

Staffing

The program has research staff at both laboratories. The current complement comprises three ANU contributed researchers. An RRA for a further contributed researcher from UNSW is expected to be finalised in 2004. The program recruited four researchers in 2003 taking it to approximately 40% of its anticipated steady-state level. The program has offered a position to a researcher in the United States.

The recruitment objectives for the program in 2004 are to secure the appointment of a Program Leader by mid-year. Offers for a further three Level B positions will be made by the same time, through either the generic NICTA postdoctoral or program-specific postdoctoral mechanism. To ensure that the Program Leader has sufficient scope to shape the research focus on appointment, the recruitment of a further two to three researcher staff will be reserved to the Program Leader.


5.1.3 Networks and Pervasive Computing (NPC)

Research Focus

The objective of NICTA's Networks and Pervasive Computing program is to contribute to the development of new applications and communication system functions which will develop and deploy pervasive computing systems. The program is based around three fundamental areas of research that contribute to Universal ICT by making different wireless networks accessible to the increasing range of wireless devices on terms of 'access from anywhere at anytime'. The research areas are:

Pervasive Applications aims to support the development of applications that will run on the emerging pervasive infrastructure by developing mechanisms for dealing with:

- intermittent availability and variation of application services
- discovery of services and resources
- the safe and easy use of the new and emerging pervasive applications (usability).



Network Infrastructure which will be used in pervasive computing systems will need to support extremely large numbers of diverse devices, numerous networking technologies, and a highly mobile user population. This work will develop mechanisms for:

- configuring extremely large numbers of devices
- satisfying the different end-to-end transport requirements of new applications
- satisfying the special quality of service and security requirements
- dealing with the high mobility between different network types.

Instrumentation – for pervasive computing to become reality, the physical world has been instrumented with sensors and embedded computing that can communicate with each other as well as with the systems that can use the inputs in a useful manner. This work will develop mechanisms for dealing with:

- limitations of access
- extreme dynamics.

Program Activity

The program is leading the development of research infrastructure to support research and project activity within NICTA. Two significant test-beds will be under development within the program during 2004, these are:

NICTA Test-bed for Sensor Networks Research


In 2003 the program initiated development of a hybrid test-bed of sensing/wireless devices such as Crossbow MICA motes and Stargates to support experimental sensor networks research. The test-bed will be controlled and configured from a desktop machine and will be used to emulate, test and validate previously-described sensor network protocols with real devices and sensor data.

Mobile Networking Laboratory

This NICTA objective is to build an experimental test-bed for mobile routers and networks, enabling both academic and industrial researchers to test further protocol enhancements in a controlled, reproducible setting. The implementation of the test bed will be in two stages:

1. Several wireless access points will be mounted within NICTA's ATP headquarters. They will be configured as separate networks and movement will be emulated through control of signal strength and other parameters.
2. A mobile router will be mounted in a vehicle to support 'real world' testing of protocols and algorithms.

The initial infrastructure is expected to be in place during the latter part of 2004, and for 'clients' (faculty and students) to begin using it then. The second stage will commence implementation after 'proof of concept' has been established for the mobile routing



algorithms in the emulated environment. This is expected to happen in the first half of 2005. The laboratory is expected to draw interest from the mobile networking community and provide opportunities for commercialisation of research in environments such as equipment manufacture and service applications such as public transportation.

Supervision will be provided for six PhD candidates from the program.

Network and Linkage Activity

The strong application focus of the program creates significant opportunities for collaboration within Australia and overseas. The program will host the following international visitors in 2004:

- Professor Michel Dias, Director CNRS LAARS Laboratory, Toulouse France, January/February 2004
- Dr. Yuri Ismailov, Ericsson Research, March 2004
- Dr. Christophe Diot – Intel Research Labs, Cambridge UK
- Professor Tomasz Imelinski, Rutgers University, USA.

Through the program NICTA is co-sponsor of the IEEE EmNetS workshop which is to be held in November 2004. Nirupama Bulusu and Sanjay Jha are workshop co-chairs on behalf of NICTA and UNSW respectively.

Staffing

The program is currently based on a contributed Program Leader and five fractional contributed researchers from UNSW. In 2003 it recruited researchers from the USA and Israel and a research engineer. The current research staff level is 33% of the planned steady-state level.

One Level B offer has been made to a researcher from France and two additional Level B researchers from the USA are being considered.



5.2

Software Engineering



Theme:	Software Engineering
Programs:	Formal Methods
	Empirical Software Engineering
	Security and Trust Management – new program
Research	
FM	ESE
Specialised semantics and languages	Software quality
Calculi for reasoning in specialised languages	Software architectures product lines and evaluation
Algorithmic techniques for verification and synthesis	Empirical research methods
Tools for the systems developer	Software process improvement
	Software engineering experience management

ICT technology is unimaginable without software; NICTA's vision for universal ICT is unachievable in the face of ongoing challenges to the development of increasingly more reliable software at reduced cost. In an environment of Universal ICT where software is essential to even the most basic utilities and services, reliability is fast becoming a matter of national and business interest. The *Software Engineering* Theme brings together programs that address critical challenges confronting the design and development of software.

Formal Methods research holds out the prospect of software development methods that guarantee certain performance criteria essential to both safety-critical systems and systems requiring high assurance such as operating systems, computer security and defence applications.

Empirical Software Engineering will include research on the crucial but still poorly understood empirical aspects of software construction.

The **Software Engineering** Theme will be extended in 2004 by the addition of a program *Security and Trust Management* that will pursue the integration of security and trust technologies into the fabric of the software and hardware that Universal ICT depends on. A further prospective program related to the Theme is *Programming Paradigms and Development Environments* which would research new technologies such as coordination languages, mixed-paradigm languages, program manipulation tools and domain-specific languages. This would be of particular importance to embedded systems work.



5.2.1 Formal Methods (FM)

Research Focus

Formal Methods involve the use of formal languages and mathematical techniques for system specification and verification.

The Universal ICT products that form the core of NICTA's vision involve increased conceptual complexities in the design of embedded systems, hybrid systems, systems involving concurrency, probabilistic behaviours, process and thread scheduling, and fault-tolerance and security protocols, since the behaviour of the system as a whole is not under the full control of the programmer, who must reason about a complex set of contingencies. Experience has shown that subtle, but critical, errors are extremely common in such systems. *Formal Methods* provide an important contribution to addressing these complexities and increasing the reliability of such systems.

Program Activity

During 2004 the program will be pursuing a number of research activities.

Dr Gerwin Klein joined the program in December 2003 after completing a PhD that provided a fully formal, executable and machine-checked specification of a representative subset of the Java Virtual Machine and its bytecode verifier, an important part of Java's security architecture, together with a proof that the bytecode verifier is safe. The program's research activity in 2004 will include an extension of this work to the full JVM standard. The result will be a fully executable, standalone, verified bytecode verifier for all of Java.

An extended report is expected to be completed in the second half of 2004 which will address formal operational semantics, type system(s), virtual machine, bytecode verifier, compiler (all with formal, mechanized correctness proofs). It will show how to formalize semantics for Object-Oriented languages (high and low level) modularly and readably and how to conduct proofs about these languages in full formal rigour. The work is a precursor to a book in the area. A further book manuscript on *Reasoning about Knowledge and Time* is also planned to be completed.

Work in formal models of rights management in distributed systems will be carried out in the form of a PhD project to be commenced on the formal modelling of financial contracts. Outcomes expected in 2004 include an initial proposal for a formal language for rights modelling suited to this application.

Research training and education by program researchers is anticipated to result in the delivery of a new course on *Algorithmic Verification* and another in *Theorem Proving Tools* during 2004. The research of two PhD candidates will be supported within the program.



Network and Linkage Activity

Following the success of the initial *Formal Methods* workshop held over three days in May 2003, a second annual *Formal Methods* program workshop is planned for the second half of 2004. This will provide a valuable opportunity to bring together leading researchers in formal methods and industry interests.

The program intends to establish two key research linkages in 2004. It will formalise its relationship with the SVRC, University of Queensland, with the possibility of one or more NICTA Fellows being established. Discussions will also be initiated with potential Australian receptors of embedded systems verification such as the ARC Centre of Excellence for Autonomous Systems. In addition it will undertake discussions with DSD towards the application of formal methods for security. A NICTA Fellow project possibly with DSTO as a client will also be investigated.

At an international level the program will negotiate the establishment of linkages to a major centre in embedded systems research such as Verimag, France and NASA, USA.

Staffing

The research staffing commenced with a Program Leader and three fractional contributed staff from UNSW. An ARC Professorial Fellow affiliated with UNSW also participates in the program. A researcher (Level B) has been recruited from Germany. Two offers have been made and the staff are expected to commence by mid-2004. The program is currently at 25% of steady-state staff levels.

The recruitment priorities for 2004 are for researchers in formal methods for computer security and formal methods tool development.

5.2.2 Empirical Software Engineering (ESE)

Research Focus

The goal of the ESE program is to contribute towards ensuring that software is reliable and trustworthy.

It is concerned with the scientific measurement, both quantitative and qualitative, of software engineering process and product. The research areas for the Empirical Software Engineering program are:

- software process
- requirements engineering
- software architecture
- software quality
- empirical methods.

Taken together these represent issues of current importance to industry and provide the base technology needed to support empirical and evidence-based software engineering, process improvement and risk management. A very significant part of the program's expertise lies in the area of technology evaluation.



Program Activity

The empirical base of the program means that much of the research work carried out within the program will be undertaken as part of research projects. To support its project and PhD-based research the program will develop best practice research infrastructure and procedures.

The infrastructure will comprise a central mechanism for reference management based on a database of appropriately classified and summarised references to allow reports on important topic areas to be compiled rapidly. The second development is procedures for literature search and systematic review. This is particularly important in empirical software engineering where the aim is to evaluate the evidence supporting software engineering technologies in a systematic manner.

In 2004 research supervision will be provided by program research staff for the following thesis topics:


- Strategic Alignment and Requirements Engineering in the E-services domain
- Requirements and Architecture
- Collaborative Software Engineering Project Management
- Evaluation of Software measurement
- Software Cost Estimation and Technology Transition
- Software Architecture Evaluation.

A further range of program activities are in various stages of planning and development for 2004. A joint development with Drexel University and Georgia Tech involves defining a software quality module for an undergraduate degree in software engineering. Support may also be provided to the NICTA-UNSW RoboCup project in architecture and code evolution. A working definition of 'software project success' is being developed to support PhD research work.

Network and Linkage Activity

A possible collaboration with Software Engineering Australia (SEA) will be pursued. SEA has some success in encouraging medium-sized companies to undertake software capability assessments. The Empirical Software Engineering group has the expertise to undertake research around the process improvement actions indicated by such assessments. This area presents a good opportunity for initiating industrial linkage projects.

The ESE program has formal collaboration and exchange agreements with the Nara Institute of Science and Technology (NAIST) and the Fraunhofer Institute for Experimental Software Engineering (IESE) through the Centre for Advanced Software Engineering Research at UNSW. Links to the major ESE research groups such as University of Maryland, University of Kaiserslautern, University of Bournemouth and the Blekinge Institute of Technology, Sweden will be fostered. The program will continue to



build its research linkages in 2004 through prospective links with the Federal University of Rio De Janeiro, the University of Ulster, Simula Laboratory in Norway, the University of Auckland and the University of Oula in Finland.

Staffing

The present research staff complement is based on a Program Leader and two fractional staff contributed by UNSW. An affiliated ARC Research Associate is also active in the program. Four Researchers have been recruited in 2003 taking the program to 50% of its anticipated steady- state level. An additional Level B will be recruited in software architectures in 2004.

5.2.3 Security and Trust Management (STM)

A new program in Security and Trust Management will commence in 2004 at the Canberra Research Laboratory. The program will align closely with the National Research Priority of Safeguarding Australia.

Research Focus

The research focus of the program will be defined on the appointment of a Program Leader. It can be expected to include a broad range of topics within the general area of security and trust management such as:

- Malware (Malicious software, like worms, viruses, and trojan horses)
- protocols
- security in embedded systems
- secure distributed systems
- security protocols and human factors – understandable and easy security
- use of formal methods in security analysis
- security of ubiquitous and mobile systems
- identity and rights management
- trusted computing
- security risk management.

Program Activity

It is expected that the program will form linkages with other programs within NICTA; other research institutions (especially Australian); a number of government agencies with an interest in Security and Trust Management (including Defence Signals Directorate, Defence Science and Technology Organisation, National Office of the Information Economy, Attorney-General's Critical Infrastructure Protection Group, Department of Prime Minister and Cabinet's Science, Engineering and Technology Unit in Counter Terrorism); and local and national companies with an interest in the area.

Staffing

A search for a Program Leader will commence in January 2004. An appointment is expected by the third quarter. It is expected that three researchers will have been appointed by the end of 2004.

A decorative graphic on the right side of the page consists of several concentric circles. The outermost ring is a metallic, reflective grey. Inside it is a blue ring, followed by a teal ring, and a central light blue circle. A thin yellow horizontal line passes through the center of these circles. To the left of the circles, there are three small teal dots of varying sizes, and a larger white circle containing the number '5.3'.

5.3


Intelligent Systems



Theme:	Intelligent Systems
Programs:	Statistical Machine Learning and Sensor Signal Processing
	Symbolic Machine Learning and Knowledge Acquisition
	Knowledge Representation and Reasoning
	Autonomous Systems and Sensing Technologies
Research	
SMLSSP	SMLKA
Machine learning techniques	Learning of Robotics
Information theoretic limits to learning	Learning and Knowledge Acquisition
Sensor technology fusion	Learning and Logic
Learning from structured data	Learning and Unstructured Data
Mining and modelling large data sets	
KRR	SMLKA
Intelligent Knowledge Systems	Robotics
Multi-agent Systems	Computer Vision
Intelligent Knowledge Systems	
Cognitive Robotics	
Constraints and Planning	

The idea of intelligent systems is strong in scientific and social thinking about ICT. The aim in this theme is to take ICT beyond mere speed and to imbue it with intelligence. The prospects are computer peripherals that can 'figure out themselves' how to integrate into a system; database software that turns data into information; and more generally technology that can, in some ways, do what people can. Central to the Theme is the challenge of turning data into usable information. Four programs are clustered within the Theme:

1. **Symbolic Machine Learning and Knowledge Acquisition** focuses on the symbolic and representational issues associated with acquiring information.
2. **Statistical Machine Learning and Sensor Signal Processing** covers a range of problems from extracting trends from large databases to the fusion of information from multiple sensors.

- 
3. **Knowledge Representation and Reasoning** is focused on problems associated with structured information and ways of organising information for reasoning.
 4. **Autonomous Systems and Sensing Technologies** is founded on research and development in the interface between ICT and mechanical systems.

A prospective future program is *Distributed Intelligence* in the form of Agents and similar ideas which show signs of becoming more prominent in the future.

5.3.1 Symbolic Machine Learning and Knowledge Acquisition (SMLKA)

Research Focus

This program concentrates on symbolic approaches to research in machine learning and knowledge acquisition. It is motivated by the need to make sense out of the explosion in data and device complexity and addresses the development of core technologies for adaptation and personalisation.

The aim is to learn concepts by machines in such a way that the knowledge learnt is accessible to humans. The foundational research within the program focuses on the development of algorithms and techniques in the following areas:

- learning and representation
- learning and unstructured data
- learning in logically complex domains
- learning and knowledge acquisition.


Program Activity

While the program undertakes significant foundational research it is strongly oriented towards projects that are more application-based and designed to be demonstrators of the underlying research. Demonstrators fall into two key domains:

- robotics and entertainment
- semi-structured and unstructured data (e.g., XML documents, text-mining).

The program's key research objectives for 2004 are those posed by its demonstration projects. Papers reporting the results of demonstrators are a significant part of the program's research output.

In the case of *Project Lear* the scientific challenge underlying the project will be to scale machine learning algorithms to handle complex environments made up of multiple objects or agents and characterised by simultaneous action. This will be extended to conditions of imperfect perception, redundant information and uncertain action consequences.



The proposed *Humanoid project* will direct research towards the development of algorithms and novel machine learning techniques that can be demonstrated in robots that can:

- learn incrementally over a lifetime from experience and human guidance
- use what they have learnt to adapt to a variety of new situations
- be taught through reward and punishment, demonstration and explanation
- creatively explore their environment and correct their own misconceptions.

In a similar way the proposed *Robot Rescue project* will direct research into problems associated with machine sensing in an unstructured environment. It will also require the research advances into simultaneous localisation and mapping, locomotion and into component research.

During 2004 researchers in the program will deliver an advanced course in *Learning and Representation* and will support the research of five PhD candidates.

Network and Linkage Activity

Network and linkage activity is strongly tied to the program's demonstrator projects. *Project Lear* is in collaboration with DSTO. The *Robot Rescue project* will form the basis for a formal collaboration with the ARC Centre for Autonomous Systems.

Identifying partners for the *Humanoid project* is a priority and is dependent on decisions pending in 2004 on the platform that will be used for demonstrator purposes and the application domain that is finally selected. In the case of the robotic platforms, some initial discussions have taken place with Sony and Fujitsu.

The *Generalised Queries for Search Engines project* will use the million-book digital library project as a platform and this will consolidate the program's collaborative relationship with Carnegie Mellon University.

Staffing

The contributed research staffing for the program is based on a Program Leader and eight fractional staff contributed by UNSW. Four positions were filled in 2003, including researchers from the USA, Germany and UNSW. A research engineer was also recruited from USA. The program is currently at 25% of its expected steady-state complement. A new Program Leader will be appointed in 2004. This will be followed by the recruitment of a further two researchers in 2004.



5.3.2 Statistical Machine Learning and Sensor Signal Processing (SMLSSP)

Research Focus

The objective of the program is the development of technologies that can learn. Statistical machine learning can be viewed as an outgrowth of classical signal processing, statistics and pattern recognition. The techniques used now are much more diverse and include methods to solve problems going far beyond classical pattern recognition. Examples include novelty detection or condition monitoring, adaptive filtering, reinforcement learning (related to some control engineering problems) and feature extraction (determining relevant aspects of data sets).

Research covers topics from the theoretical limits of learning to the development of practical systems that can exploit the data available from huge databases and multiple cheap and smart sensors.

Program Activity

The research activities of this program for the coming year are:

- Fundamental work unifying a wide range of different machine learning algorithms. The expected outcome is better algorithms for a range of problems
- Kernel methods for a range of learning problems (especially those on complex discrete structures) including problems such as novelty detection. Expected outcomes include the ability to solve problems (such as detecting when a network is significantly changing its topology and better tools for detecting structure in heterogeneous document collections) in a manner much more principled and with better performance than before
- The use of learning techniques in planning. The expected outcome is the development of algorithms for automated planning that can deal with more realistic situations
- Large scale parallelisation of machine learning algorithms for data-mining. The expected outcome is development of a capability for applying highly sophisticated machine learning algorithms to larger data sets than currently feasible
- Advanced signal processing techniques for acoustic source localisation. The expected outcome is robust and reliable methods for locating a person talking in a room in the presence of significant reverberation and noise.

The program will provide research support for one PhD candidate in 2004.



Network and Linkage Activity

The program is expected to build collaborations with a range of government and private organisations. A number are already in place or close to finalisation. Machine Learning technology can find application in a wide range of fields, but has particularly topical application within the general area of the National Research Priority of Safeguarding Australia.

Staffing

The program commenced with two contributed ANU staff. Two Researchers were recruited from the ANU and from the Indian Institute of Science. The program is currently at 33% of its projected steady-state research staff complement.

Two offers at Researcher level have been made to recent PhD graduates from France and the USA for the *Dynamic Planning, Optimisation and Learning* project (DPOLP), and they are likely to be housed in the program. The program has four positions advertised that are to be filled in 2004, these are for:

- Senior Principal Researcher (Level E)
- Principal Researcher (Level D)
- Researchers (two) (Level B).

The need to recruit a third Researcher and the prospect of engaging one or two further fractional contributed employees will also be under consideration.

5.3.3 Knowledge Representation and Reasoning (KRR)

Research Focus

Efficient representation of knowledge and reliable reasoning mechanisms are at the core of intelligent programs. To be efficient, knowledge representation has to be succinct yet comprehensible. An understanding of designs which can achieve these somewhat conflicting properties has driven much of the research in this area. Reliability of reasoning not only involves correctness, but also controversial properties like intuitiveness and commonsense appeal.

The Knowledge Representation and Reasoning program addresses these issues by considering a number of challenging problems as motivations for both basic and targeted research. The program's initial focus lay in the following areas:

- Intelligent Knowledge Systems
- Multi-agent Systems
- Cognitive Robotics
- Constraints
- Planning.



Program Activity

Throughout 2004 work will continue in the following areas: negotiation axiomatics and belief merging; logic programming; cognitive robotics; model-based diagnosis and planning, evolutionary and game-theoretic approaches to web semantics.

Logic and model theory are applied to the areas of artificial intelligence, systems theory, and software correctness.

In artificial intelligence (AI), belief revision (BR), especially in abductive and coherent modes using the belief revision framework developed by Alchourrón, Gärdenfors and Makinson (AGM paradigm) as the main vehicle will be studied. Belief merging (BM) is the more general case in which two or more theories are mutually revised, work will continue on the examination of extended logic programs as a basis for modelling evolutionary and negotiation games.

The connection of the AI and systems theory is the application of BR to reasoning about action as exemplified by the Knowledge Management (KM) postulates and other non-monotonic frameworks. Another connection is the generalisation of BR to account for ontology revision (OR), which is about theory change under linguistic expansion. Theoretical terms as understood in the philosophy of science is part of OR, and so is the justifying status of experiments. There is interest in enhancing the power of such logics by incorporating practical structures like object-orientation, and to explore the connections between these logics and simulation formalisms like Discrete Event Simulation (DEVS) that have an algebraic flavour.

A recent area of interest is in visual and diagrammatic reasoning and understanding the logical foundations that account for successes and failures in such reasoning. In the area of software correctness research will aim to explicate refinement rules in software specifications as relations between theories.

Some new areas to be explored in 2004 are trustworthy agents; constraint solving and game theory. The programs basic research expertise will be applied in the DPOLP project led by the *Statistical Machine Learning* program.

KRR scientists will deliver a standard undergraduate AI course in addition to senior/graduate courses *Introduction to Modal Logic* and *Logical Foundations of AI*. A graduate course on game theory or finite model theory will be trialled. Research supervision will be provided from the program for two NICTA PhD students in NSW and one in the ACT.



Network and Linkage Activity

A team from KRR visited DSTO Edinburgh during 2003 to discuss research collaboration. A project proposal may be developed in 2004 to consolidate the relationship.

Visitors to the program who are committed for 2004 are:

- Prof Luis M. Pereira (Lisbon)
- Prof Gerd Brewka (Leipzig)
- Prof Pavlos Peppas (Patras)
- Prof Samir Chopra (CUNY)
- Prof Randy Goebel (Alberta).

Some of the visitors will give short courses.

Staffing

The initial 2003 research staff were the Program Leader, a Principal Researcher and senior Researcher contributed from UNSW, and a senior Researcher contributed by ANU. A Senior Researcher and Researcher were recruited from South Africa and Austria respectively. The program is at 25% of the projected steady-state research staffing level.

A number of positions within the program remain to be filled. These are

- Deputy Program Leader, full time level E
- full time level D
- full time level C
- four full time level B.


The current Program Leader, Norman Foo, will induct the new Level E appointee into a Deputy Leader role. The latter will succeed to the leadership no later than mid 2006.

5.3.4 Autonomous Systems and Sensor Technologies (ASST)

Research Focus

The ASST research focus is centred on the development of the technologies and methods that will advance computer vision and robotics, especially at their intersection.

The possible applications for computer vision and robotics make it evident that there is a need for research into both real-time and off-line methods. Many important applications require immediate interaction with the environment, and this requires real-time methods. Expanding computational capacity means that many common vision tasks can be accomplished in real time with ease on ordinary computer hardware. That this is a relatively recent capability accounts for the increased importance of video.



At the same time, there are some tasks in the analysis of video that are beyond the scope of real-time applications for the medium-term future. The bandwidth of video is so high that it will overwhelm the capability of many analysis methods. Consequently, off-line analysis of video will continue to be an important area of research.

A promising research direction for the future is the implementation of selected image-processing algorithms in hardware. It is anticipated that it will be possible to identify important, but time-consuming parts of a vision system that are best implemented in hardware (such as Field-programmable gate-arrays or even Application Specific Integrated Circuits). However, it must be borne in mind that doing this generally leads to only a temporary advantage over general-purpose computer hardware.

Medical image understanding is an increasingly important area of research in which Australia should be able to play an important role.

Program Activity

The *Robotics and Computer Vision* group is concerned with aspects of mobile robotics and video analysis.


Research in basic technologies associated with vision is undertaken. These include developments in area segmentation, contour finding, edge finding, point tracking, object tracking, object recognition (from single images and video), stereo correspondence, physics-based vision and statistical techniques.

The research objectives for the program are largely undertaken within projects as demonstrators of the underlying research. In the case of *Smart Vehicles* the program is developing algorithms to use in unobtrusive driver aids. The research is embodied in technologies that support:

- methods for monitoring driver behaviour and alertness
- pedestrian and obstacle detection where the system will give alerts to the driver based on the driver's awareness of the presence of critical obstacles
- road sign detection
- lane following and detection of straying from the lane
- gaze detection to determine where the driver is looking, assessing driver response to road and traffic conditions, and monitoring driver alertness.

Investigations into video analysis will be in two areas:

- Motion segmentation of dynamic scenes. The goal is to analyse a video sequence containing several independently moving objects, and to separate out each object. This is an important recent research area. Two new approaches to this problem have



been developed, introducing two different new mathematical theories based on motion-tensors and Generalised Eigenvalue analysis, with promising results. Applications of this technology in surveillance, tracking and scene analysis are evident and project proposals are under development

- An initial capability is being developed in video synopsis which involves reducing a long video, such as that taken by a surveillance camera, to a sequence of scenes containing the 'interesting' parts. This has many applications in areas such as domestic surveillance and monitoring of remote areas where project work is being negotiated.

The program will support the research of three PhD candidates during 2004.

Network and Linkage Activity

An application for funding to the Western Australian government to set up a Centre of Excellence for Imaging and Technology in Medicine by UWA, CU and ECU provides a good opportunity for collaboration. The purpose of the centre is to engage in research in Medical Imaging and associated technologies. The program expects to be involved in two main areas of ophthalmology and virtual colonoscopy.

The project potential for the program in the commercial sector could extend into a diverse range of applications that will be evaluated in 2004. These include manufacturing technology, mining and exploration and health care.

Staffing

The initial research staff comprised a Program Leader and two researchers contributed by the ANU. Researchers were recruited from Sweden, USA and Australia as well as a Research Programmer from ANU. The present complement is 50% of the expected steady-state staffing level. A further Researcher is due to join the program in early 2004 from the Robotics Institute, Carnegie-Mellon University.

An offer has also been made to a Senior Principal Researcher (Level E) in the area of Robotics to complement current expertise in Computer Vision.

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5.4

Foundations




Theme:	Intelligent Systems
Programs:	Systems Engineering and Complex Systems
	Logic and Computation
Research	
SEACS	LC
Complex Systems, including theory for the analysis and design of Networked and Hierarchical Systems	Pure and Applied Logic
Vision and Control Systems	Mechanised Reasoning
Systems Optimisation	Logical Foundations of Computing
Robust and Adaptive Control Systems	

Twentieth century electro-mechanical technologies had their foundation in the science of physics. Universal ICT will have its foundation in the abstract mathematics, modelling, methods of reasoning, and algorithms essential to the development of complex systems, ‘smart logics’ and mechanised reasoning.

Without foundation science ICT technology will lack essential tools that will enable mechanised reasoning, intelligence and other capabilities essential to the vision of Universal ICT. The *Foundations* Theme incorporates two programs dedicated to the long term foundational science of Universal ICT.

Systems Engineering and Complex Systems is concerned with all manner of dynamic behaviour in systems, ranging from (by now classical) control problems to exciting and new areas of distributed control and the control of systems combining continuous and discrete elements.

Logic and Computation covers problems such as the development of logical calculi for reasoning in non-traditional situations, such as temporal reasoning, and reasoning about hybrid systems.



Future programs may include *Information Theory* which is centred on problems in the fundamental limits to the transmission, storage, extraction, and processing of information. *Social and Organisational Sciences* which would extend NICTA's research capability to foundational problems associated with the social and organisational use of ICT.

5.4.1 Logic and Computation (LC)

Research Focus

The research focus for the *Logic and Computation* program is based on mathematical logic as a core discipline of the information sciences. Logic is studied as a branch of mathematics in its own right, as one of the underlying technologies of intelligent computing and as a tool for the theoretical and practical analysis of computation.

The program is a resource for the whole of NICTA and therefore especially values close relationships with other programs.

Mechanised Reasoning

The first major goal of the Logic and Computation program is to implement logical reasoning methods with a view to making future software more intelligent, easier to produce and demonstrably correct. Topics under this heading are: *Automated Deduction, Constraints and Search* and *Interactive Reasoning*.

Pure and Applied Logic


The study of reasoning begins with the study of logic, or the mathematical theory of inferential systems. Topics under this heading are: *Modal Logics, Sub-structural Logics, Algebraic Methods in Logic* and *Mechanised Mathematics*.

Logical Foundations of Computing

The most important broad application domain for recent work in mathematical logic is computation theory. An adequate model of computational processes is an absolute prerequisite for formal reasoning, whether about correctness or efficiency. Topics under this heading are *Semantics of Programming Languages, Specification and Verification* and *Type Theory* and *lambda Calculus*.

Program Activity

The program expects the publication of theoretical results in all three of its areas of activity throughout 2004. In addition the following research outcomes are planned. A website devoted to the program's work on electronic voting systems will be made publicly accessible. This includes reports on the system used to elect the ACT Legislative Assembly and on formally verified vote counting algorithms, together with a range of downloadable software.



Research software developed by the program and planned for release during the year includes a theorem proving system applicable to pure mathematics and with potential applications in software verification. This program will be run in an international competition for software of this type, where it is expected to perform well in comparison with other theorem provers in its class.

A further software suite, the *Tableaux Workbench*, is planned to be completed to demonstration level late in 2004 for the testing and development of reasoning systems. This software takes a specification of a logical system in the form of inference rules, and generates a theorem prover embodying those rules.

Research staff within the program will be engaged in supervising the research of two PhD candidates during 2004.

Staffing

The program commenced in 2003 with a Program Leader and two researchers contributed by ANU. Three researchers and a Research Programmer were recruited taking the staff level to 50% of its expected steady-state level.

The program is pursuing two more senior appointments, including a Senior Principal Researcher, in 2004.

5.4.2 Systems Engineering and Complex Systems (SEACS)

Research Focus

The program will conduct research in Control Systems, Signal Processing, and Optimisation; and contribute to research results and tools applicable to the emerging application areas which are the subjects of other NICTA programs, such as: Vision Systems, Robotics, Telecommunications, Machine Learning, and Decision Systems.

The scientific challenges and techniques of the program span a huge range of potential application domains.

While it is expected there will be some projects developed within the program that directly interact with industry, some interactions will occur only in conjunction with other NICTA programs. The most likely candidates are the *Statistical Machine Learning and Sensor Signal Processing*, *Autonomous Systems and Sensor Technologies* and *Networks and Pervasive Computing* programs.



Program Activity

Three conference papers will be presented at the Sixteenth International Symposium on Mathematical Theory of Networks and Systems (MTNS2004) to be held in July in Leuven, Belgium. Members of the program have organised two invited sessions at this conference *Geometric optimisation in robotics and computer vision* and *Observer theory, observer design and applications*. Four or five follow-on journal papers are likely to be submitted in 2004.

Two international workshops on optimisation techniques in robotics and vision will be organised to be held in Wurzburg, Germany, and Canberra. Grants have been applied for from The Australian Academy of Technological Sciences and Engineering.

A paper will be presented at the 7th Workshop on Numerical Ranges and Numerical Radii, July 04, Coimbra, Portugal on the topic of the conference and another at the 11th ILAS Conference, Coimbra, focusing on the design of algorithms for improving quantum computing experiments. An invited paper will be presented at a workshop on stochastic behaviours in Israel in 2004. One paper is ready for submission to 2004 IEEE conference on decision and control, dealing with optimisation strategies for solving important problems in robotic path planning and stabilisation strategies in systems theory.

The program will continue to develop results for real-time optimisation using neural computing, for optimising self-concordant functions on Riemannian manifolds using interior-point methods, and alternating projection methods and for optimal portfolio management using neuro-dynamic programming. The outcomes are expected to be reported in six or seven conference and/or journal papers submitted in 2004.

A commercially focused project on portfolio management will be developed with an external expert in financial management.

Three or four papers will be submitted during 2004 in the area of observers for singular linear systems, including low complexity observers, with application to estimating the reliability of complex technical systems online. Work will be submitted on optimal coding for telecommunications and will commence on a near range wireless underwater communication solution for use in small autonomous submersibles.

Conference papers in the area of control system design methods are, or will be, submitted to the 2004 IFAC Workshop on Adaptation and Learning in Control and Signal Processing, Yokohama, Japan, the IEEE Conference on Decision and Control, Bahamas, the Asian Control Conference, Melbourne, Australia and the IFAC World Congress, Prague. The program will support the research of five PhD candidates in 2004.



Staffing

The program commenced with a Program Leader and two Researchers contributed by the ANU. The NICTA Chief Scientist is also allied to the program. During 2003 two Researchers and one Senior Researcher were recruited, taking the program to 55% of its steady-state level.

Two UNSW Researchers are expected to join the program in 2004. During 2004, two additional researchers and one Senior Principal Researcher will be recruited. The latter is a potential future Program Leader since both Program Leader and Chief Scientist are due to retire in a few years. The addition of a further contributed employee from the ANU in 2004 is also being considered.

The image features a large, abstract graphic on the right side, consisting of several concentric circles. The outermost ring is blue with a metallic, reflective texture. Inside this is a light blue ring, followed by a teal ring, and a central light blue circle. A horizontal yellow line passes through the center of the graphic. To the left of the graphic, there are three small teal circles of varying sizes, and a larger white circle containing the number '5.5' in blue. The background is white.

5.5

Human-Machine Interaction



Theme:	Intelligent Systems
Programs:	Humans Understanding Machines – Visualisation
Research	Graph visualisation
	Physical interaction metaphors
	Surveillance of fast-streamed data sets
	Ambient visualisation

Information and Communications Technology is ultimately for human ends. The vision of Universal ICT brings this to the forefront. One of the great challenges currently facing human-computer interaction is to replace the mouse-keyboard-screen interface that currently resides in around 750 million desktops throughout the world. Under this Theme challenges dealing with identifying and refining the next generation of computer user interface will be in complementary programs.

Humans Understanding Machines – Visualisation deals with user interfaces and data visualisation. It is the first program within this Theme.

Possible future programs in human machine interaction are *Machines Understanding Humans* around the problems of speech and gesture recognition and *Machine Mediated Interaction* which will address a range of issues that have historically been given relatively little priority: how people can and want to communicate using technological devices.

5.5.1 Humans Understanding Machines (HUM)

Research Focus

The current 'grand challenge' for human-computer interaction is to replace the mouse-keyboard-screen interface that currently resides in around 750 million desktops throughout the world.

The HUM program will concentrate on 'visualisation', where the information flow is mainly from the computer to the human. Challenges in visualisation are some of the key areas of research that will shape the design of the next generation of commodity user interfaces. The economic significance in this challenge is enormous. If Australia can play a large role in addressing the challenge the benefits will be very large.

The *Humans Understanding Machines (HUM)* program within NICTA's human-computer-interaction theme will use this grand challenge as a driving force for its research.



Program Activity

As a new program in 2003, the HUM program has carried over activities from the Information Visualisation group at the University of Sydney. These include a variety of PhD-thesis projects and a few ARC projects. The program currently has six research students and this is expected to rise to 13 by the second half of 2004.

The key objectives for the program in 2004 are refinement of its research focus within specific challenges associated with visualisation methods for the next generation of commodity user interfaces. The specific challenges to be refined are in the areas of:

1. Metaphor design for visual data mining.
2. Navigation of large information spaces.
3. Automatic Layout for the mapping of abstract information.
4. Psychologically-based evaluation of user interface design.
5. Automatic adaptation of interface design to different user perception.
6. Investigation of how new hardware developments affects information visualisation.

The approach that the program proposes to take is to define its research in an applications context. Several possibilities exist for this such as a military command and control centre, a financial market trading room; a coffee shop or a business boardroom.

The applications focus can be expected to lead to an extensive project portfolio. An initial group of eight major projects have been identified but to undertake all of these is not feasible. Three of the proposed projects will be considered in 2004, including development of a distributed laboratory for the study of human-machine interaction.


This will be a significant development in research infrastructure involving major partners such as VisLAB (Sydney University), eWorld Lab (Uni South Australia) and DSTO. A number of minor partners are also part of the team including the Powerhouse Museum, Universidade Federal de Goias (Brasil), and Charles Sturt University. The aim of the project will be to investigate collaboration and interactive visualisation using a novel mechanism referred to as a Collaborative Access Table (CAT). The project will develop a distributed facility that will allow dispersed scientists to collaborate in the study of how humans interact with data and each other.

The program supports the research of six PhD students.

Network and Linkage Activity

Visitors to the program in the near future include:

- Ricardo Baeza Yates, U de Chile, January 2004
- Stephen North, AT&T Laboratories, February 2004
- Gunnar Klau, Vienna University of Technology, February 2004
- Kozo Sugiyama, Japan Advanced Institute of Science and Technology, March 2004
- Colin Ware, University of New Hampshire, March 2004
- Brad Paley, Columbia University, March 2004
- Falk Shreiber, Garterschleiben, January 2004.



A number of contacts have been set up with industrial and university laboratories. These include:

- Mitsubishi Electric Research Laboratories, Boston
- Pacific Northwest National Laboratories
- AT&T Laboratories
- IRoom Laboratory, Stanford.

Staffing

The HUM program commenced late in 2003 with a Program Leader and three research staff contributed by the University of Sydney. Two Level B Researchers have been offered a one-year contract. The program is currently at 50% of its expected steady-state staff level. The recruitment objectives for 2004 are to reach a total of four Researchers or Senior Researchers by mid 2004 and one Senior Principal Researcher by the end of 2004.

5.6 Program Milestones

The general outlook for the research programs over 2004 is for a continued emphasis on recruitment and ongoing sharpening of the research focus. The programs will become more discernible as NICTA's programs rather than as activity inherited from the partner universities. Accordingly the program level milestones for 2004 are:

01 January – 30 June

1. Recruitment of three Program Leaders.

01 July – 31 December

2. Research focus for *Security and Trust Management* program established.
3. Research infrastructure under staged development for:
 - a. *Mobile Networking*
 - b. *Test-bed for Sensor networks*
 - c. *Visualisation and Interaction Collaborative Access Table*.

THE RESEARCH PROJECTS

6.1 PROJECT-BASED RESEARCH


Projects are application or end user driven research activity. There are several kinds of activity conducted within NICTA's program that can be conceptualised as projects. These are activities that may contribute to the infrastructure needed to support research excellence directly funded by NICTA. Student research on PhD topics may also be viewed as projects. They clearly have the potential to contribute directly to educational aims and research excellence and may even lead to commercialisation outcomes through technology licensing or a start-up company. These activities are funded through NICTA's program block grants or supported by the scholarship pool.

In NICTA's parlance projects have a particular significance that will be made apparent in 2004 through introduction of *Priority Challenges* and the application of contestable funding. They will emerge as the mechanism by which NICTA interacts with external organisations and under the influence of *Priority Challenges*. Projects will offer opportunities for prototyping or validating program research. They will also provide the output for rapid commercialisation gains and will accelerate network and linkage activity. The overall level of project activity built up over the next few years may also be a good indicator of the extent to which industry and other research interests value NICTA's developing capability. In this sense projects will play a strategic role in NICTA's mission.

A modest number of projects were in progress during 2003.

Table 4: Projects underway at January 2004

Program	Project
ERTOS	Gelato; Linux Microkernel
NPC	Ambient Networks; Project Nightingale
ESE	Statistical Process Control for Software Development; Problem Frames
SMLKA	Project Lear, RoboCup
SMLSSP	DPOLP (with KRR and FM)
ASST	Autonomous Road Vehicles
LC	Specification and Verification of Software for Electronic Voting Systems



These were not based on contestable funding or influenced by *Priority Challenges*. A number of them were carried over to NICTA by seconded staff and will continue into 2004. The remainder of this section deals with progress in the existing portfolio of projects and identifies the areas where future project activity is likely to emerge.

The objective for NICTA's performance in 2004 is the definition, assessment and funding of 12 new projects in 2004.

6.2 EXISTING PROJECTS

6.2.1 Gelato

Gelato is an ongoing project within the ERTOS program. It aims to improve Linux kernel performance and scalability and to provide support for kernel and device driver development. The project has funding from Hewlett-Packard and is expected to result in ongoing improvements to Linux stability and performance, particularly with respect to multiprocessor scalability.

6.2.2 Linux and Microkernel Performance

This is a joint project between the ERTOS program and IBM *J T Watson Research Center*, USA and IBM *OzLabs*, Canberra. An MOU has been signed, and IBM has supplied computing equipment which was used to port the program's kernel and perform performance measurements.


A NICTA student will commence an internship at Watson in January 2004 in order to learn more about the IBM microkernel project. The expected outcome in 2004 is enhanced understanding of issues affecting the performance of microkernel-based systems and a specific project plan for future collaboration.

6.2.3 Ambient Networks

The objective of the *Ambient Networks* project is to deliver the network solutions for mobile and wireless systems beyond 3G. It is located within the NPC program.

The project will enable scalable and affordable wireless networking while providing rich and easy to use communication services for all. It is geared towards increasing competition and cooperation in an environment populated by a multitude of user devices, wireless technologies, network operators and business actors.

The design paradigm adopted for the project is horizontally structured mobile systems that offer common control functions to a wide range of different applications and air interface technologies. This will require the definition of new interfaces and a multitude of standards in key areas of future media-aware and context-aware multi-domain mobile networks.



The Ambient Networks project is a three-phase project supported by the European Union. The objectives of each phase are:

1. Establish the *Ambient Network* concept and feasibility.
2. Technology development.
3. Systems synthesis.

The first phase is to be funded to 14 Million Euros over two years and is expected to comprise a total effort of 3000 person months.

6.2.4 Project Nightingale

The objective of the project is to create a series of mechanisms that will support the operation of devices that are capable of interacting with a pervasive computing environment. It is a collaborative project undertaken by the NPC program and the Smart Internet CRC.

The project commenced in December 2003 and will be active throughout 2004. The planned deliverables from the project are:

- a virtual personal server system implemented across a network that connects the ATP and UNSW
- a home server system
- secure and authenticated access schemes.

Alongside this infrastructure the project will develop a personal data service device with local wireless connectivity. Demonstrator applications will allow virtual personal server access and will be based on sharing of multi-media content.

6.2.5 A Personal Universal Communicator (PUC)

This proposal covers the emerging areas of wireless networking and personal alarm monitoring. It will involve the development of appropriate generic Bluetooth technologies and other information and communications infrastructure for ubiquitous connection to communications networks.

The aim of the PUC project is the creation of a communications framework that will allow a body-worn Bluetooth transceiver to seamlessly connect to communications infrastructure including local Bluetooth Piconets, wireless LANS, community-based 3G data networks, GSM and GPRS networks and landlines.



Table 5: Project Personal Universal Communicator

1 Year Term	PUC
2004	Prototype of the PUC
2005	Intergration with Ambulatory sensors

6.2.6 Wireless Sensor Technology

Four current projects within the *Networks and Pervasive Computing* program fall in the general area of embedded wireless sensor technology or wireless sensor networks. These are *Data Routing/Transport Protocols for Sensor Networks*, *Security and Privacy*, *Cane Toad Monitoring* and *Adaptive Media Access Control*. All are concerned with investigating specific applications of sensor networks and their associated research challenges. In each case research is directed towards developing core technologies that are common and can be used across applications.

Data Routing/Transport Protocols for Sensor Networks

This is a continuing project concerned with sensor networks for pervasive computing that are energy-efficient, data-centric, oriented around the gathering (e.g. sensor data) or dissemination of data (e.g. code used for sensor tasking/control/reprogramming). Work in 2004 will extend research that has so far:

- performed extensive comparisons of existing data dissemination protocols for sensor networks
- developed a hybrid sensor network architecture consisting of a small percentage of resource-rich nodes (microservers) to overcome scaling, energy and bandwidth bottlenecks and an anycast-based dissemination service
- developed wavelet-based loss-tolerant transport protocols for data gathering
- developed reliable code dissemination protocols for macro-programming the sensor network.

Security and Privacy

Security and privacy is a continuing project that seeks to address challenges for sensor networks stemming from the use of wireless communication media (susceptible to spoofing, snooping, jamming); limited resources of sensor nodes; and their unattended operation due to which some sensor nodes may be physically compromised. The program is developing security primitives for Byzantine fault-tolerance and message integrity in sensor networks.



Cane Toad Monitoring

This project will continue through 2004 and is investigating the deployment, cost and network organisation requirements for a large-scale sensor network for monitoring cane toad population growth in the Kakadu National Park, based on application requirements (in this case biological study guidelines). Contrary to commonly assumed models of sensor networks, the network model that emerges from the study, which is also cost-effective and matches application requirements, is hybrid, largely disconnected and continually evolving. A Bayesian-learning algorithm has been developed to reconfigure deployment in response to changing habitat conditions.

Adaptive Media Access Control (MAC)

The objective is to develop an adaptive, self-organising, location-aware, CDMA-Based Media Access Control (MAC) protocol for sensor network application scenarios that have high traffic and stringent latency requirements (e.g. real-time battlefield surveillance). Preliminary ns-2 simulation-based evaluations show that the developed protocol (in comparison to the best alternative protocol S-MAC); can significantly improve network capacity and energy-efficiency in a multi-hop network.

6.2.7 Selfish Power Level Management in Mobile Nodes

This project will aim to study novel issues in wireless communication with varying-power nodes, both for infrastructure-based (e.g. wireless LANs) and ad-hoc (including sensor) networks, focusing especially on problems arising when the networks are operated by selfish nodes (i.e. nodes that care only about their own performance and battery usage).

The project is expected to go through a theoretical definition stage and may extend over three years from the initial literature survey to the final results.

6.2.8 Statistical Process Control for Software Development

This is a project in empirical methods with the objective of establishing more informative means for analysing and presenting statistical process control data. It is in collaboration with a global ICT corporation. At this stage a confidentiality agreement has been signed by NICTA and the scope of NICTA research contribution is under discussion

The process improvement experience studied may be used to assist Australian companies who need to use SPC to achieve Capability Maturity Model level 5. Barbara Kitchenham is the chief investigator and is supported by Ross Jeffery.



6.2.9 Problem Frames

Problem Frames are a promising new approach to describing problem domains and documenting how to conduct requirements engineering that is relevant to the context at hand rather than applying a generic modelling approach such as the Unified Modelling Language. Little empirical or theoretical research has been conducted on Problem Frames.

The aim of the project is to investigate in detail whether the Problem Frames approach will work on large-scale projects and if it is of benefit to requirements engineering. This is a collaborative project with UNSW, Bournemouth University, the Open University in software process and requirements engineering. It may extend to an industrial collaboration on a full case study of Problem Frames.

The project will deliver research into aspects of Requirements Engineering that have not been conducted thus far on a large-scale industrial project.

Karl Cox is the lead NICTA researcher with Steven Bleistein (NICTA PhD student), Josef Nedstam (visiting PhD student to NICTA, from Lund University, Sweden). Other researchers are Aybuke Aurum (at UNSW), Keith Phalp and Ian Bray (at Bournemouth University, UK), Jon Hall and Lucia Rapanotti (at the Open University, UK).

6.2.10 Project LEAR

Project Lear was developed from extensive planning and definition work carried out in 2003. The project objective is to develop models and algorithms to support decision making for national and military strategic courses of action. The primary application is in strategic and theatre operations where decision superiority is expected to be achieved through close cooperation of many elements and the synergy of forces operating in concert. The project anticipates development of relevant decision support tools and methodologies which will be adopted by Air HQ and HQAST. The tool and integrated intelligence engine developed under the project should present commercialisation opportunities.

Project Lear is planned to run over a five-year term and involves both DSTO and NICTA researchers. The project plan sets out three tracks of concurrent activity that define the essential project subtasks and allocate the workload.

Table 6: Project Lear

5 Year Term	Track 1	Track 2	Track 3
2004	1st version of aerospace strategy tool	Apply existing ML using agreed features	Extend existing HRL and test on prototype
2005	Add UAVs and land interaction	Engineer multiple agent controllers	Include partial observability and multi-goals
2006+	Develop model complexity to include non-physical models. Priorities and further research to be driven by periodic reviews and progress.		

HRL = hierarchical reinforcement learning

ML = machine learning

UAV = unmanned aerial vehicle

Track 1 involves simulator development and will largely be done by the DSTO, track 2 is a joint activity and track 3 is more fundamental research that will be conducted by NICTA.


6.2.11 RoboCup

The RoboCup is an international competition with the goal of developing a team of fully autonomous humanoid robots that can win against the human world champion team in soccer by 2050.

For NICTA the RoboCup represents a continuing challenge in research and technology development. RoboCup is a seasonal project for the program. It involves a significant amount of time, approximately 85% for one Level B and 50% for another, in the six months prior to the RoboCup, as well as student contributions. Outside this peak period the time demand is reduced to about 15% which allows documentation of results in research and conference papers.

To succeed in the RoboCup requires teams to approach the competition as a major research effort across a range of robotic technologies. In 2003 the team effort was based on developing algorithms to instruct robots to learn to walk faster.

In 2004 a diverse research effort will be mounted across a range of technical developments. An area for special attention will be vision. The current vision system uses semi-automatic calibration to adjust itself to the specific set of lighting conditions



when the calibration pictures were taken. During RoboCup 2003 the team observed that as crowds gathered around the field during important matches, their presence subtly changed the colour of the background light reaching the field which had an impact on the robot's play.

A major thrust for the 2004 research effort will be to research and develop vision systems that are more robust and not affected by lighting changes. A strategy based on dynamically re-calibrating robot vision during the course of a game will be investigated.

6.2.12 Dynamic Planning, Optimisation and Learning

The *Dynamic Planning, Optimisation and Learning* project is a collaboration between the SMLKA program, DSTO, the University of Adelaide and Aarhus University, Denmark. The project commenced in July 2003 with a workshop held between NICTA and DSTO researchers to refine the project and develop plans for future research. The project aims to develop practical planning tools for operational military planning and will deliver:


1. Theoretical models for planning and uncertainty.
2. Algorithms and tools that can be integrated in to the existing Course Of Action Scheduling Tool (COAST).

Over its life the project will be a significant step in cross program collaboration as it will also include contributions from both the *Knowledge Representation and Reasoning* and *Formal Methods* programs. In addition to the short to medium-term objective of COAST improvements, the project also allows for longer-term speculative research in planning and planning tools. The agreement with DSTO allows NICTA to pursue the commercial application of the outcomes of the research for application in the many civil and commercial areas where planning problems arise.

6.2.13 Autonomous Road Vehicles

This project is continuing early work done in the ANU in the area of *Smart Vehicles* to develop algorithms for use in driver aids to enhance safety. The project is based around the application of program research developments into technologies that support:

- methods for monitoring driver behaviour and alertness
- pedestrian and obstacle detection where the system will give alerts to the driver based on the driver's awareness of the presence of critical obstacles
- road sign detection
- lane following and detection of straying from the lane
- gaze detection to determine where the driver is looking, assessing driver response to road and traffic conditions, and monitoring driver alertness.



The scientific challenges for the project are mainly in the domain of robust sensing and control, as well as adequate methods of interfacing with the driver. The problem of robustness can to some extent be addressed by keeping the driver in the loop, that is, enhancing the driving capabilities rather than completely replacing the driver. Therefore, the project aims at 'driver assistance systems' instead of autonomous driving.

A significant step in the project in 2004 will be the demonstration of developed technology at the internationally renowned trade-show 'smartDemo 2004' in Sydney in May. In addition, recent research will be presented at conferences in Italy, USA and Japan. Overseas students will contribute to the project by developing specific hardware useful for automatic control. In 2004, it is expected that the project will focus more on intelligent integration and user interfaces as many of the underlying algorithms have reached a sufficient level of usability.

6.3 PROJECT PROPOSALS 2004

During 2003 a considerable effort was made within each program to identify and refine proposals to expand NICTA's project base in 2004.


Project definition is itself a resource intensive and time consuming activity; researchers may generate numerous concept papers and internal research reports before a clear objective is established. Where collaborators are involved additional time and resources will be applied to building confidence and role definition.

Notwithstanding these requirements more than 20 project proposals were identified in 2003. Not all the project proposals seeking contestable funding in 2004 will necessarily be supported; the growth benchmark for NICTA in 2004 is to commence at least 12 new projects. Regardless of whether the individual proposals identified in this section receive funding the project information provided gives some useful insights into research interests of the programs and external collaborators.

The descriptions given vary significantly, reflecting the fact that some proposals are already at the stage of fully developed funding proposals while others are in the early problem definition stage.

Wireless signal processing is an area that offers many prospects for project development. Prospective projects for 2004 are in the areas of:

- a feasibility study with an Australian SME into the potential for a radar array to be utilised as a communications platform to provide Gigabit/s radio connectivity in difficult environments
- the development of algorithms for improved mobile terminal performance in conjunction with a global equipment supplier

- 
- high performance receiver algorithms which mitigate the effects of multi-path for the purpose of position location for a Global Positioning System (GPS) terminal
 - oversaturated multi-access communication receiver systems, specifically, data detection, acquisition, and tracking methods to improve system capacity and cell size
 - development of a surround sound demonstration platform to prove the concept of a recently developed sound reconstruction technology that can electronically compensate any incorrectly positioned speakers in home theatre systems and a spatial sound mixing tool for audio producers
 - develop a fundamental understanding of how multi-path propagation affects the accuracy of radio location schemes and in so doing develop improved mitigation strategies
 - A study to derive the true information capacity of time varying channels which, if achieved, will be a significant advancement to the Shannon's capacity calculation of additive white Gaussian noise (AWGN) channels
 - Investigation of the effect of the electromagnetic coupling between the antennas on the capacity of the multiple-input-multiple-output (MIMO) antenna system to get better physical insight into the mutual coupling mechanism.

A project proposal is in the preliminary stages of definition for Multi-user detection for 3G CDMA base stations as a planned collaboration between the WSP and ERTOS programs. In 2004 work is expected to establish the feasibility of the project and development of a funding proposal under NICTA's contestable funds. The full project is likely to be structured over two years with a 12-month milestone feasibility demonstration to justify scaling up to a full demonstrator.

In embedded systems the ERTOS program is a partner in an EU 6th Framework project proposal investigating Robust Embedded Systems (**ROBES**). The project involves collaboration with Dresden University of Technology, Charles University, Prague and STMicroelectronics. Around 30% of the whole project effort is expected to fall to NICTA. The funding application is presently under review and a decision is expected early in 2004. A NICTA student has already spent some time at STMicroelectronics to help port the program's kernel to their hardware and further internships are anticipated in 2004.

In the area of networks two collaborations proposed within the *Networks and Pervasive Computing* program are based on participation in EU-funded projects and are pending decisions by the European Commission. The projects are in the areas of End-to-end Quality of Service support over heterogeneous networks (EuQoS) and Reconfigurable ubiquitous networked embedded systems (RUNES).



Five project proposals are under development for funding through NICTA's contestable funding pool:

- SPIDERNet Configuration: Scalability, and Mobility of devices between different networks in conjunction with the Intel Cambridge (UK) Labs
- Predicting the quality of service of the environment through the use of quality of service maps
- Centralized error control and reliability management for mobile segments
- Sensor Networks for Precision Agriculture in collaboration with RIRDC
- Sensor Networks for Bushfire Monitoring.

Three projects have been proposed for development in 2004 under the *Symbolic Machine Learning and Knowledge Acquisition* program in support of research into the development of life-long learning algorithms that will allow autonomous agents to learn complex tasks in unknown complex environments


The *Humanoid project* will aim to develop software for humanoid robots that allows the robots to learn to perform a variety of tasks in a complex environment. The project is in early stages of definition. The platforms and demonstrator tasks will be selected and defined in 2004. The project has applications in areas such as workforce productivity as demographics trend to a smaller aging population. The project team will be led by Bernhard Hengst and will include a post-doctoral fellow, three PhD students and three undergraduate students.

The *Robot Rescue project* is a proposed joint project with ARC Centre of Excellence for Autonomous Systems. This project is still under early discussion. It aims to minimize risk to search and rescue personnel, while increasing victim survival rates, by fielding teams of collaborative robots which can:

- Autonomously negotiate compromised and collapsed structures
- Find victims and ascertain their conditions
- Produce practical maps of their locations
- Deliver sustenance and communications
- Identify hazards
- Provide structural shoring.

The project represents a significant commercial opportunity to develop software that can be deployed in humanoid robots to allow them to be trained in different environments to perform a variety of tasks.

The *Gamebots project* is aimed at the rapidly growing interactive entertainment industry. Making personalised interactive entertainment is very resource intensive. The project aims to develop intelligent authoring systems for agent behaviours in games. Medium



term deliverables include systems for hand-coding some behaviour, learning unspecified behaviour, mimicking demonstrated behaviour, discovering behaviour traits, and recombining behaviour in new ways.

Other prospective projects related to robotics are under development in the ASST program in the areas of:


- Smart Vehicles: including road vehicles, under-water vehicles and mobile robotics
- Active Vision Robot Systems: the development of robust and reliable real-time systems
- Robot control and manipulation: construction and control of smaller, faster and more gentle robots, operating in a way safe to humans and the environment.

Project proposals across several programs encompass the broad areas of information extraction, pattern analysis and reasoning.

Three projects are being developed by the *Statistical Machine Learning* program. The most advanced of these is a proposed EU 6th Framework Project in pattern analysis, statistical modelling and computational learning (PASCAL). A formal agreement involving over 50 research organizations is expected to be finalised early in 2004. The project mission is to encourage the development, understanding and widespread use of well-founded methods of statistical pattern analysis, statistical modelling and computational learning as a core technology for the knowledge-based society. The project supports mechanisms and resources for collaboration and exchange of researchers.

A second smaller project is under development with a commercial partner in the area of discrete kernel techniques for information extraction and intelligence. A third collaboration with external organizations in the area of bioinformatics is also under development. There is a prospect of further collaboration with DSTO in the area of intelligent signal processing and the detection of change in sequences of graphs.

The *Symbolic Machine Learning and Knowledge Acquisition* program plans to investigate generalized queries for search engines as a project proposal is in the area of semi-structured and unstructured data. The project would aim to develop high-level mechanisms that allow users to express complex queries in a declarative manner using techniques from learning and logic. Initially the application domain will be limited to XML documents, but eventually it will be extended to unstructured texts. For the latter part, text-mining research will be employed and the million-book digital library project in collaboration with Carnegie Mellon University will be used as a research platform.




A collaborative project is under development between with the KRR program, the SMLKA program and the ARC Centre of Excellence in Autonomous Systems in the area of knowledge representation for planning in robotics. The KRR program will also undertake development of a new external project on Negotiation Axiomatics and Belief Merging, with DSTO Edinburgh, South Australia.

In Human Machine Interaction a proposal is under development for a joint collaboration between the HUM program and the *Logic and Computation* program in Canberra on visualization of search spaces in automated reasoning. The aim is to help humans understand logical reasoning algorithms, using visualization. This will be a fundamental research project, but it could be applied in software engineering disciplines associated with the Formal Methods program. A further project under development will investigate the interactive visualisation of very large and complex networks.

In software engineering four projects are under development in the area of software process. Discussions have been held with a commercial collaborator on research in to the areas of software process modelling, experience management and requirements engineering. A successful project would provide firm level benefits as well as add to accumulated process improvement experience that may be used to assist other Australian companies.

A proposed collaborative project with *Software Engineering Australia* (SEA) in empirical methods is under development. It is expected to provide process improvement opportunities for individual firms and to add to the body of research data into process improvement within SME's. The proposal is based on an SEA trial of SME capability assessment with a number of organizations using the European Software Institute (ESI) model. Under the proposal the SEA would perform capability assessments and process improvement awareness raising among SME's, while NICTA ESE would identify research opportunities and form SME consortia focused on particular software development issues.

The review and analysis of a set of State Government IT projects to discover factors influencing success and failure is planned. The project, Risk Analysis for Government IT Projects, is expected to provide substantial results in risk management and areas for process improvement that could be generally applied to government procurement and firms that are concerned with reducing IT implementation project failures.



Public Sector IP Project Management Improvement is a planned investigation into the kinds of measurements required to show the extent of improvement in IT project management in public sector projects. The project is expected to deliver IT project management improvement measurements that may be used to assist other Australian Government organizations IT management and Australian IT companies.

A proposed project involving a Comparative Evaluation of Linux and NT Server Clusters is related to a commercial bid for the implementation of a Linux server cluster. It is based on an empirical evaluation of the server configuration involving before and after comparisons. Measures will need to be defined and taken once the outcome of the bid is known. The process improvement experience arising from the project may be used to assist Australian companies who plan to use Linux.

The *Formal Methods* program will be a partner in development of an EU 6th Framework RODIN project. This will lead to refinement of the B-toolkit for computer aided software engineering. The project itself is conditional on EU funding of RODIN. The program's contribution to RODIN would be in the area of refinement tool development.

6.3.1 Project Milestones

In 2004 NICTA will introduce an additional 12 projects to its current research portfolio.

Research Projects

01 January – 30 June


1. Introduction of six new projects.

01 July – 31 December

2. Introduction of six new projects.

6.4 RESEARCH MILESTONES

The expected outcomes from the perspective of corporate management of research for 2004 are that NICTA's research culture will be oriented towards entrepreneurship through the influence of contestable funding while remaining strongly compatible with research excellence and collegiality. Project development will be shaped by the influence of the *Priority Challenges*. Research staffing levels will show a balance in favour of NICTA researchers over seconded staff.



Taking account of the objectives achieved in 2003 and the development objectives for NICTA's research capability in 2004 the following milestones have been identified as fundamental to progress in research activity for 2004:

Research Outreach

01 January – 31 December

1. Progress towards achieving the target of \$14m in additional in kind/cash contributions for 2006.

Research Management

01 January – 30 June

1. Formulation and announcement of *Priority Challenges*.
2. Allocation of 35% of research funding through contestable funds.
3. Review of *Priority Challenges* by ISAG.

01 July – 31 December

4. NICTA Research Staff in the majority over seconded staff.
5. Completion of Annual Review of programs.

Research Programs

01 January – 30 June

1. Recruitment of three Program Leaders.

01 July – 31 December

1. Research focus for *Security and Trust Management* program established.
2. Research infrastructure under staged development for:
 - a. *Mobile Networking*
 - b. *Test-bed for Sensor networks*
 - c. *Visualisation and Interaction Collaborative Access Table*.

Research Projects

01 January – 30 June

1. Introduction of six new projects.

01 July – 31 December

2. Introduction of six new projects.



6.5 STRATEGIC OUTLOOK 2005 AND 2006

By the end of 2005, it is expected that the initial programs will be sufficiently staffed to provide NICTA with the critical mass of researchers that will see the beginnings of substantial research outcomes and which will allow NICTA to operate near capacity by 2007.

As part of its staged growth, NICTA will be extending the range of its outreach activities to become a truly national centre of excellence. An overall outreach strategy will attract a further \$14m of cash and in-kind support to NICTA from State and university sources by 30 June 2006. Agreements to this effect will be achieved by 30 March 2006.

In 2005-2006 outcomes from projects will be evident in the form of research papers, conference proceedings and the first collaborative deliverables should be near completion. Formal program and project evaluations will be in operation providing a full complement of review mechanisms to maintain a leading edge to NICTA's research activities.

The assessment process for 2 – 3 new programs will have been completed allowing for their introduction in 2006. There will be substantial activity in a range of collaborative research partnerships with other research institutions. Alongside domestic standing, it is expected that research acceptance will have been established at international conferences. At the same time as NICTA's research capability is maturing the processes for the commercial scanning of research for commercialisation opportunities will have been developed, trialled and institutionalised.

In 2006 the first graduate research students should have completed their enhanced studies programs adding to the potential pool of research talent available to NICTA.

By the end of 2006 the development of a Phase 2 Research Focus will be underway to determine the need for new directions in research Themes and *Priority Challenges* as necessary. As the research base matures it will allow for new investments in research support to be made such as the establishment of a NICTA Research Journal and the setting up of Outreach Foundations for research interaction across Australia.

COMMERCIALISATION

7.1 OBJECTIVE, POLICY AND STRATEGY

The objective of NICTA's *Commercialisation* program is to facilitate the transfer of research outcomes from NICTA to technology producers and the wider community. Within this objective NICTA's policy is to maximise outcomes in the national interest.

The primary strategies that NICTA will employ in support of commercialisation are:

1. Building an entrepreneurial culture amongst researchers and students associated with NICTA.
2. Ensuring clarity of intellectual property ownership.
3. Providing support to NICTA staff for
 - Opportunity identification
 - Commercialisation.
4. Adopting flexibility in IP commercialisation to maximise outcomes in the national interest.
5. Fostering open relationships between the researchers of NICTA and the Australian business community.

7.2 GENERAL APPROACH TO COMMERCIALISATION MANAGEMENT

The current focus of commercialisation activity is the development of infrastructure that will support future start-up opportunities and other transfers. The main outcomes in 2003 have been development of a comprehensive Intellectual Property (IP) policy which extends to all aspects of IP management including transfer through licensing; trialling of a commercialisation identification process; and the foundations for a Pre-seed funding program.

Clarity of ownership is paramount to the successful commercialisation of IP. NICTA supports certainty by maintaining a comprehensive Intellectual Property Policy that incorporates protocols and procedures for:

- Student Assignment
- Visitor Assignment
- Publications
- Disclosure
- Patent Applications
- Laboratory Book
- Collaborative Research and Commercialisation
- Licence Agreement
- Confidentiality Agreement.



Opportunity identification is based on two-stage activity:

1. An internal review of research reporting and disclosure.
2. Engagement with external business development professionals and entrepreneurs.

Commercialisation activities that are to be undertaken in 2004 will be based on Pre-Seeding using NICTA funds and equity and also revenue sharing arrangements. Pre-seed funds may be deployed unilaterally or jointly with other investors following an objective review of the opportunity, simulating and/or involving external venture capital raising rigor. A 'portfolio' approach to investment will be followed to maximise opportunity and minimise risk.

NICTA inventors and founders will benefit from equity and/or revenue sharing from their ventures that will be at least as generous as the prevailing policies of Australian universities and public research institutes.

Flexibility in how NICTA exploits IP generated under its programs is regarded as a key to maximising national benefits from NICTA's research output. A case by case assessment of commercialisation options will be applied in order to preserve flexibility.


7.3 STATUS AND ANTICIPATED PROGRESS IN 2004

During the term of this plan it is envisaged that the further development of commercialisation activity will be based on bringing entrepreneurs into NICTA on structured terms to support commercialisation awareness and acceptance.

The focus of commercialisation activity in 2004 will remain on infrastructure development in anticipation that beyond 2004 well structured internal and external services will be required to support the transfer of research and research staff to a commercial setting. There have been several discussions during 2003 with possible service providers to identify which, if any, capabilities NICTA should develop in-house and which should be sought from service providers. This analysis will conclude early in 2004 and a formal proposal made with regard to internal capability development and possible external services.

The main activities to be undertaken in 2004 to support the development of the commercialisation infrastructure are to:

- test the processes for identifying and facilitating commercialisation opportunities
- disseminate approved IP & Commercialisation policies and related information across NICTA staff
- develop 'Umbrella' Agreements with organisations that are able to provide



complementary professional services as an extension to internal commercialisation activity including:

- National ICT Industry Alliance and other Industry associations in user 'verticals'
- Pre-seed and Incubator service providers
- Venture capital services
- establish an operational Business Advisory Group, perhaps in conjunction with other public sector R&D organisations.

It is also important that the foundations are laid for a business development education program for students in 2004. Content development will be a priority for the first half of 2004.

7.4 STAFFING AND RESOURCES

The scaling of commercialisation activities to meet emerging research output will require additional resources during 2004. In addition to the current Director Business Development and Government and Industry Liaison Manager, two SME Liaison Officers will be appointed in NSW & ACT and a Commercialisation and IP Mgr will be appointed in NSW. NICTA expects to establish a full complement of commercialisation and industry liaison staff by mid 2004.

7.5 ACTIVITIES OF THE INTERNATIONAL BUSINESS ADVISORY GROUP

The IBAG provides an opportunity for NICTA's programs to be put under constructive scrutiny by international experts in ICT markets and commercialisation.

Suggestions from the IBAG and ISAG in 2003 prompted discussion about realignment of some research activities from a vertical program structure to a series of projects under what are now referred to as *Priority Challenges*. This approach will be examined from several perspectives including enhanced opportunities for SME participation in NICTA research activities.

The International Business Advisory Group will continue as a consultative and advisory forum alongside the ISAG. It is expected to meet in September 2004. A list of IBAG members is provided in section 14.3.



7.6 MILESTONES

The milestones listed below reflect what are considered to be the essential achievements for 2004 in order to achieve the infrastructure to support commercialisation of research outputs from 2004.

1 January 2004 – 30 June 2004

1. Commercialisation and IP Manager appointed.
2. Entrepreneur In Residence panel established.
3. Scan of commercialisation opportunities undertaken.
4. Commercialisation education and awareness program devised.
5. NICTA Seed Funding process devised.
6. Review of commercialisation capabilities finalised.

1 July – 31 December

7. Scan of commercialisation opportunities undertaken.
8. First seed opportunities identified.
9. Recommended and agreed commercialisation relationships with other parties formalised in start-up funding, technology licensing and incubator support.

7.7 STRATEGIC OUTLOOK 2005 AND 2006

As the ICT market continues to recover, NICTA's commercialisation infrastructure will be geared to meet increasing market opportunities.

NICTA support for staff and students in commercialisation will emerge as a key attraction and retention lever for top talent.

During this period the flow of wholly NICTA generated IP will commence. Professional services and other support mechanisms for technology transfer and start-up activity will be established. NICTA will have defined the best structure for pre-seed investment and co-investment in start-up ventures and will operate both a local and global network of 'surrogate entrepreneurs'.

It is also anticipated that in the event that the 'roundtable' activities between DSTO, CSIRO, Council of ICT CRCs and NICTA result in some opportunity for consolidation of commercialisation support, this will be in place during 2006.

EDUCATION

8.1 OBJECTIVE, POLICY AND STRATEGY

NICTA's objective in education is to expand the scale and quality of ICT research education in Australia through a dual focus on research and commercialisation. NICTA's overall policy is to work with partner universities to increase the quality and quantity of ICT PhD graduates.

To achieve this, NICTA is focused on the twin strategies of:

1. Re-casting the traditional PhD in a wider context of technical breadth, networking with colleagues, the development of professional skills, and awareness of commercialisation potential.
2. Exposing PhD students to the local industry for domain relevance and to make public or industrial research career paths equally accessible.

8.2 GENERAL APPROACH

NICTA has made a strategic shift in its approach to education by maximising the match of its aspirations to each local partner university. This approach will enable more rapid development of PhD enhancements.

A partnership with ANU in the provision of resources for enhanced PhD training in ICT topics will continue to develop. This partnership is based on using NICTA resources to enable the ANU to add value to its traditional PhD degree. A similar partnership with UNSW and University of Sydney for provision of resources for enhanced PhD training in ICT is being developed.


8.3 DESCRIPTION, STATUS AND ANTICIPATED PROGRESS

8.3.1 PhD Training Programs

The new PhD study program to be launched in 2004 places the traditional PhD in the context of technical breadth, networking with colleagues, the development of professional skills, and an awareness of commercialisation potential.

The NICTA PhD program developed with the ANU, UNSW and University of Sydney incorporates all the elements of the education program envisaged by NICTA. It has been linked to NICTA's student IP policy, and to a scholarship scheme in which NICTA supplements and extends university and government scholarships for PhD study.

At ANU 15 qualified students were enrolled in 2003 with the intent of signing up for the new program once all its details are determined. It is anticipated that a similar number of students will also enrol in the program during 2004. During 2003, 22 students were enrolled with scholarships and top-ups to Government and University scholarships at UNSW. Around 35 students are expected during 2004 at UNSW and the University of Sydney.



A range of accredited courses offering overview, foundational and advanced topics in the research program areas is largely in place. The majority of courses will be offered via video-link facilities to interested students at other locations.

8.3.2 Recruitment and Outreach

Recruitment of students at the Canberra Laboratory has been by a combination of personal networks of the rapidly increasing number of NICTA research staff and researchers contributed to NICTA by ANU and by maintaining an up-to-date web presence where the programs and coursework supported by NICTA are advertised.

At the Sydney Research Laboratory, in addition to the above strategy, the PhD program is heavily promoted among the large number of Honours students at UNSW. International visibility of NICTA among potential students is being promoted through Best Student Paper awards at select major conferences.

Vacation Research Scholarships

A strong NICTA presence was maintained in January 2003 by offering all ANU and UNSW summer research scholars video-linked talks from each NICTA program. This will be repeated and enhanced in January 2004 by also involving some of the NICTA PhD students.

In mid-2003 four highly talented overseas students were invited to work with NICTA researchers. Similar invitations may be made in 2004 as interest from suitable applicants develops.

28 Vacation Scholarships have been offered at UNSW. This talented pool of students will be a significant source of future PhD students for NICTA.

Secondary Sector Outreach

In the ACT plans were developed in 2003 for a recruitment and outreach taskforce. It is envisaged that in 2004 one or two taskforces operating in areas of interest to Canberra Laboratory research programs will conduct outreach to secondary colleges through visits and a web presence.

In Sydney, both UNSW and University of Sydney have a significant Secondary Sector Outreach program to attract students to pursue ICT studies at University. NICTA researchers and NICTA-endorsed PhD students will be made available to both the universities to strengthen their promotion activities.



8.3.3 Expected numbers of PhD Students

The Canberra Laboratory endorsed 15 students who commenced their PhD program in 2003 as NICTA candidates. Not all of these students will necessarily sign up with NICTA once conditions are finally agreed between NICTA and ANU. The number of PhD candidates endorsed at UNSW in 2003 was 22.

In 2004 the Canberra Laboratory will aim to support a similar number of commencing students. The Sydney Laboratory will support 35 students at UNSW and University of Sydney.

8.3.4 Training Relationship with Partner Universities

During 2003 a *NICTA-Approved PhD Study program* was developed with the Research School for Information Science and Engineering (RSISE) and it is expected that this will be adopted by other areas of the ANU seeking to collaborate with NICTA in PhD training. The study program is a formal offering of the ANU through RSISE. NICTA will be an essential partner in this new program through the provision of supervisors for student projects, PhD coursework, networking opportunities and commercialisation support. NICTA also contributes to quantitative growth of PhD training in ICT by supplying additional scholarships for PhD students.

At the University of New South Wales, NICTA- endorsed students are enrolled at two schools in the Faculty of Engineering: School of Computer Science and Engineering and the School of Electrical Engineering and Telecommunications. The rules of the Faculty of Engineering allow the addition of coursework to the PhD program. NICTA provides the university with scholarships, supervision by NICTA researchers and advanced coursework for the PhD program. At the University of Sydney, NICTA- endorsed students are enrolled in the School of Information Technologies. Similar arrangements to those at UNSW apply.

8.4 MILESTONES

Education milestones reflect the fact that the foundations for the NICTA PhD program, including supporting course work were established in 2003. The key objective for 2004 is to address controlled growth in student numbers with excellence in course content.

01 January – 30 June

Canberra

1. 10 new students endorsed for NICTA-supported PhD study at ANU.
2. Five postgraduate courses offered to local and remote PhD students.
3. Out-placement organised for two local students.

Sydney

4. 20 new students endorsed for NICTA-supported PhD study at UNSW and University of Sydney.
5. Five courses offered.
6. Out-placement organised for two local students.

01 July-31 December

Canberra

7. Five postgraduate courses offered to local and remote PhD students.
8. Out-placement organised for two local students.

Sydney


9. Five courses offered and out-placement organised for two students.

8.5 STRATEGIC OUTLOOK 2005 AND 2006

In 2005 the NICTA-endorsed student body is planned to be in excess of 90 students. The anticipated growth in new students at each research laboratory to 2007 is shown below:

Table 7: Expected student numbers to 2007

PhD Students	2004	2005	2005	2007
Canberra				
ACT estimate (max)	24	27	33	42
Sydney				
Kensington estimate	29	35	41	50
ATP estimate (max)	24	29	34	41
NSW estimate (max)	53	64	75	91
Total NICTA estimate	77	91	108	133



Some qualifications must be noted in relation to the figures in Table 7. Firstly the estimated student number is based on an average payment of \$22,900 for each student. Student numbers will accordingly vary if there are a high number of students requiring smaller scholarship awards. Secondly, while the 2004 figures are based on a set budget, the budgets for 2005-7 have not been agreed and are based on a notional increase of 20% per year. New research activities in the projected period have yet to be agreed. The number, size and location of these activities will have an effect on the number and breakdown of students.

In 2006 25 students are expected to complete their studies. It is anticipated that out-placements of students to other NICTA laboratories and within their respective research communities in Australia and overseas will be in operation after development of this aspect of PhD training in 2003 and 2004. It is also anticipated that there will be established patterns for increased student interaction with industry both at an SME level and larger-scale companies. This interaction will intensify the commercialisation awareness of all students and lead some into entrepreneurial activities that will extend beyond their PhD projects.

LINKAGES

9.1 OBJECTIVE, POLICY AND STRATEGY

The objective of NICTA's Linkages and Networks pillar is to nurture national excellence in research. To achieve this NICTA has adopted a policy of open and collaborative working with a range of stakeholders

The primary strategies for nurturing national excellence in ICT research through linkages are to:

1. Build high quality partnerships, interactions and linkages with Australian industry including
 - SMEs
 - Research institutions in Australia and overseas
 - Multinationals
 - Users and producers of ICT.
2. Leverage the support provided to NICTA by Australian government agencies.
3. Serve as a focal point for the development of ICT industry clusters.

9.2 GENERAL APPROACH TO MANAGING NETWORKING AND LINKAGES

The guiding principles for managing networking of research, training, and commercialisation with both domestic and international organisations are founded on encouraging and building relationships that are:

1. Real in terms of the relative contributions of collaborating parties.
2. Oriented towards excellence.
3. Aligned with the expertise of NICTA's research programs.

These have proven to be useful and robust guides to establishing networks and linkages to date.

In 2004 there will be an expansion of staff resources committed to the task of developing and managing networks and linkages as an extension to the research level linkages that have already emerged. A further dimension to network and linkages activities in 2004 will be the implementation of a *Communication and Brand Recognition Strategy* which is expected to provide important dividends for recruitment, research collaboration opportunities and commercialisation activity.

9.3 'OPEN AND COLLABORATIVE' WORKING

9.3.1 National and International Research Institutions

Collaboration with other ICT Research Institutions at both an international and national level is a fundamental objective for NICTA and has been made one of several key decision criteria for project selection.



In the areas of international research linkages NICTA has a series of ventures and collaborations in place, or in development, that are a natural outgrowth of research interaction. Collaboration will be extended as programs refine their focus and there is an alignment of research expertise and aspirations. International visitors as researchers and lecturers within NICTA programs and the placement of NICTA researchers in overseas institutions and at major conferences are prime vehicles for building these relationships. The quality and number of these relationships are significant for the development of NICTA's reputation and standing during its growth phase.

In terms of local engagement with Australian research institutions the ICT Outlook Forum has provided and will continue to provide a valuable organisational opportunity for bringing research interests together. In 2004 the Outlook Forum will be held in the ACT.

An R&D road-mapping exercise will be conducted in 2004. This has the objective of developing a consolidated high-level Australian ICT R&D technology roadmap. It will be based on the input of DSTO, CSIRO, Council of ICT CRCs and NICTA and is planned to be initiated during February 2004. The exercise arises from recommendations made in the Framework for the Future Report (2003) and can be expected to support development of:

1. An agreed format and process for road-mapping.
2. A consolidated documented technology roadmap for Australian Public Sector ICT R&D.
3. A continuous consultative process between institutions and within NICTA itself on road-mapping issues beyond the February milestone.

Individual programs will be developing specific research relationships in 2004 and, in the case of *Wireless Signal Processing*, a concerted effort will be made to link the national research effort in a comprehensive network. These prospective relationships have arisen from work on refinement of the research in each program during 2003 and are exemplified in the relationship formalised with DSTO late in 2003. This has rapidly progressed from an Umbrella agreement to a source of significant project development.

9.3.2 Major ICT Users

NICTA's commitment to the vision of Universal ICT places a strong emphasis on the interests of end-users of ICT. Major users are consulted where it is conceivable that their interests may be served through NICTA's research or where the output of research is likely to result in a benefit to the user. In 2004 NICTA will seek to extend the range of possible new networks and linkages by participating in the Innovation Xchange to explore opportunities for collaboration with a range of mature industrial sectors and communities of interest where ICT is changing industry or community dynamics.



9.3.3 International ICT Companies

NICTA is currently engaged with a number of International ICT firms with various levels of operations in Australia. The nature of the engagement varies according to the activity that firms undertake in Australia. Some have expressed commitments to collaboration on projects while others, largely centred on marketing and sales, have noted NICTA's existence.

NICTA will continue to interact with ICT multinationals in 2004 to test opportunities for collaboration in research and commercialisation. ICT multinationals will be routinely advised about NICTA's activities at both the national and international level.

9.3.4 Small and Medium Sized Enterprises

A structured program will be introduced in 2004 to enhance SME participation in research to build and research and SME links with the ultimate aim of strengthening firm-level capacity to engage with forward looking ICT.

Three activities will form the mainstay of SME networks and linkages:

- an internet-based subscription program will invite firms to register an interest in NICTA's programs and activities
- R&D focus workshops will be held with firms or groups of firms and NICTA researchers
- a series of leading user workshops will bring to NICTA and clustered SMEs the views of leading ICT users on the challenges faced by the user sector.

These activities will provide the basis for developing depth and quality in research-based collaboration and for building clusters of firms around the research programs.

9.4 STAFFING AND RESOURCES


The responsibility for networking and linkage activities runs throughout the NICTA structure. However, the scaling up of the network and linkages activities will require additional resources during 2004. Recruitment will be directed to the appointment of SME Liaison Officers in Sydney and Canberra.

9.5 MILESTONES

The milestones listed below reflect the key objective for 2004 of providing a structured program of interaction to support linkage activity.

01 January – 30 June

1. R&D road-mapping project conducted.
2. Website subscription program and services implemented.

- 
3. Leading user seminars in Canberra and Sydney.
 4. International visitor program (12 visitors).
 5. Comparator data set developed.
 6. *Priority Challenges* workshop with non-ICT industry sector or regional community.
 7. Terms and conditions for assistance program issued.
 8. Leading user seminars in Canberra and Sydney.

01 July – 31 December

9. *Priority Challenges* workshop with non-ICT industry sector or regional community.
10. Results of road-mapping project analysed and disseminated.
11. Feasibility of establishing a pool of comparator institutes assessed.
12. ICT Outlook Forum.
13. Leading user seminars in Canberra and Sydney.
14. International visitor program (12 visitors).
15. *Priority Challenges* workshop with non-ICT industry sector or regional community.
16. Leading user seminars in Canberra and Sydney.

9.6 STRATEGIC OUTLOOK 2005 AND 2006

As industry conditions improve it would be expected that the networks and linkages activities will result in more meaningful feedback information to NICTA about how different interest groups value particular research activities. By 2005, NICTA's activities in relation to networks and linkages will have achieved a strong network of relationships built on a clear understanding of NICTA's mission with respect to various stakeholders.

In the period 2004-05 the development of a formal comparator program will begin to provide NICTA with the information necessary to support management decision making on adjustments to programs and other activities as it seeks to achieve a global recognition.

Developing linkages with industry sectors and communities that are 'remote' from ICT and Sydney/Canberra offers the opportunity to deepen the impact that NICTA will have on the National Research Priorities.

The clustering of SMEs around research programs and projects should be apparent.

HUMAN RESOURCES

10.1 ACTIVITIES

Human Resources programs and outcomes in 2003 were focused on the development of the infrastructure that most organisations take for granted: accounting and finance systems, budgeting, payroll, human resource policies and basic office administration. The end result of endeavours in 2003 has been the establishment of HR infrastructure and foundation policies for recruitment and staff management.

In addition to providing the essential infrastructure, Human Resources statutory policies were developed to reinforce NICTA's mission, with a strong emphasis on differentiating NICTA from the dominant university culture of the university partners. These were developed, with input from the Laboratories, and approved by the Board in November 2003.

In 2004 HR activities will address a range of more strategic activities with an emphasis on culture building within NICTA.

10.2 GENERAL APPROACH TO MANAGING HUMAN RESOURCES

NICTA's personnel are from disparate groups: NICTA appointees specifically recruited for their innovation and commercialisation skills, as well as quality of research; seconded (contributed) staff from the partner universities, often with long careers in the university sector and international reputations in ICT research; corporate staff with commercial and private sector experience. One of the key opportunities for NICTA during 2004 will be to build a common culture from these different backgrounds. To ensure the integration of these cultures, human resource strategies will be designed to optimise cultural integration.

In the development of new HR processes such as management and leadership education, development of commercialisation capabilities for research staff, remuneration review, performance management, promotion and career management; there will be a deliberate strategy to align these with the NICTA culture and mission.

There will be close liaison with communications and industry development functions and the research programs to ensure that there is commitment to the concept of the NICTA culture and that there is a shared understanding of the behaviours and values that underpin it.



10.3 STATUS AND ANTICIPATED PROGRESS

The foundation HR policies and programs have been established and a series of new Human Resources policies and programs will be implemented in 2004 to reinforce the growing maturity of the company and its culture. Current HR policies will be reviewed to ensure that they provide not only the appropriate reinforcement for the NICTA mission, but actively support the culture that NICTA aspires to achieve.

There will be a continuing emphasis on recruitment of researchers to achieve critical mass and balance seconded and appointed staff. The emphasis for 2004 will be to improve targeting of researchers, making the process more efficient, and more aggressive marketing of NICTA's employment benefits with potential appointees.

10.3.1 Recruitment Strategy

The main focus of recruiting in nearly all programs is at the Researcher (level B). Targeted advertisements were developed during 2003 and attracted a higher proportion of applicants than the more general advertisement for the generic Researcher level B. Targeted advertisements allow for more precise distribution to newsgroups and other networks. Researchers travelling to overseas conferences will be tasked with attracting suitable candidates to apply for NICTA positions.

Implementation of the on-line recruitment system (nga.net) will improve the efficiency of the recruitment administration process, and will allow Program Leaders to monitor applications. Currently the administration process is long (average appointment time for researchers is three months from application to appointment) and makes heavy demands on the time and effort of Human Resource staff and Program Leaders.

Recruitment and Selection policies for research and support staff will be reviewed to ensure better streamlining of the process, and to incorporate contemporary, commercial practices (employed by commercial competitors for high quality research staff).

All staff involved in the recruitment process, such as administrative and senior research staff, will receive education in the new processes. This will be aimed at making better hiring decisions and also at assessing the innovation and commercialisation skills of researchers prior to appointment.

10.3.2 Payroll and Benefits Administration

Currently an outsourced payroll provider undertakes all payroll administration including calculations for Payroll and Group tax and superannuation contributions. It is proposed to in-source payroll administration during 2004. This will provide NICTA with greater quality and accuracy control over this vital HR function.

10.3.3 HR Policies

The first phase of Human Resource policies was completed in late 2002. These policies were developed to provide an orderly process of recruitment and employment contracting. It was anticipated by the Board that these would need to be reviewed to bring them into line with the NICTA mission and contemporary practice. Once the NICTA intranet has been established, all policies will be disseminated through that mechanism. The policies completed in 2003 are shown in Table 8.

Table 8: NICTA HR Policies established in 2003

Employment conditions	Occupational health and safety
Salary scales	Equal employment opportunity
Recruitment & Selection	Learning and development
Salary Sacrificing	Remuneration
Interview Recruitment Processes	Code of conduct
Appointment Expenses	Immigration
NICTA Fellows	

The policy and procedures covering HR matters planned for 2004 are:

- Performance management
- Career management and promotion
- Management leadership
- Building researcher capabilities in commercialisation
- Equal Employment Opportunity programs for female researchers.

10.4 STAFFING NUMBERS

Projected headcount has been estimated as an integral part of the budgeting process for 2004. Table 9 shows how the numbers of support and research staff are anticipated to grow on a quarterly basis over 2004.

Table 9: Projected staffing numbers for 2004 by function and site

Projected headcount for 2004 by Quarters				
	Mar	Jun	Sep	Dec
Researchers				
ATP	13	17	20	20
Kensington	20	23	28	29
Canberra	19	22	31	37
Total Researchers	52	62	79	86
Seconded Researchers				
ATP	10	10	10	10
Kensington	25	25	25	25
Canberra	16	16	16	16
Total Seconded researchers	51	51	51	51
Technical Support				
ATP	7	8	8	8
Kensington	4	6	7	7
Canberra	2	3	3	3
Total Tech Support	13	17	18	18
Administration				
ATP	3	3	3	3
Kensington	8	10	11	11
Canberra	6	6	7	7
CHO	19	19	19	19
Total Administration	36	38	40	40
Total Staff Projections for 2004	152	168	186	195




Table 9 does not include student numbers which are projected to be a maximum of 24 PhD candidates in the Canberra Research Laboratory and 35 in NSW.

NICTA anticipates that planned recruitment efforts will see a shift in the preponderance of seconded researchers compared to NICTA recruited researchers. By the end of 2004 it is anticipated that there will be twice as many NICTA appointed researchers as seconded researchers.

10.5 MILESTONES

The key HR deliverables to be developed during the year will be new policies and programs covering:

1. Occupational Health and Safety committees and risk assessment.
2. In-sourcing of payroll processing.
3. Design and implementation of Performance Management System.
4. Design and implementation of Management leadership course.
5. Appointment of Business Development and Commercialisation staff.
6. Career Management and Promotion Policy.

10.6 STRATEGIC OUTLOOK 2005 AND 2006

The development of HR infrastructure into 2005 and 2006 will include a continued refinement of the recruitment and remuneration foundations laid in 2003 and the performance management and career progression focus to be applied in 2004. The outlook beyond these foundation programs is largely conditioned by the direction of NICTA's research output. Emerging HR programs will need to focus on the development of the commercialisation capabilities of staff. Similarly, encouraging teamwork across the programs will be a major objective.

During 2005 it is expected that NICTA will begin development of programs that will essentially coach staff in start-up arrangements and facilitate their exposure to a greater depth of industry experience and collaboration. With the progress of research programs and usual organisational development factors NICTA can be expected to experience some staff turnover, this will mean periodic enhancement of recruitment efforts.

In 2006 NICTA should start to see strong collaboration with industry and it may then be appropriate to implement programs for formal secondment arrangements between NICTA and industry collaborators.

ACCOMMODATION

11.1 ACTIVITIES

11.1.1 Status and Anticipated Progress in 2004

Canberra

Temporary Accommodation

The Canberra Research Laboratory (Canberra Node) has been established in the RSISE building at the Australian National University and is currently planning to expand into further accommodation in Northbourne Avenue by March 2004. This is expected to meet planned short-term accommodation needs. Telephone, data and security infrastructure is being provided by ANU.

Permanent Accommodation

NICTA has appointed a development manager who is currently negotiating with ACT authorities on the purchase of land at Section 61 in Civic and is developing a building brief that describes NICTA's accommodation requirements. A two-part tender process for a developer to fund, design, obtain authority approvals, build, lease and manage a landmark building on Section 61 is in progress. NICTA will lease its required accommodation from the developer. An Expression of Interest (EOI) for developers closed on 16 December 2003. Tenders will be sought in about March 2004 with building completion scheduled for May 2006. ICT collocation planning is occurring in parallel with current activities.

Kensington

Temporary Accommodation

The UNSW Research Laboratory is being established in the Electrical Engineering Building in three stages. Stage 1 is complete and Stage 3 will be complete in July 2004. Further accommodation is being established in the Applied Sciences Building and will be complete in January 2004. This accommodation is expected to meet known short-term accommodation and recruiting needs.

Permanent Accommodation

A building is currently under construction by UNSW (L5 Building). NICTA and UNSW are currently developing a lease to accommodate NICTA's UNSW Research laboratory. The building is expected to be completed in December 2004.

Australian Technology Park

Temporary Accommodation

NICTA has completed fit out of temporary accommodation in Bay 15 of ATP and is progressively occupying the building. NICTA's HQ has been established in the building along with two programs from UNSW. A third program from Sydney University will establish on site in late January 2004.



Permanent Accommodation

NICTA's permanent HQ will be established in a landmark building to be constructed at ATP. A heads of agreement has been established between NICTA and ATP and a building brief is currently being developed. ATP will develop the new building to meet NICTA's requirements and NICTA will lease its required space. ICT collocation planning will occur in parallel with planning for the new building. Construction is expected to commence in July 2004 with completion in June 2006.

11.1.2 Telecommunications Infrastructure

The telecommunications infrastructure for NICTA operations conducted from ANU and UNSW is as provided by the respective universities. At ATP the facilities are as described below:


CustomNet Spectrum is a sophisticated telecommunications service, which delivers advanced call handling capabilities from the network. Telephone handsets located at ATP are connected directly to the Public Switched Telephone Network, which uses network intelligence to provide unique communications solutions, tailored to meet NICTA specific needs, with access to over 150 features.

It offers the following capabilities:

- network access from the telephone handset via analogue or digital lines
- advanced call handling features equivalent to those of the latest PABXs
- inter-site networking and low cost inter-site local calls with the City Wide option
- central call answering position features
- call centre features
- data features
- call traffic information via Spectrum Call Data.

NICTA's communications data infrastructure, designed and implemented in the third quarter 2003, consists of UTP (structured cabling) to the desktop, Fibre optic cable backbone, and all intelligent devices (concentrators, switches and routers) which drive the network.

NICTA's ATP site link to the outside world and other NICTA sites is through a dedicated 1000Mbits/second multimode NICTA-owned Optical Fibre link to UNSW's Kensington campus and a 100Mbits/second link to the internet from UNSW via AARNET. The NICTA-managed network provides for higher data rates and reduced congestion allowing data to be completed sooner and support all research activities. It allows extensive use of resource-hungry applications, and new applications which demand real-time data transfer, such as audio and video distribution, to run over the network.



At the NICTA ATP end of this link is a CISCO 4006/4506 switch router. This device has 48 x 1 gigabit UTP Ethernet ports. The 4006 feeds a dedicated Linux router which performs the primary routing fire walling functions of the whole site. The 4006 has a large number of 1 gigabit ports which feed the servers in the computer room, as well as connecting to the floor switches. A number of floor switches, Cisco 2500 series switches (24 x 100 megabit UTP Ethernet ports), feed the workstation printers, wireless access points etc., distributed around the site.

IPSec is used to tunnel network traffic in an encrypted form between NICTA sites. Although a network is designed to transmit data, sometimes that is exactly what is not wanted. Not all resources on the network are available to all users. The network technology installed allows the network to be broken into smaller sections or subnets (VLANS), with access between subnets being controlled. For example, a student subnet may have restricted access to certain confidential servers while the staff subnet is allowed access.

11.1.3 Development of the ATP site as NICTA's Headquarters

A Memorandum of Understanding (MOU) has been entered into with ATP Management to develop the anchor license agreement for the new headquarters building. Included in the provision of the MOU is an undertaking to jointly market the ATP site and raise NICTA and ATP's profile.

11.2 MILESTONES

The progress milestones for accommodation and site development for 2004 are as follows:

01 January – 30 June

1. Canberra Temporary accommodation occupied.
2. New ATP headquarters licence agreement signed.
3. University of Sydney based program relocated to ATP.
4. New Canberra site developer appointed.

01 July – 31 December

5. Work commenced on new ATP headquarters building.
6. Construction work completed on permanent UNSW site facility.

11.3 STRATEGIC OUTLOOK 2004 AND 2005

With much of the foundation work completed and new dedicated facilities coming on stream during this period on all sites, work will then shift to attracting appropriate co-tenants and partners into the facility and optimising the interaction with the public through industry development events and demonstrators. Table 10 shows the major anticipated developments to 2006.

Table 10: Major accommodation developments

Site	2004	2005	2006
NICTA Research HQ, Australian Technology Park, NSW	<p>Stage 2 temporary accommodation fit-out in Bay 16 completed.</p> <p>Stage 1 (Bay 15) and Stage 2 (Bays 16) temporary accommodation. Fully occupied by admin. & research staff and students.</p> <p>Detailed design and commencement of construction of new research HQ.</p>	<p>Construction of new research HQ continues.</p>	<p>Landmark research HQ building complete and occupied by NICTA.</p> <p>Temporary accommodation in Bays 15 & 16 vacated.</p> <p>NICTA expansion and ICT collocation at ATP.</p>
Sydney Research Laboratory, UNSW Kensington, NSW	<p>Applied Sciences Building refurbished and Stages 2 & 3 fit-out of temporary accommodation in Building G17 completed.</p> <p>Progressive occupation of temporary accommodation by NICTA research staff and students.</p> <p>Construction of new research laboratory building completed.</p>	<p>New building occupied by NICTA's Sydney Research Laboratory staff and students. Temporary accommodation in UNSW vacated.</p> <p>NICTA expansion.</p>	<p>NICTA expansion</p>
Canberra Research Laboratory, ANU and Civic, ACT	<p>Fit-out of additional temporary accommodation in Northbourne Ave. completed.</p> <p>Land acquisition of site in Section 61 Civic completed.</p> <p>Construction of new research laboratory commenced</p>	<p>Construction of new research laboratory building continues.</p>	<p>New landmark building complete and occupied by NICTA's Canberra Research Laboratory staff and students.</p> <p>NICTA expansion and collocation on Section 61.</p>

FINANCIAL PLAN

12.1 ACTIVITIES

The following set of accounts shows NICTA's expected financial situation as reflected in projected income statement, cash flow statement and balance sheet at the end of the Plan. A set of notes at the end of the accounts provides additional information necessary to explain how NICTA will be applying the Australian Government Funds.

Statement of Financial Performance		AAP Forecast 31-12-04
	Notes	\$000's
Revenue from ordinary activities	1	46,203
Expenses:		
Employee benefits expense	2	20,465
Depreciation and amortisation expense		1,599
Other expenses from ordinary activities		6,462
Activities outside Sydney and Canberra	3	6,075
Profit from ordinary activities before income tax expense		11,602
Income Tax Expense		-
Net Profit		11,602

Statement of Financial Position		AAP Forecast 31-12-04
	Notes	\$000's
Current Assets		
Cash	4	18,977
Other Current Assets		2,025
Total Current Assets		21,002
Non-Current Assets		
Property, plant and equipment	5	14,446
Total Non-Current Assets		14,446
Total Assets		35,448
Current Liabilities		
Other current liabilities		628
Total Current Liabilities		628
Total Non-Current Liabilities		-
Total Liabilities		628
Net Assets		34,820
Equity		34,820

Statement of Cash Flows		AAP Forecast 31-12-04
	Notes	\$000's
Cash flows from operating activities		
Receipts	6	50,495
Interest received		1,303
Payments to suppliers and employees		-37,884
Income taxes paid		-
Net cash inflow from operating activities		13,914
Cash flows from investing activities		
Payments for property, plant and equipment		-13,488
Net increase (decrease) in cash held		426
Cash at beginning of the financial year		18,551
Cash at the end of the financial year		18,977

Notes - Revenue	
Details of revenue receipts are as follows:	
- Contribution from members	4,400
- Dept of Communications Information Technology and the Arts	28,500
- Australian Research Council	12,000
- Interest received	1,303
Total	46,203



FINANCIAL ACCOUNTS – PART 1 – SUMMARY

Note 2. Employee Benefits Expense

This area of expenditure reflects a considerable uplift from the 2003 level stemming from an almost doubling of staff numbers, and is in line with NICTA growth strategies.

Note 3. Activities outside Sydney and Canberra

This expenditure reflects outreach activities for the establishment of a NICTA presence outside of the current Sydney and Canberra centres.

Note 4. Cash

The cash at the end of 2004 is in line with NICTA activity strategy and is explained as follows:

- a) An amount of \$6 million is for the development of commercial prototypes from research product.
- b) The balance of approximately \$13 million is sufficient to fund activities until the next major funding receipt forecast to be in April 2005. The monthly organisation cash requirements are forecast to be approximately \$3 - \$4 million per month going into 2005.

Note 5. Property, plant and equipment

The increase in this area during 2004 reflects the establishment of the new site in Canberra.

Note 6. Receipts

Receipts are higher than the revenue amount in the Financial Performance Statement because the Cash Flows statement includes the GST component.

FINANCIAL ACCOUNTS – PART 2 – DETAIL

	Budget 2004
Revenue	
Grants / funding	44,900,000
Interest	1,302,859
Total Revenue	46,202,859
Less: Expenses	
Direct Employment Costs	
Salaries	11,951,722
Employee On-Costs	298,793
Performance Based Pay	1,195,172
Payroll Tax	597,368
Contractors/Temp	146,980
Appointment & Recruitment Costs	1,299,000
Other Employment Costs	597,586
NICTA Fellows	0
Scholarships	2,222,698
University Contributed Staff Support	1,424,103
Visiting Staff Costs	732,000
Total Direct Employment Costs	20,465,423

	Budget 2004
Other Overheads	
Consulting	999,320
Depreciation	1,598,989
Entertainment	0
Facilities	153,200
General Operational Costs	1,238,462
IT Costs	121,248
Library Costs	175,000
Rent	1,514,221
Travel	1,391,672
Total Other Overheads	7,192,112

Centralised Admin Costs	
Advertising	110,000
Amortisation	0
Audit	25,000
Bank Charges	18,000
Communications	444,000
Insurance	209,000
Legal & Regulatory	44,000
Promotional Expenses	18,000
Total Centralised Admin Costs	868,000

Activities outside Sydney and Canberra	6,075,000
Net Position (Tax Exempt)	11,602,324

	Dec-04 Budget
Current Assets	
Bank	18,976,892
Cash on Hand	100
Receivables	1,864,500
Other Debtors	0
Prepayments	36,000
Other Current Assets	124,434
Total Current Assets	21,001,926
Non Current Assets	
Fixed Assets	16,410,046
Less: Provision for Depreciation	(1,963,805)
Net Fixed Assets	14,446,241
Intangible Assets	0
Total Non-Current Assets	14,446,241
Total Assets	35,448,167
Current Liabilities	
Payables	840,308
Other Creditors & Accruals	(460,809)
Lease Liabilities	0
Loans	0
GST Payable / (Receivable)	(84,031)
Provisions	332,250
Total Current Liabilities	627,718

	Dec-04 Budget
Non Current Liabilities	
Lease Liabilities	0
Loans	0
Provisions	0
Total Non-Current Liabilities	0
Total Liabilities	627,718
Net Assets	34,820,449
Shareholder's Funds	
Retained Earnings	23,218,125
Current Year Earnings	11,602,324
Total Shareholder's Funds	34,820,449

Comments

The budgeted expenditure level for 2004 includes an amount of \$16.7 million in research expenditure according to definitions acceptable for the application of ARC funds.

12.2 EXPECTED CASH AND IN-KIND CONTRIBUTIONS: OTHER THAN THE AUSTRALIAN GOVERNMENT

The quantum of the expected cash and in-kind contributions to NICTA from organisations other than the Australian Government is as follows:

Cash

UNSW \$0.6 million
 ACT Government \$1.1 million
 NSW Government \$2.5 million
 University of Sydney \$0.2 million

In-Kind

UNSW \$3.8 million
 ANU \$3.9 million
 University of Sydney TBA



12.3 EVALUATION METHODOLOGY FOR IN-KIND CONTRIBUTIONS

The methodology used to calculate the value of in-kind contributions is based on a publication of the Australian Vice-Chancellors' Committee (AVCC) dated February 1996 and titled 'University Research: Some Issues. The AVCC document provides a well founded basis for the costing and charging for research in a 'university context'. The paper provides a general statement of application to universities across Australia, rather than being specific to any one particular university or organisation.

The approach to costing set out in the AVCC paper represents an approach which can be adopted in calculating the fair value of employees who are contributed to NICTA by universities.

In relation to the Contributed Employees of ANU and UNSW, applying the principles of the AVCC approach raises the following considerations:

- The level of salary on-costs will vary from Contributed Employee to Contributed Employee. As noted in the AVCC paper, in some cases salary on-costs may be up to 52% of salary costs. A more standard figure is likely to be in the range of 25% – 30%. Such an employee by employee approach is broadly consistent with the financial information required to be supplied in applications under the Cooperative Research Centres Program
- The costing of infrastructure costs is based on the assumption that the Contributed Employees are carrying out their duties using university infrastructure. For example, a UNSW Contributed Employee who was to work full time at the NICTA premises located at the Australian Technology Park in Redfern, would not be expected to have any infrastructure costs associated with their particular costing
- The proportion of time which a Contributed Employee is 'devoted' to NICTA is taken into account in determining fair value
- Given the nature of the research being undertaken by UNSW and ANU Contributed Employees, the appropriate multiplier for determining infrastructure costs is 1.25 (namely, that which applies to laboratory based researchers)
- The AVCC multiplier is based on a 1996 paper from the AVCC and data obtained at that time from the Department of Employment, Education and Training for the higher education system as a whole. It could be expected that the relevant multiplier would



change over time as underlying cost structures change

- Adopting the AVCC methodology has the attraction of representing a methodology generic to universities and thus prima facie applicable to any university which becomes an Alliance Partner of NICTA
- The application by NICTA of a common multiplier in respect of Contributed Employees, regardless of the university providing the in-kind contribution, represents a sound approach.

In respect to the contribution of other in-kind contributions, that is, other than contributed staff, an 'arms length' transaction valuation methodology is used.

12.4 MILESTONES

The milestones listed below reflect the key activities necessary to increase the required value-add of the financial administration system in NICTA's management operations and the validation of cyclical processes.

Jan 2004 – Jun 2004

1. Internal management accounting system established.
2. Detailed management reporting system established.
3. Comprehensive and detailed accounting work process documentation finalised.

Jul 2004 – Dec 2004

4. Budget prepared for 2005.
5. A regular forecast review process established.

PERFORMANCE INDICATORS

13.1 INTRODUCTION

The fundamental purpose in determining KPIs is performance management against internally set objectives and/or external benchmarks. In terms of NICTA's mission both purposes clearly apply.

During its development to steady-state performance indicators that will be applied will be those applicable to reaching mature operational levels. The application of KPIs to assess NICTA's performance against comparator institutes at a global level will necessarily have to wait NICTA's full development and the agreement of comparable institutes to comparative performance benchmarking.

Two sets of indicators are presented in this section to reflect the need for an immediate set of indicators that will assist planning and monitoring of growth to steady-state level and the need for a long-term set of indicators for performance benchmarking steady state performance in national and global terms.

13.1.1 Growth Indicators

A set of KPIs that show the development of NICTA during its growth phase are proposed in Table 11. These indicate the key measures considered to be essential indicators of how NICTA is progressing towards its steady-state operations. They are aggregate output measures for NICTA as a whole and will be reported each year commencing from the Annual Report 2003.

The performance benchmarks set for 2003-2007 show the staged growth of NICTA over the period of development.

Table 11: Growth Performance Indicators and Benchmarks

Performance Measure by Key Result Area	Proposed Performance Benchmark				
	2003	2004	2005	2006	2007
Research Capacity					
Number of research staff	-	110	144	202	260
Number of programs	11	13	15	17	17
Number of projects	10	22	35	45	50
Number of Outreach agreements concluded	2	3	-	-	-
Research students population	37	77	91	108	133
Research student graduating	-	-	-	25	40
% of contestable research funding	-	35	45	50	60



13.1.2 Research KPIs

An extensive series of KPIs were proposed for use in the AAP 2003. These applied across the four pillars of activity and included qualitative and quantitative measures. A full benchmarking scheme necessarily depends upon NICTA reaching its steady-state operations. The use of qualitative measures requires some development. The reason for this is simply that a qualitative statement is inherently difficult to apply to performance free of context such as the perspective of the appraiser, whether a short- or long-term perspective is adopted or the visibility of the impact. Consequently, before NICTA can begin to apply qualitative indicators in reporting and managing its performance it is necessary to develop qualitative performance benchmark statements that will provide reasonable direction on what constitutes performance against a qualitative measure. A mechanism will also need to be developed by which qualitative statements can be evaluated fairly.

It is envisaged that these performance benchmark statements will comprise numerical and normative statements. The key areas where qualitative measures have been proposed as performance indicators are for determining performance against the following objectives:

1. Researchers of the highest calibre.
2. 'Best' research outcomes.
3. Effective commercialisation, particularly national benefit.
4. 'Extensive Linkages'.

In 2004 NICTA will develop qualitative benchmark statements in each of these areas and submit them to the project executive for approval together with a proposal for their use in annual reporting.

13.1.3 Researcher Performance


Two objectives were proposed in the AAP 2003 for the performance evaluation of NICTA research. These were:

1. To have researchers of the highest calibre.
2. For research activity to be recognised internationally and supported by external organisations both within Australia and overseas.

Both will be determined on the basis of qualitative and quantitative measures.

Researcher Calibre

Researcher calibre will be indicated by the quantitative measures listed in section 13.6. Reporting against these measures will first be made in the 2003 Annual report.



There is also a qualitative element to determining researcher calibre, particularly in the case of young researchers. In 2004 NICTA will develop an appraisal system that will provide a basis for trustworthy qualitative benchmarking of researchers to support institutional growth and individual researcher development. This will be based on the nomination of researchers of the same experience level who are prominent in the field and then a comparison against performance criteria will be made. Taking account of NICTA's mission with respect to commercialisation and linkages some form of linkage partner inputs will also be incorporated.

Aggregated reporting against the qualitative component will commence from the Annual Report 2005.


In 2004 NICTA will develop the process for qualitative assessment of researcher calibre and submit it to the project executive for approval together with a proposal for its use in Annual Reporting.

Research Recognition

The benchmark objective for international recognition and support by external organisations both within Australia and overseas is for the average number of outcomes by NICTA researchers to be at least as good as those in comparator institutions.

The indicators to be applied are listed in section 13.6 under research recognition. These measures will only be reported in 2003 and 2004 given that NICTA is in early start-up stage. This will also allow for validation and enhancement of data collection and processing. From 2005 they will be reported against benchmarks which will be based on the average calculated outputs for the ICT CRCs. From 2007 an additional set of benchmarks will be included which will be the average output for a set of international comparator institutes.

The use of researcher citations as a systematic quantitative indicator of research recognition will be deferred until an appropriate methodology based on current ARC work is established and validated. Although this is potentially a valuable indicator of peer recognition and the impact of research, its implementation depends upon finalisation of an ARC methodology addressing difficulties in citation measurement such as capacity to cover the field, sample size, and cost of collection.



Qualitative data will be applied through the development of benchmark statements for quality publications. Description of the three best research achievements across NICTA will also be used. In 2004 NICTA will develop qualitative benchmark statements for:

- quality publications
- 'a best research achievement'.

A further qualitative benchmark statement will be developed to determine what constitutes a world-class research institution.

These will be submitted to the project executive for approval together with a proposal for their use in Annual Reporting.

13.2 EDUCATION KPIS

Education KPIs will be based on quantitative and qualitative measures. For quantitative measures performance will be against criteria listed in section 13.6.

A qualitative measure will be applied from 2006 based on the destination of completing students. In 2004 a set of benchmark descriptors covering the destination of completing students will be developed and submitted to the project executive for approval together with a proposal for their use in Annual Reporting.

13.3 EFFECTIVE COMMERCIALISATION KPIS

Effective commercialisation will be determined on the basis of quantitative and qualitative data. Quantitative measures of performance will be against criteria listed in section 13.6.

A qualitative measure will also be applied in the form of a satisfaction survey covering commercialisation activities. The survey instrument will be developed in 2004 and collection commenced in 2006.

13.4 EXTENSIVE LINKAGE KPIS

Extensive linkages will be determined on the basis of quantitative and qualitative performance indicators. The quantitative indicators used will be the criteria listed in section 13.6.

The quality of linkages will be determined on the basis of an agreed qualitative benchmark statement that will be applicable from 2005. Performance against quality benchmark statements will be measured by satisfaction surveys with the following stakeholders:

- International Research Institutions
- Australian Public Sector Organisations

- 
- Australian Universities
 - Cooperative Research Centres
 - SMEs
 - Sophisticated ICT users
 - Multinational ICT Companies.

In 2004 NICTA will submit a qualitative benchmark statement for determining the quality of linkages and a satisfaction survey proposal to the project executive for approval together with a proposal for their use in Annual Reporting from 2005.

13.5 NATIONAL BENEFIT

This is inherently a value judgement that will vary significantly from appraiser to appraiser. Some economic and public policy methods may yield numeric data but interpretation of that data will still be dependent upon assumptions and values. An ARC study, *A Wealth of Knowledge*, released in September 2003 will be studied and evaluated during 2004 to ascertain whether it provides a robust and cost-effective methodology for assessing national benefit on quantitative terms. It is anticipated that NICTA will commission a full national benefit evaluation of its activity and impact in 2015.

NICTA will develop qualitative benchmark statements that reflect anticipated national benefits outcomes from NICTA's four pillars of activity: Research, Commercialisation, Education and Linkages. Three impact benchmark statements will be developed that will apply to NICTA for 2007, 2012 and 2017. These will be submitted to the project executive for approval in 2004.

In annual reporting, performance against benchmarking statements will be reflected in external commentary, case studies and similar material that reflect the extent to which NICTA's activities approach its benchmarking statements year by year.

Table 12 shows the proposed introduction of performance and benchmarking arrangements.

Table 12: Benchmark and KPI measurement

	2003	2004	2005	2006	2007
Quantitative					
Growth Indicators	Data gathering and Reporting against Benchmarks				
Research Calibre	Commence data collection and Reporting		National Benchmarks apply		International Benchmarks Apply
Research Recognition					
Education					
Commercialisation					
Linkages					
Qualitative					
Quality Publications	Benchmark Statements developed		Commence collection		
Best research outcomes					
Student destination	Survey developed		Commence		
Commercialisation	Benchmark and survey developed		Commence		
Linkages	Benchmark and survey developed		Commence		
National benefits	Case study and related material collected				



13.6 NICTA KPIS ONGOING

Researcher Calibre

Invited Talks

Specialised individual citations

Membership of staff on external program committees and editorial Board

Prizes and Awards

Membership of Academies

Research Recognition

Number of Journal publications

Number of publications other than journals (conference papers, industry papers)

Invitations to address and participate in international conferences

Citation recognition of researchers (Deferred till ARC project completed)

Number of commentaries about the Centre's achievements

Number of research collaborations domestic

Number of research collaborations International

Education

Number of FTE NICTA-endorsed students

Number of PhD completions

Number of courses delivered

Number of professional courses undertaken by students

Vacation research scholarships offered and accepted

Secondary sector outreach contacts

Commercialisation

Number of patent applications

Australia

USA

EU

Japan

Other

Economic impacts

Number of Joint Ventures and Start-up companies established

Number of staff and students trained in technology transfer and commercialisation

Linkages

Number of international visitors

Number of workshops or conferences attended

Number of teaching or research visits to international laboratories

Number of SME Clusters established

Number of government, industry and business briefings

Number of Public Awareness programs and technology outreach events

Number of firms participating in subscription service

Number of courses or workshops offered to industry

INFORMATION ANNEXES

14.1 RESEARCH STAFF ANNEX

This Annex provides a list of research staff by program and shows the position of each research staff member. Their affiliation and the fraction of their time contributed to NICTA is shown for contributed staff. For recruited research staff the place they were recruited from is given.

Within the research programs there are four ranks of researcher (from postdoctoral to a level analogous to full professor): Researcher (Level B), Senior Researcher (Level C), Principal Researcher (Level D) and Senior Principal Researcher (Level E).

The information is correct at 31 December 2003 – it excludes program administrators and research assistants.

Name	Position	Affiliated	%	From
Embedded, Real time and Operating Systems (ERTOS)				
Gernot Heiser	Program Leader	UNSW		
Frank Engel	Level B			Germany
Ihor Kuz	Level B			Netherlands
Manuel Chakravarty	Level C	UNSW	30	
Gabrielle Keller	Level C	UNSW	30	
Oliver Diessel	Level C	UNSW	30	
Kevin Elphinstone	Level C	contracted from UNSW	50	
John Zaitseff	Research Engineer		50	
Ben Leslie	Research Programmer			
Carl Van Schaik	Systems Programmer			
Wireless Signal Processing (WSP)				
Rodney Kennedy	Interim Program Leader	ANU	100	
Thushara Abayapala	Level C	ANU	100	
Dhamikka Jayalath	Level B	ANU	100	
Predrag Rapajic		UNSW		

Name	Position	Affiliated	%	From
Mark Reed	Level C			Switzerland
Tony Pollock	Level B			New Zealand
Leif Hanlen	Level B			Australia
Sarah Johnson	Level B			New Zealand
Networks and Pervasive Computing (NPC)				
Aruna Seneviratne	Program Leader	UNSW		
Sanjay Jha	Level D	UNSW	30	
Mahbub Hassan	Level D	UNSW	30	
Nigel Lovell	Level D	contracted from UNSW	50	
Tim Moors	Level C	UNSW	30	
Robert Malaney	Level C	UNSW	30	
Nirupma Bulushu	Level B			USA
Lavy Libman	Level B			Israel
Marco Candiago	Research Engineer			
Formal Methods (FM)				
Ron van der Meyden	Program Leader	UNSW	100	
Kenneth Robinson	Level D	UNSW	30	
Arcot Sowmya	Level D	UNSW	30	
Gerwin Klein	Level B			Germany
Kai Engelhardt	Level B	UNSW	30	
Carroll Morgan	ARC Professorial Fellow	affiliated from UNSW		
Empirical Software Engineering (ESE)				
Ross Jeffery	Program Leader	UNSW	100	
Barbara Kitchenham	Level E		40	UK
June Verner	Level E			USA
Piyush Maheshwari	Level C	UNSW	30	

Name	Position	Affiliated	%	From
Amir Michail	Level B	UNSW	30	
Karl Cox	Level B	affiliated ARC Research Associate		
Symbolic Machine Learning and Knowledge Acquisition (SMLKA)				
Arun Sharma	Interim Program Leader	UNSW		
Achim Hoffman	Level D	UNSW	30	
William Wilson	Level D	UNSW	30	
Frank Stephan	Level C			Germany
Alan Blair	Level C	UNSW	30	
Andrew Taylor	Level C	UNSW	30	
John Shepherd	Level C	UNSW	30	
Raymond Wong	Level C	UNSW	30	
Eric Martin	Level C	contracted from UNSW	30	
Xuemin Lin	Level C	UNSW	30	
Will Uther	Level B			USA, CMU
Bernhard Hengst	Level B			Australia
Adonis Antonidies	Research Engineer			USA, Berkeley
Statistical Machine Learning and Sensor Signal Processing (SMLSSP)				
Bob Williamson	Program Leader	ANU		
Alex Smola	Level C	ANU		
Swaminathan V.N. Vishwanathan	Level B			India
Doug Aberdeen	Level B			Australia

Name	Position	Affiliated	%	From
Knowledge Representation and Reasoning (KRR)				
Norman Foo	Program Leader	UNSW	100	
Arthur Ramer	Level D	UNSW	30	
Thomas Meyer	Level C			South Africa
Aleks Ignjatovic	Level C	UNSW	30	
Maurice Pagnucco	Level C	UNSW	100	
Sylvie Thiebaut	Level C	ANU	100	
Jochen Renz	Level B			Austria
Autonomous Systems and Sensor Technologies (ASST)				
Richard Hartley	Program Leader	ANU	100	
David Austin	Level D	ANU	100	
HongDong Li	Level B	ANU	100	
Lars Petersson	Level B			Sweden
Rene Vidal	Level B			USA, Berkeley
Nick Barnes	Level B			Australia
Leanne Matusyk	Research Programmer	ANU	100	
Logic and Computation (LC)				
John Slaney	Program Leader	ANU	100	
Rajeev Gore	Level D	ANU	100	
Tomasz Kowalski	Level C	ANU	100	
Jeremy Dawson	Level B			Australia
Michael Norrish	Level B			Cambridge UK
Anbulagan	Level B			Indonesia
Andrew Slater	Research Programmer			Australia



Name	Position	Affiliated	%	From
Systems Engineering and Complex Systems (SEACS)				
John Moore	Program Leader	ANU	100	
Brian Anderson	NICTA Chief Scientist	ANU	100	
Knut Hüper	Level C			Germany
Alexander Lanzon	Level B	ANU	100	
Jochen Trumpf	Level B	ANU	100	
Danchi Jiang	Level B			Canada
Robert Orsi	Level B			Australia
Humans Understanding Machines (HUM)				
Peter Eades	Program Leader	USYD	100	
Mary Lou Maher	Level E	USYD	30	
Masahiro Takatsuka	Level C	USYD	30	
Seoh-kee Hong	Level B	USYD	30	

Recruitment offers have been made to several researchers with the expected date of commencement in 2004 shown below.

FM			
Rob van Glabbeek	Level D	Stanford	June 2004
Ralf Huuck	Level B	Germany	February 2004
Ian Gorton	Level E	USA	March 2004
Mark Staples	Level B	Australia	January 2004
Shyjan Mahamud	Level B	USA, CMU	-

14.2 NICTA TRAINING COURSES 2003/2004

This annex lists the courses delivered by NICTA in 2003 and those which have been developed in 2003 for delivery in 2004. Four levels of coursework are offered:

- **Transition/Foundation Courses** offer the technical foundations of ICT in collaboration with partner universities. These courses may be at undergraduate or postgraduate level and enable participants to expand their understanding of the ICT disciplines and relate to the broad sweep of ICT advances
- **Overview Courses** offer technical broadening in NICTA program areas for students who do not have the pre-requisites to examine the topic areas in technical depth. These enable participants to establish a working knowledge of the history, the technical breadth, the enabling science, the current boundaries and the current and anticipated applications of an ICT research area which is outside their own area of formal study
- **Advanced Courses** are discipline-based courses that enable participants to advance their understanding towards the boundaries of the ICT disciplines in which they have sufficient foundational understanding. They broaden the technical base of PhD students working in adjacent technical areas
- **Professional Courses** are presented in collaboration with partner universities and external professional training bodies. These courses provide non-technical skills primarily to NICTA-endorsed PhD students and staff.

The courses offered in 2003 and new courses to be added in 2004 are shown below:

2003	2004
NICTA Foundation Course	NICTA Foundation Course Applied Linear Algebra Advanced Calculus Linear Systems Theory
NICTA Overview Course Systems and Control Logic and Automated Reasoning Computer Vision Statistical Machine Learning	NICTA Overview Course Wireless Communications Signal Processing Robotics Statistical Machine Learning Logic and Computation
NICTA Advanced Course Combining Agents, Answer Sets and Planning (Informal) Category Theory and Categorical Logic	NICTA Advanced Course Model Reduction, Uncertainty & Robustness H-two & H-infinity Optimal Control Turbo Receiver Design Continuous Wireless Communications Statistical Machine Learning Theory and Application Introduction to Convex Optimisation
NICTA Professional Course Commercialising Research & Development (NGSM)	NICTA Professional Course

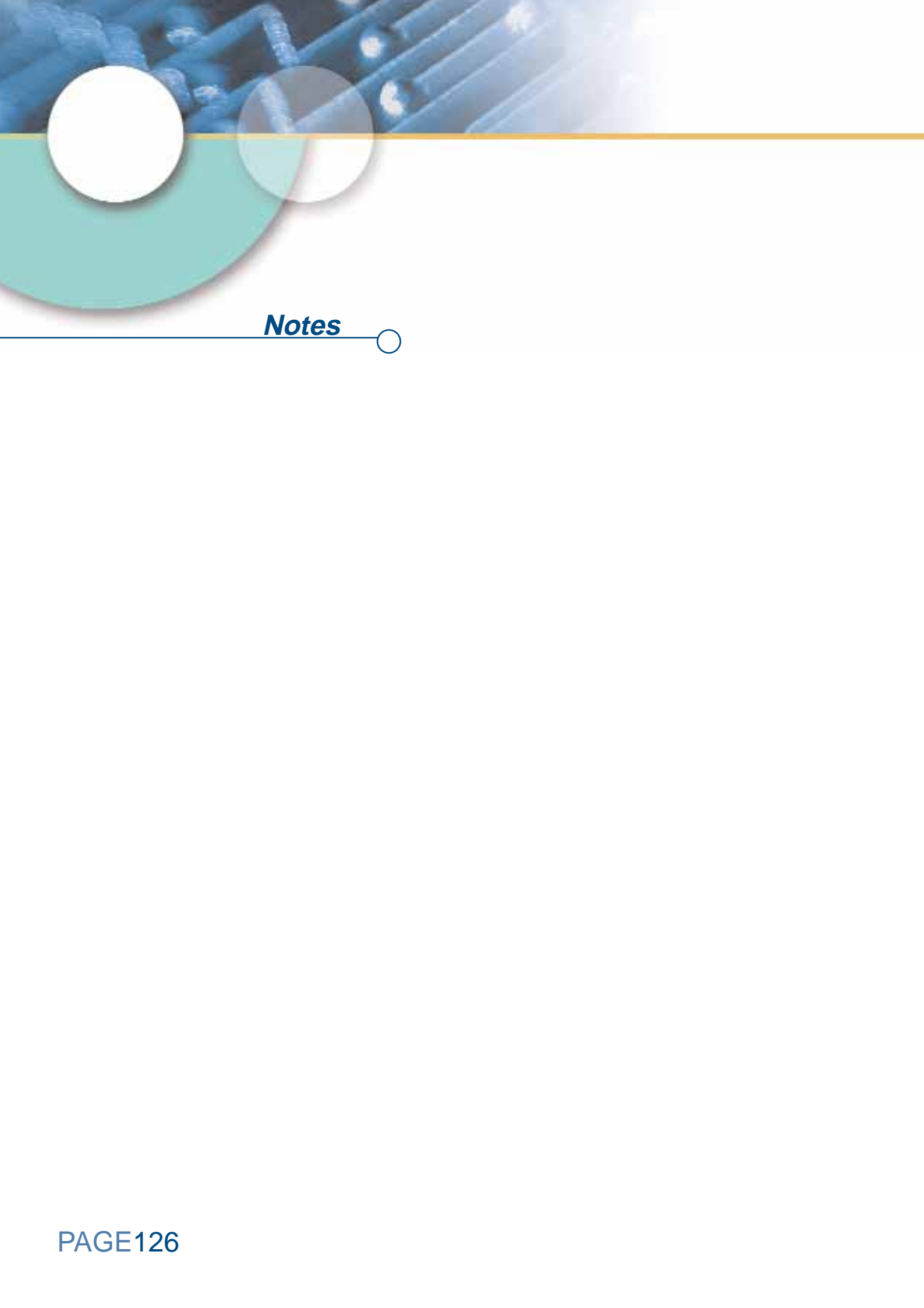
14.3 IBAG AND ISAG MEMBERSHIP

International Business Advisory Group		
Name	Position	Organisation
Dr. Bob Bishop	Chairman and CEO	Silicon Graphics
Mr. Ian Buchanan	Chairman	Booz Allan Hamilton, Australia, New Zealand, SE Asia
Mr. Seah Moon Ming	President	Singapore Technologies Electronics
Dr. Craig Mudge	Managing Partner	Pacific Challenge
Dr. Kazuo Murano	Corporate Senior Vice President and Group President	Global Business Development Group, Fujitsu Ltd.
Dr. Narayana Murthy	Chairman and Chief Mentor	Infosys Technologies Ltd.
Mr. C. D. Tam	CEO	Hong Kong Science and Technology Parks Corporation
International Science Advisory Group		
Name	Position	Organisation
Prof. Gunnar Bjurel	Managing Director	Swedish Institute of Computer Science, Sweden
Prof. Rodney Brooks	Director	MIT Artificial Intelligence Laboratory, USA
Dr. Stuart Feldman	Vice President	Internal Technology, IBM Corporation, E-Commerce Learning Centre, NC State University, USA
Prof. Bill Howard	Independent Consulting Engineer	Chairman, US Department of Defense Advisory Group on Electron Devices and serves on the Defense Science Board. Chairman, Board of Credence Systems Corporation.



International Science Advisory Group

Name	Position	Organisation
Dr. Gilles Kahn	Scientific Director	INRIA Rocquencourt, France
Prof. Richard Newton	Dean	College of Engineering, University of California, Berkeley, USA
Prof. Raj Reddy	Dean	School of Computer Science, Carnegie Mellon University, USA
Prof. Shankar Sastry	Chairman	Electrical Engineering and Computer Sciences, University of California, Berkeley, USA
Prof. Des Taylor	Tait Professor of Communications	Electrical and Computer Engineering Department, University of Canterbury, New Zealand
Prof. Jeffery Ullman	Professor	Computer Science Department, Stanford University, USA
Dr. Y-Q. Zhang	Managing Director	Microsoft Research China, Beijing



Notes



