Defence Technology Agency

Review of the Defence Technology Agency

Applying Science for New Zealand's Security and Prosperity

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THE NEW ZEALAND DEFENCE FORCE

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Statement from the Minister of Defence, Hon Dr Wayne Mapp

Following the Defence White Paper's release in late 2010, I commissioned a review of the Defence Technology Agency (DTA).

It was evident that the DTA's work programme needed to support the NZDF's capability development programme more directly. It was also clear that DTA could be run more efficiently, and be more closely tied into New Zealand's science and innovation sector.

The proposals made in this independent report will advance each of these objectives. I join the Chief of Defence Force in welcoming the report's recommendations, and I am pleased to note that work is already underway to implement them.

Advanced scientific research is an increasingly important component of military capability, and is central to New Zealand's economic development. This report marks the beginning of a new era in defence scientific research.

I extend my thanks to Rear Admiral (Retired) Ledson ONZM, Dr Helen Anderson QSO, and Mr Neville Jordan CNZM for producing this independent report.

Hon Dr Wayne Mapp
Minister of Defence

Statement from the Chair, Rear Admiral (Retired) David Ledson

The importance of this review, not only to Defence but also in the broader national context, has been widely acknowledged in discussions held both in New Zealand and overseas, and in the submissions that the panel read. This reflects three things. Firstly, defence science and technology plays a vital role in generating and enabling capability for the New Zealand Defence Force (NZDF), providing a 'capability advantage'; secondly, it can contribute to a whole-of-government approach to national security challenges; and thirdly, it can provide support to the Government's high technology and economic growth agendas.

While this review considers the Defence Technology Agency (DTA) in relation to these three areas, we have also been mindful of the contexts in which our review has been conducted, and in which our recommendations will be implemented.

The Government's Defence White Paper 2010 (DWP) sets out a comprehensive and ambitious programme for the New Zealand Defence Force for the next 25 years. It outlines the capabilities required to conduct a range of military tasks across the spectrum of operations from the South Pacific to further afield. Additionally, it recognises that, considering New Zealand's size and strategic circumstances, there are advantages in addressing 'defence' and 'security' as complementary, rather than separate, constructs.

The Defence White Paper also identifies the substantial challenges that lie ahead. In particular, a tightly constrained financial environment will need to be managed and savings made if the programme is to be successful. It acknowledges that every area of Government needs to demonstrate 'value for money'.

We believe our recommendations can be implemented within the current Defence science

and technology funding envelope, through the Defence Technology Agency actively seeking new sources of funding. Collectively, the recommendations will allow the Defence Technology Agency to answer the Defence White Paper's call for science and technology to be a vital 'capability multiplier' across Defence activities. The recommendations will also enable substantial improvement in the Defence Technology Agency's contribution to New Zealand's security and economic sectors.

We would like to acknowledge the many people, both in New Zealand and overseas, who have made valuable contributions to this report. They are too numerous to name individually, but we would especially like to thank, from the New Zealand Defence Force, Lieutenant Colonel Andrew Brown, Lieutenant Commander Leon Bennett, Mr Hayden Robinson, Mr Justin Fris, Ms Samantha Orange and Mr Peter Coleman.

For their assistance in arranging the overseas aspects of the review, we extend our thanks to Lieutenant Colonel Nick Gillard in London, Commander David Hedgley in Canberra and Group Captain Tim Walshe in Singapore.

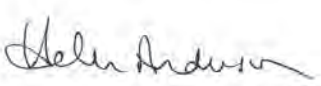
We particularly thank Mrs Paula Brown for her special contribution.

We also acknowledge the support of Professor Sir Peter Gluckman, the Chief Science Advisor to the Prime Minister, and the Ministry of Science and Innovation.

The Defence Technology Agency is doing vital work, but it can do it better and its work applied more broadly. Having met many of the people who work there, we are convinced that they share this view and would relish the opportunity to show what they can really do.

Taken together, the recommendations set out here give them their chance; Defence, and the country as a whole, will benefit from their endeavours.

Rear Admiral (Retired) David Ledson ONZM
Chair, DTA Review Panel, 31 March 2011



Dr Helen Anderson QSO
Member

Neville Jordan CNZM
Member

Executive Summary

Introduction

1.1 Following the publication of the Defence White Paper 2010 (DWP) and the Value for Money (VfM) Review of the New Zealand Defence Force (NZDF), the Minister of Defence (the Minister), through the Chief of Defence Force (CDF), commissioned a comprehensive external review of the Defence Technology Agency (DTA) to be undertaken by a three-person Panel comprising members with extensive military, scientific and industry experience.

1.2 This report is the result of the Panel's deliberations. It reviews DTA's role and makes recommendations, firstly, to improve DTA's contribution to NZDF's ongoing effectiveness; and, secondly, to enhance DTA's contributions to the Government's economic growth and high technology agendas, and New Zealand's wider security sector.

Background

1.3 The Panel visited DTA, interviewing managers and project teams, and visited equivalent organisations in Australia and Singapore. Through videoconferencing and NZDF's network of Defence Attachés, the Panel sought insights into how other countries maximise the impact of their defence science organisations. The Panel met and interviewed a range of stakeholders (including the Chief Science Advisor to the Prime Minister, heads of other Government agencies and Crown Entities, and the executive leadership team and senior officers of NZDF and the Ministry of Defence (MoD)), for their views on, and experience of, defence research, science and technology (RS&T) in general and DTA in particular. The Panel heard from those whose work synergises with DTA's current work. Through online submissions, the Panel also heard from users and providers of defence science in New Zealand and overseas.

Findings

Ownership, Governance and Leadership

1.4 There is no advantage in separating DTA as a unit from NZDF or in, at this stage, relocating its Devonport facilities. Further, this report's recommendations can be implemented within the current ownership construct.

1.5 Although the recommendations can, generally, be implemented without increasing staff or funding levels, other sources of funding should be identified. It is vital that an effective performance management framework, using Key Performance Indicators (KPIs), be implemented at an early stage. This will enable a qualitative review of DTA and science and technology outcomes to be made in three years.

1.6 Both DTA and the science and technology component of the Government's security sector would benefit from greater strategic oversight and a higher public profile in New Zealand and internationally. There would be advantages, too, for associated industry organisations and academic institutions.

1.7 A long-term defence RS&T strategy is required to indicate Defence's approach to science and technology over at least the next five years. This will provide a framework within which DTA will identify how to deliver on DWP and other related priorities.

1.8 The appointment of a part time Chief Defence Technologist (CDT) is critical to improving such strategic oversight. The CDT will provide unfettered advice to relevant Ministers, CDF, the Secretary of Defence, and others, and will chair a Defence Technology Advisory Board including eminent scientists and technologists and appropriate Defence and industry representatives. The Board will provide oversight of Defence's science and technology strategy and its implementation, and it will undertake periodic reviews of DTA and strategic defence and security related science and technology matters as requested by the Minister.

Management and Staffing

1.9 DTA must have an effective Director who will enable the agency to reach the level of organisational excellence required and implement the change programme outlined in this report.

1.10 DTA must anticipate future staffing requirements, including that staff are capable of meeting Defence priorities. For this, the professional and personal development of staff must be approached more systematically, and the organisational environment must be better attuned to retaining and motivating scientists in light of how technology agencies need to work. A more comprehensive framework is required to recruit, retain and motivate those who work at DTA. The framework must support the professional development of individuals while acknowledging the needs and priorities

of Defence. An important change will be to provide staff with better recognition and reward for outstanding contributions to innovation and scientific excellence.

1.11 Whilst the shape of the organisation requires change, the current staffing levels should be sufficient for at least the next few years while the recommendations of this report are implemented.

Role

1.12 DTA should develop a Purpose Statement, clarifying its roles and priorities in respect of its Defence work, and allowing it to contribute more broadly to the security and intelligence sector, the scientific community, and the economy.

1.13 From DTA, Defence requires solutions to technical problems and challenges as they arise, as well as independent, unbiased advice and guidance. It also needs input into the defence acquisition process. Currently, DTA's performance is variable, for a variety of reasons, some of which are beyond DTA's control. Consequently, the organisation should adopt a framework to prioritise its activities with a significant change in focus to 'support for acquisitions' and 'support of current operations' and DTA's role in delivering advice to Defence decision-making processes needs to be formalised. Furthermore, it can add value and decrease risk in military procurements by looking specifically at future technologies in the 15 to 20 year timeframe. The NZDF and MoD need to become more informed users of RS&T.

1.14 The limited technical support DTA currently provides to other New Zealand security and intelligence agencies should be expanded, allowing Defence and DTA to become central to a whole-of-government approach to security collaboration.

Priority Setting

1.15 DTA covers a wide range of activities in defence science and technology; some of these have developed through legacy programmes, others through the influence of The Technical Co-operation Programme (TTCP), and some through specific Defence requirements. This range of activities is too broad. DTA activities must be reprioritised according to Defence and other national priorities.

1.16 NZDF and MoD must improve their working knowledge of DTA-delivered science and technology and develop more expertise in how it may be used. Defence and DTA also require a more formalised and straightforward means of engaging with each other, and their respective structures and processes.

Networking

1.17 Given the size and scale of New Zealand, maintaining a high quality defence science capability requires a special focus on information sharing and collaboration with other

organisations. These include DTA's overseas counterparts, Crown Research Institutes (CRIs), academia, and the wider science sector, domestically and internationally. Networking improves leverage and helps avoid duplicating the efforts of DTA and the wider science sector. Examples of networking include staff secondments to other organisations, and arrangements with CRIs - in particular the Institute of Environmental Science and Research Ltd (ESR) and Industrial Research Limited (IRL).

1.18 While DTA benefits from its engagement with TTCP, other countries are finding that more effective collaboration is possible within bilateral relationships. Consequently, DTA should identify bilateral opportunities with, for example, Australia. For DTA to strengthen international engagements, its contribution to these must be credible and sustainable. Hence current activities must be reviewed, especially within TTCP and similar frameworks.

1.19 The Panel heard that security requirements have prevented, somewhat unnecessarily, easier access for those outside Defence to DTA. Where security allows, DTA should become more open and its work more visible to the scientific community and industry.

Commercialisation

1.20 Through supporting Defence, DTA have developed several products with significant commercial potential. However, as DTA's primary role is not a commercial one, it should seek industry partnerships to exploit such opportunities for the benefit of New Zealand. DTA should develop the capability to manage technology transfer through partnerships with, for example, CRIs and centres of commercialisation excellence. Such capability should also link Defence needs with research developments.

1.21 A significant proportion of revenue earned from commercialisation should be retained by DTA and the benefits shared with staff.

Conclusion

1.22 DTA provides substantial RS&T support to Defence but it can do more. The scope of its defence activities is currently too broad and needs reviewing. As a consequence its impact and influence could be increased to contribute more significantly to the Government's high technology and economic growth agendas. And it could achieve this within existing funding levels.

1.23 The ownership structure of DTA inside NZDF is appropriate. However, changes to management structures and processes will increase flexibility and autonomy, especially in budgeting and personnel matters. While opportunities exist for a greater presence in Wellington, DTA facilities in Auckland are appropriately located.

1.24 Greater coordination and engagement with NZDF and MoD, as well as with industry

and the wider science sector, both domestically and internationally, are central to DTA delivering value for money. Engaging more broadly in New Zealand and overseas through more active partnerships is also key to improving DTA's performance.

The first important steps to success

1.25 The recommendations in this report provide the foundation for a set of plans that will enable DTA to play a central role in applying science and technology for New Zealand's security and prosperity. Among them, though, are three that constitute the first vital few steps to success and they are: the appointment of a Chief Defence Technologist (CDT); the appointment of a Director DTA; and the formulation and development of Defence RS&T Strategy.

> **DTA is part of the NZDF but it's not as fully integrated as it should be. The agency has the technical expertise to play a more active and valuable role in NZDF capability development, and in the delivery and employment of Defence Force capabilities.**
>
> *– Written submission*

CASE STUDY

RNZAF RB211 Engine Bearing Failure Detection

DTA has expertise in the assessment of the condition of aircraft propulsion systems, underwriting flight safety and reducing ownership costs while improving the availability of aircraft. Development work included analysing engine wear debris trapped in oil filters. Collaboration with TTCP partners prompted DTA to recommend the RNZAF buy FilterCHECK, a commercial filter debris analysis system.

The programme has already been successful. For example oil filters from the engines on the Boeing 757 (B757) designated for the first flight to Antarctica were sent to DTA shortly before the flight. Analysis indicated an abnormal condition in one engine. DTA's experience with diagnosing engine wear symptoms indicated a serious defect in a main shaft bearing. This advice was delivered to the RNZAF in approximately two hours.

The RNZAF were able to select the alternate B757 to carry out the mission. The defective engine was removed for overhaul which confirmed that high-pressure turbine main bearing elements were dangerously worn. If the engine had remained in service, a complete bearing failure would have occurred within a short period of operation, causing significant engine damage and a potential in-flight shut down. The early detection of this defect restricted the damage to the bearing itself (repair cost USD 300k). The cost of repairing the engine had the bearing failed is estimated to have been approximately USD 3M.

Outcomes:

- The RNZAF successfully completed the first B757 mission to Antarctica
- A costly and dangerous engine failure was avoided
- The utility of the FilterCHECK system was confirmed, supporting the RNZAF decision to use the equipment for engine condition monitoring, diagnosis and prognosis.

Recommendations

Ownership structure and location	1. That the current ownership structure of DTA is appropriate and is retained. 2. That DTA remain in its current location in Auckland and establish a greater presence in Wellington. 3. That funding for DTA is maintained at current levels for the next three years. 4. That RS&T funding be a seperate Output Class. 5. That, in the meantime, a comprehensive performance management framework is implemented to enable a qualitative review of DTA, and that this is completed before the end of the three years.
Who does DTA serve?	6. That while DTA's principal client is Defence, it should also be mandated to provide advice and technical support to other government agencies with security and intelligence responsibilities
Informed customers	7. That NZDF and MoD develop a systematic programme of activities to enhance the level of RS&T capability and awareness within their current and future workforces.
Governance and leadership	8. That the Minister appoint a part-time Chief Defence Technologist (CDT) as the first step in implementing the recommendations of this review.

	9. That the CDT, in consultation with the Minister, Defence Principals and the Prime Minister's Chief Science Advisor, convene an Advisory Board composed of eminent scientists, technologists and appropriate defence and industry representatives. 10. That CDF appoint, as a high priority, a Director DTA with the requisite scientific and management competencies as a senior appointment within the NZDF and reporting directly to CDF. 11. That the Director DTA's professional advice is formally integrated into relevant Defence decision-making processes.
Priority setting	12. That DTA take a leading role in Defence's work to develop a new Defence RS&T Strategy linked to defence, security and economic priorities to set the future strategic direction and priorities for Defence's RS&T investments. 13. That DTA conduct a comprehensive re-examination of current scientific programmes to ensure alignment with the Defence RS&T Strategy, and make any changes required to ensure alignment.
What should DTA do?	14. That DTA rebalance its programme of work to increase the level of support it provides to 'acquisitions' and 'current operations'. 15. That DTA is systematically and formally engaged early in each stage of the acquisition life-cycle and that this approach is trialled using the Advanced Pilot Training as a short term project and Land C4ISR as a long term project. 16. That DTA develop its foresighting capacity to provide Defence Principals with periodic updates on future and emerging technologies. 17. That Director DTA conduct a stocktake of current NZDF RS&T activities and recommend to Defence Principals a process for the appropriate coordination of all Defence RS&T activities. 18. That NZDF in consultation with DPMC identify

	an appropriate role for DTA in CBRE risk mitigation and management. 19. That the Director DTA establish a policy and clear priorities and accountabilities for all human factors research undertaken in Defence and review the current work programme against these.
Accessibility	20. That DTA adopt a new approach to the 'security' elements of its work, shaped to a greater extent than present by pragmatic and situational factors, in order to develop a culture of 'openness' within the organisation and enable greater collaboration with relevant organisations in New Zealand and overseas. 21. That DTA develop and implement a communications and engagement strategy to better facilitate outreach and collaboration. Elements of the strategy are likely to include a website and regular dialogue and interaction with the science community and industry, both in New Zealand and abroad.
Commercialisation	22. That a significant proportion of any revenue earned from commercialisation activities should be retained by DTA. 23. That the Director DTA appoint a senior manager whose role will be to build relationships with industry and develop business opportunities. 24. That MoD develop defence industry policies that stimulate greater commercialisation and industry development opportunities with DTA. 25. That DTA actively identify other sources of revenue to support its work, such as, for example, gaining accreditation to the Technology Voucher Scheme. 26. That DTA develop the capability to manage technology transfer and serve as a portal between Defence and the scientific research community.
Key relationships	27. That NZDF coordinate with partner agencies to develop a formal mechanism for DTA to provide

	core RS&T advice and support for the security and intelligence agencies. 28. That DTA's programme of work with TTCP be reviewed and more tightly focused on New Zealand national priorities. 29. That DTA more actively explore opportunities for strengthened bilateral collaboration, both inside and outside the TTCP framework, with a particular emphasis on Australia. 30. That DTA consult with IRL and ESR with a view to strengthening their collaborative research programmes and identifying any opportunities to share resources. 31. That DTA increase its interaction with the national and international research community through ICT, conferences, and exchanges. 32. That DTA acquire appropriate connectivity such as secure e-mail, video teleconferencing and encrypted broadband allowing staff to effectively engage in meetings, conferences and exercises with counterpart organisations domestically and internationally.
People	33. That NZDF create policies and practices allowing DTA to implement the appropriate HR processes that acknowledge the different requirements of scientific personnel, including motivational ones. 34. That DTA conduct a review of personnel competencies against the Defence RS&T Strategy in order to identify and mitigate potential gaps. 35. That a structured programme of two-way secondments between DTA and counterpart organisations be instituted as soon as practicable. 36. That DTA through, for example, RSNZ and IPENZ awards schemes, seek out opportunities to reward innovation and scientific excellence in staff.
Management	37. That relevant NZDF policies enable the Director DTA to approve minor capital

	expenditure for specialised RS&T equipment. 38. That the policy of allowing staff to have commercial interests deriving from their full-time employment at DTA is discontinued, but that commercialisation activities should be incentivised through some form of benefit-sharing with staff. 39. That DTA implement a process to monitor and enhance the quality of science and reporting. 40. That a simpler and more effective project management approach be adopted across Defence for the management of DTA tasks and tasking.
Implementation	41. That the recommendations and associated change agenda be implemented as a package and that these new arrangements be given at least three years to stabilise before they are reconsidered.

CASE STUDY

Diver Signature Evaluation System (DSES)

DSES is a portable system for evaluating diver performance when identifying and deactivating mines during training exercises. DSES uses sensors and electronic systems mounted in a fibre glass Manta mine shape.

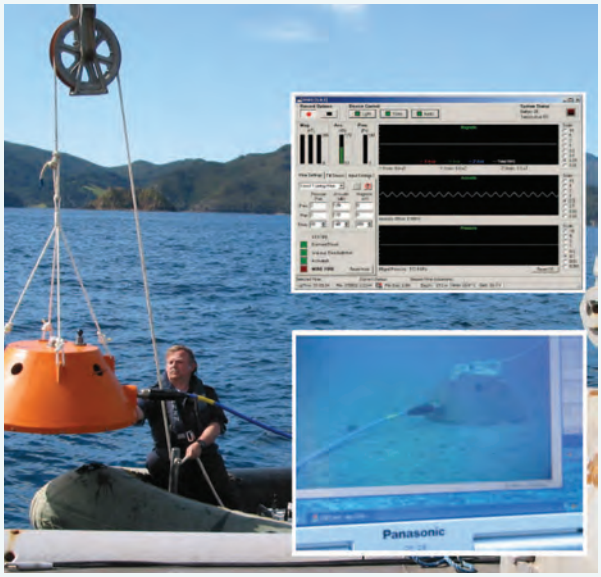
The Manta mine shape houses the sensor package which includes acoustic, magnetic and pressure sensors. It is also fitted with an electric compass module with tilt and temperature sensors, mine activation warning light and an audible alarm to indicate mine activation when trigger thresholds are reached (i.e. when the mine would have exploded).

Data is collected and transferred to a seabed computer for real time analysis of the signature from divers and their equipment. Control, power and data are transferred via a 150 metre cable from the seabed computer to a vessel, typically a Rigid Hull Inflatable Boat, on the surface for recording and analysis.

Recording and playback software was developed by DTA. It allows real time viewing and data capture of the diver signatures. The operator can also specify mine settings and thresholds, monitor mine and system status.

An underwater video camera is also available; this is cabled from the seabed computer and allows diver actions and movement to be observed and recorded.

DSES presents a small footprint. It is lightweight, making it simple to set up and operate. It is COTS-based and easily supportable.



Development of the DSES system commenced in 2007 and the system has since been extensively field tested.

DSES is to be commercially produced, marketed and supported by Air Affairs Ltd.

Part One
Introduction

2.1. Following publication of the Defence White Paper 2010, the Minister of Defence, through the Chief of Defence Force established an expert Panel to undertake an external review of the Defence Technology Agency, focusing on DTA's role now and into the future. We were asked to recommend options for 'structuring DTA to give best effect to the Crown's long-term investment in defence science and technology outcomes.'[1]

2.2 The Terms of Reference for the review are at Annex A and biographical details of the Panel members are at Annex B.

Purpose of the review

2.3 DTA is the principal provider of RS&T for New Zealand Defence. This report reviews DTA's role and recommends how it can improve its contribution to the military effectiveness of the NZDF over the next decade or so. We also make recommendations aimed at enhancing DTA's contribution to the wider security sector in New Zealand, and the Government's economic growth and high technology agendas.

The Consultation Process

2.4 We heard the views of about 100[2] users and providers of defence RS&T in New Zealand and overseas. We also heard from those whose work has links with DTA's current work.

1 DTA Review Terms of Reference. Appendix A.
2 Consultation included individual interviews conducted domestically and internationally as well as public submissions via the dedicated Defence Science Review page on the NZDF website which was open to submissions from 12 January 2011 until 14 February 2011.

2.5 We spent three days visiting the DTA, interviewing managers and project teams, and gaining a better understanding of the research programmes undertaken. We saw examples of DTA research that have been applied in New Zealand or in multinational operations. DTA staff provided thoughtful and constructive contributions to our review.

2.6 We met with Professor Sir Peter Gluckman, the Prime Minister's Chief Science Advisor, three times, and he visited DTA on 9 February. We also visited Australia and Singapore and met with senior leaders of DTA's counterpart agencies. We gained insights into how other nations maximise the impact of their defence science agencies, and how such agencies are managed differently from other components of military organisations. Videoconference discussions with UK agencies helped clarify their model for commercialisation of defence science, and underlined that science and technology capabilities should sit inside Defence structures.

2.7 We invited NZDF Defence Attachés to interview their counterparts about their experience in defence science and technology applications.

2.8 We requested comparative data on New Zealand investment in defence science and technology from the Ministry of Science and Innovation.

2.9 NZDF's website invited online submissions and other invitations were widely communicated. Regular communications were provided to interested stakeholders and the Minister.

2.10 The University of Queensland's quantitative analysis tool, Leximancer, was used to analyse 13 key documents and present, in graphical form, the connectedness between the NZDF and DTA, and the strength of that relationship. This analysis verified the essence of interviews.

What the Panel Heard

2.11 The consultation process provided valuable information from which some consistent themes emerged.

2.12 While a small number criticised DTA's performance, overwhelmingly most responses expressed a very positive view of DTA's contribution to the defence and security of New Zealand.

2.13 Similarly, though there were some criticisms of DTA staff, the more common view is that staff are highly committed and the quality of their work is very good. However, notwithstanding some areas of excellence, the breadth of focus comes at the expense of depth. Generally, DTA activity is considered too broad for both the size of the organisation and the requirements of Defence.

2.14 Likewise, DTA could focus on areas that align closely with Defence needs, short- and long-term, and in areas where DTA is able to deliver value for money. The processes that determine DTA priorities can also be improved.

2.15 It is generally recognised that changes inside DTA will bring maximum benefits only if complementary changes occur inside the NZDF and MoD. NZDF and MoD must be 'intelligent customers', while DTA's participation in relevant processes must be formalised, and project management simplified and improved from both 'purchaser' and 'provider' perspectives.

2.16 Many submissions reflected that DTA could, and should, collaborate more with other agencies. In a country of New Zealand's size, leveraging capabilities and avoiding duplication is vital. 'Critical mass' must be considered in terms of both the infrastructure that provides capability and the infrastructure that consumes it.

2.17 DTA provides limited technical support to other New Zealand security and intelligence agencies; therefore, for many submissions, bringing 'defence' and 'security' closer, and compelling DTA to support both sectors, is where DTA can make an even greater contribution to the national good. Areas for increased collaboration were also seen to exist between DTA and CRIs, universities and industry respectively. In this, DTA could contribute more broadly to the Government's high technology and economic growth agendas.

2.18 The vast majority of submissions do not support DTA moving outside the NZDF and there is only limited support for alternative structures, such as establishing DTA as a CRI. Most believe that while an increased presence in Wellington would have some advantages, the current location is appropriate.

2.19 Although DTA's contribution to international defence science is respected in some areas, in others it is considered to lack depth and could be better connected to New Zealand's highest priorities. DTA's existing efforts, largely conducted inside the TTCP framework, should be leveraged by more formalised collaboration in bilateral relationships with countries with which New Zealand has close defence relationships, such as Australia and Singapore.

2.20 While we heard and read many comments focused on purpose, structure and process, our conversations overseas contained compelling comments about the importance of cultural issues in ensuring the effective working of science and technology organisations. This reflects that people are the single most important deliverer of capability. Changes should at least be made in DTA's enabling HR and financial processes to sustain an appropriate culture.

The Panel's Response

2.21 In developing our recommendations we were guided by a number of principles:

- The Government requires value for money to be demonstrated across all Government agencies, including DTA.
- The relevance and performance of New Zealand's military capabilities depend on unimpeded access to trusted science and technology advice.
- New Zealand's defence and security activities must be underpinned by high quality and relevant science and technology.
- Defence science and technology requires levels of security that, principally because of the international dimension, can only be effectively maintained in a Government organisation.
- NZDF and MoD are the principal customers of DTA.
- DTA's activities (other than those bound by non-negotiable security requirements) should be accessible to a wider range of stakeholders across the country.
- DTA activities should complement and provide leverage to those of other Government security and intelligence related agencies.
- DTA's current size is adequate to discharge its current and future functions.
- Greater value for money will come from better use of DTA's existing capabilities across a broader range of stakeholders.
- DTA is part of New Zealand's high technology sector and should contribute to that sector and to the government's economic growth agenda.

2.22 This report's conclusions and associated recommendations aim to improve DTA's performance. While we believe that the recommendations should be implemented as a 'package', the most urgent recommendations relate to the appointments of the Chief Defence Technologist (CDT) and Director DTA – and to the development of a Defence RS&T Strategy.

2.23 Given DTA has regularly been subject to close scrutiny over recent years, we believe that the recommendations should be implemented and monitored over the next three years before being reviewed.

In many cases security is an obstacle but this is not insurmountable.

– Written submission

Part Two

Review of the Defence Technology Agency

The Strategic Context: Research, Science and Technology for the Defence and Security of New Zealand

3.1 The DWP and the Defence Assessment[3] depict a world of uncertainty and complexity. Accordingly, agencies responsible for New Zealand's defence and security will need to be agile, responsive and able to adapt to dynamic circumstances. With fiscal restraint expected to largely define the State Sector over the next decade at least, Defence must be innovative in its coordination of activities across agencies if it is to deliver value for money and increase its support for broader national security and economic agendas.

3.2 New Zealand will not face future challenges alone. While a number of close relationships with other countries and organisations are crucial to our defence and security, in some areas we must make informed decisions by ourselves; for example, whether to commit the NZDF to particular operations, and whether national and international military and security risks are being managed appropriately from a New Zealand perspective. Defence and security related RS&T funding, then, must maintain an independent and appropriate level of capability to provide an assurance to the Government that defence and security strategies and capabilities address the range of possible threats within an acceptable level of risk.

3.3 Ongoing investments in RS&T will help understand the current challenges to defence and security, and also provide valuable insights into potential future threats. There will be occasions when developments in defence RS&T will create

3 New Zealand Ministry of Defence. Defence White Paper 2010. Ministry of Defence, Wellington, November 2010. pp.23-33.

commercial opportunities. DTA, and other RS&T infrastructure, have helped solve NZDF operational problems with innovative and cost-effective solutions. They have also provided unbiased advice based on sound scientific evidence to both enable informed decisions regarding capital investment options and mitigate operational risks to NZDF personnel. Furthermore, DTA has played an important, if unheralded, role in developing and sustaining capabilities across our national security agencies.

3.4 While New Zealand's defence and security RS&T efforts are modest compared to counterpart organisations, DTA has made valuable contributions in the international domain.

3.5 With defence and security responsibilities spread across a number of relatively small Government agencies, New Zealand cannot create substantial capabilities, particularly in niche areas such as science and technology, solely dedicated to each agency. However, New Zealand's small size allows relatively short decision, coordination, and information exchange lines. A whole-of-government approach is often easier to implement and maintain in New Zealand than in larger countries. When this is linked to the national strategy of managing 'defence' and 'security' as inclusive rather than exclusive domains, then DTA's contribution to national security efforts, beyond solely defence requirements, can and should be increased.

Defence Technology Agency: Current State

Relationship with Defence

3.6 DTA is essentially the sole provider of defence RS&T to the NZDF, but its support to MoD is more limited. DTA sits within the NZDF; and its core operating functions are managed in common with other NZDF support and overhead functions.

Funding

3.7 DTA has a current budget allocation of $9.4m, about $8m of which is allocated to personnel costs. The remaining $1.4m is operating funding, including minor capital purchases and travel.

Mission

3.8 DTA's current mission is to practice 'the innovative application of science and technology to enable the NZDF to secure and protect New Zealand – now and in the future.'[4] It operates under a strategic plan approved by the Defence Technology Committee in 2007. This plan ensures that NZDF's investment in technological research is aligned to the development and operational needs of the organisation; articulates the Defence RS&T programme and desired RS&T capabilities; links

4 Science and Technology Strategic Plan 2007-2012.

NZDF's strategic direction and DTA activities; and guides the research capability to be delivered. The plan proposes to increase DTA staff to 133 over the life of the plan.

Staff

3.9 DTA is staffed by 82 full-time equivalent (FTE) scientists, technologists, technicians, and corporate support staff.[5] DTA scientists' median age is 38, whilst the entire agency (including corporate support staff) has a median age of 41. Approximately 10% of DTA scientists and 17% of the total workforce are women. The core scientific competencies for DTA scientists and technologists correspond to the following five broad disciplines:

- Applied mathematics.
- Physics.
- Electronic engineering.
- Materials and mechanical engineering.
- Chemistry.

Organisation

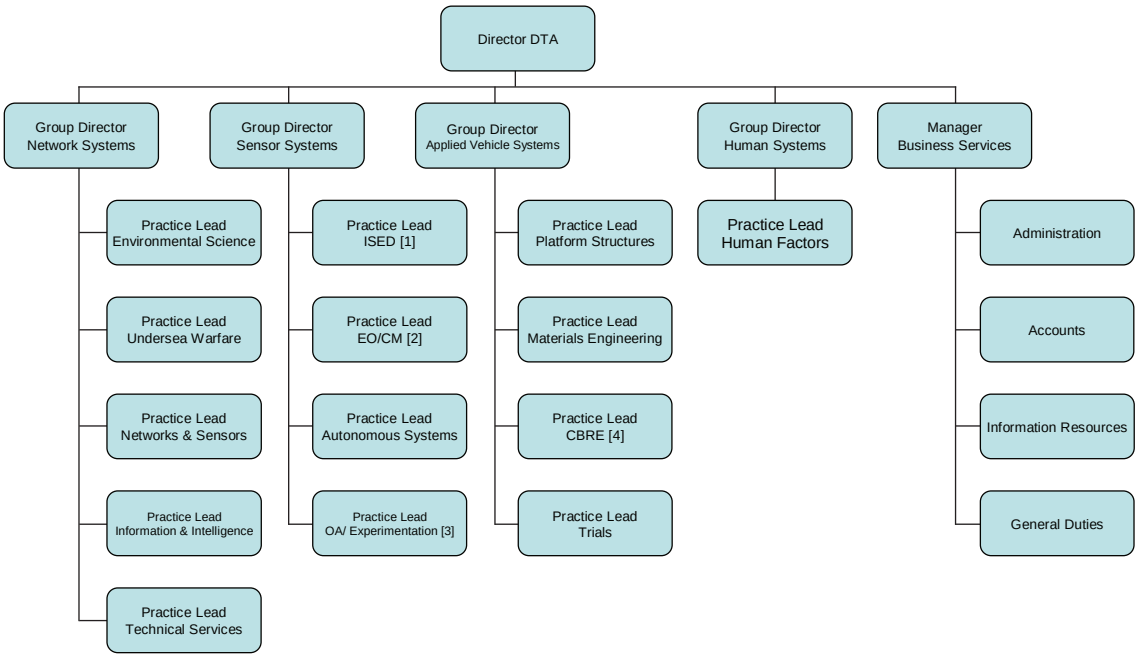
3.10 With the exception of a modest corporate support capability, DTA is organised along functional lines. The functional areas, headed by Group Directors reporting to the Director DTA, are:

- Network Systems.
- Sensor Systems.
- Applied Vehicle Systems.
- Human Systems.

DTA should be in a position to partner and help financially support NZ innovations which look to a significant impact on the business sector and open opportunities for international business through defence contracts globally. – *Written submission*

5 Of the 82 staff, 73 FTE are scientists, technologists or technicians and nine are corporate support staff. 16 (23 per cent) have a doctorate, 60 per cent hold a master's degree or above, and 86 per cent hold a bachelor's degree or above.

Figure 1: Defence Technology Agency Organisation.



Notes
[1] Intelligence, Surveillance, Electronic Defence
[2] Electro-optics/ Counter-measures
[3] Operations Analysis/ Experimentation
[4] Chemical, Biological, Radiological, Explosive Defence

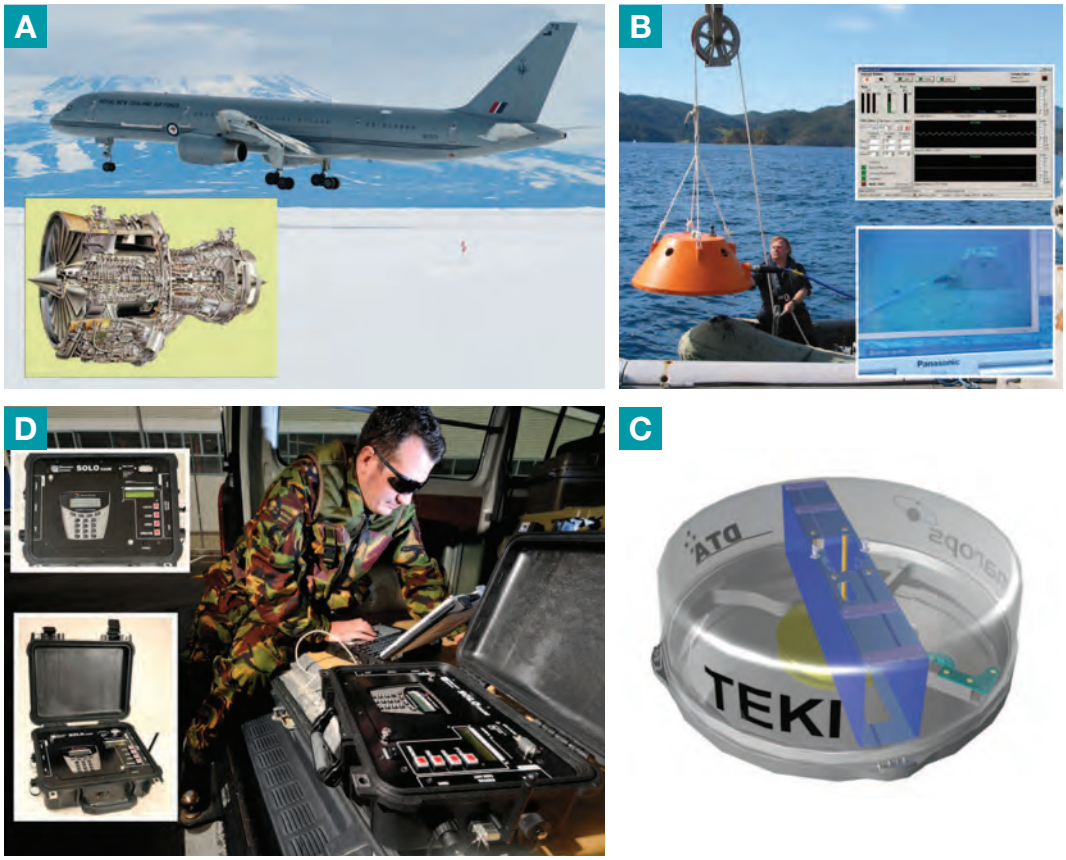
I believe their independent thought, yet ready access to classified areas of the NZDF is a unique contribution both to NZ industry and our Defence Force capabilities. –

Written Submission

Successes

3.11 We have been impressed by the commitment and enthusiasm of DTA staff to their work and their relationship with the NZDF. However, we were concerned that the value of their work does not always come to the attention of important stakeholders. During our visits to DTA we were provided information on a number of important and successful projects that included:

a. RNZAF RB211 Engine Bearing Failure Detection.
b. The Diver Signature Evaluation System (DSES).
c. The Te Kupenga Irirangi Radar Tracking System (TeKI).
d. The SOLO Secure Communications Case.

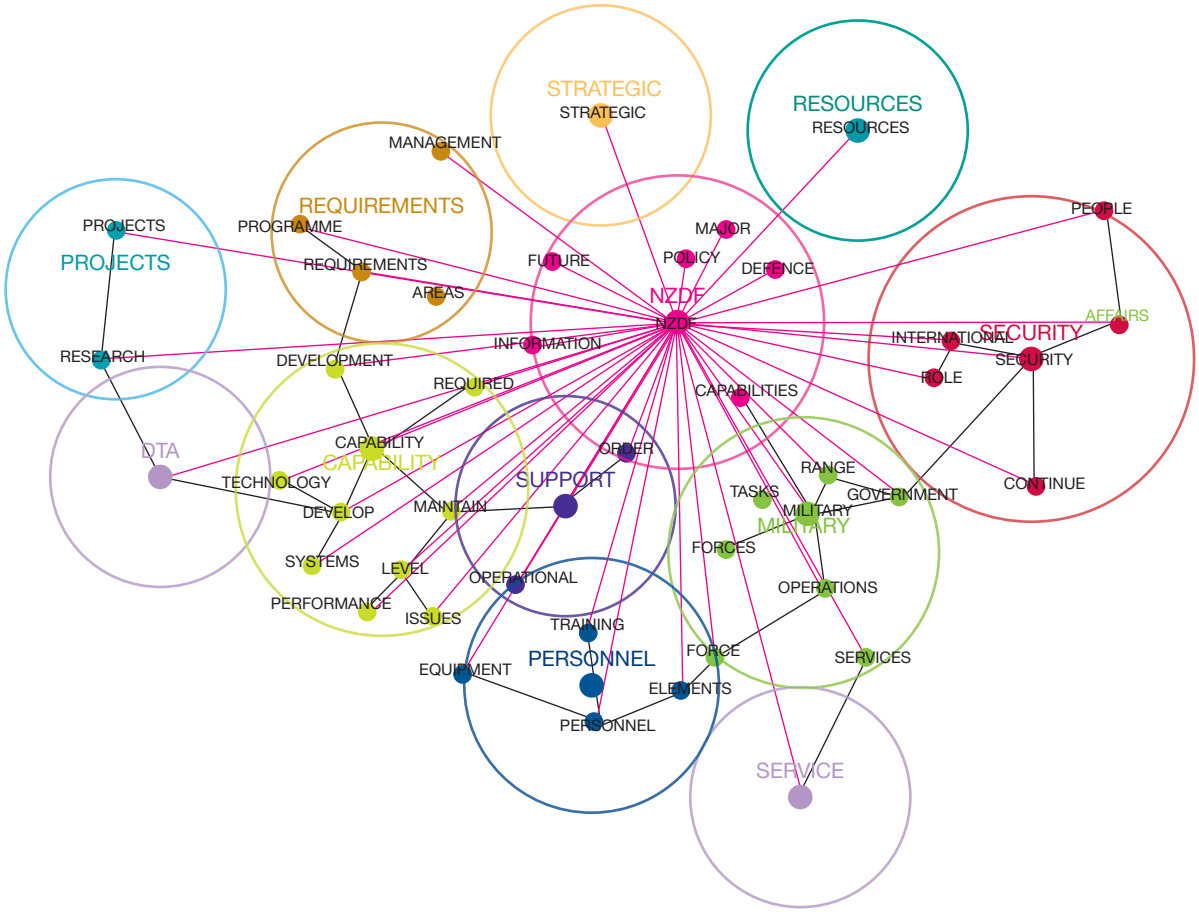


'Connection' with the Defence Force

3.12 The University of Queensland's software tool Leximancer analysed words and phrases in 13 key NZDF documents to measure the strength of the 'connection' between DTA and the NZDF.

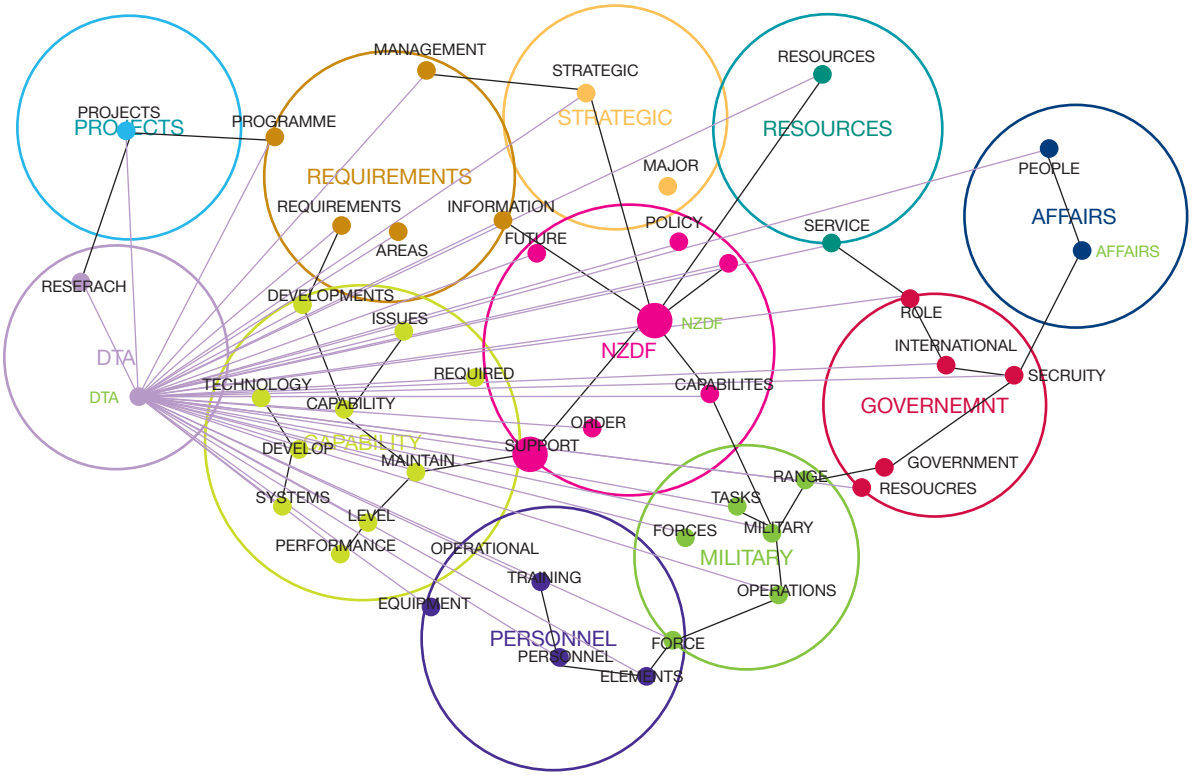
3.13 The direct connection between DTA and the NZDF differed according to the concept (relationship) analysed. For DTA, (Figure 2), the NZDF was the fourth strongest concept and so the NZDF is considered central to DTA's functions. However, for NZDF, (Figure 3), DTA was only the 16th strongest relationship and is not considered central to the NZDF's functions.

Figure 2: Leximancer results for DTA – NZDF relationship



DTA provide a key insight into the defence needs for future materials and new innovations. – *Written Submission*

Figure 3: Leximancer results for NZDF – DTA relationship



3.14 The analyses offer insights into the NZDF's view of its connectedness with DTA. While most uniformed NZDF staff spoken to value DTA for its importance to the NZDF, this is not reflected in corporate communications which, in fact, marginalize the DTA – NZDF 'connection'.

3.15 This gap between what individuals within the NZDF say – and what is communicated in corporate documentation – needs to be closed if the value of DTA, and science and technology in general, is to be recognised and not undermined.

New Zealand Defence RS&T expenditure

3.16 New Zealand's investment in defence science and technology is low in comparison to other nations.

3.17 There is no available data to indicate the proportion of government funding spent on defence Research and Development (R&D); other than funding directly allocated to DTA which amounts to $9.4m, or 0.3 per cent of the total Defence Force budget (ie, Vote: Defence Force). This is less than the investment made by Australia, which invests around 2 per cent of its budget in Science and Technology (S&T), and Singapore, which expects to spend up to 5 per cent on S&T annually. For both of

these countries, an underpinning principle is that S&T investment reduces defence costs, particularly through supporting more effective acquisition programmes, and the development of a local defence industry which enables early take-up of emerging technologies.

3.18 Compared to other OECD nations, New Zealand's expenditure on defence R&D is very low; both as a proportion of GDP and as a percentage of total R&D. OECD figures, however, are dominated by a few major players, such as the US, which, in 2007, spent 58 per cent of its total government R&D budget on defence research. The comparable figure for New Zealand is 0.9 per cent.

3.19 Despite the low level of investment, the Ministry of Science and Innovation (MSI) data in Table 1 shows that recent expenditure on defence R&D in New Zealand has increased. Business expenditure on defence R&D has grown from $2.7m in 2004 to around $10m in 2008 (the most recent data). In total, recent national expenditure on defence R&D has grown substantially: from around $4.3m in 2004 to around $19m in 2008. This may indicate increasing recognition that defence science has applications beyond the military, and reflect the growing global markets for defence-related products.

Table 1: Government and Private Sector Expenditure on Defence R&D 2004, 2006, 2008

Statistics New Zealand Reference Year	National R&D (GERD)	Business R&D (BERD)	Govern-ment R&D (GOVERD)	University R&D (HERD)
2004	$4.3m (estimate)	$2.7m	$0.6m (estimate)	$1.0m
2006	$16.8m	N/A	N/A	N/A
2008	$19m (estimate)	$10m	$4m (estimate)	$5m

3.20 While the Government's science vote has provided limited support for defence science, security-related technologies, (such as electronics, sensors, software, chemical and biological research, etc), have been relatively well resourced as illustrated in Table 2.

Table 2: Vote RS&T funding for defence and selected security related technologies 2009/10

Financial Year	Defence and Security	Software	Electronics	Sensors	Chemical Research	Biological Research
2009/10	$0.35m	$5.27m	$1.73m	$21.65m	$1.81m	$15.39m

3.21 Over the last five years 17 defence related projects amounting to over $8m have been undertaken by firms with government co-funding. That the number of projects has

been increasing, notwithstanding from a low base, supports the view that there is an emerging defence industry in New Zealand.

New Zealand Defence RS&T personnel

3.22 The number of staff engaged in the Defence RS&T organisation is very small compared to counterpart organisations overseas. NZDF has 14,584 personnel (full-time, part-time and civilian)[6] of which 82 are DTA staff (or 0.56 per cent). The Australian Defence Force (ADF) has 99,823 full-time, part-time and civilian personnel[7] of which 2,516 are Defence Science and Technology Organisation (DSTO) staff (or 2.52 per cent). As a percentage of the total Defence workforce, the ADF employs nearly five times as many staff as the NZDF employs in Defence RS&T.

3.23 Like most counterpart nations, New Zealand maintains a defence science capability as an integral part its Defence Force. In some countries, however, the commercialisation of 'spin off' technologies takes place through an 'arm's length' agency; for example, QinetiQ in the UK and Singapore Technologies (ST) in Singapore.

Observations and Recommendations

Ownership structures

3.24 DTA currently sits within the NZDF. Despite the advantages of operating DTA as a separate agency (such as improved accessibility for other security agencies, and contributing more visibly to the science community) we consider the costs would be prohibitive. For this reason, and anticipating the security expectations of overseas military counterparts with which New Zealand may wish to partner or collaborate, we believe the current ownership construct should be retained. This approach is also consistent with the Government's drive to consolidate the number of Crown agencies.

Recommendation 1. *That the current ownership structure of DTA is appropriate and is retained.*

3.25 DTA must recruit, develop and maintain a credible critical mass of defence and security RS&T capability amongst staff. While the current NZDF RS&T strategic plan proposes to increase staff numbers significantly, the right critical mass could also be achieved by identifying and exploiting opportunities for partnership and collaboration with the wider science and industry community in New Zealand and overseas. Consequently, we do not support the growth targets in the 2007 strategic plan and believe current DTA staffing levels are adequate for at least the next few years.

Location

3.26 There is currently no need for DTA to move from its location within the Devonport Naval Base. However, we note that in the future it is likely there will be opportunities for greater

6 NZDF personnel strength as at January 1, 2011; http://www.nzdf.mil.nz/personnel-records/personnel-branch/default.htm
7 Australian Department of Defence. Defence Annual Report 2009-10 Volume 1. Department of Defence, Canberra, 2010. p.34.

collaboration and collocation with other research organisations. DTA should investigate these opportunities as they arise. For example, the close alignment with IRL in Auckland has the potential for major equipment sharing and greater scientific collaboration and, similarly, there is potential for ESR in Wellington to share resources and staff, particularly in Chemical, Biological, Radiological and Explosive (CBRE) research.

3.27 A number of public submissions support a greater DTA presence in Wellington. We agree. DTA could increase Wellington-based personnel to provide RS&T support to some Defence functions in the Wellington area. These include capability development and acquisition (in HQNZDF and MoD) and support for current operations (in Headquarters Joint Forces New Zealand (HQJFNZ)). We expect that these staff will also be available to support the CDT and the Director DTA when they are in Wellington, and to take a leading role in the development of the Defence RS&T strategy.

Recommendation 2. *That DTA remain in its current location in Auckland and establish a greater presence in Wellington.*

Funding

3.28 In view of comments made during our discussions in Australia, Singapore and the UK, and given current fiscal constraints, there is a risk that, over the next few years, the level of DTA funding will be reduced. We believe defence RS&T should be a separate Output Class.

3.29 Notwithstanding financial pressures, for DTA to continue to provide appropriate RS&T support, we believe present funding should be maintained. Furthermore, over the next three years at least, DTA funding should be quarantined from NZDF reprioritisation processes. There are, however, opportunities for DTA to access other sources of funding such as Vote: RS&T, and other security and intelligence sources of funding should also be actively pursued.

3.30 Measuring DTA's value for money is difficult without a comprehensive performance management framework using relevant Key Performance Indicators (KPIs). Such a framework should, therefore, be established and used by the NZDF to comprehensively review DTA in three years' time. Future funding and personnel levels can then be robustly determined.

Recommendation 3. *That funding for DTA is maintained at current levels for the next three years.*

Recommendation 4. *That RS&T funding be a separate Output Class.*

Recommendation 5. *That, in the meantime, a comprehensive performance management framework is implemented to enable a qualitative review of DTA, and that this is completed before the end of the three years.*

Who does DTA serve?

3.31 Defence and DTA are instruments by which Government gives effect to its policy decisions. In this, the DTA's primary role is to give effect to the Government's Defence policy.

3.32 We realise that, in New Zealand's case, connections between defence, intelligence and security ought to be recognised and exploited. However, while there is a constructive relationship with Police, Customs and other government agencies in sharing technical knowledge and providing advice, DTA's contribution is apparently not formally recognised in its mandate. We believe these relationships should be formalised and mechanisms put in place to give the related agencies access to DTA, consistent with a whole-of-government approach to security.[8] We note that in Australia, for example, support to other government agencies is capped at 5 per cent of the DSTO budget.

3.33 To ensure the right balance is achieved between a relatively narrow defence focus and a broader collective remit, DTA needs to develop a brief, clear Purpose Statement. This should clarify and communicate DTA roles and priorities including those which benefit the intelligence and security sector, the scientific community, and the economy.

Recommendation 6. *That while DTA's principal client is Defence, it should also be mandated to provide advice and technical support to other government agencies with security and intelligence responsibilities.*

Informed users

3.34 There is evidence that there are opportunities for Defence to become a more intelligent user of RS&T services and capabilities. In Singapore and Australia, for example, the importance of a high level of technology competency inside the Defence Ministry and the Armed Forces is seen as critical. We saw the benefits of this approach during our visits to those countries. Consequently, it is our view that to fully utilise DTA services NZDF military and civilian personnel must be educated in DTA capabilities and, more broadly, in the force-multiplying role that RS&T plays in supporting Defence's short-, medium- and long-term outcomes.

3.35 We detect a widely held view inside the NZDF and MoD that no 'fundamental relationship' exists between 'technology' and 'capability'. To redress this attitude, we recommend an appropriate programme for Defence be developed in consultation with the Defence Personnel Executive. This will be an early and important task for the Director DTA.[9]

Recommendation 7. *That NZDF and MoD develop a systematic programme of activities to enhance the level of RS&T capability and awareness within their current and future workforces.*

8 For example, we were advised in Australia that this is managed by giving agencies access to a set level of DSTO funding.

9 There is a range of mechanisms by which the NZDF and MoD could enhance S&T capabilities throughout their organisations. For the longer term, we believe S&T modules should be included in all training programmes. Other mechanisms include secondments to DTA and its counterpart research agencies. More short term actions might include workshops and short courses on emerging technologies. While DTA will be closely involved in supporting this up-skilling, other agencies, such as tertiary institutions, RSNZ and IPENZ should also play a role in providing short courses and access to key scientists / technologists from the Academy.

Governance Arrangements

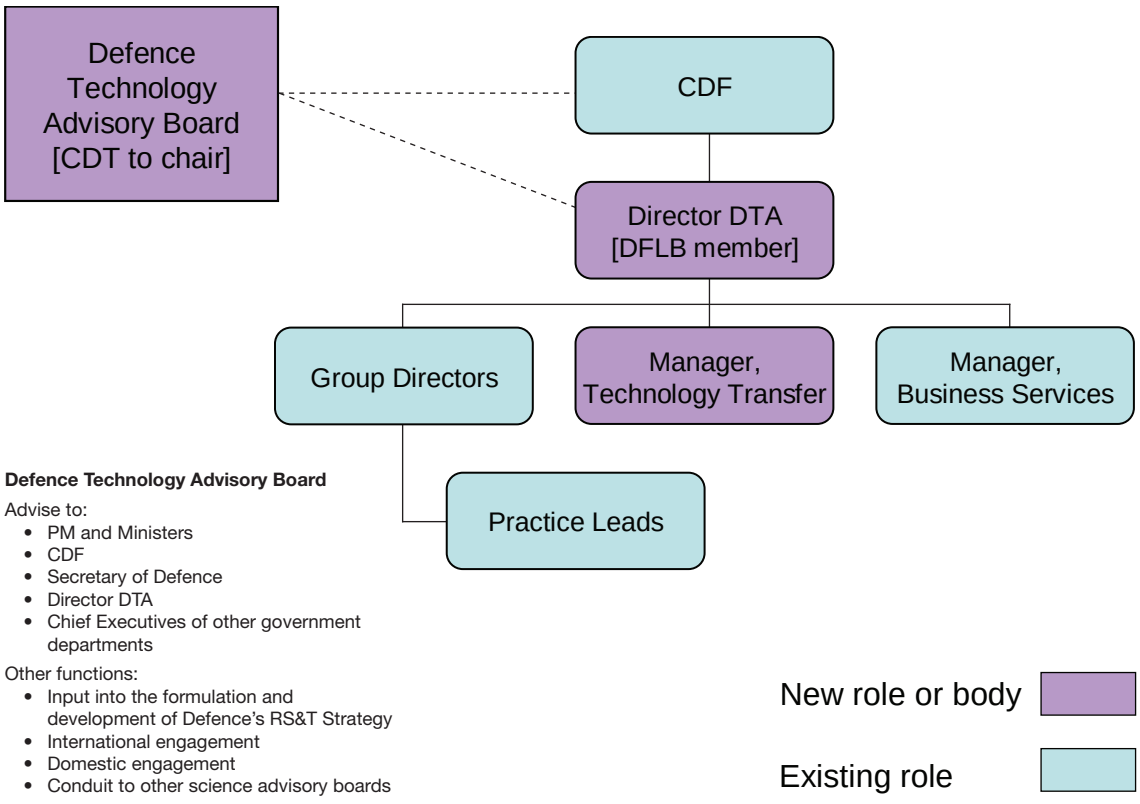
Governance and leadership

3.36 Ministers and Defence principals must receive informed, impartial and unalterable technical and scientific advice on issues ranging from acquisitions, to crash investigations, to current and future operations. In some countries, such advice is channelled through a formalised role such as a Chief Defence Scientist; who may also be the chief executive of the RS&T agency. This person is generally an esteemed scientist, engineer or technologist, often with a concurrent high level academic career and typically with some knowledge of military operations.

3.37 The relatively small size of DTA and the likely level of remuneration are obstacles to finding a candidate to fulfil such a role. As a practical solution, we propose two separate roles: a Chief Defence Technologist (CDT) (part-time, approximately 0.2 FTE) and a Director DTA (full-time).

3.38 The principal difference between the two positions is that the CDT would take a broader, more strategic view of defence RS&T within a national, international and whole-of-government context. The CDT will have no day-to-day line management responsibility for DTA. By contrast, the Director DTA will focus on leading and managing the organisation in line with Defence policies and strategies, and in accordance with agreed priorities.

Figure 4: Proposed Governance Arrangement



Chief Defence Technologist

3.39 The key role for the CDT is to provide unfettered RS&T advice with a defence and security focus to relevant Ministers, CDF, the Secretary of Defence, and the Chief Executives of Government agencies with security and intelligence related responsibilities. The CDT will develop a close relationship with the Prime Minister's Chief Science Advisor, Professor Sir Peter Gluckman. Given the range of responsibilities and expected high level engagement, the CDT should be appointed by the Minister.

3.40 The CDT will have outstanding leadership qualities, a significant background of achievement in S&T, and considerable experience in both the management of R&D and the application of technology at a senior level. The CDT will also bridge the gap between Defence and security requirements and have some experience in the Defence and security domain.

3.41 The CDT will be a part-time post, and we anticipate that most of his or her time would be spent in Wellington. The CDT will work closely with key stakeholders in the Government's Defence and security agencies, and with those in industry, CRIs and academia to contribute to the development of a long-term strategy for New Zealand's Defence and security RS&T requirements; and in line with both the national science agenda and the nascent national security strategy. The CDT could potentially be included in the proposed Defence Advisory Board.[10]

3.42 The CDT will convene (and chair) a Defence Technology Advisory Board (DTAB) comprising eminent scientists, technologists and industry representatives, as well as Defence and other Government agency officials.

Recommendation 8. *That the Minister appoint a part-time Chief Defence Technologist (CDT) as the first step in implementing the recommendations of this review.*

The Defence Technology Advisory Board

3.43 The Defence Technology Advisory Board should be convened by the CDT and it should comprise up to ten people, including the Prime Minister's Chief Science Advisor and the Director DTA. This would facilitate a strategic approach to defence RS&T across national stakeholder groups. The DTAB will also bring defence RS&T capabilities to bear on initiatives supporting the Government's high technology and economic growth agendas.

Recommendation 9. *That the CDT, in consultation with the Minister, Defence Principals and the Prime Minister's Chief Science Advisor, convene an Advisory Board composed of eminent scientists, technologists and appropriate defence and industry representatives.*

10 Defence White Paper para 9.37 refers.

3.46 The principal purpose of the DTAB will be to provide advice and support to the CDT. It will meet at least three times annually, and take a strategic (vice operational) overview of DTA activities. One of its earliest tasks will be to contribute to the development of the new Defence RS&T strategy. It will also, from time-to-time, undertake specific work as requested by the Minister.

Science cannot survive without peer review.

– Professor Sir Peter Gluckman, Prime Minister's Chief Science Advisor, 9 February 2011.

Director DTA

3.44 The selection of the Director DTA is one of the most important and urgent decisions that the CDF will make if the organisation is to quickly seize the opportunities identified in this report, and implement the change programme it sets out. The Director DTA will need to have scientific credibility, an ability to develop and drive a clear strategy for defence and security RS&T, and be well connected with scientific agencies. The 'ideal' person filling the role would also have good military experience or knowledge. In deciding where the Director DTA should sit inside the NZDF, and to whom they should report, we have carefully considered the feedback of those occupying similar roles in the UK, Australia and Singapore. We believe that while the Director DTA could be either a military or civilian appointment, it should be a senior NZDF role, reporting directly to the CDF.

3.45 Given the Director DTA's importance to the successful implementation of the change programme, and the special personnel qualities being sought, finding a suitable candidate may take some considerable time. We are concerned that a delay of more than nine months will threaten the opportunities for improvement identified in this report. In case of a delay, the CDF should consider appointing an interim Director for a period of 12 to 18 months while a permanent Director is sought.

Recommendation 10. *That CDF appoint, as a high priority, a Director DTA with the requisite scientific and management competencies as a senior appointment within the NZDF and reporting directly to CDF.*

Formal Advice to Defence Principals

3.47 Overseas evidence confirms that RS&T advice must be scientifically based, independent, transparent and unalterable. Offering advice appropriately in the capability lifecycle decision-making process will be central to the Director DTA's role.

Recommendation 11. *That the Director DTA's professional advice is formally integrated into relevant Defence decision-making processes.*

Priority Setting

Strategy and accountability

3.48 DTA lacks an effective Defence RS&T strategy against which to align its short-, medium- and long-term work programme and resources. The current Defence RS&T Strategy should be reviewed and replaced early in the Director DTA's tenure.

3.49 The new Defence RS&T Strategy should shape changes to DTA organisational structures, focus areas and work programmes. It should indicate how DTA will support capability delivery as contained in the DWP, and how DTA will contribute to other defence, security, and economic priorities over the next 5 to 10 years.

Recommendation 12. *That DTA take a leading role in Defence's work to develop a new Defence RS&T Strategy linked to defence, security and economic priorities to set the future strategic direction and priorities for Defence's RS&T investments.*

Priority Setting Process

3.50 DTA is a small defence RS&T organisation on almost any scale. While difficult for a small organisation (with a small budget) to properly cover every aspect of defence RS&T, DTA is not expected to do this – and it should not attempt to do so.

> **Emphasis needs to be shifted to those areas where DTA can make a credible improvement to NZDF capabilities and cost effectiveness.** – *Public Submission*

3.51 However, if it is to be a centre of excellence, DTA needs to focus its efforts suitably, adopt transparent and systematic processes for prioritisation, work to an agreed long-term programme, and be accountable for the programme's delivery. DTA should therefore play to its strengths, carefully choosing the capabilities it should focus on, while ensuring its work closely aligns with Defence priorities. Resources currently allocated to Defence areas that are not Defence priorities, as expressed in the DWP, should be urgently reprioritised according to the guidance that this report provides.

CASE STUDY

TeKI Radar Tracking System

As an outcome of collaborative electronic warfare research carried out over the last decade, DTA identified an opportunity to reduce costs and increase automation of electronic sensor systems, making these specialist systems practical for the RNZN, with affordable staff and acquisition costs.

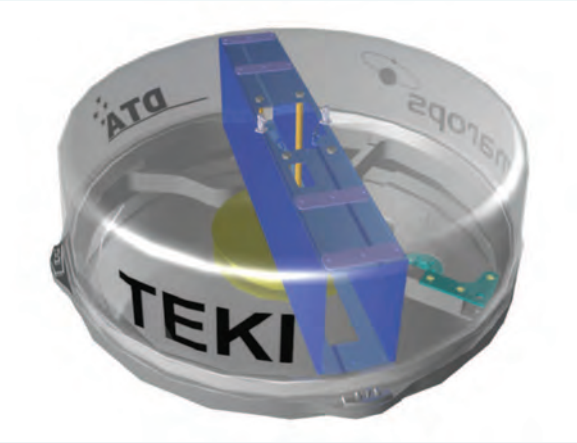
A review of existing systems from foreign defence contractors showed these systems were too expensive in terms of initial and operating costs for RNZN patrol vessel use. Working closely with the Navy on system requirements, DTA determined it could quickly design and test a system to meet Navy requirements.

The resulting TeKI system is a radar tracking system for patrol vessels, similar in concept to the radar warners found on military platforms. It is differentiated from these by:

- a very high degree of automation, so much so that a specialist operator is not needed to operate it, and
- the extensive use of commercial and locally designed and built software, and of high quality commercial hardware, to keep costs down.

A team of approximately three people at DTA, with civilian contractor support for specialist engineering activities, delivered a near production level prototype for test less than two years from the January 2008 programme start. This was made possible by reuse of previous DTA work, done under a TTCP cooperative programme, on radar signal measurements.

Final development and production of the units for Navy delivery was contracted out under license to a local company. The first delivered system conducted sea trials on board HMNZS HAWEA in November 2010.



The resultant system was inexpensive, both in terms of acquisition and operating costs. While there is no directly comparable product available, the system is about a third of the cost of similar systems. The cost savings of eliminating a trained operator are also significant.

In Singapore we heard that prioritisation, complemented by quick changes of direction when required, including stopping entire programmes, is important for defence RS&T. This will almost certainly be the case in New Zealand as well.

Recommendation 13. *That DTA conduct a comprehensive re-examination of current scientific programmes to ensure alignment with the Defence RS&T Strategy, and make any changes required to ensure alignment.*

What should DTA do?

3.52 Defence needs solutions to immediate as well as less pressing technological challenges. It requires independent, unbiased advice based on good scientific practice to support decision-making in military operations and capability investment. Capital investment decisions in the next 5 to 20 years will require such support. We believe the framework used by Australia's DSTO should be used to prioritise DTA's future activities.

Support to operations

3.53 The NZDF's first priority is to conduct operations but DTA is not closely involved in providing the practical application of technological solutions in the field. DTA should develop scientists and technologists able to solve operational problems in the field, within days to weeks rather than over years. This will require DTA staff able to participate in NZDF operational deployments.

Support to force-in-being

3.54 DTA adapts technologies to ensure the NZDF has appropriate technology based capability for operations. We saw many examples of DTA anticipating and resolving technical problems, and this is a highly valued capability. Sometimes, however, whole-of-life support functions could be better managed by outsourcing to companies, thereby freeing up DTA capacity to deliver greater value elsewhere.

Acquisitions:

3.55 Defence's acquisitions programme needs to match the capabilities identified and priorities established by the DWP. However, for the acquisition programme to be successful, DTA must provide competent, timely advice to the right people, contributing to formal advice delivered to Government.

Future Technologies

3.56 The DWP provides important guidance for DTA focus on future technologies such as ISR and cyber warfare, among others. DTA's research in understanding and adapting

future technologies is well regarded by counterpart Defence science organisations. We consider, however, that its contribution can be further enhanced by strengthening connections with, among others, leading researchers within universities and CRIs. This will allow resources to be reallocated over time, especially towards support for acquisitions. Formalising long-term RS&T foresighting processes will ensure DTA enhances its ability to anticipate major technological developments.

Shifting priorities

3.57 DTA should focus on 'support to acquisitions' and 'support for current operations' over the next few years. This shift will bring gains in efficiency and effectiveness, better value for money, and improved alignment with DWP priorities. Table 3 outlines how this chnage would affect current staff efforts.

Table 3: Priority Setting (as percentage of total FTEs)

Activity	Current Effort	3-5 yrs
Support for current operations	<5	10
Support to the force-in-being	45	30
Support to acquisitions	<5	30
Future technologies / foresighting	45	30

Recommendation 14. *That DTA rebalance its programme of work to increase the level of support it provides to 'acquisitions' and 'current operations'.*

Current Strengths

3.58 DTA has significant competencies in Defence RS&T, including underwater acoustics, electronic warfare, and materials engineering. While these core competencies, mostly developed over time, provide leverage in international collaborative activities, regular reviews are required to ensure their ongoing relevance and sustainability.

Support to acquisitions

3.59 While DTA has a good record in providing scientific and technological advice to Defence in the acquisition process, this is at times a reluctant engagement, and there is, in practice, no systematic approach underlining DTA's involvement in the acquisition process.

3.60 Due to scope and complexity, Army's proposed Land Command, Control,

Communications, Computers, Intelligence, Surveillance & Reconnaissance (Land C4ISR) could be a long-term project with which DTA could be more effectively engaged, and from an early stage.

3.61 Similarly, the short term Advanced Pilot Training programme could benefit from DTA's expertise in applied mathematics and human factors competencies.

Recommendation 15. *That DTA is systematically and formally engaged early in each stage of the acquisition life-cycle and that this approach is trialled using the Advanced Pilot Training as a short term project and Land C4ISR as a long term project.*

Foresighting

3.62 The Defence RS&T sector is fast-moving, matching the complexity and rate of change in the operational environment. DTA can add value and reduce risk in military procurements by developing a set of capabilities and people to specifically address future technologies in the 15 to 20 year timeframe. DTA can update Defence on relevant emerging technologies, helping Defence to make well informed decisions when capabilities require upgrading or replacement.

Recommendation 16. *That DTA develop its foresighting capacity to provide Defence Principals with periodic updates on future and emerging technologies.*

Joined up Approach to Research

3.63 Given current research underway within the Services and at HQNZDF, some overlap or duplication with DTA research efforts is not unexpected. Nevertheless, while not all RS&T activities carried out in Defence need to be conducted solely within DTA, there should be greater coordination between DTA, the NZDF and MoD with regard to RS&T. The Director DTA should conduct a thorough stocktake of all RS&T activities within Defence and, subsequently, recommend a Defence-wide mechanism for ensuring all RS&T activities undertaken within Defence are appropriately coordinated. This will ensure that Defence's RS&T's needs are being met while mitigating duplication of effort and unnecessary cost.

Recommendation 17. *That Director DTA conduct a stocktake of current NZDF RS&T activities and recommend to Defence Principals a process for the appropriate coordination of all Defence RS&T activities.*

Chemical, Biological, Radiological and Explosive (CBRE) Defence

3.64 Many of New Zealand's key security partners are investing substantial time and capital in CBRE defence. New Zealand's geographic isolation does not make us immune from CBRE threats. While security agencies and first responders may be the leads in the CBRE domain, DTA's access to classified information through its international fora membership places it at the forefront of identifying CBRE trends.

3.65 Security agencies, perhaps led by the Department of the Prime Minister and Cabinet, should determine the scope of DTA's role in a whole-of-government approach to national CBRE risk mitigation and management.

Recommendation 18. *That NZDF in consultation with DPMC identify an appropriate role for DTA in CBRE risk mitigation and management.*

Human Factors research

3.66 In recent years DTA has had to strengthen its capacity in Human Factors research. While the rationale is understood, and most comparable Defence Forces have also recognised the importance of Human Factors research in solving current and future technology challenges, this research appears to benefit Defence less than other areas of DTA expertise.

3.67 We noted various models for integrating Human Factors researchers into both defence forces and research organisations. Sometimes, researchers are spread across the organisation and at others established as a discrete functional area. In our view NZDF's approach lacks clarity. Though six DTA staff are directly employed in the Human Systems team, others are also employed within NZDF. Human Factors research is conducted at, for example, DTA, Defence Personnel Executive, Defence Psychological Services, and in the Services. This effort appears uncoordinated.

3.68 The Director DTA must quickly establish clear priorities and accountabilities for all Human Factors research undertaken within the Defence portfolio. Outsourcing to other Crown agencies and universities should be considered.

Recommendation 19. *That the Director DTA establish a policy and clear priorities and accountabilities for all human factors research undertaken in Defence and review the current work programme against these.*

Accessibility

3.69 We recognise the need for security when dealing with sophisticated and sensitive Defence technology. We also recognise that security arrangements must meet both national requirements and the expectations of our international partners.

3.70 DTA must have secure, compartmentalised facilities where it is necessary. However, we observe instances within DTA where security classifications are overstated and seem to unnecessarily contribute to a sense of isolation, dislocation and detachment from Defence, the wider scientific community and industry in New Zealand.

3.71 In our view, DTA security requirements should be kept to the minimum level required, and only where absolutely necessary. This shift in approach and attitude will make DTA more accessible and, where security considerations allow, enable more effective collaboration with the wider New Zealand scientific community, industry and academia.

Recommendation 20. *That DTA adopt a new approach to the 'security' elements of its work, shaped to a greater extent than present by pragmatic and situational factors, in order to develop a culture of 'openness' within the organisation and enable greater collaboration with relevant organisations in New Zealand and overseas.*

3.72 Compared to counterpart defence RS&T organisations globally, the engagement between external organisations and DTA is limited.[11] Consequently, wider knowledge of DTA and its value to defence, security and other sectors is limited. Such limitations create strategic risks for the organisation, compounded in fiscally-constrained times, and disable two-way collaboration in terms of both 'spins offs' (say, from DTA to academia) and 'spin ins' from, for example, industry to DTA. We believe DTA needs to be more accessible and must use contemporary tools to engage effectively with both customer and stakeholder groups.

Recommendation 21. *That DTA develop and implement a communications and engagement strategy to better facilitate outreach and collaboration. Elements of the strategy are likely to include a website and regular dialogue and interaction with the science community and industry, both in New Zealand and abroad.*

Commercialisation

3.73 Although opportunities to exploit Intellectual Property (IP) need to be taken, we do not advocate that DTA become a CRI (or be privatised). Experts from the UK (where Defence RS&T infrastructure was largely privatised[12]) provided firsthand insights into the potential pitfalls of privatisation. Expectations, for instance, need to be realistic. IP exploitation, according to a Deloitte study, can take 'several years of careful development and investment before a suitable return on investment can be expected.'[13]

3.74 DTA capabilities are a national asset, and yet, inside DTA, not necessarily regarded as such. As a consequence, DTA is not adding the value it otherwise would to the New Zealand economy. DTA's analysis and development of technological solutions, though primarily for defence and security applications, have cross-over utility, linking with a broad range of other sectors. As we considered the opportunities that lie in this area of DTA's work, we particularly noted that the Government has identified the high technology sector's importance to growing an innovative and sustainable economy.

3.75 Much of the New Zealand science industry operates in the high technology sector already. DTA should be more involved with New Zealand's scientific community and industry, and demonstrate its many potential links with the Government's Economic Growth Agenda (EGA).

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11 Similar organisations in Australia (www.dsto.gov.au), the United States (www.darpa.mil), and the UK (www.dstl.gov.uk) all have detailed websites to inform and facilitate engagement.

12 In 2001 the Defence Evaluation Research Agency (DERA) was split into two. The UK government retained key national security related defence RS&T capabilities in the Defence Science and Technology Laboratory (DSTL) whilst other less sensitive parts were sold and became the private firm QinetiQ.

13 Wilson, Dr Scott. Deloitte Research. *Value, Protect, Exploit: How Managing Intellectual Property Can Build and Sustain Competitive Advantage.* Deloitte Development LLC, 2007. p.40.

Commercialising its products effectively

3.76 Some products DTA develops for the NZDF have applications in other industries. The UAV is a good example. DTA must assess IP issues to determine whether commercialisation will impede the 'license to operate'. If not, DTA should identify commercial partners early. DTA's role is not to develop in-house commercialisation expertise; rather it should have the capability, by way of a dedicated senior manager, to find partners early or consult other research organisations with expertise in commercialising high technology products. Such organisations include IRL and, potentially, the proposed centres of commercialisation.

3.77 We saw several products with commercial potential. Though DTA's primary role is to support Defence, there should be incentives encouraging DTA to identify dual use technologies. Revenue from licensing or other IP arrangements should be retained by DTA to enhance its capabilities. If there are no capability needs then revenue should be returned to the NZDF. The DTAB should oversee such decisions and modalities.

Recommendation 22. *That a significant proportion of any revenue earned from commercialisation activities should be retained by DTA.*

Recommendation 23. *That the Director DTA appoint a senior manager whose role will be to build relationships with industry and develop business opportunities.*

Industry development

3.78 For many nations defence technology development provides access to high technology product markets. The acquisitions process provides an opportunity to place valuable niche products onto generic platforms, and so support the domestic high technology sector's development.

3.79 The Government has identified the high technology sector as part of its EGA but we saw no evidence, in our discussion with officials at MoD or DTA, of any awareness of, or connection to, industry development. In our view, success in this area will depend on MoD developing relevant policies that will enable opportunities for local industry. Providing an effective 'voice' for local industry will also be important. While a defence industry body advises the Minister, and there is a Defence Industry Association, we found that both of these are facing substantial challenges in being able to effectively provide that 'voice'.

Recommendation 24. *That MoD develop defence industry policies that stimulate greater commercialisation and industry development opportunities with DTA.*

3.80 DTA's technical expertise is valued by many, particularly in the area of product adaptation – and this, together with a number of other initiatives identified elsewhere in this report, creates a range of alternative funding opportunities for the organisation. For example, schemes such as the Government's Technology Voucher programme

are intended to enhance such research-industry collaboration and we encourage DTA to become accredited agents, for both inward and outward use of the programme.

Recommendation 25. *That DTA actively identify other sources of revenue to support its work, such as, for example, gaining accreditation to the Technology Voucher Scheme.*

Technology Transfer:

3.81 DTA should be closely networked with organisations with the ability to undertake research directly applicable to Defence. This will enable opportunities for technology transfers to be identified by DTA. Defence could then be advised of relevant and emerging technology developments within New Zealand. This would be useful in ensuring that DTA capabilities and activities do not duplicate that available and happening elsewhere in New Zealand. It would also provide useful information for the development and review of the Defence RS&T strategy.

Recommendation 26. *That DTA develop the capability to manage technology transfer and serve as a portal between Defence and the scientific research community.*

Key relationships

Defence and security networks

3.82 Keeping abreast of developments affecting New Zealand's defence and security RS&T partners, is an important element of DTA's activities. Attending multilateral and bilateral meetings and fora helps DTA to maintain a profile within the defence RS&T sector and usefully builds the trust that is a vital enabler of information exchange and collaboration in the sector. It also facilitates the benchmarking and peer review which provide an effective approach to determining the quality of science.

Single Services

3.83 Stakeholder relations with the single services are of vital importance and we saw that these have, been allowed to lapse. The Director DTA and senior staff must develop relationships with stakeholders which have trust and credibility as central characteristics. This is particularly the case in DTA's relationship with the Services. We saw evidence that this relationship has been taken for granted by both sides for far too long.

Intelligence Community

3.84 DTA is well-positioned to contribute to both the defence and security intelligence capabilities in New Zealand. We were given evidence that the technology component of the intelligence jig-saw is becoming increasingly important if the whole picture is

to be seen. Without DTA's participation the newly emerging Technical Intelligence (TECHINT) capability, is unlikely to deliver on its full potential.

Security Sector

3.85 Defence is, for a number of reasons, central to a whole-of-government approach to security collaboration. The NZDF and DTA need to apply defence related RS&T more widely. For example, investment in EW / ESM techniques can be applied to other Government agencies, turbine-bearing analysis to large mission-critical bearings, geospatial mosaics to medical research, and CBRE applications to bio-security applications. Applying Defence RS&T more widely supports other science-based collaborative agreements which have a security dimension.

Recommendation 27. *That NZDF coordinate with partner agencies to develop a formal mechanism for DTA to provide core RS&T advice and support for the security and intelligence agencies.*

International networks

Multilaterals

3.86 While not widely regarded as such, we view the TTCP as a national asset. Information provided to New Zealand by the 'Five Eyes'[14] community through DTA is extremely valuable to our Defence and security agencies. We recommend that NZDF look at allowing involvement in the TTCP from non-DTA and non-NZDF representatives, such as personnel from other Government agencies and academia.

Recommendation 28. *That DTA's programme of work with TTCP be reviewed and more tightly focused on New Zealand national priorities.*

Bilaterals

3.87 Notwithstanding the importance of the TTCP, we believe that broader and deeper bilateral relationships should be developed – and with both TTCP nations, (such as Australia), and non-TTCP nations, (such as Singapore). This is the approach being taken by a number of New Zealand's other Defence science partners.

3.88 Obvious areas for international collaboration are shared common platforms, work programmes, and capability requirements.

Australia

3.89 We believe deepening the relationship between DTA and Australia's DSTO should be a priority for the Director DTA. The close relationship with Australia, mentioned in Prime Minister Gillard's address to Parliament on 16 February, extends to Defence

14 The 'Five Eyes' refers to the close defence and security relationship between Australia, Canada, the UK, the USA and New Zealand.

RS&T. During our visit to Australia and we were particularly struck by DSTO's willingness to develop the Defence RS&T relationship, and support efforts to conclude Memorandum of Understanding (MoU) between DTA and DSTO as soon as possible.

Recommendation 29. *That DTA more actively explore opportunities for strengthened bilateral collaboration, both inside and outside the TTCP framework, with a particular emphasis on Australia.*

Research networks

3.90 The Government's interest in defence RS&T is largely focused via CRIs such as IRL and ESR. IRL has probably the closest synergies with DTA, (it has comparable scientific expertise, significant equipment, and close links with the high technology sector), as well as expertise in managing IP and technology transfer.

3.91 IRL and DTA collaborate in some research with obvious Defence and security applications, as in, for example, the Composites Cluster - which may well lead to advances in metallurgy and subsequent force protection technologies. But collaboration could be increased and there may be opportunities for sharing premises and equipment which should be investigated.

3.92 There is a similar situation with ESR - which has, for example, complementary skills and equipment in the CBRE domain. Consequently, opportunities for collaboration between DTA and ESR should also be identified as a priority.

Recommendation 30. *That DTA consult with IRL and ESR with a view to strengthening their collaborative research programmes and identifying any opportunities to share resources.*

3.93 High quality defence RS&T capabilities cannot be maintained by DTA operating in isolation. Information sharing and collaboration with other organisations is critical if informed decisions are to be made about priorities, duplication of effort avoided, and resources allocated effectively and efficiently. We believe DTA can usefully, and without compromising its security requirements, strengthen its research networks with other Government agencies, research organisations, and technology end users, both domestically and internationally.

Recommendation 31. *That DTA increase its interaction with the national and international research community through ICT, conferences, and exchanges.*

From a scientific viewpoint, historically DTA has not engaged substantively with the New Zealand science sector, therefore potential synergies and benefits may not have been fully utilised. *– Written Submission*

Enabling Infrastructure

3.94 Providing DTA with improved Information and Communications Technology (ICT) infrastructure will reduce costs in international collaboration. While face-to-face engagement is usually preferable and more effective, advances in ICT are allowing useful discussions, meetings and exercises to be held remotely.

3.95 If DTA's is to broaden its operating context in line with many of the recommendations contained in this report, then its ICT infrastructure needs to provide access to both secure and non-secure communications.

Recommendation 32. *That DTA acquire appropriate connectivity such as secure e-mail, video teleconferencing and encrypted broadband allowing staff to effectively engage in meetings, conferences and exercises with counterpart organisations domestically and internationally.*

People

Developing DTA staff

3.96 DTA's capabilities will always depend critically on staff. There is, however, little evidence of a systematic approach to the professional and personal development of DTA staff. This needs to be quickly addressed for DTA to credibly pursue, achieve, and maintain the delivery of RS&T excellence.

3.97 In Singapore we found a sensitivity to the unique nature of S&T organisations, including the unique requirements of scientists and technologists. In our view this approach directly correlates with Singapore's excellent S&T reputation. The NZDF should recognise DTA's unique HR needs that reflect its role as New Zealand's centre of excellence for Defence RS&T endeavour. The development required by DTA staff may not fit with the NZDF's standard HR models and may necessitate separate policies and practices exclusive to DTA.

3.98 DTA scientists' development must satisfy their professional development needs while acknowledging the needs and priorities of Defence. Personnel development in DTA should be based on the premise that quality applied research will only be consistently delivered by motivated staff.

Recommendation 33. *That NZDF create policies and practices allowing DTA to implement the appropriate HR processes that acknowledge the different requirements of scientific personnel, including motivational ones.*

Personnel Competencies

3.99 DTA provides timely advice to Defence principals based on agreed scientific

practices. Much of this advice is gleaned from a particular, experienced DTA expert on a particular issue, or issues, relevant to current operations. Given DTA's size and the 'single points of failure' in some domains (where one or two people represent the difference between success and failure), a more comprehensive framework to recruit, retain, and motivate DTA staff should be developed.

3.100 When personnel with highly specialised knowledge leave the organisation, DTA's credibility might begin to erode. DTA therefore needs to anticipate future requirements and ensure that it is congruent with DWP priorities and the nascent Defence RS&T Strategy.

Recommendation 34. *That DTA conduct a review of personnel competencies against the Defence RS&T Strategy in order to identify and mitigate potential gaps.*

Developing World Class Scientists

3.101 Knowledge-sharing opportunities across the whole-of-government and with counterpart defence RS&T organisations have not been fully utilised. We recommend the Director DTA be given tools to develop the positive culture and long term commitment of its staff through two-way secondments, both in New Zealand and offshore and through an appropriate system of recognition for scientific achievements.

Recommendation 35. *That a structured programme of two-way secondments between DTA and counterpart organisations be instituted as soon as practicable.*

Recommendation 36. *That DTA through, for example, RSNZ and IPENZ awards schemes, seek out opportunities to reward innovation and scientific excellence in staff.*

Scientists need to be in communities

– Professor Sir Peter Gluckman, Prime Minister's Chief Science Advisor, 9 February 2011

CASE STUDY

SOLO Communications Case

The Solo Communications Case provides an integrated secure communications capability using existing communications infrastructure. The case is designed around the General Dynamics C4 Systems Sectera Wireline Terminal, Black Digital Interface variant and enables secure voice and data calls to be made utilising the SWT PSTN modem and the integrated GSM and ISDN modems.

It also provides added functionality and user friendly features such as:

- Dialling from the integrated telephone handset
- USB data connectivity
- Built in rechargeable battery
- One-touch switching between communication modes
- Support for other external communications devices, such as an Iridium Satellite Phone.

The SOLO Case was developed to fill a capability gap within NZDF. DTA engineers developed the Case from initial user requirements, conceptual design, hardware design and implementation, initial prototype production and testing, and product refinement.

Bluewater Systems Ltd, Christchurch, were contracted to produce and commercialise the Case, working closely with DTA, and were licensed to market and sell the SOLO Case C30 on behalf of NZDF.

Management

Minor Capital Expenditure

3.102 While Defence, through the Defence Transformation Programme (DTP), has embarked on a wide-ranging value for money effort which strived to standardise organisational practices, situational imperatives allow for some exceptions. DTA's unique personnel and capital expenditure demands will, on occasion, justify a 'DTA approach' within the overall framework that underpins the Defence Force.

3.103 Where DTA requirements diverge from the norm, particularly regarding specialised ICT equipment, NZDF policies should enable the Director DTA to approve minor capital expenditure.

Recommendation 37. *That relevant NZDF policies enable the Director DTA to approve minor capital expenditure for specialised RS&T equipment*

Commercial Interests

3.104 Allowing DTA staff to set up independent commercial interests (for instance, companies) is not practised elsewhere (such as, for example, in DSTO), and should be reassessed. The policies of other Government-owned research organisations which prohibit this practice should be examined. However, NZDF should consider how to share benefits with staff from the commercialisation of DTA products and related IP.

Recommendation 38. *That the policy of allowing staff to have commercial interests deriving from their full-time employment at DTA is discontinued, but that commercialisation activities should be incentivised through some form of benefit-sharing with staff.*

Science Quality

3.105 Generally, DTA work should be subject to more rigorous professional peer review than is presently the case. Consequently, internal review, (driven by the Group Directors), and external review, potentially facilitated by the DTAB or professional organisations such as the RSNZ and IPENZ, is essential.

Recommendation 39. *That DTA implement a process to monitor and enhance the quality of science and reporting.*

Managing DTA Tasks

3.106 DTA exists to support Defence, typically via the Services and in line with operational and future force development priorities. While this works, it is clear to us that real improvements in managing DTA will only happen if its relationship with Defence is made less complex and, at the same time, formalised in the areas where this is important.

Effective planning is key and, in this area, Single Services and other stakeholders must have an agreed allocation of DTA capacity. Current planning arrangements are ad hoc, with the Single Services and the Ministry of Defence engaging DTA in different ways, leading to administrative inefficiencies. Furthermore, it was clear to us that the management of DTA's work progamme did not clearly demonstrate either broad or deep programme and project management competencies.

The current system of managing projects with uncoordinated charters is not effective.

– Public Submission

Recommendation 40. *That a simpler and more effective project management approach be adopted across Defence for the management of DTA tasks and tasking*

Implementation

Funding

3.107 We believe the recommendations package can be implemented without significant new operating funding. Future capital funding should be determined in light of the new Defence RS&T Strategy.

Legislative Implications

3.108 There are no legislative implications arising from this review.

Implementation Timeline

Post-implementation Audit

3.109 Our recommendations are significant and, if implemented systematically, will have far-reaching and beneficial results for DTA and Defence.

3.110 There are several years of implementation ahead for DTA. The implementation of these recommendations and other organisational changes to DTA will need to be monitored to ensure DTA maintains its focus and performs to the highest possible standard.

Recommendation 41. *That the recommendations and associated change agenda be implemented as a package and that these new arrangements be given at least three years to stabilise before they are reconsidered.*

Three important steps to success

3.111 While all the recommendations are crucial to the successful change programme, the most important steps involve those that address DTA's governance, leadership and strategy, work programmes, personnel makeup, principal relationships, and the areas in which funds should be focused.

3.112 We believe, therefore, that the most essential and foundational steps are:

- The appointment of the CDT and the establishment of the DTAB.
- The appointment of the Director DTA.
- The establishment of the Defence RS&T Strategy.

Part Three
Appendices

Appendix A. Terms of Reference

Context

Defence White Paper 2010, released on 2 November 2010, foreshadowed the requirement for the Defence Force to undertake a comprehensive external review of the Defence Technology Agency (DTA). The Lead Contractor will prepare a report for the Capability Management Board (CMB) addressing options to more effectively deliver defence science and technology outcomes.

In the context of constraints on Government expenditure, and in response to Ministers' direction to achieve better value for money (VfM) across the State Sector, Pacific Road Corporate Finance was engaged by the Secretary of Defence to provide advice on how the Government can get improved VfM out of their current and future investment in defence. Dr Roderick Deane made specific recommendations with respect to DTA (pp. 207 refers); including the primary recommendation to consider structuring DTA as a Crown-owned commercial entity – similar in nature and scope to a Crown Research Institute (CRI).

The Review will inform advice to Ministers on ensuring DTA provides appropriate science and technology support to the Defence Force while at the same time delivering VfM defence science and technology outcomes.

Investment in Defence Science and Technology

The Defence Force currently spends $9.4 million in direct costs on DTA per annum, approximately 75 per cent of which are personnel-related costs. This figure does not include some discrete project funding contributed to by the Services.

Objectives

The purpose of the Review is to provide external advice to Ministers on the options of structuring DTA to give best effect to the Crown's long-term investment in defence science and technology outcomes.

Specific objectives of the Review are to:

- Review the efficacy of the current management structure, funding arrangements, level of funding, work programme and research outputs of the DTA.
- Comment on the total cost to the Crown of current defence science and technology services.
- Report on the core research outputs that New Zealand will require in the defence sector in the next 25-30 years.
- Examine options for, and make recommendations on, how these requirements can be met with regard to cost, timeliness, security and sovereignty.
- Examine the options and recommend the most appropriate ownership, governance and funding arrangements for a defence-specific science and technology organisation.
- Provide full costs, including transition and set-up, for the options considered.
- Specifically examine the United Kingdom model; to include visiting the Defence Science and Technology Laboratory (DSTL), the Chief Defence Scientist and QinetiQ.
- Report on any legislative implications.
- Report on any other issues with respect to defence science and technology.

Scope

It is expected that the scope of the Review will include (but not be limited by) an examination of the following:

- Ownership Structures. Examine the range of ownership structures for a defence science and technology organisation, identifying the costs, benefits and limitations of each.
- Governance. Report on the range of governance structures relevant to each ownership option.
- Funding. Examine the range of relevant funding models including (but not limited to) input funding, contestable funder-provider contracting and direct Government appropriation, with consideration of ownership, required outputs and cost-effectiveness.
- Internal Cost Structures. Determine the current internal cost structure of defence science and technology services and examine the range of cost-efficient options.
- Work Programme. Develop the range of outputs or subject areas that will be required in the defence sector in the next 25-30 years, and the broad resource levels required to meet them.
- External Engagement. Examine the current linkages with other science and technology providers in New Zealand (eg, industry, universities and CRIs) and overseas organisations (eg, The Technical Cooperation Program (TTCP) members, Australia's Defence Science and Technology Organisation (DSTO), and the United Kingdom's DSTL. Recommend cost-effective ways to maintain domestic and international engagement in science and technology communities of interest.
- Third Party Work. Consider the potential to undertake consultancy work, especially for

other government agencies in New Zealand and internationally, including how this could be resourced and the implications of different funding arrangements.

- Intellectual Property (IP). Examine the range of IP held by DTA and report on the options for future IP development, protection and commercialisation.
- Alternative Business Models. Consider the extent to which Public Private Partnerships (PPP) and Private Finance Initiatives (PFI) could be an appropriate mechanism to: a) reduce costs to the Crown, or b) generate greater economic return for the Crown.
- Location. Consider the extent to which partnering with other Crown-owned science and technology institutions, including relocation to, for example, the science and technology 'hub' located at Gracefield, Lower Hutt could accrue benefits.
- Recommendations. Provide a set of fully costed recommendations covering the scope outlined in para 6 above.

The Lead Contractor (Chair)

The Lead Contractor will:

- Chair a three-person Panel comprising members with extensive military, scientific and industry experience.
- Be well-informed about the Defence Force and defence science and technology.
- Be free to appoint additional advisors.
- Have, or be able to obtain, a high grade security clearance.

Governance

- The Lead Contractor will determine the method of the Review, giving effect to the requirements of para. 5 and 6 above.
- The Chief of Defence Force, in consultation with the Minister of Defence, will appoint the Lead Contractor and Panel members.

Deliverables, Timeline and Completion

- Regular engagement with the Minister of Defence is expected.
- A mid-point progress report, including examination of top-line findings, is expected.
- The final report should be submitted to the Minister of Defence through the Chief of Defence Force not later than 31 March 2011.
- The Chief of Defence Force may appoint a Steering Group to facilitate the work of the Review.
- The final report will inform Defence's advice to the Government.

Terms and Conditions

- The Terms and Conditions of this engagement will be set forth in a contract between the Lead Contractor and the Chief of Defence Force.

LTGEN J. MATEPARAE
December 2010

Appendix B. Members

Rear Admiral (Retired) David Ledson ONZM, Panel Chair

Rear Admiral (Retired) David Ledson ONZM was Chief of Navy from 2004 to 2009. He joined the Navy in 1967 and underwent his initial training at the Royal Australian Naval College, Jervis Bay. He has a BA in history from the University of Auckland and attended the US Navy War College in Newport, Rhode Island. During his career he supervised the Navy's Anzac frigate project in Hamburg, Germany, and served as Chief of Naval Development and as the Defence Force's Director of Resource Policy. He is currently the chair of Maritime New Zealand.

Dr Helen Anderson QSO, Member

Dr Helen Anderson was a successful scientist for many years before moving into leadership roles. In 2004 she became CEO of the Ministry of Research, Science and Technology, after being its Chief Scientific Advisor. She has been New Zealand's representative at several international fora including APEC and the OECD. She was recently elected a Companion of the Royal Society of New Zealand and appointed a Companion of the Queen's Service Order. She is currently a member of the board of DairyNZ and Fulbright New Zealand.

Mr Neville Jordan CNZM, Member

Neville Jordan CNZM is a graduate engineer from Canterbury University. In 1975 he founded MAS Technology Ltd, a telecommunications microwave company, which he developed into a large international operation which was successfully floated on the NASDAQ stock exchange. In 1998 he formed Endeavour Capital Ltd and now invests in New Zealand science and technology companies. He is a Distinguished Fellow of the Institute of Professional Engineers of New Zealand and has received the British Kirby Medal, awarded for "outstanding eminence and distinction in advanced technology". He holds an honorary Doctorate in Engineering and is the immediate past president of the Royal Society of New Zealand.

Appendix C. Submissions and Consultation

Principal Stakeholders

Hon Dr Wayne Mapp, Minister of Defence

Lieutenant General Jerry Mateparae, Chief of Defence Force, NZDF

Mr John McKinnon, Secretary of Defence, MoD

Major General (now Lieutenant General) Rhys Jones, Chief of Army and Chief of Defence Force (designate), NZDF

Rear Admiral Jack Steer, VCDF, NZDF

6-7 January

Dr Ralph Marrett, Acting Director DTA and Director Network Systems

Mr Tony Brown, Director Sensor Systems, DTA

Mr Patrick Conor, Director Applied Vehicle Systems, DTA

Mr Andy Richardson, Director Human Systems, DTA

Mr Mike Wardlaw, Managing Director Babcock Fitzroy Ltd (and President Defence Industry Association)

13 January

Dr Patricia (Trish) Shaw, Research Leader, DTA

Mr Paki Ormsby, Senior Analyst, MoD

Mr Simon Tregear, Deputy Director Strategy Capability and Analysis, MoD

Mr Paul Froggatt, Senior Advisor Science and Technology, MoD

Air Commodore Gavin Howse, Deputy Chief of Air Force, NZDF

Commodore Bruce Pepperell, Deputy Chief of Navy, NZDF

Captain RNZN Wayne Burroughs Deputy Chief of Navy (desig.) NZDF

17 January

Colonel Peter Kelly, Director Special Operations, NZDF

Mr Wayne Higgins, Director Planning, MoD

Dr Warren Tucker, Director of Security, NZSIS

Brigadier Kevin Riordan, Director General Defence Legal Services, NZDF

Captain RNZN John Martin, Acting Assistant Chief Capability, NZDF

18 January

Mr Iain MacKenzie

Professor Sir Peter Gluckman, Chief Science Advisor to the Prime Minister

20 January

Brigadier Dave Gawn, Deputy Chief of Army, NZDF

Commodore Kevin Keat, Assistant Chief Personnel, NZDF

Detective Inspector Don Lee, NZ Police

Air Commodore Peter Guy, Commander Defence Logistics Command, NZDF

Mr Chris Howley with Mr John Eccles, NZ Customs Service

27 January

Mr Tim Burfoot, TAIC

Mr Terry Bowe, PhD student VUW, (back-brief to Panel on key word analysis)

Professor David Bibby, VUW

Mr Neal Garnett, Chair DICNZ

Mr Des Ashton, Deputy Secretary Acquisition, MoD

31 January

Colonel Angie Fitzsimons, Director Defence Intelligence and Security

Air Vice-Marshal Peter Stockwell, Commander Joint Forces New Zealand

Dr Di McCarthy, RSNZ

Commodore (Retd) Pat Williams

Dr Shaun Coffey, IRL

Mr Mark Steel, MED

Mr Maarten Wevers, DPMC

3 March

Representative of the Director, Government Communications Security Bureau

United Kingdom

Mr Graeme Ferrero, Managing Director for Strategic Business, QinetiQ

Professor Phil Sutton, UK MoD (representing DTSL and UK Chief Defence Scientist)

Australia

Professor Bob Clark, Chief Defence Scientist

Mr Alan Gray, Assistant Secretary Science Industry and External Relations

Dr Lynn Booth, Director General Science Strategy and Policy

Mr Clive Dunchue, Director Science International Relations

Dr Warren Harch, Deputy Chief Defence Scientist (Information and Weapon Systems)

Mr Steve Pendry, Chief of Staff Information and Weapon Systems

Singapore

Group Captain Tim Walshe, Defence Advisor, NZ High Commission

His Excellency Peter Hamilton, High Commissioner to Singapore

Professor Ron Matthews, Deputy Director, Institute of Defence and Strategic Studies, S. Rajaratnum School of International Studies, Nanyang Technological University

Brigadier General (NS) Ravinder Singh, Deputy Secretary of State (Technology), Ministry of Defence

Colonel Lim Soon Chia, Deputy Chief Research and Technology Officer, Ministry of Defence

Mr Quek Tong Boon, Chief Defence Scientist/ Chief Research & Technology Officer, Ministry of Defence

Lieutenant General (Retd) Lim Chuan Poh, Chairman, Agency for Science, Technology and Research (A*STAR)

Mr Andrew Fun, Head Planning & International Relations, Agency for Science, Technology and Research (A*STAR)

Mr Teo Tiat Leng, Deputy Director Industry, Ministry of Defence

Ms April Lim, Senior Manager (policy), Ministry of Defence

Written Submissions

Mr Robert Grimm

Wing Commander John Lovatt

Squadron Leader R M Kennedy

Mr Robert D Davidson

Flight Lieutenant A Hutchings

Squadron Leader Peter Johnson

Flight Lieutenant Janet Thomsen

Brigadier (Retd) Rick Ottaway

Squadron Leader Jason Markham

Wing Commander Tim Evans

Mr Peter Jackson

Mr Warren McLuckie

Mr Warwick Downing

Mr Michael Rosser

Squadron Leader Alan Duke

Lieutenant Colonel David McBride

B Housden

Mr Paul Jacobs

Squadron Leader Graham Streatfield

Mr Chris Lemon

Mr Lindsay Hall

Surgeon Captain RNZN Alison Drewry

Dr Michael Crozier

Commander Greg Reynolds

Mr Brian Oliver

Flying Officer Gareth Iremonger

Ms Cate Pickett

Mr Dennis Thornton

Directorate of Personnel Capability Development, Defence Personnel Executive

Mr Warren Young

Embassy of the United States of America

The Treasury

Institute of Environmental Science & Research Ltd (ESR)

Institute of Professional Engineers New Zealand (IPENZ)

Dr Chris Reid

Mr Steve Robinson

Appendix D. Benchmarking

Overview of Counterpart Defence Research, Science, and Technology Arrangements

Canada

Introduction

Canada has recently recognised the growing importance of RST to its long term economic well-being. In May 2007 the Government released its national science and technology strategy, *Mobilizing Science and Technology to Canada's Advantage*[15], intended to connect industry with Canadian scientists (most of whom reside within government or academic institutions) to create national competitive advantage. The strategy focuses federal support for RST in four key areas: natural resources; the environment; health; and information technology.

Governance Structures

The Government set up the Science, Technology and Innovation Council (STIG), in October 2007. The STIG, whose Chair is appointed by the Minister of Industry, advises the Government on RST issues and produces reports measuring Canada's S&T performance against international standards. The Federal Government invests in RST in two main ways: first as part of the internal departmental RST budgets; and second via grants to higher education and business. The department of industry, Industry Canada, manages grants to the commercial and academic sectors at the macro level, but other departments with RST budgets invest externally as well.

Almost all of the large Government departments have integrated RST arrangements. The Departments with the largest RST components are Health, Fisheries & Oceans, Environment & Natural Resources, and Defence. RST in the Department of National Defence (DND) is the responsibility of Defence Research and Development Canada (DRDC).

Strategic Direction

The Assistant Deputy Minister (Science & Technology) – ADM(S&T) – is CEO of DRDC, comprising 1750 personnel across nine centres. Defence S&T Strategy guides DRDC output. The strategic direction is derived via a business cycle of assessment, advice, and agreement. Annual reviews of the agreed business plans form new plans that are, effectively, performance contracts.

Organisational Structure and Capabilities

ADM(S&T) is a Level 1 Defence post equivalent to Single Service chiefs and VCDS. Being a CEO allows ADM(S&T) more control over the DRDC work force. ADM(S&T) and CEO DRDC are distinct roles undertaken by one person, with a third role as a senior executive in the Centre for

15 The document is available for download at www.ic.gc.ca/s&tstrategy.

Security Science, which provides scientific services to the department of Public Safety Canada (PSC). PSC is part of a whole-of-government approach to national security. PSC is concerned with Space, the Arctic, Cyber security, and Energy. ADM(S&T) is the Canadian TTCP Principal.

Defence scientists work within six Partner Groups (PGs), co-led by scientific advisors and military officers (who co-sign decisions and policy). The six PGs are:

- Integrated Capability
- Navy
- Land Force
- Air
- Personnel (aka Human Performance)
- C4ISR.

Up to 70% of DRDC's business supports military equipment and systems acquisitions. Main Defence customers are Chief of Force Development and ADM Materiel.

Links with Military, Other Government Agencies and Industry

PSC uses scientists from many departments and fields, including DRDC. DRDC also has strong links with academia and industry with whom it works in IP exploitation. DRDC IP has usually been shared with, or owned by, industry after it was realised that protecting IP was counterproductive to Canada's wider interests.

Australia

Introduction

The Australian Defence Force (ADF) has a long-standing relationship with Defence RS&T efforts via the Defence Science and Technology Organisation (DSTO). DSTO is the Australian Government's lead agency in applying science and technology to protect Australian national interests. It delivers advice and solutions for Defence and national security.

Governance Structures

DSTO answers to the Minister of Defence who is provided with defence related RS&T advice via the Chief Defence Scientist (CDS), Professor Robert Clark. The CDS is a member of the Australian Prime Minister's Science and Engineering Committee and ADF's Strategic Command Group. The CDS performs CEO duties for DSTO; advises Ministers on S&T matters; and contributes to ADF's Strategic Command Group. He is TTCP Principal for Australia.

Strategic Direction

DSTO's mission is to provide proficient, independent advice and modern solutions to ADF and other security agencies. DSTO aims to be a world leader in defence science and technology

and play a crucial role in transforming ADF and Australia's national security. DSTO's main roles in support of ADF are to:

- Enhance Defence operations
- Support the sustainment of in-service capabilities
- Deliver key advice and solutions for future capability
- Build Defence capacity through partnerships with industry

Though there is a fixed level of funding for national security work, there is some cross-over of solutions developed by DSTO for the security sector. DSTO acts as an RS&T focal point in the national security context by providing:

- Threat anticipation, public safety and border security
- Crisis management and command systems
- Critical infrastructure protection, including information infrastructure
- Chemical, biological, radiological and nuclear defence and explosives and improvised explosive devices
- Intelligence support tools

Organisational Structure and Capabilities

The CDS is based in Canberra, with the Chief Operating Officer of DSTO. Deputy Chief Defence Scientists are present at DSTO's main sites at Melbourne and Adelaide. More than 2,500 staff in twelve different scientific divisions work at eight sites across Australia.

DSTO provides support to ADF operations via the deployment of Operations Analysts (OA). DSTO also raises, trains, and deploys two-person OA teams on ADF operations. Since 2005 over 60 personnel have been deployed to 7 countries and conducted RS&T efforts in maritime counter-piracy, tribal analysis, and information flow studies.

Links with Military, Other Government Agencies and Industry

DSTO's programme of forward-looking enabling technologies feed into ADF capabilities. Corporate Enabling Research Programme (CERP) initiatives focus on ADF priorities such as Electronic Warfare, bioterrorism preparedness, UAVs, Intelligence Surveillance and Reconnaissance (ISR), and Systems Integration. DSTO contributes to emerging technologies such as nanotechnology and biotechnology. DSTO also has a variety of interactions with industry, universities, cooperative research centres, centres of expertise, and other research agreements.

DSTO advocates innovation via collaboration. It is involved an many initiatives such as the Centres of Expertise (CoE) which helps universities to focus on technology of interest to Defence, and the Defence Future Capability Technology Centre (DFCTC) which links government, research agencies and industry to develop defence capability.

DSTO participates in TTCP and the American, British, Canadian, Australian and New Zealand

Multilateral Master Information Exchange MOU (ABCANZ). The organisation also has a number of bilateral agreements. The majority of cooperation between DSTO and DTA occurs multilaterally through TTCP and the ABCANZ MOU.

UK

Introduction

The principal defence research agency in the UK is the Defence Science and Technology Laboratory (DSTL). DSTL formed in 2001 when the Defence Evaluation and Research Agency was split into DSTL and a commercial arm, QinetiQ.

DSTL provides independent, high quality scientific and technological services to the UK Armed Forces and Government (MoD). Its aims are to:

- Enhance Defence operations
- Support the sustainment of in-service capabilities
- Deliver key advice and solutions for future capability
- Build Defence capacity through partnerships with industry

DSTL is a Trading Fund agency required to make a financial return at least equivalent to its cost of capital. It is funded through work originating mainly from MoD, but also other Government departments, QinetiQ, and foreign governments. DSTL only takes on commercial work if directed by MoD. A significant amount of the Dstl programme is outsourced to University and Private Sector research providers.

QinetiQ later formed a public-private partnership with the US-based Carlyle Group, and MoD sold its remaining share of QinetiQ in 2009.

MoD established the Counter Terrorism Science and Technology Centre (CT Centre) to act as the hub for MoD research. The CT Centre reports to the MoD Chief Scientific Adviser through an independent board but is collocated with DSTL to take advantage of existing infrastructure and expertise.

Governance Structures

The UK Government Chief Scientific Adviser is the personal adviser on science and technology-related activities and policies to the Prime Minister and the Cabinet; and head of the Government Office for Science. Every UK Government department has a Chief Scientific Adviser (CSA). MoD's CSA is provides strategic management of science and technology issues, and is a full member of the Defence Management Board and the Defence Council.

DSTL answers to the Minister for State for Defence Procurement. The Minister sets DSTL's objectives, establishes its policy and financial framework, and approves major business decisions. Below the Minister is the DSTL Board, led by an independent chairman. Below

the Board is the DSTL Chief Executive, whose role is to deliver set objectives, such as the approved Corporate Plan. The DSTL Chief Executive is the current UK TTCP Principal.

Strategic Direction

DSTL takes strategic guidance from three primary documents. The Defence Technology Strategy 2006 (DTS) publishes MoD priorities for R&D, funding, skills, processes, opportunities, and international research collaboration. The Defence Technology Plan (DTP) provides a cost-balanced list of current R&D priorities of MoD and directs R&D investment in defence technology. The Innovation Procurement Plan 2009 was published in response to the Government's 'Innovation Nation' White Paper, published in March 2008, committing all Departments to produce an innovation procurement plan.

Organisational Structure and Capabilities

DSTL employs approximately 3500 people and consists of twelve departments including:

- Air and Weapons Systems; analysing systems on platforms and weapons systems that use the aerial battlespace
- Biomedical Sciences; developing effective countermeasures for personnel against chemical and biological agents, blast and ballistics
- Detection; researching and advising on the detection and decontamination of chemical and biological agents and explosives
- Environmental Sciences; managing environmental, radiological and chemical weapons demilitarisation hazards
- Information Management; offering technical support, analysis, consultancy and research
- Joint Systems; offering systems advice on complex issues which cross environmental boundaries
- Land Battlespace Systems; analysing and advising on land systems
- Naval Systems; analysing and advising on maritime systems
- Physical Sciences.

Links with Military, Other Government Agencies and Industry

The UK recognises the trend of 'spin ins' of defence developments industry, enterprises, and universities are engaged with to extend capabilities. DSTL engagement programmes include:

- Ploughshare Innovations Ltd; developing DSTL technology and IP to meet MoD needs but recognising where the technology suits different markets
- Defence Technology Centres; joint MoD-industry research centres, bringing together business and academia to develop new technologies in Electro Magnetic Remote Sensing, Systems Engineering for Autonomous Systems, Human Factors Integration Data, and Information Fusion
- Centre for Defence Enterprise; run by DSTL to bring together inventors, investors, entrepreneurs, and academics to incubate new businesses and technologies with defence and other applications

- Interlab; bringing together seven public sector research establishments, including DSTL, to collaborate on key projects such as disaster response
- Project Athena; funded by MoD and managed by DSTL to provide a repository for storing scientific and technical reports and make defence science research results available to the wider defence community

US

Introduction

The US is the world's largest investor in defence science and technology. Each of the US military's single services (US Navy, US Army, US Air Force, United States Marine Corps etc.) has research and development organisations to deal with operational, near term RS&T and longer term requirements.

The basic and applied research and advanced technology component of the Department of Defense (DoD) programme is coordinated by the Assistant Secretary for Defense Research and Engineering (ASDR&E), who is responsible for the Department of Defense Research and Engineering (DDR&E). DDR&E has 67 DoD laboratories across 22 states and a workforce of about 60,000 employees, including 35,000 scientists and engineers. DDR&E operates 10 Federally Funded Research and Development Centers, 13 University Affiliated Research Centers, and 10 Information Analysis Centers. Relationships with industry and academia are fostered through initiatives such as the Small Business Innovation Research programme, Cooperative Research and Development Agreements, and the Joint Reserve Unit.

Governance Structures

ASDR&E is a member of the Office of the Secretary of Defense, and is the principal advisor to the Under Secretary of Defense for Acquisition, Technology and Logistics, and also to the Secretary and Deputy Secretary of Defense for research and engineering matters. The current US TTCP Principal is the DDR&E Director of Research.

DARPA

DDR&E funds the Defense Advanced Research Projects Agency (DARPA), responsible for developing advanced technology for the US military. Since 1958, when DARPA was established in response to the Soviet Union's Sputnik launch, the agency has provided revolutionary military capability to DoD.

DARPA is independent from other more conventional military R&D organisations and largely autonomous. The current DARPA Director, reporting to ASDR&E, is Dr. Regina Dugan. DARPA has around 240 personnel including about 140 technical staff. DARPA focuses on specific short term (two to four year) projects run by small, purpose-built teams and partners with industry to exploit and fund high technology RS&T activities.

Strategic Direction

DARPA preserves the US military's technological dominance by sponsoring research and linking discoveries to military applications. DARPA funds research in biology, medicine, computer science, chemistry, physics, engineering, mathematics, material sciences, social sciences and neuroscience.

Organisational Structure and Capabilities

DARPA research ranges from conducting laboratory science to building military prototypes. DARPA operates Technology Offices, each with distinct areas of specialisation. The Offices and their responsibilities are:

- Adaptive Execution Office: it is believed the AEO's focus areas are: technology transition, assessment, rapid productivity and adaptive systems. The AEO conceives and executes novel technology and system developments that are adaptive both in end function and development.
- Defense Sciences Office: links fundamental science to applications by recognising and pursuing the most promising initiatives within the science and engineering research communities, and transforming these ideas into new US military capabilities.
- Information Innovation Office: aims to ensure US technical dominance in areas where information can be a force multiplier and give military advantage.
- Microsystems Technology Office: researches integrated Microsystems to enable revolutionary performance and functionality for future DoD systems. Technology is developed to support protection from biological, chemical, and information attack, and provide military operational dominance.
- Strategic Technology Office: focuses on technologies that have a global impact and involve multiple services.
- Tactical Technology Office: develops technology for military systems, emphasising the 'system and subsystem' approach to aerospace systems development.
- The Transformational Convergence Technology Office: advances new capabilities derived from a wide range of emerging technological and social trends, predominantly in areas related to computing and computing-reliant areas of life sciences, social sciences, manufacturing, and commerce.

In addition to Technical Offices, DARPA has staff offices supporting overall agency operations.

Links with Military, Other Government Agencies and Industry

DARPA funds unique and innovative research through the private sector, academic and other non-profit organisations as well as other government labs. Typically DARPA partners with industry to develop new technologies. DARPA has engaged with all major US primes including Lockheed Martin, BAE Systems, and Raytheon.

Singapore

Introduction

The main defence RS&T agencies in Singapore are the Defence Science and Technology

Agency (DSTA), the Defence Research and Technology Office (DRTech), the Future Systems Directorate (FSD), and the Defence Science Organisation (DSO), which is the principal defence applied research centre. Singapore's defence budget is pegged to GDP, equating to circa 6% of GDP (of which they currently use 5%). Key concepts in Singaporean defence RS&T are to:

- create the technology edge
- do more with less
- enhance operational freedom
- maintain short management chains to optimise RS&T organisations' value
- avoid enforcing standardised processes and procedures
- avoid stifling innovation through excessive processes and procedures.

DSTA is an executive agency of the Ministry of Defence (MINDEF). It is responsible for implementing defence technology plans, acquiring defence material and developing defence infrastructure for MINDEF. It has approximately 3,000 staff.

DRTech is the lead agency within MINDEF to formulate and drive MINDEF's strategy for defence RS&T and to strengthen Singapore's defence RS&T community.

The Future Systems Directorate (FSD) aims to develop revolutionary concepts and capabilities through future analysis and rigorous experimentation.

The DSO National Laboratory is an executive agency of MINDEF with a staff of approximately 1200 research scientists and engineers. Substantial R&D capabilities have been generated in key areas such as guided systems; emerging technologies; robust network communications and information systems; sensor systems; electronic warfare, advanced electronics and materials; chemical-biological defence and human sciences.

Governance Structure

The Chief Research and Technology Officer and Future Systems Architect report to the Permanent Secretary (Defence). The Chief Scientist reports to the Permanent Secretary (Defence Development) and is also an advisor to the Permanent Secretary.

The DSTA and DSO agencies have governance boards chaired by the MINDEF Permanent Secretary (Defence Development). Board members variously include senior representatives from MINDEF, the Singapore armed services, the banking sector, industry, and universities as well as DSTA and DSO management.

Strategic Direction

The Defence Research and Technology Office (DRTech) is the lead agency, to formulate and drive MINDEF's strategy for defence research and technology (R&T) and to strengthen the Singapore defence R&T eco-system. DRTech is responsible for the outcomes of Singapore's Defence R&T Portfolio, its management and transition to strategic capabilities. DRTech also

works closely with the Defence Industry and Systems Office (DISO) on industry capability development, and with DSTA on R&T transition to full-scale development.

DSTA is the executive agent of MINDEF. Its roles and functions are to:

- acquire weapon systems for the Singapore Armed Forces (SAF)
- advise MINDEF on all defence science and technology matters
- design, develop and maintain defence infrastructure
- provide engineering and related services in defence areas
- promote and facilitate the development of defence science and technology in Singapore

DSO is considered a strategic and indispensable national resource. Its research and development activities run within three broad thrusts:

- enhancing the operational effectiveness of the Singapore Armed Services
- creating the critical edge in defence technology
- strengthening Singapore's national security.

Organisational Structure and Capabilities

DSO has seven functional R&D divisions:

- Guided Systems: Aerodynamics, flight control, guidance and navigation technologies for unmanned systems such as UAVs.
- Electronic Systems: Advanced electronic systems such as radio frequency and micro-electronics. These are key enabling technologies for Electronic Warfare systems.
- Emerging Systems: Critical defence capabilities including antenna design and electromagnetics, lasers and advanced materials.
- Information Division: Information assurance, information exploitation and effective information system design and evaluation. Research areas include computer security, data fusion, natural language processing, manned-unmanned system teaming, operations research and human factors engineering.
- Networks: Robust communication systems and technologies. These include ad-hoc mobile networks, software-defined radios, secured communications and datalinks.
- Sensors: Sensor technologies, including radar, acoustics, electro-optics and underwater applications
- Defence Medical and Environmental Research Institute: Protection against chemical and biological warfare agents, combat care, human effectiveness, bio-technology and bio-engineering.

Links with Military, Other Government Agencies and Industry

DSTA promotes and nurtures the development of defence RS&T capabilities locally. The organisation works closely with domestic firms such as Singapore Technologies. DSTA helps foster a community of scientists and engineers from the universities, research institutes, Government, and industry. A variety of scholarships, student programmes and innovation competitions are funded and run by DSTA.

Denmark

Introduction

Following the Defence Agreement 2005-2009, the Danish Defence Research Establishment (DDRE) was disbanded. A small team of scientists was transferred to the Danish Defence Acquisition and Logistics Organisation (DALO) in 2007, forming the Applied Research Branch. The new defence agreement 2010-2014 meant a further reduction in defence RS&T to 14 scientists in the Joint Technology and Innovation branch.

Governance Structures

Defence RS&T in industry is partly funded and overseen by the scientists from DALO. This is because relevant technology areas, such as material science, cannot be adequately covered by a small scientific staff, and supporting the defence industry in key areas is deemed necessary. The chief scientist is the scientific advisor of the Danish Armament Director.

Strategic Direction

Danish military procurement policy is to buy Commercial Off the Shelf (COTS) products whenever possible. Hence Denmark only purchases technologically mature products (technology readiness level 8 and 9), leaving little room for defence RS&T. Defence RS&T in the Danish armed forces is pursued in order to:

- get a basic understanding of military technological developments
- assist in requirements development
- be able to choose between incoming bids
- assist in an effective and efficient use of technology.

Only in cases where no commercial product is available does Denmark pursue its own research. Examples of this are research in counter improvised explosive devices and in advanced radar and jamming technology. The quality of science is measured by acceptance and peer reviews in international networks.

Organisational Structure and Capabilities

The percentage of defence RS&T tasks performed for DALO is increasing. Defence Command Denmark, and the operational commands, are still the most important customers. One of the key areas of the Applied Research Branch is Technology Foresight, where emerging and disruptive technologies are identified. Threat analysis is not one of the major tasks of DALO. Threat analysis is mainly done by the Defence Intelligence Service, but is an important part of concepts development in the military. Through-life material support is only provided for some military systems based on defence RS&T. Defence RS&T has its main role in the earlier phases of the materiel life cycle.

Links with Military, Other Government Agencies and Industry

The Danish industrial base is dominated by small and medium sized enterprises, with only a few large companies. The defence industry specifically is very small and similarly shows only a few medium sized companies and small enterprises. Compared to neighbouring countries like Norway, Sweden, and Germany the defence industrial sector is of little importance to the national economy. Hence the close cooperation between the defence industry and government sponsored defence research is not particularly important to Denmark.

However, Denmark still considers it important to have a basic defence RS&T capability in-house in a few key areas, at least to a level where they can understand and evaluate new technologies. Being a small country, national and international cooperation is of crucial importance. The NATO Research and Technology Organisation (RTO), and the Science and Technology pillar in the Nordic Defence Cooperation (NORDEFCO) are the basis for international scientific collaboration. Cooperation with national universities and engineering colleges takes place regularly.

Defence RS&T networks and partnerships with industry and academia are in principle a possibility. Public Private Partnerships are officially encouraged by the Danish government, but for contractual and policy reasons these are not easy to implement. Denmark is not part of the European Defence Agency (EDA), but conducts research funded by the EU in framework programmes, and takes part in relevant nationally funded research.

Appendix E. Bibliography

News articles, journals and periodicals

Anderson, Guy. *UK defence technology Green Paper focuses on off-the-shelf procurement.* Jane's Defence Industry, posted 20 December 2010, www.janes.com.

Bell, Mathew. *UK defence minister places cap on future defence science and technology spend.* Jane's Defence Industry, posted 23 November 2010, www.janes.com.

Boven, R. *Standing on the Shoulders of Science: Getting More Value from the Innovation Ecosystem.* Discussion paper 2009/1. Auckland, New Zealand Institute, 2009.

Copley, Gregory R. *Defense Science in the Post-Superpower World.* Defense and Foreign Affairs Strategic Policy Volume 12, 2009. pp.8-13.

Ferguson, Gregor. *ASPI Defence R&D in Australia.* ASPI, 22 December 2010 www.aspi.org.au/whatsnew/publications.aspx.

Foreshew, Jennifer. *Uni's new tool in terrorism battle.* The Australian, Tuesday February 22, 2011.

Middleton, Andrew, Steven Bowns, Keith Hartley, and James Reid. *The Effect of Defence R&D on Military Equipment Quality. Defence and Peace Economics (2006)*, 17: 2, pp.117-39.

Publications

Australian Department of Defence. *Defence Annual Report 2009-10 Volume 1*. Department of Defence, Canberra, 2010.

Australian Department of Defence. *Defence Intellectual Property Policy 2008.* Department of Defence, Canberra, 2010.

Australian Government, Department of Innovation, Industry, Science and Research. National Enabling Technologies Strategy. Canberra, 2010

www.innovation.gov.au/nets.

Canadian Department of National Defence. *Defence S&T Strategy.* Ottawa, December 2006.

Jordan, Neville (Chair). *How to enhance the value of New Zealand's investment in Crown Research Institutes: Report of the Crown Research Institute Taskforce.* New Zealand Government, Wellington, February 2010.

New Zealand Ministry of Defence. *Defence White Paper 2010*. Ministry of Defence, Wellington, November 2010.

Organisation for Economic Co-operation and Development (OECD). *Valuation and Exploitation of Intellectual Property.* Paris, June 2006.

UK Ministry of Defence. *Equipment, Support and Technology for UK Defence and Security.* December 2010. http://www.mod.uk/NR/rdonlyres/F4ACE80C-BFD7-463D-99A6-2B46098BB0C4/0/cm7989_Eqpt_supp_tech_ukdef.pdf.

Wilson, Dr Scott. Deloitte Research. *Value, Protect, Exploit: How Managing Intellectual Property Can Build and Sustain Competitive Advantage.* Deloitte Development LLC, 2007.

World Economic Forum. *Global Risks 2011 Sixth Edition - An initiative of the Risk Response Network.* January 2011. www.weforum.org.

Websites

www.darpa.mil

www.defence.gov.au

www.dsta.gov.sg

www.dstl.gov.uk

www.dsto.gov.au

www.lighthouseplatform.org.nz/wawcs0146381/Reports.html

www.med.govt.nz

www.mindef.gov.sg

www.mod.uk

www.msi.govt.nz

www.nzdf.mil.nz

www.qinetiq.co.uk

www.science.mod.uk

www.statistics.govt.nz

Appendix F. Acronyms

C2	Command and Control
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CBRE	Chemical, Biological, Radiological and Explosive
CDF	Chief of Defence Force
CDT	Chief Defence Technologist
CMB	Capability Management Board
COTS	Commercial Off The Shelf
CRI	Crown Research Institute
DA	Defence Assessment
Defence	The Ministry of Defence and the New Zealand Defence Force
Defence Principals	Secretary of Defence and the Chief of Defence Force
DIA	Defence Industry Association
DICNZ	Defence Industry Committee of New Zealand
DSES	Diver Signature Evaluation System
DSTL	Defence Science and Technology Laboratory
DSTO	Defence Science and Technology Organisation
DTA	Defence Technology Agency
DTAB	Defence Science Advisory Board

DWP	Defence White Paper 2010
ECM	Electronic Counter Measures
ELT	Executive Leadership Team
ESM	Electronic Support Measures
ESR	Institute of Environmental Science and Research Ltd
EW	Electronic Warfare
FTE	Full-time Equivalent
GCSB	Government Communications Security Bureau
HQNZDF	Headquarters New Zealand Defence Force
HQJFNZ	Headquarters Joint Forces New Zealand
ICT	Information Communications Technology
IP	Intellectual Property
IPENZ	Institute of Professional Engineers New Zealand
IRL	Industrial Research Ltd
ISR	Intelligence, Surveillance and Reconnaissance
KPI	Key Performance Indicator
MoD	Ministry of Defence
MOTS	Military Off The Shelf
NZDF	New Zealand Defence Force

OECD	Organisation for Economic Cooperation and Development
PMCSA	Prime Minister's Chief Science Advisor
R&D	Research and development
RNZAF	Royal New Zealand Air Force
RNZN	Royal New Zealand Navy
RS&T	Research, Science and Technology
RSNZ	Royal Society of New Zealand
SIS	New Zealand Security Intelligence Service
TECHINT	Technical Intelligence
TTCP	The Technical Co-operation Programme
UAS	Unmanned Aircraft System
VCDF	Vice Chief of Defence Force
VfM	Value for Money