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Ballistic Missile Defence for Australia: Policies, Requirements and Options

Stephan Frühling

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ABSTRACT

Ballistic missiles are central to rogue states' strategies to deter and coerce Western democracies in the post-Cold War world. The proliferation of missiles of longer and longer range continues throughout the world, and Australia may come within the range of missiles from North Korea and Iran in the coming decade. Regarding rogue states' ballistic missiles, the United States, Japan and some members of NATO are moving from a posture of deterrence through nuclear punishment to a posture of deterrence through denial. Australia, as a beneficiary of the extended US nuclear deterrent, will have to decide whether to participate in 'extended' US missile defence.

Various elements of a ballistic missile defence system, effective against the whole threat spectrum, are under development. The technical limitations of these systems and the importance of the BMD systems architecture (shoot-look-shoot capability, layered defence) make it important to define what role Australian BMD systems should play in the overall BMD architecture and what exactly Australia wants to achieve with its BMD systems: defending the Australian homeland against direct or seaborne attack, defence of forward deployed troops or strengthening the US alliance. Each of these missions leads to a different prioritisation of available BMD systems, and no system (for example the SEA 4000 destroyer) will be able to achieve all missions. After looking at the technical aspects of several possible Australian BMD architectures, the paper concludes with recommendations for Australia's BMD policy.

ABOUT THE AUTHOR

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In memory of

Carl Frühling

and

Dr. Ulrike Schumacher

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ACRONYMS AND ABBREVIATIONS

AAWS	Anti-Air Warfare System
ABL	Airborne Laser
ABM	Anti-Ballistic Missile Defence
ADF	Australian Defence Forces
AEW&C	Airborne Early Warning and Control
ALI	Aegis LEAP Intercept
ANZUS	Australia New Zealand United States
AWACS	Airborne Warning and Control System
AWD	Air Warfare Destroyer
BMC4ISR*	Battle Management, Command & Control, Communication & Computers, Intelligence Surveillance and Reconnaissance
BMD	Ballistic Missile Defence
BMDO	[US] Ballistic Missile Defense Organization
BMDS	Ballistic Missile Defense System
CEC	Cooperative Engagement Capability
CEP	Circular Error Probable
CIA	Central Intelligence Agency
DCP	Defence Capability Plan
DSP	Defense Support Program
DSTO	Defence Science and Technology Organization
DPRK	Democratic People's Republic of North Korea
DUNDEE	Down Under Early Warning Experiment
EKV	Exo-atmospheric Kill Vehicle
FAS	Federation of American Scientists
FOBS	Fractional Orbital Bombardment System
FY	Fiscal Year
GBI	Ground-Based Interceptor
GEM	Guided Enhanced Missile
GPALS	Global Protection Against Limited Strikes
HAA	High Altitude Airship
HEO	High Elliptical Orbit
HF	High Frequency
HMAS	Her Majesty's Australian Ship
ICBM	Intercontinental-Range Ballistic Missile
IDT	IFICS Data Terminal
IFICS	In-flight Interceptor Communication System
IR	Infrared
IRBM	Intermediate-Range Ballistic Missile

JLENS	Joint Land-attack Cruise Missile Defense Elevated, Netted Sensor System
JORN	Jindalee Operational Radar Network
KKV	Kinetic Kill Vehicle
LEAP	Leightweight Exo-Atmospheric Projectile
LEO	Low Earth Orbit
MAD	Mutually Assured Destruction
MCS	Master Control Station
MDA	Missile Defense Agency
MEADS	Medium Extended Air Defense System
MESAR	Multi-function Electronically Scanned Adaptive Radar
MIRV	Multiple Independently targeted Reentry Vehicles
MRBM	Medium-Range Ballistic Missile
NATO	North Atlantic Treaty Organization
NIE	National Intelligence Estimate
NMD	National Missile Defence
NORTHCOM	US Northern Command
NTW	Navy Theater Wide
PAAMS	Principa Anti-Air Missile System
PAC	Patriot Advanced Capability
PBV	Post-Boostphase Vehicle
PNG	Papua New Guinee
PRC	People's Republic of China
Q&A	Question & Answer
OTHR	Over The Horizon Radar
R&D	Research and Development
RAAF	Royal Australian Air Force
RAF	Royal Air Force
RAN	Royal Australian Navy
RGS	Relay Ground Station
RV	Reentry Vehicle
SAMP/T	Surface Air Moyenne Portée/Terre
SBIRS	Space-based Infra-Red System
SBL	Space-based Laser
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SIGINT	Signals Intelligence
SLBM	Submarine-Launched Ballistic Missile
SM	Standard-Missile
SMDTC	Space and Missile Defense Technical Center
SRBM	Short-Range Ballistic Missile
STRATCOM	US Strategic Command

STSS	Space Tracking and Surveillance System
TEL	Transporter-Erector-Launcher
THAAD	Theater High Altitude Area Defense
TMD	Theatre Missile Defence
TVM	Track Via Missile
UAV	Unmanned Air Vehicle
UNSCOM	United Nations Special Commission
US	United States
USN	US Navy
VLS	Vertical Launch System
WMD	Weapons of Mass Destruction

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* The longest version of a whole family of acronyms.

BALLISTIC MISSILE DEFENCE FOR AUSTRALIA: POLICIES, REQUIREMENTS AND OPTIONS

Stephan Frühling

CHAPTER I

INTRODUCTION

The first ballistic missiles and nuclear weapons were used in anger nearly sixty years ago, and the knowledge about their existence and construction is here to stay. As the general level of commercially available technology and the quality of manufacturing equipment improve, it will be increasingly easy for determined states to build both. As long as states are willing to use force to impose their will on others, arms control and export controls regimes will only delay their proliferation. In the history of mankind, no single example exists of a weapon system being abolished worldwide for any reason other than technological obsolescence (and even this is very rare). History shows that for a determined regime, the political and military value it places in ballistic missiles can only be reduced by the development of active and passive defensive measures.

No one today can imagine times past when humans mastered travel over the sea and communities along coastlines and rivers had to cope with the threat of invasion and attack from a new direction. Countless ancient lookout posts, fortresses protecting harbours, coastal batteries, and the monumental *Atlantikwall* of *Festung Europa* are testament to the reaction of humans around the world who tried to protect themselves, sometimes with success and sometimes in vain. More recently, just a blink of an eye ago in historic terms, the threat from airplanes and zeppelins signalled that warfare had again reached another dimension. The instinct of soldiers and airmen to shoot at the new machines with pistols, rifles and improvised anti-aircraft guns proved quite effective at first. But, as the technology of aircraft rapidly developed, it became fashionable to assert in certain circles that 'the bomber always gets through.' Fear of the destructiveness of modern warfare was as abundant as the reluctance to spend money in peacetime to prepare for war, and the unwillingness of the British Army and Royal Navy to discard old tactics and budgets. Great Britain was left with an obsolete fighter force that could have been decisive in the Second World War, had the situation not been changed just in time by military commanders and politicians who recognised the fallacy for what it was. Today, anybody suggesting that air defence was technologically hopeless and that states should not spend money on it would be rightly regarded as a fool.

Sooner or later, states that are threatened with ballistic missiles will again have to confront their need for ballistic missile defences (BMD) and decide whether they want to invest in such a system, seek alternatives or resign in the face of their vulnerability. From the late 1940s until the early 1970s, Great Britain and then the United States worked on BMD systems. They decided to counter the Soviet threat with nuclear deterrence only, which was seen as an alternative to active defences and incompatible with them. Strategic defences, including BMD, became seen as 'destabilising', as they 'endangered' the other side's offensive deterrent and could lead to the 'feasibility of a first strike.' The ABM treaty, negotiated together with the SALT I treaty, strictly limited the extent of permissible BMD systems and became the 'cornerstone of arms control.' The debate on the wisdom of this policy never ceased, especially since the limitations in offensive arsenals that were to accompany it never materialized. The Strategic Defense Initiative (SDI) that President Reagan announced on 23 March 1983 was thus less "an effort which holds the promise of changing the course of human history,"[1] as he claimed, than a return to the instinctive and proven reaction of mankind to the appearance of a new weapon system. The efforts that were begun by the Strategic Defence Initiative Organization (SDIO) in the United States were continued, under politically and financially more difficult conditions, by its successors, the BMDO (Ballistic Missile Defense Organization) and MDA (Missile Defence Agency). These efforts recently led to the third deployment decision for strategic missile defences in the United States in May 2003. The first resulted in the Safeguard system becoming operational for one day at Grand Forks in 1975, while the second was the first Bush administration's decision to deploy GPALS (Global Protection Against Limited Strikes).[2] Different BMD systems are be developed in Europe and the United States, and will enter active service in the coming years.

The technological feasibility of non-nuclear BMD systems is just one reason for the 'catching-up' of the defence against the ballistic missile. A second reason is that, as mentioned above, ballistic missiles are proliferating and will continue to do so. Proliferation was somewhat controlled during the Cold War, either directly through export controls or through the influence of the superpowers on their allies or client states. Yet today, ballistic missiles are produced and used by rogue states, which are not restrained by a protecting power in either ambition or action. Iraq launched some 190 Scud missiles at Iranian cities over six weeks in 1988, causing 8000 fatalities (including 6000 wounded) and a quarter of the population of Teheran to flee.[3] Two years before, Libya had launched one[4] or two[5] Scud at an American base on the Italian Island of Lampedusa. Neither event had enough direct consequences for the West to be fully noticed at the time as the omen they were. A third reason is that the limited effectiveness of the Patriot batteries (that took a great effort to be transported to Saudi Arabia and Israel in 1990/91) left little doubt that the deployed theatre missile defence capability still lagged well behind the requirements for intercepting even basic ballistic missiles. A fourth factor is the widespread belief that deterrence, which is often believed to have 'worked' during the Cold War, will be subject to more friction after the breakdown of the bipolar world order. Accordingly, it cannot be the only basis of Western security in the face of rogue states led by leaders with (quasi-)religious motivations and limited knowledge of, and appreciation for, Western vital interests and policymaking.

In the absence of a BMD policy, Australia *de facto* chooses a combination of accepted vulnerability and dependence on the United States. Ballistic missiles and ballistic missile defences are here to stay and will be on the minds of Australian warfighters for generations to come, just as the problem of air defence is now ingrained in military thinking. With the maturity of missile defence systems in the United States and — on a limited basis — in Europe, the need for Australia to define its position has become more pressing. The procurement of BMD assets is now a viable possibility and the United States is actively exploring the willingness of its allies to cooperate in a global BMD system.[6] This paper will therefore outline Australia's requirements and options in any defence against ballistic missiles, and address the key questions likely to be raised in the coming debate on BMD.

The following sections deal with the ballistic missile threat, policy options to deal with such a threat, the technology of missile defence systems, and Australian BMD architectures. Chapter II will examine the role of ballistic missiles in an asymmetric strategy by rogue states aimed at the coercion and deterrence of Western nations. It will present an overview of ballistic missile proliferation, the missile programs in China, North Korea and Iran, and detail some 'wildcard' scenarios that also require review in any threat assessment. The relationship between deterrence and defence in responding to the threat from ballistic missiles will be analysed in Chapter III. This discussion identifies four basic policies in countering a ballistic missile threat to Australia, varying in their emphasis on nuclear deterrence and the role of the US-Australian alliance. Chapter IV introduces the fundamentals of BMD technology, concentrating on kinetic kill systems. It gives an overview on available systems that are currently being developed, mainly in the United States. Chapter V examines the policy and architecture options for an Australian BMD system. One must first identify the goals that Australia could try to achieve with such a system. Second, the capability of the US BMD system will be crucial for prioritising Australian investments. The third section of Chapter V develops several Australian BMD architectures in more technical detail. Finally, Chapter VI offers concluding remarks and six recommendations.

Some points, which are either omitted or only briefly covered in the paper, warrant a mention. First, only active defences that intercept ballistic missiles in flight are considered in this paper (the one exception being in the last section of Chapter V). Not included are passive defences, including civil defence, and 'pre-boost-phase' intercept through the destruction of missiles and launch vehicles on the ground, primarily by air power and special forces.[7] They are an important part of, but not central to BMD, and the capabilities necessary for these missions are used primarily for 'normal' military operations against elusive targets in general, or currently receive attention in the fight against terrorism with weapons of mass destruction. Second, the technological and financial rewards that Australian industry could derive from an Australian BMD program or participation in allied, especially US efforts, are not the subject of this paper since they are not directly related to the strategic issues involved.[8] Third and most importantly, this paper will only superficially consider the consequences of BMD programs for the overall budget and defence expenditure. No architectures are included herein that would be more expensive than other major defence procurement programs. Yet, within the current budget projections, no major BMD program could be funded without sacrificing other capabilities. Threats to national security tend to arise independent of domestic budgetary discussions, and whether or under what conditions the Australian parliament will in the end decide to fund programs described herein lies outside the scope of a study of the strategic and technological aspects of ballistic missile defence.

CHAPTER II

THE THREAT FROM BALLISTIC MISSILES

The threat from ballistic missiles has to be seen in the context of the post-Cold War emergence of rogue states as a major threat to Western security interests. During the 1990s, Australia participated in operations aimed at containing, controlling and defeating rogue states, and therefore needs to anticipate conflict with such regimes in the future. Ballistic missiles will play a significant role in such situations on a tactical level, where they will hinder operations, cause casualties and bind forces in air defence missions; and on a strategic level, where they serve as a means for coercion and deterrence.[9] The following observations on the asymmetric strategy of rogue states will therefore set the backdrop for a discussion on both the nature of intelligence information on ballistic missile deployments, and the development programs in those states of special concern to Australia.

Rogue State 'Asymmetry' Against Australia

No accurate map of the world shows two identical and symmetrical states 'A and B'. War is always fought between states or coalitions that differ from each other in various respects. States differ in the type of world order they try to advance and the interests that lead them to conflict. Since the nature of war is purely competitive, each opposing side will use its relative strength against the other's relative weakness; thus asymmetry is an intrinsic element of warfare.[10] During the Cold War, the Soviet Union exploited its geographic asymmetry vis-à-vis the Western Alliance, i.e., it reigned over a contiguous empire while vast bodies of water separated the United States the states it protected. This distance posed a credibility problem for the United States when making security guarantees, a problem which the Soviet Union tried to exacerbate by directly threatening North America with ballistic missiles. After dragging deployment decisions on missile defence systems into the mid-1970s, the United States reacted to this Soviet threat with the development of the doctrine of Mutually Assured Destruction (MAD). In the framework of MAD, each side's ballistic missiles-were viewed as a stabilizing force that would raise the cost of a major conflict to allegedly 'intolerable' levels. Missile defences were limited by the ABM treaty, so, it was hoped, neither side could risk a second strike by the other. Assured that this condition held true for both sides, neither the Soviet Union nor the United States — according to this logic — would need to strike first to preempt an attack.[11] The basic aim of MAD was to create stability between two equal blocs, and thus guarantee the survival of both, by making sure that each could 'kill' the other.

Post-Cold War Asymmetry

The end of the Cold War led to a decline of the Western habit of thinking of stability in terms of equal strategic balances,[12] and to a rediscovery of asymmetry in strategy. Conflicts between the so-called rogue states and the West — under leadership of the United States — are in general characterised by a dual asymmetry of interest and overall capabilities: While only the allied nations have the military capability to topple hostile regimes or to simply obliterate these nations, the stakes their enemies have in regional conflicts are much greater than the interests of the United States or coalition partners like Australia. Although a Middle East dominated by Iran or Saddam Hussein, a North Korean bid for forceful reunification of the peninsula or a Chinese invasion of Taiwan constitute serious threats to the national security of Western nations and to global security,[13] such events do not directly threaten the viability of Western nations as independent liberal democracies, like a Soviet control of Western Europe would arguably have done. In the context of the post-Cold War and post-9/11 world, *asymmetry* can thus been defined as *levering inferior tactical or operational strength against Western vulnerabilities to achieve disproportionate effect with the aim of undermining Western will in order to achieve the asymmetric actor's strategic objectives*.[14] This paper will use the term 'rogue state' for relatively weaker powers that use such asymmetric strategies against the West.

Urban warfare, terrorism, WMD threats, information warfare, cyberwarfare, environmental sabotage, denial of space access, psychological operations, ballistic missiles and cruise missiles are just some examples of strategies and threats that have all been included in the concept in one form or the other.[15] The common factor among these strategies is that their threatened use raises the expected cost of a Western intervention in a regional crisis, and thus influences the cost-interest calculation that ultimately underlies a decision to deploy troops abroad. *For a rogue state, the Allied nations' willingness to fight is the centre of gravity since they have a choice.* A rogue state will thus aspire to threaten costs in military or civilian casualties on a corresponding level to the Western interest involved.[16]

As a liberal democracy, the safety and well-being of its population and its national territorial sovereignty are Australia's prime interests. Threatened with direct harm to their populations, through WMD delivered by terrorists or ballistic missiles, Australia and other Western nations may choose to refrain from intervening abroad in the first place. For example, during the first Gulf War, Iraq managed to enlist the support of various terrorist organisations for attacks against allied targets throughout the world, though these attacks were mostly thwarted by counterterrorism operations.[17] Covert action by rogue states — like the bombing campaign in Paris organised by the Iranian secret service during the mid-1980s — gives the rogue state less plausible deniability, but more control over timing, method and targets than the support of terrorists. Yet covert action and terrorism have only limited value in deterring Western intervention. By its very nature, such activity requires the enemy to be unaware of it, and any revelation before its execution endangers the operation. Delivery of WMD by ballistic missile on the other hand needs only a short time to prepare, and missiles remain under the control of a small unit within the military forces of the enemy state: "An unpiloted missile cannot question its launch order."[18] The loss of precious assets and the discovery of attack plans are thus much less likely and, for the purposes of deterrence by rogue states, ballistic missiles are far more useful than covert delivery methods.

The Continuing Nuclear Age

Prime examples of successful asymmetric strategies in the age of "post-heroic warfare" (Edward Luttwak)[19] are Beirut 1983 and Mogadishu 1993. Both constituted little more than tactical defeats, yet let to a change in the expected cost of achieving the US goals — a change that led both to the decision to retreat and to the sacrifice of — relatively minor — US national interests.[20] But the asymmetric attacks on 9/11 and the Bali bombings failed to destroy the targeted states' resolve and although also representing tactical successes, were overall strategic failures. Rogue states aim to achieve "Mogadishu, not Pearl Harbor"[21] but, when confronted with an adversary employing an asymmetric strategy, Western nations are inevitably posed with a difficult decision: Do they give up an important national interest to avoid asymmetric attacks, or do they commit to resisting the rogue state and thus risk significant civilian and military casualties if the enemy underestimates the willingness of the Allied nations to sacrifice blood and treasure? Far from contributing to stability, ballistic missiles in the hands of any rogue state will undermine the ability of Western nations to defend the relatively benign world order against hostile regimes.

It needs to be realised that what was once known as the 'nuclear age' is not over, and the massive destructive potential of nuclear weapons did not vanish with the Cold War. Fred C. Iklé remarks that

> [a] century and a half into the Industrial Revolution, advances in science and technology have reached the stage where leading industrial nations can make weapons of mass destruction that are so lethal relative to their size and weight that they can be used . . . for the purpose of annihilating a country's society without first defeating its military forces.. . . [W]hile the term "nuclear age" was in vogue forty years ago, it is rarely used today. . . . During a prolonged period of almost unprecedented international tension, the United States encapsulated the nuclear revolution in military affairs within a cocoon of non-use.[22]

Whether the conditions that contributed to nuclear non-use in combat during the Cold War will prevail in the future is far from certain, and nuclear weapons have the technological potential to seriously threaten the security of modern societies. Even if rogue states cannot match the technological, military and financial strength of the West, they can still pose an existential threat to modern societies if they deploy nuclear weapons, and maybe also certain biological ones, on ballistic missiles.

The West is not interested in the annihilation of societies, and its military community does not plan for it. But nuclear and biological weapons make it possible for interested regimes, in principle, to do so. Williamson Murray and MacGregor Knox warn that

> [t]he Cold War is over but nuclear weapons remain; their future pacific influence in the hands of rulers less responsible than those of the Cold War era should be a perennial subject of anxious speculation.[23]

The strategic effectiveness of a threat to annihilate the enemy's society[24] served the West well during the forty years of the Cold War, and one must not forget that other states might find it appealing again.[25] As sobering as such thoughts are even in a post-9/11 world, they provide the background for thinking about the threat from ballistic missiles tipped with nuclear warheads. In the words of Greg Sheridan: "That our [Australia's] survival as a nation is by no means assured is a reality we rarely contemplate."[26] Rogue states try to achieve their aims by reminding Western populations of this reality.

Australia as a Rogue State Target

Critics of missile defence often agree on the existence of rogue states' missiles, but doubt that they have an intention to use them, especially against small and far-away countries like Australia. While seemingly intuitive, such an argument fails to take into account the situation in which these missiles are used. Rogue states do not have any interest in conflict with Australia *per se*, but that does not mean that conflict will not occur. The Australian Government sees the support of global stability and the prevention of the spread of WMD as one of the country's strategic objectives.[27] Since their participation in the Second Gulf War in 1991 to liberate Kuwait, Australian forces have been maintaining a presence in the Persian Gulf region. Australia also participated prominently (given the size of its population) in operation *Enduring Freedom*, and is today closely involved in the management of the North Korean crisis. The government stated in 2000 that

> [t]he air and naval forces we develop for the defence of Australia will provide the Government with a range of options to contribute to coalitions in higher intensity operations against well-armed adversaries,[28]

and Special Forces have emerged as a third major asset for these operations since the War in Afghanistan. It is highly probable that the ADF will commit air force and navy assets and special operators to rogue state conflicts in the future.

Hostile states like North Korea, Iran, Libya, and Syria all produce and field different SCUD missile variants, sometimes numbering in the hundreds. Other states with ballistic missile capabilities like Yemen, Egypt, Saudi Arabia and Pakistan are currently not openly hostile towards Australia and other Western countries, but face internal unrest and are situated in a region with a history of sudden 'historic' setbacks for Western security. Within the Australian neighbourhood, Vietnam and China both possess ballistic missiles. The Australian Government recently stated that

> [g]iven the prospect of the ADF operating more often with our allies and friends in regions under threat of WMD delivered by ballistic missiles, Australia supports the development of effective missile defences to protect deployed military units.[29]

It seems highly likely, if not certain, that Australians will find themselves at the receiving end of ballistic missile trajectories in the future, be it Australian troops deployed abroad or even Australians at home. As has been noted above, ballistic missiles are an attractive tool for rogue states to deter a Western intervention and the Australian homeland is thus a potential target. While the threat to troops deployed abroad is acute and short-range missile capabilities are present in a variety of rogue states, some states are working on missiles that could reach Australian territory proper, as described in more detail below.

Although Australia's population lives on one of the most sparsely settled continents, it is concentrated in just a few cities. The capital cities of all states and territories lie on or not far from the sea, making them vulnerable to seaborne attack. Three of them are located in the South Eastern corner of the continent and thus more distant from rogue state territory than Brisbane and Perth. 4.2 million people live in Sydney, 3.5 million in Melbourne, 1.7 million in Brisbane, 1.4 million and 1.1 million in Perth and Adelaide, respectively. These five cities alone contain 60% of the Australian population in small geographic areas,[30] which are nevertheless large enough to be hit by missiles with a Circular Error Probability (CEP)[31] measured in kilometres. They are thus convenient targets for asymmetric attacks aimed at the coercion and deterrence of the Australian Government.

Critical infrastructure,[32] whose destruction would have a debilitating effect on Australia's national security or economy, is also considered a likely target for asymmetric attacks. Current ballistic missiles developed by rogue states are for the most part too inaccurate to destroy point targets with conventional warheads, leaving only nuclear munitions or certain chemical and biological warheads for such a mission. The destruction of infrastructure targets near urban areas with nuclear warheads is not much different in its consequences from a countercity attack, but Australia is home to at least one installation that must be considered a possible separate target from its main population centres. The Pine Gap facility, located near Alice Springs, controls US Signals Intelligence (SIGINT) satellites and, as of 2000, was staffed by approximately 420 Australian and 455 US personnel.[33] It also houses a Relay Ground Station (RGS) that connects the US Master Control Station (MCS) in Colorado with US DSP/SBIRS[34] ballistic missile early warning satellites.[35] Since these satellites form part of the US missile defence system, former Prime Minister Malcom Fraser called the Pine Gap facility a "prime target for attack" which "will create considerable danger" for Australia's security.[36] Yet, in the redundant Command and Control (C^2) system for the DSP/SBIRS satellites, Mobile Ground Terminals (MGT) and other mobile 'tactical' ground stations have made a single RGS like the one at Pine Gap relatively unimportant for the operation of the satellites.[37] Also, while the SIGINT facility is certainly a high value target, it is not part of a command chain of combat forces and thus not essential for the conduct of military operations in the short term. Except for the unlikely scenario of a global decapitation strike against the United States — arguably still within the Russian nuclear capability — Pine Gap is unlikely to be targeted for strictly military reasons.

Yet, a facility like Pine Gap might be an attractive target for a nuclear attack since it would be difficult to find a proportional response to its destruction by a 'warning shot'. The casualties would mostly consist of military or intelligence personnel and their number would be relatively limited, and the decision on the response would involve both the US and Australian Governments, including possibly diverging public pressures in both countries.[38] An attack on Australia is made less likely by Australia's distance and the size of its military forces: its contribution to coalition operations will always be small, and a strike against Australian targets could signal an aggressive intent to much more powerful states closer to the rogue state. But if Australia remained undefended against ballistic missiles while the United States and other US allies like Japan and NATO fielded BMD systems, such an attack might be more likely than today. While valuable missiles shot at protected targets run the danger of being lost, Australia might be seen as a tempting hostage to put pressure on Washington even if it was not directly party to the conflict at hand.[39] Missile defence systems might also contribute to the feeling of security of states geographically closer to the rogue state, reducing the danger to it of using missiles against an undefended Australia.

The Ballistic Missile Threat to Australia

When discussing ballistic missile development by hostile states, it is important to remember that these programs are highly secretive and clouded by deception. The information publicly available on programs in, and the intentions of, Iran and North Korea — the rogue states of biggest concern to Australia — is therefore neither fully reliable nor complete, although observations on technological capability, devoted resources and technology transfer can be extrapolated to estimate future capabilities. Certain 'wildcard' scenarios, especially the proliferation of ballistic missiles through the grey market and seaborne attack, have also to be considered. They are threats that can appear at present and in the future, but are by their nature difficult to detect in advance.

Intelligence and Uncertainty

In general, the number of potential failures in the process of collecting and analysing intelligence information is legion.[40] Such failures can concern either the assessment of enemy capabilities or of enemy intentions or both. Examples from relatively recent history abound. A spectacular failure were the assessments by Western intelligence services on the state of the Iraqi nuclear program before the 1990-91 Gulf War. That Iraq also possessed an extensive secret biological warfare program became known only after highranking defections in 1995, despite four years of ongoing UNSCOM inspections.[41] Recent examples relating to rogue states include the unexpected launch of a long-range Taepo Dong missile by North Korea in 1998 and the launch of a medium-range missile by Iran that same year.[42] The North Korean uranium enrichment program, begun after 1995,[43] was only discovered by US intelligence services in 2000.[44]

Rogue states do not indigenously produce WMD or ballistic missiles in their entirety, but rely on the importation of components and the cooperation of other states, up to the importation of whole systems (e.g., North Korean missiles). CIA Director George Tenet testified before Congress that

> [w]ith the assistance of proliferators, a potentially wider range of countries may be able to develop nuclear weapons by 'leapfrogging' the incremental pace of weapons programs in other countries.[45]

North Korea, Pakistan and Iran have cooperated in their nuclear programs since the mid-1980s.[46]. In exchange for missile parts, North Korea received Pakistani help with its centrifuge based uranium enrichment program.[47] It reportedly shared some of this technology with its Iranian partners who, by providing the opportunity to test missile engines outside North Korean territory, can conceal this activity. North Korea may even produce uranium in Iran,[48] which was discovered recently to operate enrichment centrifuges.[49] In addition, Iran is cooperating with Syria in the production of Scud missiles.[50]

In 1998, the Commission to Assess the Ballistic Missile Threat to the United States — better known under the name of its chairman as the Rumsfeld-Commission — looked in more detail into the intelligence problems concerning the assessment of rogue state ballistic missile capabilities and concluded the following:

> Deception and denial efforts are intense and often successful, and U.S. collection and analysis assets are limited. Together they create a high risk of continued surprise.
>
> The question is not simply whether we will have warning of an emerging capability, but whether the nature and magnitude of a particular threat will be perceived with sufficient clarity in time to take appropriate action. . . .
>
> [T]he fact that there are delays in discovery of those activities provides a sharp warning that a great deal of activity goes undetected.[51]

The Commission therefore based its findings on the available information on rogue state missile programs as well as on an assessment of the technological challenges of missile development, the known history of trade in missile technology between rogue states, the scope of inputs that a country devotes to its programs, and its general level of technological expertise.[52] Based on this assessment, it estimated the time that a country needed to develop a missile capable of reaching the United States, even if a decision to do so was a 'known unknown' and had not been detected. Acknowledging that

> [t]his approach requires that analysts extrapolate a program's scope, scale, pace and direction beyond what the hard evidence at hand unequivocally supports,

the Commission insisted that

> [w]hen strategically significant programs were assessed by narrowly focusing on what is known, the assessments lagged the actual state of the programs by two to eight years and in some cases missed significant programs.[53]

Technologically speaking, the most difficult aspects of the production of longer range ballistic missiles are the staging of the missile, the construction of powerful engines and the development of guidance systems. Technical information on all of these is widely known and published in principle, but their development in practice requires extensive experience and testing and, in some cases, sophisticated manufacturing equipment.[54] The inclusion of such technological considerations into the intelligence assessment can avoid mirror-imaging in making assumptions on system development processes that can be quite different in rogue states than those of typical Soviet and Western weapons programs. North Korea, for example, deployed the No Dong missile after what was believed to be a single successful test flight.[55] This does make strategic sense since requirements for reliability and accuracy of rogue state missiles are substantially different than those for 'normal' weapons systems: *To fulfil their role in the asymmetric strategy, the existence of a credible general capability to hit civilian populations in Western countries is more important than the success of a specific attack.*

A large part of every ballistic missile threat assessment thus rests on assumptions, and is prone to over- and under-estimation alike. This does not invalidate such predictions or make them less important; it is rather simply inherent to the problem that certainty cannot be achieved. The Australian Government's Defence 2000 paper remarks that

> [d]ecisions about the development of our armed forces can have time frames of 20 years or more. Our defence decisions today therefore need to consider the strategic environment we might face after 2010.[56]

Acquiring a missile defence system would certainly require a time-frame of not less than the remaining seven years until 2010. *The decision to field a missile defence system therefore has to be based on intelligence of some uncertainty*, unless Australia is prepared to risk an even longer 'window of vulnerability'.

Ballistic Missile Proliferation

Keeping in mind the cautionary remarks made in the preceding section, it is possible to briefly summarise what is known about missile developments in states that are potentially hostile to Australia. North Korea, China and Iran are such cases, and will be examined in more detail since they are working on advanced missiles that can currently, or will shortly be able to, strike Australian territory. Russian missiles have an even better capability but the likelihood of conflict with Australia is much smaller, while openly hostile states like Syria or Libya are technologically behind China, Iran and North Korea. However, since they too field missiles that would threaten Australian troops deployed abroad, their programs require inclusion in any full account of the ballistic missile threat, an undertaking too large for the scope of this paper. Table 1 gives an overview on ballistic missile capabilities that would have to be included in such an assessment. A most general summary is that "[a] decade ago the Scud was the emerging missile of concern. Today it is the Nodong."[57] Tomorrow's rogue state missiles will be the ones which are able to reach Australia.

Table 1

Ballistic Missile Proliferation

Country	System	Range (km)	Payload (kg)	Origin	Notes
PR China	CSS-8	230		Indigenous	Two stage, first solid, second liquid. Road-mobile.
	CSS-X-7	300	500	Indigenous	Solid fuelled. Road-mobile.
	CSS-6	600	500	Indigenous	Solid fuelled. Road-mobile.
	CSS-2 / DF-3 (3A)	2,800	1 x 3.3 MT	Indigenous	
	CSS-3 / DF-4	5,500	1 x 3.3 MT	Indigenous	
	CSS-4 / DF-5 (5A)	13,0000	1 x 4-5 MT, MIRV tested	Indigenous	
	CSS-5 / DF-21(5) (21A)	1,800	1 x 200-300 kt	Indigenous	
	DF-31	8,000	1 x 200-300 kt	Indigenous	In development

	CSS-N-3 / Julang-1	1,700	1 x 200-300 kt	Indigenous	SLBM, not operational
	CSS-N-4 / Julang-2	8,000	1 x 200-300 kt	Indigenous	SLBM, in development
Egypt	Scud B	300	1,000	USSR / DPRK	
	Project T	450	1,000	Indigenous / DPRK	Improved Scud
	Scud C	500	600	DPRK	
India	Privithvi-150	150	1,000	Indigenous / USSR	From Russian SA-2, Army missile
	Privithvi-250	250	500	Indigenous / USSR	From Russian SA-2, Air Force missile
	Dhanush	250	500	Indigenous	Nearing deployment
	Privithvi-350	350	500	Indigenous / USSR	From Russian SA-2, in development
	Agni-I	600-750	1,000	Indigenous / US / France	Tested, to be fired from road- or rail-mobile launchers
	Agni-II	3,000		Indigenous	In development
	Surya	Estimates from 3250 to 8,000-12,000		Indigenous	From Polar Satellite Launch Vehicle, in development
Iran	M-7 (CSS-8)	150	190	PRC	
	Scud B	300	1,000	Indigenous / DPRK	
	Scud C	500	600-700	DPRK	
	Shahab III	1,300	800-1000 ?	Indigenous / DPRK Russia	Declared operational in July 2003
	Shahab IV	2,000		Indigenous / DPRK Russia	In development
Libya	Scud B	300	1,000	USSR	Operational status questionable
North Korea (DPRK)	Scud B	300	1,000	USSR	
	Scud C Variant	500	600-700	Indigenous	
	No Dong	1,300	700-1,000	Indigenous	Single stage, liquid fuelled missile
	Taepodong I	1,500-2,000	1,000	Indigenous	Combined Nodong and Scud, tested 1998
	Taepodong II	3,500-5,500	1,000	Indigenous	In development
Pakistan	Hatf I	80	500	Indigenous	
	Hatf II / Abdali	180	500	Indigenous / PRC ?	
	Hatf III / Ghaznavi / M-111	290	500	Indigenous / PRC	
	Shaheen I	700-750	500	Indigenous / PRC ?	Solid fuelled
	Ghauri I / Hatf V / Nodong	1,300	500-750	Indigenous / DPRK	
	Ghauri II	2,000 ?	700	Indigenous / DPRK	From Nodong, tested
	Shaheen II	2,000 / 2,500	1,000 ?	Indigenous / DPRK ?	Road mobile, two stage missile displayed in parade in 2000
	Ghauri III	2,700-3,500		Indigenous / DPRK	Engines tested in 1999

Russia	Scud B	300	1,000	Indigenous	
	SS-21	100-120		Indigenous	Solid fuel
	SS-X-26	300		Indigenous	Solid fuel
	Iskander-E	275		Indigenous	Solid fuel, for export
	SS-18 Satan (RS-20)	11,000	10 x 550 / 750 kt	Indigenous	
	SS-19 Stiletto (RS-18)	10,000	6 x 550 / 750 kt	Indigenous	
	SS-24 Scalpel M1 / M2 (RS-22)	10,000	10 x 550 kt	Indigenous	
	SS-25 Sickle (RS-12M)	10,500	1 x 550 kt	Indigenous	
	SS-27 (Topol-M)	10,500	1 x 550 kt	Indigenous	
	SS-N-18 Stingray (RSM-50)	6,500 / 8000	3 x 200 kt	Indigenous	SLBM
	SS-N-20 Sturgeon (RMS-52)	8,300	10 x 100 kt	Indigenous	SLBM
	SS-N-23 Skiff (RSM-54)	8,300	4 x 100 kt	Indigenous	SLBM
Saudi Arabia	SCC-2	2,600	2,150	PRC	
Syria	SS-21	120	480	USSR	
	Scud B	300	1,000	USSR	
	Scud C	500	600	DPRK / Iran	Tested in 2000, production of enhanced variant expected
	Scud D	600-700		DPRK	Tested 2000
Vietnam	Scud B	300	1,000		
Yemen	SS-21	100-120	480	USSR	
	Scud B	300	1,000	USSR	
	Scud			DPRK	12-15 missiles intercepted by the Spanish Navy in December 2002

Source: Based on Carnegie Endowment for International Peace, *World Missile Chart*, 7 July 2003, <http: / / www.ceip.org / files / projects / npp / resources / ballisticmissilechart.htm> (1 August 2003); Carnegie Endowment for International Peace, *China Nuclear Forces, 2001*, <http: / / www.ceip.org / files / nonprolif / numbers / china.asp> (1 August 2003); Carnegie Endowment for International Peace, *Russia Nuclear Forces, 2003*, <http: / / www.ceip.org / files / nonprolif / numbers / russia.asp> (1 August 2003).

China

The People's Republic of China (PRC) is usually not regarded as a rogue state. For several decades, its leadership has for several decades avoided open confrontation with the West and actively sought an integration with the world economy. Unlike 'typical' rogue states, China is surpassing all Western nations in the size of its population, and most in terms of territory and economic potential. Nevertheless, China should be discussed because it has a significant nuclear capability and many of the remarks on asymmetric strategy made above also coincide with Chinese views on warfare.

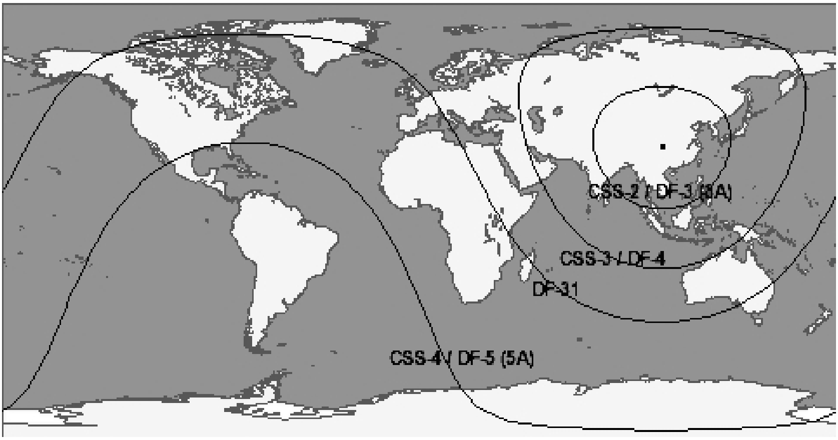
The Chinese ballistic missile force is characterised by a steady improvement in quality and quantity during the last two decades. Three main phases in the PRC's program during this time can be identified. First, the development of liquid fuelled nuclear Medium Range Ballistic Missiles (MRBM)[58] and limited-range Intercontinental Ballistic Missiles (ICBM). These include the DF-3A MRBM, a transportable missile deployed since 1988. It has a range of 2.800 km, the CEP is estimated to be 1000 m, and the missile has been tested on a depressed trajectory over a range of 1.550 km. About 40 launchers were deployed in 1997, but the missile was gradually replaced by the DF-21. With a range of 5.500 km, the DF-4 ICBM has been deployed since 1980. Perhaps 25 missiles with a CEP of around 1.500 m are based in silos in Northwestern China.

The second phase of the PRC missile program concentrated on the diversification of the force, with the deployment of long-range ICBM, new MRBM and Short Range Ballistic Missiles (SRBM). The DF-5A ICBM has been deployed since 1986 and has a range of 13.000 km, with a CEP of 500 m. About 20 to 25 missiles are deployed in silos. The JL-1 Submarine Launched Ballistic Missile (SLBM), a solid fuel missile with a range of 1.700 km, and a CEP of 700 m, is not yet deployed. The DF-21/21A MRBM is the land-based version of the JL-1 and fired from 50 (year 2000 estimate) mobile Transporter-Erector-Launcher (TEL). It can deliver conventional and nuclear warheads up to 2.500 km. The DF-15 SRBM (also known as the M-9) is a solid fuel missile that can deliver a conventional or nuclear warhead over 600 km. Fired from a mobile TEL, it has a CEP of 300 m, which the PRC reportedly plans to reduce to 30 to 45 m.[59] DF-15 have been operational since 1995 as part of the SRBM force of 450 missiles (in 2003), to with 75 new missiles are being added each year.[60] The DF-11 (M-11) SRBM is similar to the M-9 but has a shorter range. It has been exported to Pakistan[61] and is deployed, as the M-9, opposite Taiwan. The 8610 / M-7 is a another SRBM with a range of 180 km.

The third phase of the PRC's missile program centres on the development of the land-mobile, solid fuel DF-31 ICBM and the next-generation JL-2 SLBM. The JL-2 is the naval version of the DF-31 but further from deployment since it has been accorded a lower priority than the land-based missile. The DF-31 has three stages and a range of 8.000 km.[62] It could be currently deployed, with an enhanced version possibly ready for deployment in the second part of the decade.[63] This latter version might be identical with the DF-41, as both are designated CSS-X-10 and described as DF-31 with a longer range.

Figure 1

Ranges of Chinese Ballistic Missiles



Ranges for selected missiles from Chengdu in central China. Range not adjusted for height of launchpoint or rotation of the earth.

Source: Modified map produced with the 'Great Circle Mapper' available at http://gc.kls2.com/.

China has the capability to equip its silo-based, liquid fuelled ICBM force with Multiple Independently targeted Reentry Vehicles (MIRV) but would encounter significant technical and financial hurdles in doing so with its mobile missiles. The US intelligence community estimates that 75 to 100 warheads on missiles with a longer range than the baseline DF-31 will target the United States in 2015, but cautions that Chinese reactions to missile defences are a factor influencing the future force size and the possible adoption of MIRV.[64] The US Department of Defense predicts that the number of Chinese ICBM capable of targeting the United States will grow from 20 today to 30 in 2005 and up to 60 in 2010.[65] While all of these missiles could target Australia, the DF-31 also has a sufficient range to strike Perth, Brisbane and Adelaide from central China (see Figure 1 above).

North Korea

North Korea today has hundreds of Scud and No Dong deployed and produces and exports several variants of both missiles. The No Dong is a North Korean development based on a 150% enlargement of the Scud-C and has a range of 1.300 km.[66] While these missiles already pose a significant danger to forces and populations in Northeast Asia, North Korea is also active in developing longer-range missiles. Its ICBM development projects are remarkable since they are based on the extensive experience with Scud / No Dong technology gained by the country over several decades. These systems are not completely new designs, independent from shorter range missiles, as is typical for Intermediate Range Ballistic Missiles (IRBM) and ICBM projects in the United States, Russia and China. The adoption of unconventional development paths and the general secrecy of events in North Korea have already led to one important Western intelligence failure, namely to anticipate the launch of a three-stage Taepo Dong I in 1998.

The Taepo Dong I, a missile with an estimated range of around 2000 km, is a two stage system, with a first stage derived from the No Dong and a second stage derived from a Scud C missile. The development program was known to Western intelligence services which anticipated a test launch in 1998, and generally saw the Taepo Dong I as an MRBM program. On 31 August 1998 North Korea tested a three-stage version of the Taepo Dong I and tried to put a payload into orbit. While the first and second stage performed according to plan and the North Koreans were successful with achieving a multiple stage separation, the third stage failed for publicly unknown reasons. The existence of this missile had been unknown to Western intelligence, and sparked a reevaluation of North Korean missile programs.

The three-stage Taepo Dong I would probably only be able to deliver a 'small' payload over ICBM ranges and thus be only of limited strategic value, but the use of third stages as well as a possible North Korean preference for range over payload have significant implications for the interpretation of the Taepo Dong II program.[67] The Taepo Dong II is known to have two stages, although the three-stage configuration of the Taepo Dong I makes a similar version of the Taepo Dong II possible, if not likely. The first stage is a new development based on the clustering of three No Dong missiles, the second stage is a No Dong variant. Since technological hurdles like stage separation, development of advanced guidance systems, and engine and airframe design have to be overcome when making a transition from No Dong to Taepo Dong type technology, the progress of North Korea's ICBM was relatively slow and uneven during the 1990s. But the country:

> began an active program to shield the mock-ups [of Taepo Dong I and II discovered by US intelligence in 1994] from US observation. Since then it has conducted both camouflage and deception operations to mask all its missile development

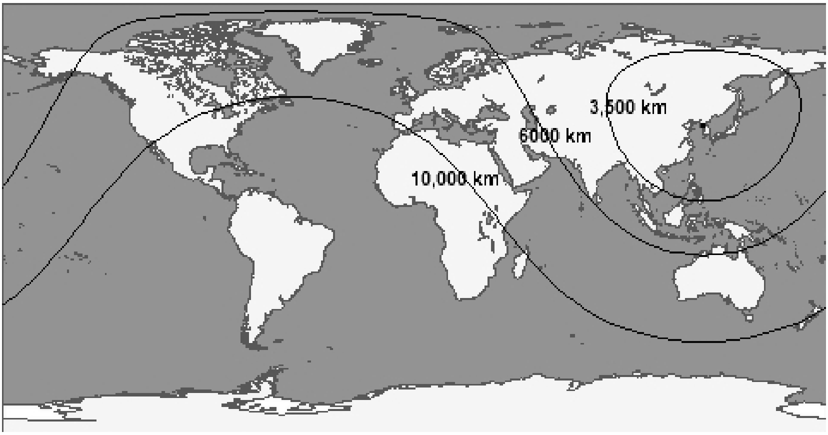
> activities [which] make it increasingly difficult to determine the developmental progress of the Taep'o-dong 1/2.[68]

At the time of writing, North Korea adheres to a flight-test-moratorium on North Korean soil,[69] so its advances in the development programs, including probably flight tests in Iran, are difficult to estimate. The 2001 US National Intelligence Estimate (NIE) on *Foreign Missile Developments and the Ballistic Missile Threat Through 2015* states that the Taepo Dong II "may be ready for flight testing." Its range is estimated to be up to 10,000 km in a two stage version,[70] and thus much further than the 4000 to 6000 km estimated earlier. Robert D. Walpole, the Strategic and Nuclear Programs Officer at the CIA, commented on this before Congress saying that the increased range estimate "takes account for different things they could do to structure, materials and even payload lightening." Unwilling to divulge classified information in an open session, he attributed the revised estimate to a combination of North Korean successes and better US intelligence on the missile.[71] Different estimates for the Taepo Dong II range are summarised in Figure 2.

The time at which North Korea will deploy the missile is even more difficult to predict than its technical capability. Since North Korea is deemed ready to test a Taepo Dong II, there is a possibility that it might use only partially tested development assets to strike Australia or the United States. This threat already exists today and is a major driving force behind the US deployment of missile defence capability in the Pacific test bed. It is unlikely that North Korea would use its few developmental missiles in anything but exceptional circumstances, especially if it — correctly or incorrectly — deems that an attack on the country was imminent. If Australia chooses to participate more closely in building up political or military pressure on North Korea than it does today, it should push to attribute the early destruction of Taepo Dong launch points the highest priority in US war plans.

Figure 2

Taepo Dong II Range Estimates



Range (km)	**Notes**	**Source**
3.500-5.500	1000 kg payload	Carnegie Endowment for International Peace, *World Missile Chart*, 7 July 2003, <http://www.ceip.org/files/projects/npp/resources/ballisticmissilechart.htm> (1 August 2003)
4000-6000	1000 kg payload	Joseph Cirincione, 'Assessing the Assessment: The 1999 National Intelligence Estimate of the Ballistic Missile Threat,' *The Nonproliferation Review* 7, no. 1 (Spring 2000), p.134
4000-6000 6,000+	700-1000 kg warhead 100-500kg warhead	Joseph S. Bermudez, 'The rise and rise of North Korea's ICBMs,' *Jane's International Defense Review* 32 (July 1999), p.59.
'up to 10.000' 'up to 15,000'	'several hundred kg-payload', two stages 'several hundred kg-payload, three stages	National Intelligence Council, *Foreign Missile Developments and the Ballistic Missile Threat Through 2015*, December 2001, <http://www.cia.gov/nic/pubs/other_products/Unclassified ballisticmissilefinal.htm> (10 January 2003).

These estimates are reproduced here as examples, other publications regularly cite them or give similar estimates. Range from Pyongyang and not adjusted for height of launchpoint or rotation of the earth.

Source: Modified map produced with the 'Great Circle Mapper' available at http://gc.kls2.com/.

A more reliable and operationally deployed North Korean capability is further away. The US intelligence community states that "before 2015 the Untied States will most likely face ICBM threats from North Korea,"[72] and Australia is approximately in the same situation: While the distance from North Korea to major Australian cities is somewhat less than that to the US West Coast, an eastbound trajectory from North Korea would profit from the rotation of the earth. Should the increased range estimate for the two-stage configuration of the Taepo Dong II be valid, North Korea is likely to have the technological capability to strike Australia rather sooner than later within the 2015 timeframe. A three stage configuration would have enough range either way, but is technologically more demanding and would necessitate a lighter payload, making a date closer to 2015 more likely.

In both cases, it can be assumed that North Korea will possess a nuclear weapon capability of substantially more than the current one or two bomb estimates (unless major political/military developments in North East Asia intervene).[73] Whether it will be able to mate these nuclear weapons into a Reentry Vehicle (RV) for its ICBM, especially if it has to be fitted to a three-stage Taepo Dong II with reduced payload, cannot be forecasted with any certainty. North Korea today uses conventional, chemical and possibly biological warheads for its shorter range missiles, and the development of similar RV for its ICBM would seem within the North Korean capability should it decide to take that path.

Iran

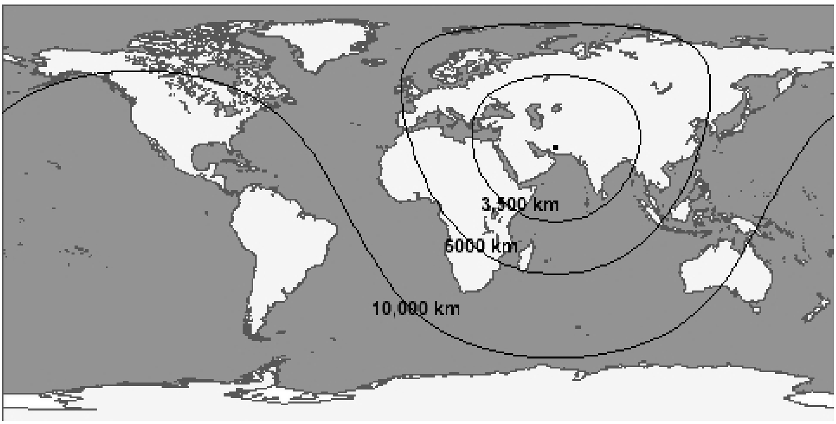
Despite Iran's technological successes, which make it the second-most advanced nation among the rogue states, it is much more dependent upon outside help in its WMD and missile programs than North Korea.[74] Nevertheless, it has a two-tier nuclear program based on reactors currently constructed by Russia, and centrifuges to produce enriched uranium. The extent of the latter has only been recently discovered by Western intelligence.[75] In its ballistic missile program, Iran is primarily cooperating with North Korea.

Hundreds of SRBM are aimed by Iran at targets in the Persian Gulf region, and the Shahab III MRBM has recently begun regular deployment. Iran has a large number of North Korean Scud C missiles. The indigenously produced Shahab III is based on North Korean No Dong technology. Iran's defence minister announced the development of the Shahab IV as a ballistic missile, but the program has since been presented as a space launch vehicle. Iranian officials have also mentioned plans for a Shahab V with an even greater range.[76] The Shahab IV is a derivative of the Taepo Dong I and is being developed with the aid of North Korean engineers. According to media reports, North Korea might finalise the export of Taepo Dong II components to Iran as early as October 2003.[77] This close association of the two countries' programs led to concern that Iran might be used by North Korea to circumvent its test moratorium and disguise its activities.[78]

The results of cooperation with North Korea will be a major factor in determining when Iran acquires an ICBM capability. US intelligence agencies estimate that Iran is capable of testing a Taepo Dong I / Shahab IV missile within several years, but that it is unlikely to build an ICBM capability based on it. Most agencies expect it to instead use Taepo Dong II type technology for such missiles. Such a missile could reach the United States in a three stage configuration. A test of a space launch vehicle by 2010 is seen as likely, although most agencies agree that a demonstration of RV technology is likely to occur only until 2015.[79]

Figure 3

Potential Coverage by Iranian Ballistic Missiles



The map shows different range estimates for North Korean Taepo Dong II missiles (see Figure 2) fired from Iranshahar, the centre of the Southeastern Iranian province of Baluchestan. Iranian Shahab IV and V are most likely based on North Korean Taepo Dong technology. Range not adjusted for height of launchpoint or rotation of the earth.

Source: Modified map produced with the 'Great Circle Mapper' available at http: / / gc.kls2.com / .

The 2001 US NIE on the ballistic missile threat states that Iran is "most likely" to present an ICBM threat to the United States by 2015, an escalation compared to the 1999 NIE that had used the word "probably." Roger D. Walpole, again unwilling to discuss details in an open-session testimony before Congress, has attributed this change to the fact that "concerns about Iran pursuing an ICBM have gone up enough."[80]

Australia is geographically closer than the United States to Iran and, as Figure 3 demonstrates, Perth and possibly Adelaide could be targeted with a 10,000 km missile fired from Iran (which can achieve greater ranges on eastbound trajectories due to the rotation of the earth). Such a missile is equivalent to a two stage Shahab V / Taepo Dong II, and could probably be deployed earlier than a three stage version (as discussed above). Yet, Iran could target all of Europe with combinations of the two- and three stage versions of the Shahab IV / Taepodong I, which is technologically further advanced in its development. To target the United States, the Shahab V / Taepo Dong II would probably have to be equipped with a third stage, making a two-stage Shahab V strategically obsolete for Iran. It can therefore be assumed that Australia will probably not come under an Iranian missile threat at an earlier time than the United States. Unless Iran acquires complete Taepo Dong II systems from North Korea,[81] a direct Iranian missile threat to Australia is unlikely before 2010, but probable by 2015.

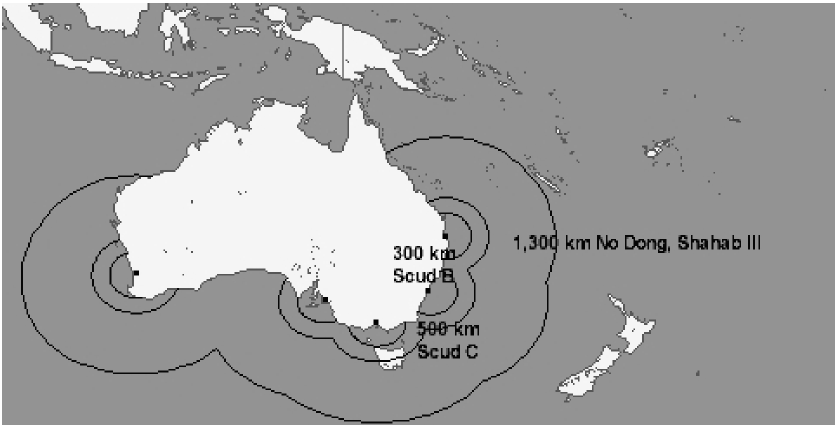
Sea-borne Attack, FOB and Other Wildcards

An important consideration regarding the threat from ballistic missiles are 'wildcard' scenarios that do not fit traditional expectations. During the 1960s, the Soviet Union, for example, developed ballistic missile launch ships under its 'Project Scorpion'. Hardly distinguishable from civilian transport and hydrographic survey ships, they were difficult to track. With an adaptation of WWII naval gun turret technology to stabilise the launcher, they achieved an overall CEP of seven km.[82] The 2001 US NIE states that

> [a]n SRBM or MRBM could be launched at the United States from a forward-based sea platform within a few hundred kilometers of US territory. Using such a sea platform would not pose major technical difficulties, . . . the accuracy probably would be better than for some of the ICBMs discussed in this Estimate.[83]

Figure 4

Vulnerability to Seaborne Missile Attack



Source: Modified map produced with the 'Great Circle Mapper' available at http://gc.kls2.com/.

India is known to develop such technology, and Iran test-fired a missile from a barge in the Caspian sea in 1998.[84] On at least one occasion a rogue state has already used an apparent civilian ship for attacks against Western targets, thereby avoiding retaliation,[85] and systems to defend against launches from forward-based ships therefore have received more attention in recent years.[86] Figure 4 shows the vast areas of ocean from which Australian cities could be targeted with different ballistic missiles. Possible defences against such an attack will be discussed in Chapters IV and V.

A second 'wildcard' scenario is the use of Fractional Orbital Bombardment Systems (FOBS), developed by the Soviet Union in the mid-1960s. Normally, ballistic missiles fly on a ballistic trajectory, without manoeuvring, and thus reach an apogee of around 1.300 km. FOBS warheads manoeuvre into a low orbit of around 160 km altitude, travel as satellites and then actively deorbit onto their targets. Their main advantages were a low signature to early warning systems (before the deployment of early warning satellites) and the capability to approach from unexpected directions; their disadvantages were the high fuel payload necessary for orbital manoeuvres and their relative inaccuracy.[87] While the development of warheads capable of manoeuvring in space is a significant technological hurdle, rogue states might find them attractive since they offer global range with any missile that is capable of putting satellites into orbit. Given the low warhead numbers required for coercion, a rogue state might accept the per-unit costs that would otherwise be considered prohibitive, as well as the relatively low reliability and accuracy.[88]

The deployment of 'wildcard' capabilities might not be detected early enough to deploy defensive capabilities in time. However, both technologies described above were demonstrated by the Soviet Union during the 1960s and rogue states might not even achieve the reliability of these early systems. Yet, to achieve their strategic goal of deterring Western intervention, it is not necessary for rogue states to do so. An Australian population which witnessed, possibly in a crisis situation, an overflight of a North Korean FOBS warhead would certainly not be reassured by the fact that the system was unreliable, probably had a large CEP and that it was doubtful that the North Koreans had the capability to deliver a nuclear payload.

A third possibility for 'wildcard' threats lies in the shadow market for ballistic missiles which makes it possible for interested states to procure such a capability within a short timeframe. In December 2002, the Spanish Navy forcefully boarded a North Korean vessel that did not fly a flag (making it a pirate ship under international law) and found several Scud missiles. These were later handed over to the Yemeni government after it acknowledged that it had previously bought them from North Korea. Indonesia seriously contemplated acquiring ballistic missiles during the mid-1980s[89] and, later in that decade, Saudi Arabia bought DF-3 (CSS-2) missiles with a range of 2,500 km from China. This deal was only discovered by Western intelligence — by accident — two years later.[90]

Australia and ten other states have recently agreed to curb the trade in missile systems, WMD and their precursors under the 'Proliferation Security Initiative,' but it is doubtful that the market will ever disappear altogether. Because of the availability of ballistic missile systems on the underground market, a sudden worsening in relations with countries that currently do not pose a missile threat to Australia, for example in Southeast Asia, could result in the rapid emergence of new threats to Australian territory.

CHAPTER III

DETERRENCE AND BALLISTIC MISSILE DEFENCE

As stated in the Australian Government's Defence 2000 White Paper, "[a]t its most basic, Australia's strategic policy aims to prevent or defeat any armed attack on Australia."[91] The proliferation of WMD and ballistic missiles capable of hitting Australian territory has to be taken into account in the formulation of this policy to secure Australia's territory, its population and its ability to take political decisions free from coercion. The Defence Update 2003 White Paper states that

> [c]ertainty and predictability have decreased [since the year 2000] because the strategic advantage offered by our geography does not protect Australia against rogue states armed with WMD and long-range ballistic missiles,[92]

while "[c]ountries like Iraq and North Korea see WMD [and long-range ballistic missiles] as a source of international leverage and domestic legitimacy."[93] Today, Australia relies mainly on the US-Australian alliance to deter an attack from such weapons. The Defence 2000 White Paper for example states that

> it is very unlikely that any of those countries would see advantage in attacking Australia with [WMD on ballistic missiles], not least because of our alliance with the United States.[94]

The Defence Update 2003 reinforces this position, saying that

> [f]or the present, the prospect of a conventional military attack on Australian territory has diminished, because of the stabilizing effect of US determination and willingness to act, the reduction in major power tensions and the increased deterrent effect of the US-Australia alliance flowing from US primacy.[95]

Yet the Defence Update 2003 also recognises that "[t]he strategic consequences of WMD proliferation are profound,"[96] and establishes Australia's "layered response" to the threat. Diplomacy and international cooperation in non-proliferation arrangements, military operations to prevent the proliferation of WMD, and the strengthening of civil defence capabilities through the establishment of an Incident Response Regiment to deal with nuclear, chemical, biological and radiological attacks are included in this policy. Missile defence for deployed troops is being explicitly supported, while the paper states the Government's intention to continue a "close dialogue" with the United States on strategic missile defence.[97] The Defence Update 2003 thus complements the deterrence provided by the US-Australian alliance with some elements of defence. The relationship between deterrence of a threat and defence against it is central to the strategic role of a ballistic missile defence system. It has to be examined before looking at Australia's options to 'prevent or defeat' an attack with ballistic missiles in more detail.

Deterrence and Defence

Both the ADF and the US Department of Defense define deterrence as "the prevention from action by fear of the consequences. Deterrence is a state of mind brought about by the existence of a credible threat of unacceptable counteraction."[98] There are two main conceptual types of deterrence: Deterrence by denial of success of the action that one tries to deter, and deterrence by punishment for undertaking the action. Deterrence through punishment relies on the deterrer's capability to inflict disproportionate pain and cost on the deterree in response to an unwanted action. It is necessary for the deterrer to convince the deterree of his possession of the means to inflict this pain, and of his willingness to actually use them. Deterrence through punishment can only have success if the deterree does not value his goal to such an extent that he is willing to incur the threatened cost or pain.

To deter an action through denial, it must seem impossible or at least improbable to the deterree to achieve his goals at an acceptable cost against the will of the deterrer. The deterrer's forces must thus be able to at least withstand the deteree's attack, and this capability and the willingness to use it must be conveyed to and understood by the deterree.[99] Deterrence through denial is the outcome and by-product of a capability to defend, and thus not directly a mission for military forces in itself. During the 1980s, Paul Dibb favoured such a defence posture for Australia, rejecting deterrence through (conventional) punishment as too imprecise to apply to defence planning.[100]

Deterrence Through Denial and Ballistic Missile Defence

Since deterrence through punishment is unreliable for reasons examined in more detail below, the case for a post-Cold War deterrence based on defensive capability has been repeatedly made in general,[101] and in connection with the development of ballistic missile defences in particular.[102]

The US government sees the lack of defences against ballistic missiles as one factor that makes such weapons attractive to rogue states.[103] Missile defence systems could deter the use of ballistic missiles by making a tactical failure of an attack more likely. Should such a posture of deterrence though denial fail to prevent an attack, the damage caused by it would be reduced by active and passive defences, and the enemy would have to expect severe retaliation for an attack that might have not caused any damage.[104] ("Ultimately, strategy is about what to do should deterrence fail," Michael Evans reminds us.[105])

Deterrence through punishment is also a less fitting response to rogue state missile threats than deterrence through denial, since the strategic effect from these missiles is caused as much by their mere existence as by their actual use. Robert D. Walpole explains that

> The missiles need not be deployed in large numbers. They need not be highly accurate or reliable; their strategic value is derived from the threat of their use, not the near certain outcome of such use. ... [T]hey are not envisioned at the outset as operational weapons of war, but as strategic weapons of deterrence and coercive diplomacy.[106]

Rogue states thus try to deter Western intervention in regional conflicts, and a Western response based on deterrence through punishment does not serve its need for a credible warfighting capability against these states.[107] Deterrence through denial of the missile threat would negate their value for deterrence and coercion, and make it possible to apply the full range of Western political, economic and military capabilities to deter and coerce in a regional crisis. The view that support for missile defence showed a 'neglect' of deterrence is therefore based on a rather impoverished concept of deterrence.[108]

Facing a public opinion somewhat sceptical of National Missile Defence systems, the British government cautiously expressed this argument in a recent report by stating that

> we need to consider carefully whether a defensive system against a limited ballistic missile attack might in some circumstances in fact serve to reinforce the deterrent effect of our conventional and nuclear forces. Any regime contemplating the use of ballistic missiles against the UK . . . would then face not only the near certainty of an overwhelming response, but also the probability that the attack would fail altogether.[109]

The challenge from rogue states seeking ballistic missiles and the problems of deterrence through punishment described below are also cited by the United States as the main reasons for the development of a BMD system:

> The contemporary and emerging missile threat from hostile states is fundamentally different from that of the Cold War and requires a different approach to deterrence and new tools for defense. The strategic logic of the past may not apply to these new threats, and we cannot be wholly dependent on our capability to deter them. Compared to the Soviet Union, their leaderships often are more risk prone. . . . Deterring these threats will be difficult. There are no mutual understandings or reliable lines of communication with these states. . . . To deter such threats, we must devalue missiles as tools of extortion and aggression, undermining the confidence of our adversaries that threatening a missile attack would succeed in blackmailing us. In this way, [missile defenses] are an added and critical dimension of contemporary deterrence.[110]

Australia's two closest allies are thus moving towards or contemplating adopting a posture of deterrence through denial of ballistic missile threats. Following a discussion of deterrence through (nuclear) punishment, two options for Australia should it decide to provide itself, too, with a defensive capability to deter and defeat ballistic missile attacks will be examined in this chapter.

(Nuclear) Deterrence

During the Cold War, the United States embraced the doctrine of MAD and fully relied on deterrence through punishment to avert a Soviet nuclear attack. Australia and other US allies in Asia and in NATO, under the 'nuclear umbrella' provided by the US extended deterrent, effectively did the same. This policy was reconfirmed by the Australian Government in its Defence 2000 paper which states that "Australia relies on the extended deterrence provided by US nuclear forces to deter the remote possibility of any nuclear attack on Australia."[111]

Friction and Deterrence Through Punishment

To deter a hostile act, the deterrer has to develop a deterrence policy and fit it to the deterree's characteristics. It is necessary to identify decisionmakers and their relative hierarchy of objectives, and to anticipate their reaction to certain threats, given their strategic culture and the options available to them in a given crisis. Based on this evaluation, a threat has to be formulated and conveyed to the deterree which he has to understand, believe to be plausible, and then lead the deterree to rationally choose the desired course of action.[112] Deterrence as a process is thus a psychological phenomenon, and to be deterred is a choice made by the deterree.

Deterrence cannot be mechanically ensured by the deterrer, even if the execution of the threat is fully within the deterrer's capability. Since international events can be rapidly developing and do not follow set schedules like most domestic issues, the decision upon, development and conveyance of a deterrence threat might simply come too late to enter the adversary's decisionmaking. This is especially true in acute crisis situations, during which a mere change in the opponent's judgment of the situation can lead to an immediate breakdown of deterrence.[113]

The seemingly mechanic deterrence relationship between the United States and the Soviet Union during the Cold War has created a sense among large parts of the Western political, military and strategic community that deterrence, especially deterrence based on nuclear weapons, was inherently stable and calculable.[114] But, as in any application of strategy to the real world, deterrence is the subject of friction since

> [f]riction is not determined by the size of arsenals nor by the devastation that weapons can inflict if fired, but by the human relationships that must be engaged in order to deter or, if need be, fight with weapons of mass destruction, including nuclear ones.[115]

Devising a deterrence strategy requires a significant amount of information about the targeted state and its leadership, which can partly be acquired through intelligence collection, but partly also consists of assumptions about the future behaviour of the adversary. The knowledge about these traits will be especially limited when Australia and the United States are confronted with regimes rooted in traditional belief systems, religiously motivated or following a cult-like ideology. Both intelligence information on current capabilities and intentions of the enemy, and assumptions on future behaviour are principal sources of friction. During war and peacetime, the deterree will interpret the conveyed message according to — among other factors — his strategic culture, past experience, and regime type. These filters may distort the intended meaning of the message and are a significant source of deterrence unreliability in general.[116] The possession of WMD can even further change the message filters in ways that might not be apparent to outsiders.[117] The set of historical events considered as a precedent might, for example, change with the acquisition of WMD, and the strategic culture will be influenced by the possession of such an arsenal. To estimate the influence of these message filters and to deter a WMD armed opponent, additional information is therefore required on the adversary's WMD operational doctrine, his views on the use of WMD as a deterrent, and his assumptions about the United States' and Australia's reaction to the use of WMD.[118] The presence of WMD in a rogue state's hands therefore leads to additional possibilities of deterrence failures. The deterree not only has to be convinced of the capability of the deterrer to execute the threatened action, but also believe the threat to be credible. The credibility of the threat will mainly be influenced by the reputation of the deterrer, and his perceived interest which is at stake in the conflict —[119] one of the two typical asymmetries of post-Cold War conflicts mentioned above. Finally, the deterree has to decide to renounce the unwanted action as a result of the deterrer's message, and not go ahead anyway because of a perceived lack of other options, hope for sufficient rewards even in the case of an execution of the threat, miscalculation, lack of true information ('yes-men' giving advice)[120] or simply psychopathological leadership.[121]

Extended US Deterrence

In the Australian context, a posture of conventional deterrence through punishment has been recurrently proposed during the last 30 years.[122] But, given the size of the ADF and the technical limitations of conventional munitions to inflict instant and massive pain,[123] the effectiveness of such a posture has its limits. While the use of ballistic missiles with conventional warheads could probably not be credibly deterred with a threat of US nuclear retaliation, the geographic distance of rogue states from Australia limits the ADF's capability of conventional retaliation and makes Australia also in this case dependent upon its coalition partners, mainly the United States. Within the current policy, the deterrence of an attack on Australia with WMD has to fully rely on nuclear forces provided by the United States. The fact that Australia is a longstanding partner of the United States which it has pledged to defend will be taken into account by any state contemplating hostile acts against Australia, and thus is an element of general deterrence. But it is not the mere existence of the alliance that deters, it merely serves to lend credibility to a threat that the United States makes explicitly or implicitly in a specific situation. All the considerations in the preceding section thus apply to the deterrence of attacks on Australia, even if the definition of the proper deterrence strategy and the deterrence threat in a specific crisis would mainly be undertaken by the US government.

Finding an appropriate retaliatory response to an attack on Australia with conventional or WMD warheads will be highly demanding and politically difficult for both the US President and the Australian Government. To facilitate this task, it is necessary to have as many political and technical choices as possible at one's disposal, including different nuclear weapons systems and target plans. But the high yield of US nuclear warheads (after the decommissioning of many tactical nuclear weapons with sub-kt options generally over five kt) and their relatively old design, developed for war-fighting in Europe and targeting of Soviet strategic nuclear forces,[124] leads to concerns about collateral damage, contamination around the target site, and fallout over enemy and allied territory if they are used. Should the US President have to consider the release of nuclear ordnance, he will likely be faced with the most difficult decision of his presidency. He will also face a world and domestic opinion that might accept the nuclear retaliation in principle, but be critical towards real or imagined effects of collateral damage, radiological contamination and fallout. There is thus a danger that the United States might be perceived as being 'self-deterred' by the high yield and low versatility of its current stockpile.[125] The aversion of the Australian public towards nuclear weapons makes this problem even graver, since a rogue state might perceive it as likely that the Australian Government would not support retaliation even after an attack on Australia.

US Missile Defence for Australia

A main reason for the development of a US BMD system is the lack of confidence in the reliability of deterrence through (nuclear) punishment. Since the United States extends its deterrence shield to numerous allies in Europe and Asia, 'extended' US BMD defences are a logical complement. The (former) Bush administration's plans for a Global Protection Against Limited Strikes (GPALS) was therefore designed to defeat any missile launch, whether against the United States or one of its allies. Yet since such a program would have been incompatible with the ABM treaty, the development of space-based kinetic interceptors for this program ('Brilliant Pebbles') was stopped when the Clinton administration took office.[126] With the demise of the treaty, a global defence architecture has again become a real possibility. In its *National Policy on Ballistic Missile Defense*, published in 2003, the Bush administration confirms that "[t]he U.S. will develop and deploy missile defences capable of protecting not only the United States and our deployed forces, but also friends and allies."[127] The deployments of Patriot batteries to Israel during the Gulf War in 1991, to South Korea during the 1994 crisis and again to Israel in 2003 are first examples of this policy to provide them with 'extended' US missile defence.

In this context it, should be remarked that the differentiation between National Missile Defence (NMD) and Theatre Missile Defence (TMD) derives from the ABM treaty and is of a purely political, not technical or strategic nature. On the one hand, so-called TMD systems like the Arrow or the SM-3 missile provide a defence for population centres of US allies or can protect the United States from sea-borne missiles, a 'NMD-mission' in the logic of MAD and the ABM treaty. The ground-based midcourse intercept system, part of 'NMD', would on the other hand be employed to defeat attacks against military bases in the Asian theatre-for example, in Hawaii. Boost-phase intercept- or space-based systems could provide protection against SRBM and ICBM alike, regardless of the targets, and thus defy a classification as either 'TMD' or 'NMD'. This paper will continue to use the term NMD only to distinguish, without implying a technological difference, the defence of population centres in the homeland from other BMD missions.

US sea-based missile defence capabilities and boost-phase intercept systems do not require the permission of attacked states to be deployed and used.[128] In the case of boost-phase intercepts, it might even be difficult or impossible to determine the target of the missile. Missile defence systems deployed by the United States alone or in conjunction with other allies will therefore — under certain circumstances — provide Australia with a defensive shield against ballistic missiles, independent of decisions by the Australian Government. Yet it would be wrong to see such a protection as a mere extension of the US deterrence shield, constantly present and not requiring day-to-day and detailed consideration of operational issues on Australia's part: The US nuclear arsenal today consists of the ICBM force, Trident missiles on submarines, freefall and cruise-missile delivered nuclear warheads. Designed to be a survivable second-strike force, its technical and operational capability to destroy targets around the globe in short time is not in serious doubt. Given its size today, and as agreed upon in the Moscow agreement (1.700-2.200 strategic warheads each), there is no doubt that the cost of preparing for contingencies involving the defence of, or retaliation for attacks on, Australia is marginal. But, unless the United States deploys a global BMD system along the lines of SDI or GPALS, this condition will not be fulfilled for an extended US BMD system for Australia:

First, the utility of missile defence systems is directly dependent upon their capability to successfully intercept hostile missiles, and thus directly dependent upon the technological capability and number of missiles fielded by hostile states. Since rogue states other than Russia or China cannot hope to be able to preempt or defeat US nuclear forces, extended nuclear deterrence (today) requires much less attention and investment in this regard than extended missile defence (although the utility of nuclear forces is of course not totally independent of enemy capabilities).

Second, missile defence systems stationed on the surface of the earth or within the atmosphere only have a limited range. While space-based systems — whether based on kinetic or direct-energy — protect all regions within certain degrees of latitude, systems on earth can only protect a limited region (midcourse- and terminal systems) or intercept missiles from a limited region of origin (boost-phase systems), or both. Extended protection provided by the United States for Australia thus depends upon the deployment of certain assets in certain regions, and will have significant monetary and opportunity costs attached to it.

If it relied on the United States to provide protection against ballistic missiles, Australia would have to make sure that Washington would always deploy systems appropriate for the threat level faced by Australia, and that it would foot the bill for the overall system. Lacking sovereign control over the system, fire control decisions and the allocation of scarce assets to various threats would be taken without direct participation of Australia. An examination of the technical and operational capability of US missile defence systems under development to defend Australia will be part of Chapter V.

The provision of a US defence shield could also lead to a significant reduction in Australia's freedom of action in crisis situations. US Air Force Airborne Lasers (ABL) and US Navy vessels with missile defence systems, together with the forces for their logistical support and protection, would constitute a force of substantial military might. Deployed by the US government to the South China Sea as a part of the US missile shield for Australia, such forces could, for example, create significant tensions between the United States, China and Australia: Between Chinese pressure to urge a withdrawal of US forces that are officially part of the defence of Australia, and US pressure for support of its policy to avoid such a move, the Australian Government would be left with a choice between either quasi-unconditional support of the United States, or the opening of Australia's territory and population to Chinese attack at a time of crisis. A certain cost of the alliance in terms of constraints of Australia's diplomatic freedom has been accepted by Australian Governments for decades,[129] but, in such a situation, an Australia without any sovereign BMD capability would be more directly dependent of its protective power than at any time since the Japanese were confronted in the battle of the Coral Sea.

Australian Missile Defence

Under its policies of 'defence of Australia' and 'self-reliance', Australia strives to be able to independently handle regional threats below the threshold of a nuclear attack or a conventional invasion by a major power.

Quite paradoxically, the US alliance is indispensable to this policy since it gives Australia access to the intelligence information, state-of-the-art equipment and training opportunities that the ADF needs to overcome the problem of a necessarily small force-to-space ratio.[130] Australia, as a stabilizing force in the South Pacific region, complements the US strategic policy in Asia. This in turn creates the stability that allows Australia to assure its security with relatively small military forces and address common security concerns together with the United States. Burdensharing in this sense is a main reason for the endurance of the alliance.[131] The policy of self-reliance thus serves to maintain its long-term viability, as the Defence 2000 White Paper explains:

> We believe that, if Australia were attacked, the United States would provide substantial help, including with armed force. We would seek and welcome such help. But we will not depend on it to the extent of assuming that US combat forces would be provided to make up for any deficiencies in our capabilities to defend our territory. A healthy alliance should not be a relationship of dependency, but of mutual help. In the long run, dependency would weaken the alliance, both in the eyes of Australians and in the eyes of Americans. For that reason, self-reliance will remain an inherent part of our alliance policy.[132]

But the threat from ballistic missiles in an asymmetric strategy does not fully fit the underlying distinction into regional contingencies, handled by 'self-relying' Australia, and strategic attacks, handled by the US extended deterrent. As mentioned above, the rogue state threat is on the one hand much less able to be managed by US nuclear deterrence alone than the threat from Soviet missiles during the Cold War. The strategic defence of Australia in this sense requires some defensive capabilities, which cause distinct and identifiable costs. On the other hand, ballistic missiles de-facto negate the strategic depth which is the foundation for the policy of 'defence of Australia', as threats by rogue states do not originate in Australia's immediate neighbourhood and are intended to deter an Australian engagement in operations alongside the United States.

Other US allies under the US nuclear umbrella have begun to develop or even deploy NMD systems which provide them with a sovereign capability, albeit in cooperation with the United States.[133] Israel, for example, has fielded two operational Arrow batteries, and Japan is planning a two-tiered system of Patriot PAC-3 and SM-3 missiles, in whose development it is closely involved.[134] The South Korean government is also determining wheter it will participate in a US missile shield for Northeast Asia.[135] NATO countries are so far only participating in the development of terminal defence systems against SRBM (MEADS for example is a joint US-German-Italian development project), but NATO heads of state agreed in 2002 that they would begin a:

> NATO Missile Defence feasibility study to examine options for protecting Alliance territory, forces and population centres against the full range of missile threats.[136]

The parliamentary assembly of the Western European Union recommended in 2001 that a study of a European NMD system be undertaken, under the consideration that

> (a) a future European missile defence strategy could be based on an architecture consisting of a first line of defence composed of land-based, naval or air-based BPI (boost phase interception) systems deployed in Turkey and the Black Sea, a second line of defence composed of naval TMD systems deployed in the eastern Mediterranean and a third line of defence composed of sea- or land-based TMD platforms for the terminal defence of ports and towns;
>
> . . .
>
> (b) it would make sense to establish an architecture reflecting the specificities of each country and allowing a differentiated approach, in other words a sharing of tasks, the United States taking responsibility, for example, for intercepting missiles during the boost phase and mid-course, while the Europeans would be responsible for terminal defence;[137]

Technological and operational issues in connection with a similar course for Australia as recommended here will be examined in Chapter V. Technological capabilities of interceptors, the integration of US and Australian sensors and battle management, and the cost associated with such a system will also be addressed below.

Given the financial and technological challenges involved in the development of a BMD system (as in all modern major weapons systems), Australia will have to rely on the adaptation of existing systems to Australian needs and the integration of early warning, target tracking and acquisition systems with US and allied systems. Yet the Joint Strike Fighter program shows that Australian industry could also profit from close cooperation in a major US program, despite the overall limited Australian share. The US government invited Australia participation in a joint missile defence system, involving the internetting of both countries' systems.[138] Australian BMD capabilities in such a system would also be of value to the United States and could be a catalyst for the continued interoperability of Australian and US forces.

Alone in the Cold? Options outside the US-Australian Alliance

As unrealistic as such a scenario seems at the moment, an end of the US-Australian alliance would give Australia other options to counter a threat from ballistic missiles, which should not be left unmentioned for the sake of logical coherence. A complete break would, for example, leave Australia free to embark on a course of isolationism, avoiding involvement into crises that would make it a potential target for ballistic missiles in asymmetric strategies. Such a policy could be reinforced through a posture of appeasement towards rogue regimes and a subsequent reduction of military forces, or a posture of 'armed neutrality' along Swiss and (declaratory) Swedish lines. The Israeli example shows that even small states can deploy military forces of an astonishing capability, and Australia would, in theory, have the option of providing for its own defence, including a sovereign nuclear deterrent force. The technological and scientific expertise available in Australia's economy and academic community, and domestic supplies of natural uranium would make such a move relatively easy after a political decision to do so.

Yet, although predictions cannot be made with full certainty and the view of the US-Australian alliance can and will change on both sides of the Pacific in the coming years and decades, such a fundamental break in Australia's foreign policy seems out of the question at the moment. 'The Emerging Anglosphere'[139] might be the victim of the next certain crisis between the United States and its allies, or of changing perceptions of Australia's role in Asia, but a complete end of the defence relationship is too unlikely to be further considered in this paper. Suffice to remember that both the ballistic missile threat to Australia, and the options to deter and defeat it, originate in the end from Australia's engagement, at the side of the United States and other allies, in upholding world order against rogue regimes.

CHAPTER IV

TECHNOLOGY OF BALLISTIC MISSILE DEFENCE SYSTEMS

To assess Australia's options of providing itself with a missile defence shield, it is necessary to give a short introduction to the flight phases of ballistic missiles and to the properties of ballistic missile defence systems designed to counter them. A basic understanding of sensors, interceptors and overall BMD system architectures is required to discuss the advantages and disadvantages of existing and future BMD elements. Of the systems developed in the United States and Europe, those most relevant to Australia will be treated in more detail in the second part of this chapter.

Ballistic Missile Defence Basics

Flightpath of Ballistic Missiles

The two basic flight parameters of ballistic missiles, range and speed, are related according to the laws of physics (see Figure 5). More powerful missiles, i.e. those that achieve a greater velocity, can either fly further than less capable missiles (on an energy-efficient trajectory), achieve a higher terminal velocity (over the same range but with a higher apogee), or fly on a depressed trajectory (over the same range but with a lower apogee to avoid detection and cut flight time). Missiles with a range of less than 1000 km are classified as Short Range Ballistic Missiles (SRBM) and usually have only one booster stage. Missiles with a range between 1000 and 3000 km are designated Medium Range Ballistic Missiles (MRBM). Those with a range of 3000 to 5500 km are called Intermediate Range Ballistic Missiles (IRBM) and usually have two or more stages. Some modified IRBM can be used for space launch. Missiles with a range of more than 5500 km are Intercontinental Ballistic Missiles (ICBM). Every ballistic missile flight is comprised of distinct boost-, midcourse- and terminal phases, each of which poses certain advantages and disadvantages for missile intercepts.[140]

Figure 5

Ballistic Missile Flight Phases

Source: Ronald T. Kadish, *Lt. Gen Kadish Special Briefing on Missile Defense, Slides*, 25 June 2002, <http://www.defenselink.mil/news/Jun2002/020625-D-6570C-006.jpg> (4 February 2003).

The boostphase lasts three to six minutes (depending on the range of the missile and whether it is propelled by liquid or faster-burning solid fuel), and is characterised by a rapid gain in height and velocity of the missile. While advanced missiles, for example the Russian SS-18 and SS-27, can manoeuvre during the boostphase, every long-range missile has a somewhat irregular acceleration pattern due to the dropping and igniting of stages. The ballistic part of the missile trajectory and its exact target can only be calculated after the burnout, when the missile has received its full forward momentum and is oriented in its final heading. The boostphase is advantageous for intercept since it is the slowest part of a missile trajectory, the missile cannot yet deploy multiple warheads, possible countermeasures are limited, debris from intercepts is likely to fall on hostile territory, and the missile is easily detectable because of the heat it generates. Disadvantages are the short duration, the location of the missile on or near hostile territory, and the hot plume of gas which engulfs the missile in the higher atmosphere and space which blinds many infrared sensors.

In the midcourse phase, the payload (or whole missile in the case of non-separating systems like Scud) is flying on a predictable path through space or the higher atmosphere.[141] The payload can be a single warhead or a post-boostphase vehicle (PBV, often referred to as 'bus') which corrects the flightpath and deploys warheads and countermeasures during the ascent phase, until reaching the apogee. Space is rapidly cooling the warheads which can be equipped with stealth measures and salvage fusing devices. The target package can also include launch debris, decoys, chaff and active jammers. Advantages for intercepts during midcourse are the relatively predictable flightpath of the warheads and the long time available (up to 20 minutes in the case of ICBMs) for observation and intercept. Disadvantages are the possible deployment of countermeasures by the missile and the relatively small temperature signature of cold objects in space.

During the terminal phase (lasting less than one minute for ICBM), the warheads enter the atmosphere at ca. 100 km altitude. The altitude between 40 and 80 km is the 'missile defence sweet spot', since the warheads are heated up and separated from the lighter decoys, but cannot yet perform aerodynamic manoeuvres in the thin air. In altitudes of less than 40 km, the RV will be slowed down, but may at the same time — by design or unintentionally — begin to tumble and spin, which complicate the intercept.

Sensors

Detecting and tracking a missile, and discriminating the target array in midcourse flight are necessary prerequisites for destroying a ballistic missile or its warhead. The two main sensor systems included in ballistic missile defence systems today are infrared (IR) sensors and radar. Both will be described here in some technical detail since they determine to a large degree the effectiveness of a BMD system. Certain systems employ other sensors (visible light scanner on the GBI kill vehicle, laser range finder on the ABL), and laser radar (LADAR) sensors for kill vehicles are in early development stages.[142]

Infrared scanners are passive sensors that determine the horizontal and vertical angle from which an infrared signal of a certain frequency was received. A single IR scanner thus cannot generate data on the distance of an object. Signal intersection, triangulation or stereoscopic observation with two or more sensors are necessary to form a three-dimensional picture. Infrared signature wavelengths are classified as short, medium, long and very long. Missiles emit short and medium wavelengths during the boost-phase, medium wavelength immediately after burnout (observation of which makes a calculation of the trajectory possible) and long wavelengths during midcourse. To observe the latter, it is necessary to cool the IR scanner and have neither the earth nor sun in the background. Observing one wavelength reveals only the brightness of an object. To gain information on the temperature (and thus the composition of target arrays), it is necessary to measure at least two IR frequencies. Observing a pattern of temperature change over multiple frequencies is necessary to separate RVs from artificially heated decoys during midcourse intercept.[143]

Radar systems are active sensors that gain information from interpreting the reflection pattern of electromagnetic radiation they emit. Radar gives information on horizontal and vertical angle of the reflection, and the range of the object. Because of the curvature of the earth and ground interference, radar systems have a dead space which they cannot observe. Phased array radars[144] achieve their highest resolution at or near the radar's boresight (the angle perpendicular to the face).[145] To increase the resolution, it is necessary to increase the power of the beam. Since the range of the radar is proportional to the fourth root of transmitted power, resolution increases as range decreases. Wavelength and bandwidth of the radar system are critical parameters. The longer the emitted signal's wavelength is, the further it propagates; the shorter the wavelength is, the more information can be gained about the observed object.[146] Unlike ballistic missile early-warning radars and the Spy 1 (Aegis) radar which have limited bandwidth, X-band radar (as developed for THAADS and the GBI) can employ Linear Frequency Modulation (LFM), sending out radar pulses containing information in the form of changing frequencies. The pattern received in the echo then allows the calculation of parameters such as nose wobble motion, diameter, length, spin rate and mass, velocity and position of objects within a target array, critical for intercepts in the midcourse phase.[147]

Interceptors

There are two basic mechanisms to destroy ballistic missiles in flight, interceptor missiles and direct energy weapons. Interceptor missiles can be employing nuclear warheads (as in the US Safeguard and Russian NMD programs), fragmentation warheads, and hit-to-kill technology. Western missile defence programs today do not incorporate nuclear warheads, although these have certain advantages over conventional solutions.[148] Lasers for missile defence applications are all still in development or conceptual phases. They destroy missiles by heating their hull during the boostphase, leading to an explosion or leaking of propellant, or the creation of aerodynamic drag which makes the missile tumble.

Every missile interceptor in principle consists of booster, guidance system, steering- and kill-mechanism. Fragmentation warheads add weight to the interceptor, but can achieve a successful intercept even if they only approach the incoming missile. Hit-to-kill technology demands exact targeting and highly agile interceptors, but destroys a target more reliably than fragmentation warheads, which are also less efficient in space. The major components of the guidance system are sensors on the interceptor for final guidance, a link to receive data from external sensors, and the processing unit. IR sensors are difficult to use in the atmosphere and have to be protected between 40 and 80 km. Interceptors designed for use within the atmosphere therefore usually carry active or passive radar sensors. Steering mechanisms can consist of fins for manoeuvring within the atmosphere and/or small thrust systems for manoeuvres in thin atmosphere or space. Depending upon its range, the interceptor missile will have one or a set of separable boost-stages.

In principle, it is possible to 'take a shot' at an incoming missile or warhead with nearly any interceptor and achieve a successful intercept if conditions are right. The probability of a successful intercept of a given missile is mainly influenced by the following parameters:

- The external data which allows to give a launch command and to guide the interceptor to the intercept point before its own sensors take over. This relates both to the quality of the battery radar and the availability and quality of data from sources which are not part of the defence system proper, in which case one speaks of 'external cueing'.[149]

- The divert envelope of the missile or kill vehicle, which is dependent upon the range of its sensors, the fuel capacity for diversion manoeuvres, and the divert velocity relative to the target.[150]
- The computational capacity of fire control and guidance systems on the ground and in the interceptor which determine the accuracy of calculations and speed of commands.
- The speed of the interceptor and the relative position of the launch point to the flight path of the missile it is trying to intercept.
- The engagement altitudes for which the interceptor is designed (most importantly a maximum altitude for endo-atmospheric systems and a minimum altitude for exo-atmospheric interceptors).
- The kill mechanism (hit-to-kill or fragmentation warhead, or a combination of both).

As a result of these factors, 'protected areas' are defined by a certain probability of intercept and "[d]etermining protected areas . . . can be nebulous,"[151] especially in the case of intercepts in boost, ascent and midcourse-phases. For these systems it is easier to specify the area in which missile launches can be suppressed, but both areas are related (i.e. a ship with missile defence interceptors in the sea of Japan will, for example, suppress a launch area over North Korea for missiles aimed at Japan, but not necessarily for missiles aimed at the United States and most likely not for missiles aimed at Australia.)

Integrating Missile Defence Systems

At a basic level, missile defence systems can be characterised as "a collection of several sensors, one computer system to integrate the sensor data, plan the battle, and command the weapons, and one weapons complex."[152] The capabilities of single elements, like sensor systems or interceptors, are important for the capability of the whole system. But, to a large degree, it is dependent upon the way the architecture integrates all elements. A general knowledge of the advantages and disadvantages of missile defence architectures is therefore necessary to assess the importance of single systems for the overall defence capability.

First, one has to realise that missile defence architectures will evolve in the future in accordance with the quantity and quality of the threat, technological developments, cost of systems and other parameters. During the debate on SDI and its successor systems, a multitude of 'final' architectures for missile defence systems have been proposed, discussed, criticised and rejected in the United States. But, given the relatively 'young' technology involved, these standards have either not been reached, or were seen as too expensive, so that today hardly any capabilities are fielded. Under the concept of evolutionary acquisition, the Bush administration has therefore split its missile defence efforts into successive two-year 'blocks'. These field new capabilities or improve existing systems based on the available technology, threat level and cost, and make it possible to gain operational expertise with the overall system and its components.[153] The United States thus tries to balance the financial and technical risks inherent in such a large development program against the current and future operational and strategic risk of not having any missile defence capability.[154] This approach has consequences for Australia since the sensors and weapons developed and fielded today are not 'final' versions, but will be further developed and upgraded in the near future. They might also turn out to be valuable only as a stop-gap measure, and cancelled at a later date in favour of other systems: "[W]hat we propose to field initially in 2004 and 2005 may evolve to look very different a decade later."[155] But *unlike the United States, Australia cannot afford to commit to a system which will be obsolete or inadequate a few years later, and should therefore pay special attention not to commit to one system too early*.

Secondly, the overall system effectiveness and capability is dependent upon several factors directly determined by the system architecture.[156] The required probability of kill for example determines to a large part how many interceptors have to be fired at one incoming missile. Since the probability is influenced by the flight geometry of both missiles and the sophistication of the incoming target, there is no fixed number of interceptors that is necessary to achieve a certain kill probability in a given architecture. But a higher requirement will in general lead to the expense of a higher number of interceptors and a more rapid depletion of the arsenal.

A critical factor in the system architecture is the capability to employ shoot-look-shoot tactics instead of salvo firings, which also rapidly deplete the interceptor arsenal. Both tactics can be combined, so that the system launches a second salvo of interceptors after the first one fails. The geographical location of the interceptor launch site relative to the missile trajectory is the most important factor in determining whether shoot-look-shoot tactics can be used; others are the general system reaction time, the time needed to assess the missile trajectory and target array complexity (in the case of midcourse intercepts), and the time needed to make a kill assessment after an attempted intercept.

Shoot-look-shoot capability can be achieved by one system alone, and/or within an overall architecture between two different interceptor layers.[157] Rear stages can have a relatively low number of interceptors compared to the 'front' systems, if they only have to deal with those missiles which slip through the first layer. Layering of missile defence systems can also raise the kill probability by compensating for possible inherent weaknesses of each layer, and countermeasures employed by the enemy. It is thus most effective to combine BMD systems designed for intercepts in different flight phases of ballistic missiles. *Australia should therefore consider whether it is more efficient for its purposes to marginally reinforce an existing US-allied BMD layer with Australian capabilities, or to build a small second layer system to intercept missiles which slip through the first screen.*

Missile Defence Elements in Development

The following section gives an overview of some BMD technology that is relevant to Australia, and mainly developed by the United States. The block structure of the US program gives an indication of how close to operational deployment a system or capability is. Block 2004 development goals for example will be demonstrated in Fiscal Year (FY) 04 and FY 05, block 2006 capability procured during FY 06 and FY 07. The initial defensive capability procured in block 2004 and in the following years is integrated into the test-bed, and can thus be enhanced by items that are normally used for development purposes only.[158] An analysis of the capabilities of the US BMD forces for the defence of Australia is part of Chapter V.

Sensors

Due to the restrictions imposed by the ABM treaty, 'tactical' sensor systems like Aegis Spy-1, AWACS, Patriot or THAAD radars were not allowed to be linked with the 'NMD' system. With the end of the ABM treaty restrictions, data from these radars can be integrated with 'NMD' systems like DPS/SBIRS, STSS, and the upgraded early-warning radars. One of the main activities within the area of sensor development in the US BMD program is therefore the integration of existing assets into one BMC4ISR system, similar to the integration of radar data in the US Navy's Cooperative Engagement Capability (CEC).[159]

Radars

Radars that are available in the short term for missile defence against longer-range missiles include the Aegis Spy-1 S-band radar, and the X-band radars originally developed for the GBI. The Aegis radars on 15 destroyers and 3 cruisers will be modified in block 2004 to give them an initial ICBM detection and tracking capability. They will be used primarily for the sea-based midcourse defence with SM-3 missiles against SRBM, MRBM and later IRBM, but the data they generate on ICBM flight paths will be relayed to the GBI system.[160] The capability of these early radars is limited to a range of 500 to 1000 km and the tracking of first-generation ICBM with few or no countermeasures, since their discrimination capability is limited due to the lack of bandwidth mentioned above. Navy officials reportedly estimate that it would take until the end of the decade to give the Aegis radar the capability to discriminate elements in target arrays as far away as 3000 km.[161] The main emphasis of Aegis BMD blocs 2006 and 2008 therefore lies on the upgrading of the radar with increased bandwidth, leading to its integration into the future Navy Aegis open architecture.[162]

The GBI are mainly supported by the Cobra Dane radar in Alaska and two early-warning radars in Shemya, AL, and Beale AFB, CA, that are all being upgraded to deliver tracking data. Similar upgrades of radars at Thule AFB, Greenland, and RAF Fylingdales in Britain are also planned, pending the host nations' agreement. A containerised, relocatable new X-band radar capable of all sensor functions (tracking, in-flight update of interceptors, target discrimination and kill assessment) will be constructed on a semi-submersible platform, similar to an oil-rig. From the fourth quarter of 2005 on, it will be used in the Pacific testbed and for initial defence operations.[163] To complement these existing systems, MDA is developing a Ballistic Missile Defense System (BMDS) Radar. It could be forward deployed on land or at sea in a network of layered sensors to observe missiles in their ascent phase and during the deployment of payloads. First versions of the radar will be integrated into the missile defence testbed in FY 2006, but MDA did not make a firm commitment to deploy it.[164]

There are a variety of other radars under development which have, or could have, a role in missile defence. France, to begin with a non-US radar, is developing the Arabel X-band radar for its Aster-30 interceptor. Besides other battery radars for THAAD, Patriot or the Israeli Arrow (the latter's radar being much less capable than the THAAD system, a consequence of the high emphasis placed on an early deployment of the Arrow), several naval radars have to be mentioned in this regard. The Anti-Air Warfare System (AAWS) on Dutch LCS and German F-124 frigates for example consists of the I/J-band APAR and D-band long range SMART-L radars, both two solid state, coherent pulse doppler radars. Unlike traditional non-doppler naval radars, AAWS can discriminate an incoming warhead from debris and has been designed to be easily upgradeable for an area defence mission against ballistic missiles.[165] Other modern naval multi-function radars, as developed for the French and Italian Horizon frigates, the British Type 45 destroyer (using the Sampson active phased array radar), or the Australian CEA-FAR and Auspar radars are inherently more capable for target discrimination than earlier passive array types like the Aegis Spy-1 and could all be adopted for BMD purposes.[166] BMDO for example examined the British Multi-function Electronically Scanned Adaptive Radar (MESAR) for its purposes in the late 1990s.[167]

Space-Based IR Sensors

A system of space-based IR sensors will eventually be part of the overall US missile defence system. Currently deployed are the geostationary Defense Support Program (DSP) early warning satellites and two Space Based Infrared Satellite (SBIRS)-high payloads on high elliptical orbits (HEO). Beginning around 2004, the DSP satellites will be replaced by more capable SBIRS-high systems. SBIRS-high sensors have a higher revisit rate of the observed area than the DSP-constellation[168] and a staring sensor that can determine burnout-velocities of missiles in a theatre-size region. Its ground resolution using stereoscopic observation will be less than one kilometre (3 km for DSP), and the multicolor IR scanner will allow a more accurate identification of missile types. Like DSP, SBIRS-high cannot observe missiles in midcourse flight.[169]

Tracking of objects in midcourse flight and discrimination between warheads and countermeasures was to be the function of the SBIRS-low satellite constellation, which was cancelled in 2002 because of cost overruns.[170] It has since been restructured and renamed the Space Tracking and Surveillance System (STSS), whose first two satellites will be launched in FY 07 to support the BMD testbed. On a Low-Earth Orbit (LEO), SSTS satellites can observe objects in midcourse against the background of space, and deliver exact tracking data through stereoscopic vision with two or more platforms. The two block 06 satellites will not be enough for worldwide coverage (for which up to 30 satellites are necessary), but allow more testing before the launch of future satellites.[171] Also in 2006, France plans to start two experimental early-warning satellites that will prepare the development of geostationary satellites, to be launched around 2012.[172] The French system is thus even further from entering service than the US STSS. But it is very possible that the project will be enlarged to a wider European program in the future and integrated into a future European missile defence system as currently studied by NATO. Once it is integrated with US capabilities, such a program might at some stage also be of interest to Australia.

Ground Based Interceptor

The GBI is designed to intercept ballistic missile payloads during the midcourse-phase in space. It is therefore only capable of intercepting IRBM and ICBM which spend a significant time of their trajectory above the atmosphere. The heart of the GBI is the Raytheon Exo-atmospheric Kill Vehicle (EKV), which destroys incoming missiles by colliding with them during the midcourse flight phase in space (hit-to-kill). The collision occurs at a closing velocity of approx. 7.4 km (4.6 miles) per second, at an altitude of about 230 km (144 miles).[173]

As a hit-to-kill system, the EKV (weighing 65 kg (144 pound)) does not have a warhead. An inertial navigation system, which is updated by stellar navigation, guides the EKV to the intercept point. The sensor for target acquisition and discrimination measures visible light, medium wave- and long-wave IR signatures, the data on the target distance has to be determined by ground-based radar and relayed to the EKV via In-flight Interceptor Communication System (IFICS) Data Terminals (IDT) that are installed with the X-band and modified early-warning radars. The booster that transports the EKV into space provides almost all forward momentum; final vertical and horizontal manoeuvres are performed by thrusters on the EKV. These manoeuvres take just seconds, but are less challenging because of the speed involved than because of the number of calculations necessary to determine the optimum intercept course. The power of the processing unit on the EKV is therefore a central factor to its overall capability. All eight or nine subsystems on the EKV are modulated and can be easily upgraded and replaced, so that only the integration of a LADAR would require system reengineering.[174] While a two-stage boost vehicle based on the second and third stages of the Minuteman-III ICBM were used in the GBI tests so far, future tests and deployed interceptors will use one of two competing three stage booster designs.[175]

SM-3

The geographic flexibility of a BMD system with seabased interceptor makes them especially attractive. As mobile assets, naval BMD forces can be quickly moved to react to new threats, concentrated in areas of special concern, and provide layered protection. In an area defence mission, BMD is in this sense a logical extension of the classical role of traditional air-warfare vessels. Several types of naval ships in the United States and Europe are designed to be able to participate in BMD in the future, and two naval BMD interceptors, the SM-3 and Aster-30, are in advanced stages of development. While the SM-3 is a midcourse intercept system, the Aster-30 is a terminal defence missile.

The SM-3 interceptor is primarily designed to intercept MRBM and IRBM during their ascent phase, but the system has some capability to intercept SRBM during their flight above the atmosphere. It consists of a three-stage booster based on the Standard missile family, which propels the Leightweight Exo-Atmospheric Projectile (LEAP) kill vehicle into low space. Formerly known as the Navy Theater Wide (NTW) system, it is now designated the 'seabased midcourse BMD element'. The block 2004 version of the interceptor originates from the Aegis LEAP Intercept (ALI) tests conducted in 2002. Block 2008 and 2010 will increase the overall system capability through upgrades of both the interceptor and Aegis Spy-1 radar.[176]

The LEAP kill vehicle used on the SM-3 originates from a technology demonstration program in the early 1990s that aimed at a miniaturization of kill vehicles. Its technology thus does not represent the state-of-the-art, and its capabilities are inherently limited. Unlike the EKV of the GBI, LEAP is not hardened against nuclear Electromagnetic Pulse (EMP) as would occur during intentional or unintentional nuclear explosions (e.g. through salvage fusing) in space.[177] The IR-scanner on the LEAP is a mono-colour system and not sufficiently cooled to detect very cold objects such as ICBM warheads that have travelled a long way through space. Even the improved LEAP with solid-fuel thruster charges only has a relatively limited divert envelope. The US-Japanese Cooperative Research program therefore focuses on improved sensors, including a future two-colour IR scanner, second stage propulsion, kinetic warhead and lightweight nosecone of the SM-3 missile.[178] Currently the SM-3 missile has a burnout velocity of about 3.1 km per second,[179] artificially reduced by the Clinton administration from the originally planned 4.5 km per second because of AMD treaty restrictions.[180] 4.5 km per second was to be the burnout velocity for the NTW block II missiles which, before the restructuring of the program into two-year blocs, were to succeed the block I version.[181] But even fitted with such a booster the SM-3 would hardly be able to intercept ICBM.[182]

Insufficient velocity and the limitations of the LEAP are thus restricting the capability of the SM-3 against ICBM.[183] The upper ceiling of the capability of the SM-3 is the interception of IRBM, which MDA plans to achieve with block 2006 (the block 2004 version is limited to the intercept of SRBM and MRBM).[184] At the same time, the system is limited in its capability to intercept targets on the lower end of the ballistic missile spectrum. Since LEAP is designed for use in space, thrusters and sensors are affected by the atmosphere and cannot be used in anything but relatively thin air. NTW was originally designed to counter only MRBM and IRBM, while SRBM like Scud and SS-21 were to be defended against by the Navy Area Wide program.

Navy Area Wide was based on the SM-2 IVA air defence missile, a variation of the existing SM-2 IV, and aimed at defeating both SRBM and modern cruise missiles.[185] As a terminal defence system for use within the atmosphere, it was fitted with a blast fragmentation warhead and a shielded IR-sensor. Because of cost overruns, Navy Area Wide was cancelled in December 2001. Instead of a starting a new terminal defence program, the Pentagon decided that it was possible to achieve "much" of the capability of the SM-2 IVA by modifications to the air-defence SM-2 IV missile, and by modifications to the SM-3 to give it some capability against SRBM.[186] The development program for the SM-3 thus includes in block 2004 a "low exo-atmospheric experiment to test the ability to expand the Aegis BMD element engagement volume to lower engagement altitudes," which necessitates changes on the sensor and propulsion system of the SM-3.[187] Even though these changes make intercepts at lower altitudes possible, LEAP remains constricted to engagement in space. It is thus at a disadvantage compared with endo-atmospheric interceptors since SRBM spend only a small part of their overall trajectory there, and none at all if they are flying on a depressed trajectory.

Aster-30 and Landbased Terminal Defence Systems

Terminal BMD systems are available in a much greater variety than midcourse defence systems. Since they are usually designed to destroy incoming missiles or RV in the atmosphere, many terminal BMD systems are 'traditional' air-defence systems with enhanced capabilities. Often they provide protection against conventional aircraft, cruise missiles and ballistic missiles alike. Since the cancellation of the US Navy Area Wide program, most terminal defence systems have been primarily designed for land-based use.[188] But the naval Aster-30 version could be upgraded for terminal BMD missions as performed by its land-based counterpart. Provided they fit into Vertical Launch System (VLS) containers, any land-based missile could be navalised, or their warheads fitted to naval boosters. Russian systems, especially the S-300 that is similar to the US Patriot system, are not discussed here since political, strategic and technological considerations de-facto limit Australia to the procurement of Western equipment.

Aster-30

The Aster missile is produced by MBDA, which was created at the end of 2001 by a merger of Matra BAe Dynamics, Aerospatiale Matra Missiles, and the missile activities of Alenia Marconi Systems. The two-stage Aster combines thrust-vector control in the centre of gravity of the missile, which moves it sideways, with aerodynamic steering ('pif-paf'-system). It is therefore a highly agile missile capable of defeating advanced cruise missiles. Aster comes in two versions, Aster-15 and Aster-30, which differ in their first boost stage. Aster-15 is effective between 1.7 and 30 km, Aster 30 between 3 and 100 km. Aster-15 and Aster-30 are combined in the Principal Anti Air Missile System (PAAMS), which has been adopted for the French-Italian Horizon frigates and the British Type 45 destroyer. PAAMS is considered more capable than its US counterparts and is designed to counter saturation attacks. It can fire eight missiles in ten seconds and control 24 missiles in 12 engagements at one time. PAAMS is using the DCN Sylver VLS container, but Lockheed Martin “aspires” to integrate Aster missiles into its Mk 41 VLS container as well.[189] In the block 1 Surface Air Moyenne Portée / Terre (SAMP / T) land-based version, which is using the Arabel X-band radar, the Aster-30 has a capability to intercept SRBM with a range of 500 to 600 km. Block 2 systems, currently under development, can intercept missiles with a range of up to 1.500 km (low MRBM range). Future enhancements could include a dedicated BMD warhead, an IR seeker for higher engagement altitudes and stronger boosters. Although PAAMS does not include these BMD variants of the Aster-30, the radars of the Horizon frigates and Type 45 destroyer are fully capable of supporting such missions. It therefore seems highly likely that the area BMD mission will be incorporated at least into the later batches of these modern European air defence ships.[190]

Landbased Terminal Defence

The Patriot family has some point defence capability against SRBM with the Patriot Advanced Capability (PAC)–2 Guidance Enhanced Missile (GEM), which is a lower-tier system designed for intercepts well within the atmosphere. The PAC-2 GEM is based on the original Patriot air-defence missile and has a fragmentation warhead and passive radar seeker (Track-Via-Missile, TVM). It has a range of approx. 70 km and an intercept altitude of more than 24 km. The PAC-3 missile, in early deployment stages, is lighter and more agile than the PAC-2. It uses hit-to-kill technology backed up by a small fragmentation warhead and has an active radar seeker.[191] Patriot will in the future be succeeded by MEADS, a mobile system with 360° radar coverage. MEADS, jointly developed by the United States, Germany and Italy, is still in the early development stages and will not be available for at least another decade.

The Israeli Arrow-2 Homa system uses the two-stage Arrow-2 interceptor to destroy SRBM and MRBM. It is twice as fast (2.5 km per second) as the PAC-3 and has an intercept envelope of max. 90 km range and ten to 50 km engagement altitude. Because of the lesser technological risk involved and the limitations of the relatively weak Israeli battery radar, Arrow-2 carries a blast fragmentation warhead. THAAD and Arrow share the same IR sensor, adapted from the Navy Area Wide program.[192] The Homa system is interoperable with Patriot batteries (via Link-16) and provides upper-tier defence in the Israeli two-layered NMD system.

THAAD is a program for upper-tier terminal intercept of SRBM and MRBM. It has a single boost stage and a separating Kinetic Kill Vehicle (KKV), which can intercept incoming missiles in the upper atmosphere or lower space as they transition from the midcourse to the terminal phase. The battery radar of THAAD is a X-band radar and the most capable battery radar of all the land-based systems discussed here. The missile has a range of 200 km and can intercept as high as 150 km.[193] Block 2004 of the US BMD program does not include a deployment of THAAD yet since the system is still undergoing tests and evaluation. MDA Director Kadish stated before Congress that block 2010 included a demonstration of a THAAD capability against IRBM and ICBM threats,[194] but MDA's FY 2004 budget request does not yet include funding for a THAAD block 2010.[195]

Boost-Phase Intercept, Space-Based Systems and Advanced Interceptors

There are several BMD programs under development in the United States that are at least the better part of a decade away from deployment, but could have significant consequences for any Australian BMD program if they reach US troops. While the exact capabilities of deployed systems based on these technologies are often unclear, it is necessary to be aware of these programs since some of them will probably make current technology obsolete in the future. They are thus relevant for decisions on a possible procurement of BMD systems in the years ahead. Among these programs are kinetic and direct energy boost-phase intercept systems, advanced kinetic interceptors, and space based interceptors and direct energy weapons. The BMDS radar program, which is also in early development stages but is planned to mature earlier than the programs considered in this section, has already been mentioned above.

The ABL is a direct energy weapon system for the destruction of ballistic missiles in their boostphase. It consists of a large chemical laser inside a modified Boeing 747 airplane that also carries sensor suites and adaptable optics in the nose to focus the laser beam. While sensors, communications and battle management equipment are already installed in the first aircraft, the development of the main laser[196] is still plagued by excess weight. MDA hopes to have it installed into the first aircraft by FY 2005, and plans to equip a second aircraft in block 2008.[197] Although emergency operational capability can be provided with the test aircraft, regular deployment of ABL aircraft is at least a decade away. Since (variable but related) performance parameters like the beam strength, range (also depending upon the altitude) and associated number of 'shots' in the chemical laser are classified, only general assumptions can be made on the capability of the ABL. Solid fuelled missiles have significantly shorter burn-time and are less heat-sensitive than liquid-fuelled missiles, so the ABL will be less capable against them. Since the range of the ABL is limited (estimations are 600 km for the destruction of liquid fuelled and 300 km for solid-fuelled ICBM), it might be necessary for the ABL aircraft to fly over hostile territory in order to suppress all launch areas. A recent detailed study by the American Physical Society concluded that the ABL would probably be able to defend the United States against liquid-propelled ICBM from North Korea, but not against any missiles from Iran or North Korean solid-fuelled missiles (It should be noted that the result is highly dependent upon whether the ABL can fly over hostile territory or not, as assumed in the study).[198]

Kinetic boostphase intercept could in the future be provided by 'Ballistic Missile Defense System (BMDS) interceptors'.[199] MDA is developing a common BMDS interceptor for boost-, ascent-, midcourse- and exo-atmospheric terminal-phase defence in the future.[200] First tests of the ground-based version of the interceptor are to be conducted in block 2008, while evaluations of air-,[201] sea-, and space-based[202] versions are planned as well. Block 2008 of the sea-based midcourse defence segment, which is currently using the SM-3 interceptor, will for example prepare the integration of the BMDS interceptor into the Aegis system.[203] If the United States decided to build a space-based system of BMDS interceptors in the future, Brilliant Pebbles would de-facto be resurrected and provide a global defence capability. Such a system would most likely cover Australia and thus completely change the qualitative and quantitative requirements of an Australian missile defence shield. But even less prominent, sea-based use of the BMDS interceptor in the future would be important for Australia since such a system could very well be a successor to the SM-3. Yet it is unclear whether BMDS interceptors could provide seaborne midcourse defence against ICBM in the future.[204] In a separate but related program, MDA develops miniature kill vehicles, several of which could be deployed with one booster and then target different parts of a target array.[205]

A development program from the times of SDI, the Space Based Laser (SBL) is still being funded to overcome the significant technological hurdles involved. MDA Director Kadish has voiced hopes for a rudimentary space-based laser capability by 2008-2010.[206] A future SBL constellation could probably be overcome by a mass launch of missiles (although probably only

China and Russia will have sufficiently large numbers of ICBM available in the future), and the effectiveness of the SBL depends upon an early weapons-release since it has to destroy missiles during their boostphase. SBL thus does not make terrestrial defences superfluous, especially since today's program — unlike its SDI predecessor — aims at a kill probability of only around 80%.[207]

'Coastal Defence'

The problem of defending population centres and military installations close to shore from seaborne attack with SRBM (and possibly MRBM) is somewhat different from other problems in BMD. It is not primarily of a technical, but more of a financial and organisational nature. (The more demanding intercept of SLBM is usually not included in the threat spectrum since they are unlikely to be used by rogue states.) Terminal defence systems, which could be used against the threat spectrum encountered in covert seaborne attack, are the technologically most advanced BMD systems. PAC-3, SAMP/T, Arrow-2, THAAD, and SM-3 are all capable of intercepting SRBM fired from ships within their engagement area, but it would be highly expensive to constantly operate BMD batteries around vulnerable population centres, especially if their coverage area per battery is small. Since the threat of missile launches from forward based ships has until recently only received relatively little attention, a variety of proposals for countering this threat in the short term have been floated without any solution emerging as a clear favourite.

To make a surveillance and suppression of the vast potential launch area (300 km off the coast for Scud B, 500 km for Scud C, 1,300 km for No Dong and Shahab III, see Figure 4) possible, it is, in general, imperative to increase the coverage of existing BMD systems as far as possible. The networking of existing radar systems in naval vessels, airborne surveillance assets and land-based batteries is therefore an essential step in creating a defence capability against seaborne missiles.[208] Naval, airborne and land-based assets which happen to be in potentially threatened areas (for example navy ships in ports) could then be made part of the local BMD system.

Cheap long-term surveillance could be provided by radar systems mounted on large aerostat balloons. The United States is developing such assets as the centrepiece of the Joint Land-attack Cruise Missile Defense Elevated, Netted Sensor System (JLENS). Connected with generators on the ground by a supply-cable, which includes a fiber-optic data transmission system, they could hold a more than 2,700 kg (6000 pound) heavy sensor package for days or longer in 3000 to 4,500 m (10,000 to 15,000 feet).[209] MDA will test a High Altitude Airship (HAA) prototype in 2006 for missile defence applications, which has also generated interest in Israel. It will be capable of carrying more than 1,800 kg (4000 pound) to a height of nearly 20 km (65,000 feet) and stay there for up to one month, powered by solar energy.[210] If either system reaches production, it could be adapted for a 'coastal' BMD mission. Australia itself is fielding the Jindalee Operational Radar Network (JORN) to provide surveillance of its maritime approaches. JORN can detect ships, aircraft, cruise missiles and ballistic missiles over the horizon, and could therefore potentially be adapted to play a central role in the 'coastal BMD' mission.[211]

Since any missile launch off a population centre would be qualified as hostile, battle management of 'coastal BMD' would be relatively simple and the decision times short. The lack of conventional military threat to the 'coastal BMD' system also makes possible the adoption of relatively simple launch platforms, which could operate close to (potentially) hostile launch ships. Interceptors could, for example, be based on Unmanned Aerial Vehicles (UAV) to provide relatively inexpensive long-term presence. UAV-based interceptors are already studied by the United States and Israel for certain boost-phase intercept missions. As a short term measure, it has been proposed that SM-2 IV missiles could be modified to provide boost-phase intercept capability of missiles launched within a few tens of kilometres from the ship-based interceptor battery.[212]

CHAPTER V

AUSTRALIAN BALLISTIC MISSILE DEFENCE

The development of the threat and the available technology are only two of four factors that have to be taken into account in designing an Australian BMD. First, it is necessary to decide what the strategic goal of the BMD system should be. Second, the quantitative and qualitative aspects of the US and allied BMD systems that Australia will profit from in the future have to be assessed. A short discussion of these points will enable possible BMD programs, especially the SEA 4000 project for a new air warfare destroyer and Australian NMD architectures, to be placed into their strategic context.

A BMD System for what?

Unless a strategic goal is defined for an Australian BMD system, any discussion of technical and military-operational aspects of various BMD architectures is of limited relevance to the political decisionmakers. Three main objectives can be pinpointed: First, protecting the Australian territory and population from ballistic missile attack ('NMD'), second protecting Australian troops deployed abroad, and third a strengthening the US-Australian alliance by participation in a global BMD network. The relative priority of these objectives and their importance in relation to other projects within the defence budget (and the budget as a whole) has to be determined by the government in accordance with its overall goals of Australian defence policy.[213]

Defending Australian Territory and Population

Defending Australia's population, territory, and sovereignty from outside attack is a primary mission of the Australian Government. Just as the RAAF and RAN defend Australia today from threats from maritime vessels and manned and unmanned aircraft, the defence against ballistic missiles is a mission that would fall into the responsibility of the armed forces. As described in the Chapter II, the threat spectrum to Australia in the next decade will most likely consist of a relatively massive Chinese arsenal, the possibility of seaborne attack by rogue states, and then later the threat of direct attack from North Korea and Iran. If Australia took the decision to deploy a sovereign missile defence capability to counter this threat and not to rely on the US deterrence or US missile shield alone (as discussed in

Chapter III), several factors would have to be considered in the decision on what kind of architecture to build.

Financial considerations necessitate a careful choosing of the requirements defined for the missile defence system. This relates to the emphasis placed on defence against seaborne attack vs. direct attack, and the quantitative capability of the system to defeat incoming missiles. A defence against direct attack should be designed as a second layer to defeat missiles slipping through a first US-allied screen, and would thus be dependent upon the capability of these systems. Compared with a system designed to defeat a full-scale attack, the requirements would be less for a system that is only designed to defeat a limited number of missiles, possibly smaller than a hostile state's arsenal. Such a system could 'deflect' the threat of attack back to undefended allies. It could also serve to defeat possible 'warning shots' and thus confront an attacker with the choice between full-scale attack, including certain nuclear retaliation, or inaction. The distinction between both types of systems would be most apparent if it was primarily designed to counter a threat from China.

Should Australia procure a BMD system to protect the Australian homeland, it would be dependent upon US early warning and targeting data (from DSP / SBIRS, STSS, and radars on the surface of the earth) which would make the US alliance even more important for Australia's defence. But, at the same time, Iranian or North Korean missiles targeted at Australian population centres would make it difficult for Australia to participate in operations against these regimes alongside the United States, unless it was protected by a NMD system. Australian NMD and the US alliance are thus mutually reinforcing. As discussed in Chapter III, such a system would constitute a partial break with the doctrine of self-reliance. Australia will be in a similar situation as most other US allies that participate in a BMD system under the leadership of the United States, and should therefore observe how these states (e.g. Japan, Israel, NATO) insure unimpeded access to US data and sovereign fire control.

Defending Deployed Australian Troops

The Defence 2000 White Paper defines circles of Australian strategic interests ranging from the defence of Australia and its approaches over stability in Australia's neighbourhood and in East Asia to support of global world order.[214] In defence of these interests — and in support of the US alliance — Australian troops are regularly deployed into crisis regions and high intensity combat operations abroad. As mentioned above, these troops are confronted with a growing threat from ballistic missiles and the

Australian Government explicitly "supports the development of effective missile defences to protect deployed military units."[215] Providing missile defence for forward deployed troops is thus a logical possible mission for Australian BMD assets. Although an integration into US sensor networks would enhance the capability of such tactical defences, they are usually stand-alone systems that can be operated without direct American support.

Australia's commitment of forces to foreign conflicts is proportional to the Australian interests involved and to Australia's military capability; while it has taken the lead in operations in its neighbourhood (e.g. East Timor, Solomon Islands), it only contributes smaller force elements to US led operations elsewhere in the world (e.g. Afghanistan, Iraq). Australia is thus in the relatively lucky situation that all operations which it conducts without major outside support take place in an environment free from the ballistic missile threat to deployed forces.[216] The procurement of 'tactical' BMD systems like Patriot, Arrow or THAAD today thus only makes limited sense for Australia. The only Australian troops which could in theory benefit from such systems are forward deployed air force units which need base protection, but Australia does not have the strategic transport capability to rapidly deploy these systems anyway, nor could their procurement be justified in terms of 'defence of Australia'. The procurement of 'tactical' BMD capabilities, dedicated for use in faraway theatres, would thus touch at the core of the discussion on the priority given to operations for the defence of Australia relative to capabilities for expeditionary warfare.[217]

The same consideration in principle applies to naval BMD assets. Royal Australian Navy (RAN) vessels defending Australia's waters or the lead forces under their air defence screen are currently under no threat from ballistic missiles, and procurement of such a capability would be primarily needed for the purposes of expeditionary warfare. Yet, naval BMD systems are different in two regards from their land-based counterparts. First, naval forces — as the first line of defence — will more likely than the Army be confronted with missiles newly introduced into Australia's neighbourhood. They are also more likely to be involved in conflicts in East Asia that affect Australia's security more directly than operations in the Middle East or North Asia, and these conflicts could involve ballistic missiles (e.g. China, Vietnam). Second, a naval BMD capability would be integrated into naval air defence vessels (notably the new SEA 4000 Air Warfare destroyer) and thus constitute an enhancement of existing and highly flexible assets rather than the procurement of a specialized and new capability like a land-based battery (Although there will of course be distinct costs associated with a naval BMD capability as well). While naval BMD assets are thus preferable to land-based protection of deployed troops, the intercept geometry required for certain intercepts, especially of IRBM, can preclude the launch ship from executing other missions (like convoy protection). This point will be further expanded on below.

Strengthening the US-Australian Alliance

Australian participation in a US-allied BMD system would strengthen the US-Australian alliance in several complementary ways. Any support by Australia of the US BMD system creates political capital similar to the 'Joint Facilities', which binds the United States to a maintenance of the alliance on which Australia's security ultimately rests.[218] With the establishment of the SBIRS RGS at Pine Gap, the mission of the 'Joint Facilities' has already been expanded from SIGINT to BMD operations.[219] While the exact activity in the 'Joint Facilities' has traditionally been clouded in secrecy, Australian open political support to the US BMD program would give credibility to a program which has not yet gained much open commitment in Asia (outside Japan) and Europe, but is of high importance to the US government. Such political support would, in the end, have to be based on the willingness to physically contribute to the overall system in one form or another, beyond the small RGS at Pine Gap. Assistant Secretary for International Security Policy J.D. Crouch, responsible for the policy side of missile defence in the Pentagon, said before Congress on the international contribution to the US BMD program that

> [c]ountries will be encouraged to participate at whatever level they deem appropriate up to and including co-development and production of various systems. They might also provide in-kind contributions such as territory and facilities upon which to build components of our missile defense system.[220]

Australia does the latter to a small extent today, but there is a wide variety of other BMD elements it could contribute. As was shown in greater detail above, a BMD system consists of a multitude of netted sensors and interceptors, and communication links that connect them with the battle management and command elements. The RGS is a small part of the communication link from sensors to BMD commanders in Colorado, and Australia could provide other small elements of the overall system, especially in the area of sensors and communications.

One of the issues requiring consideration in this regard is whether and how far Australia should sacrifice its sovereignty rights for such cooperation. The RGS will soon be part of a US combat system which will, sooner or later, be involved in combat operations against a third country, possibly in a conflict to which Australia is not directly a party. Since Australia taps into the SBIRS data flow at Pine Gap (and has personnel stationed in Colorado who analyse data relevant to Australia), it could be argued that the system is at least partly 'Australian owned'. Yet, as the North West Cape communications station during the Cold War showed, such a fiction is difficult to maintain in many cases. It might become much more of a problem today since the likelihood of BMD being used is arguably much greater than a use of the North West Cape Station ever was. Before allowing the United States to station parts of its BMD system on Australian soil, whether interceptors, sensors or communications equipment, Australia should therefore try to operate the installation with Australian, or at least mixed, personnel.

One area where Australian owned and operated assets can be relatively easily integrated into the US BMD system is that of sensors. As discussed above, the availability of sensor data on the flight of a hostile missile is essential to establish a track-file and make possible a calculation of the intercept trajectories. If Australian airborne and naval radar systems would be modified to generate tracking data on ballistic missiles, and provided with communications systems that link them into the US BMD sensor system, these assets would significantly increase their value in the eyes of US military commanders and the US government (the same applies to an integration in the US Navy CEC system, of course). An integration of Australian owned sensors would reduce the problems of sovereignty mentioned above, as they could be withdrawn from the network at any stage. This integration would be of direct benefit to Australia by providing Australian forces better situational awareness via access to US and allied sensor data. It would also be promoting the interoperability with US forces on a technical level, and through the participation in joint exercises involving the system.

The US Missile Defence Program and the Defence of Australia

Chapter II briefly touched upon the political-strategic consequences of a US 'extended defence' for Australia to complement the extended nuclear deterrent, and Chapter III described US BMD systems as potential procurement options for Australia. As noted above, the future US BMD system is also important for the Australian efforts in this field in several ways, since an Australian system would — for technological and political reasons — most likely be integrated into a wider US-allied system primarily consisting of US assets. Different variants of Australian BMD programs, to be discussed in the following sections, thus must be analysed in context with the US assets that will complement them.

Table 2

Block 2004 Initial Defensive Capability

Threat Class	Weapons	Sensors	C2BMC
Long-Range Ballistic Missiles Intermediate Range Ballistic Missiles	Up to 20 GBI	DSP 1 Sea-based X-band Radar* 1 Upgraded Cobra Dane Radar 2 Upgraded Early Warning Radars ABL Sensor* 15 Aegis BMD Surveillance and Tracking Ships	BMDS C2BMC
Medium-Range Ballistic Missiles Short-Range Ballistic Missiles	3 Aegis BMD Cruisers with up to 20 SM-3 Missiles 6 Bn / 340 PAC-2 GEM Missiles 4 Bn / 192 PAC-3 Missiles	15 Aegis BMD Surveillance and Tracking Ships 2 THAAD Radars* 11 Patriot AN / MPQ-53 Radars ABL Sensor* 43 Patriot AN / MPQ-65 Radars	2 THAAD BMC3* Patriot BMC2 (ICC / ECS)** ABL BMC4I*

* Augmentation of Initial Defensive Capability with testbed assets
** Information Coordination Central / Element Capability Specifications

Source: Missile Defense Agency, "Fiscal Year (FY) 2004 / FY 2005 Biennial Budget Estimates Submission," *Press Release*, no date given, pp.6-7.

Table 2 gives an overview on the capability that will be provided by the MDA block 2004 program and fully available at the end of FY 2005. While the PAC-2 and PAC-3 batteries are fielded in a normal procurement process, the other assets are deployed as an 'initial defensive capability' and integrated into the MDA test bed. They are developmental systems that, in many cases, have not yet been fully tested, and are procured as a R&D program. The 'initial defensive capability' will provide limited operational capability and can be augmented by other assets, such as the sea-based X-band radar or THAAD battery radar, that are otherwise used solely for the development program. The sea-based modified radars on selected Aegis destroyers and the SM-3 interceptors on Aegis cruisers will be operated by US Navy personnel, while the battle management for the GBI is still in the hands of the civilian development team. A transition of this function to STRATCOM and NORTHCOM is planned for the future. (STRATCOM will be responsible for the integration of the US BMD system, while the defence of the continental United States is the responsibility of NORTHCOM. Exact arrangements for the operation of the GBI are still being worked out.)[221]

The block 2004 BMD system will give the United States some new capability, but is very limited both in quantitative and qualitative terms. The GBI, which will be based at Fort Greenly in Alaska and Vandenberg AFB in California, are not yet supported by a fixed X-band radar at Shemya in the Aleutians, as was planned for the first deployment under the Clinton administration. Assistant Secretary Crouch testified before Congress that "[t]he modest capabilities that are planned for that system do not require the sea- based X-band radar,"[222] which implies that the GBI system will not usually have a high target discrimination capability. Undersecretary of Defense Aldridge testified that, with the use of the sea-based X-band radar and the firing of several interceptors, a 90% success probability of destroying a North Korean missile would be achievable.[223]

Overall, the block 2004 'initial defensive capability' deployed by the United States will only be of limited value for the defence of Australian population centres as only Patriot batteries are deployed in larger numbers. Both PAC-2 and PAC-3 have been used in the recent war in Iraq and were rapidly forward deployed with the 3rd US Infantry Division on its way to Baghdad.[224] Every target the batteries could engage was hit during the war, although two friendly fire incidents and the Patriots' performance against cruise missiles still have to be examined in more detail. Patriots were also not faced with a more demanding Scud-class threat during the war.[225] Patriot batteries are the least scarce missile defence asset, and Australian troops participating in coalition operations with US forces will most likely be provided with missile defence based on these systems. The lack of a seabased endo-atmospheric defence against SRBM will continue, as SM-3 have only a limited capability against them. Yet, Australian troops in coalition operations with the United States will profit from their defence capability against MRBM and IRBM. In the short term, Patriot, SM-3 and later THAAD could also protect Australian troops and bases in the Northern Territory should relations with Indonesia unexpectedly sour and that country procure ballistic missiles. During the Gulf War in 1991, the United States trained Israeli crews on the Patriot batteries deployed there and handed them over after some months. A similar arrangement could probably be made for Australia if a comparable situation arose.

As the only system capable of defending against ICBM, the GBI stationed in Alaska and California will be of no use to Australia since their launch bases are too far from the missiles' trajectory from North Korea to Australia. The seabased midcourse part of the 'initial defensive capability' of block 2004 is also relatively small. Three cruisers that can fire SM-3, 15 destroyers that provide tracking data to GBI or SM-3, and a total of 20 interceptors will be available. The Pentagon defines their mission as

> to help protect U.S. forces and allies and provide some limited protection of the U.S. homeland against shorter-range missiles launched from ships off our coasts."[226]

As the defence of the US East coast against ship-launched missiles requires at least one missile-carrying ship, and the defence of forces and allies in the theatre in Northeast Asia or the Gulf a second one, it does not seem possible for the United States to provide any sea-based capability even in emergency situations for the 'coastal defence' of Australia. (In addition, one of the three modified ships would have to be in the vicinity of Australia to provide protection quickly.) Patriot batteries are limited in the area covered, require significant airlift capability to deploy, and are not available in such abundance that they would likely be available for 'coastal defence'. Even if concrete intelligence information about a sea-borne attack on Australia was available, the logistical problems of deploying them would be immense.

All in all, the block 2004 US BMD shield will provide Australian expeditionary forces with protection, and constitutes a 'fall-back' position for a crisis with Indonesia, should that country acquire ballistic missiles. The US assets will have technical capability to provide 'coastal defence' in crisis situations with rogue states, but not when considering the operational problems and scarcity of BMD assets, and no capability whatsoever to defend Australia against direct attack from ICBM. It is also unlikely that this situation will change fundamentally with the following blocks 2006, 2008 or 2010, whose capability can be — roughly — extrapolated from the R&D programs on which they will be based. The only major weapons system likely to be added to the block 2004 arsenal in significant numbers are THAAD interceptor batteries, which could again in theory be used to provide Australia with 'coastal defence' but are highly unlikely to be used in that way. More and improved Patriot batteries will, together with THAAD, provide an increasingly capable shield for deployed forces against SRBM and MRBM. SM-3 and Aegis radars will be gradually improved and probably fielded in higher but still limited numbers. Because of the geographic situation, Australia will not profit from more and improved GBI that are likely to be fielded even if such missiles are placed in Hawaii. The first two ABL aircraft, possibly available in 2006 and 2008, are the first systems which have a technical capability to defend Australia from the North Korean ICBM threat. Yet they will be developmental versions, requiring further testing, and only be available in emergency situations. With a mere two aircraft, it is doubtful that it would be possible even to maintain a constant presence in a position to intercept missiles bound for the United States. The intercept geometry for missiles bound for Australia would probably require a different positioning, making a defence of Australia with ABL unlikely.

Since the block 2004 does not include a X-band radar dedicated to operational use and the STSS is still years from deployment (the two block 2006 satellites will only intermittently overfly any given area), the capability of both SM-3 and GBI to defeat anything but rudimentary decoys is questionable. In addition, the tracking of missiles after the end of the boostphase, during which they are visible to the DSP satellites, rests upon the upgraded early warning radars, modified Aegis ships and other available sensors. It is likely that future blocks will, as a priority, include the networking of existing and future sensor systems[227] to prevent holes in the tracking of missile flightpaths and to generate higher-quality data. Yet, in the absence of systems capable of intercepting ICBM on a trajectory to 'down-under', Australia will profit only marginally from these improvements.

More advanced versions of the SM-3 might have a better chance of 'beinglucky' when trying to intercept an ICBM, but the likelihood remains marginal. Only with systems like the BMDS Interceptor, SBL or fleets of ABL could the United States acquire a capability to defend Australia with anything near the probability of success needed to rely on the BMD system. As noted above, there are some experts who doubt the effectiveness of the boost-phase intercept in principle, but even if they are wrong, the defence provided to Australia by such systems will most likely be a single-layered system.[228] From the present until about 2010, there is a possibility of a North Korean attack with a developmental Taepo Dong I or II missile against Australia, and the US capability of one or two ABL will probably be nowhere near enough to defend Australia against even such a limited threat. After 2010, Australia has to expect a threat from operationally deployed ICBM from Iran and North Korea, and again the US capability to defend Australia with ABL, probably some BMDS Interceptors and possible SBL seems very limited. If the Australian Government decides that Australia needs a protection against seaborne or direct attack, it will be necessary to examine Australian solutions for these threats.

Australian BMD Elements

Australia already has or plans to procure several sensor systems that could have a BMD role. BMD interceptors and the sensors they require could be placed on new RAN vessels or be based in Australia itself. Acquiring any of these capabilities would contribute to some extent to one or more of the three missions for Australian BMD mentioned above. In the following sections, sensors, the SEA 4000 and the architecture for an Australian NMD will be discussed in further detail. In addition, landbased terminal defence systems like THAAD, Patriot and SAMP/T could also play a role in defending Australian expeditionary troops or bases in the North of the country.

JORN and other Sensors

As part of its strategic surveillance capability, Australia is acquiring a variety of advanced sensor systems over the coming years. At the end of the decade, it will have three major stand-alone sensor systems in service: Airborne Early Warning & Control (AEW&C) aircraft, the Jindalee Over The Horizon Radar (OTHR) and the Global Hawk UAV. These and other elements of the strategic surveillance system could, with relative ease, be made part of a BMD system.

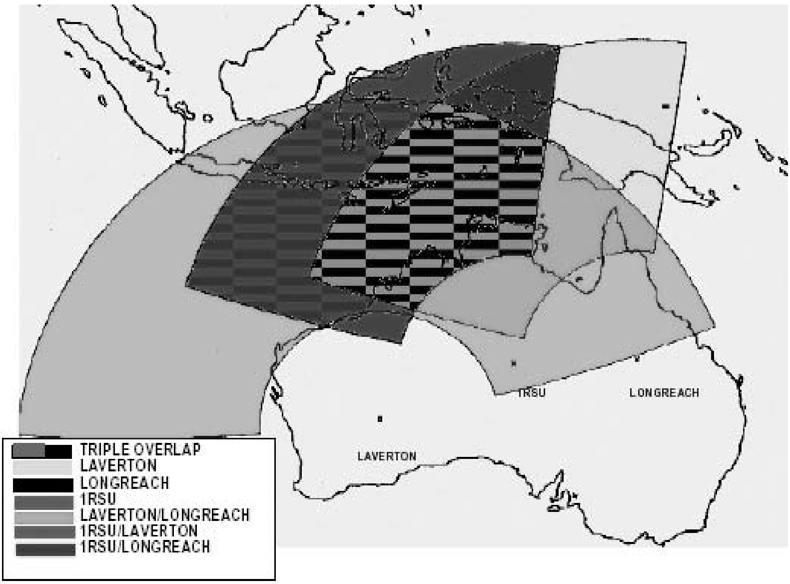
The first two Wedgetail AEW&C aircraft will be delivered in 2007, two more are on order and Australia has an option for another three. The system is based on the Boeing 737 and will support the F-18 fighter, F-111 strike aircraft and the air defence of surface ships. The Northrop-Grumman Multi-role Electronically Scanned Array (MESA) radar will be able to detect fighter aircraft at a range of at least 300 km and provide 360° coverage.[229] Similar to new AWACS systems under development in the United States,[230] the Australian Wedgetail aircraft could be made capable of supplying tracking data of ballistic missiles into an Australian or US BMD system. While the data would probably not permit discrimination of RV in target clusters, AWACS systems would be useful for BMD since they extend the footprint of terminal defence interceptors and quickly provide track-files for missiles in their boost- and post-boost-phase.[231]

As mentioned in the preceding section, large aerostats are under development in the United States as platforms for sensors capable of detecting cruise missiles (JLENS) and ballistic missiles (HAA). The HAA, with a projected endurance of possibly up to one year, would be of particular interest for Australian strategic surveillance needs in general, and could complement the Global Hawk UAV that Australia will receive in 2007 for land- and maritime surveillance.[232] Both aerostats and Global Hawk are highly versatile platforms and can be equipped with a variety of exchangeable sensor payloads that are currently in development in the United States and Europe.[233] Once sensor packages with missile detection capability become available for aerostats or Global Hawk, it will be possible to give such platforms a second role in BMD in addition to their primary mission of maritime surveillance. Deployed in Australia, their data could benefit a 'coastal defence' system or the air defence assets of RAN vessels covering the northern approaches to the continent. As mobile platforms, aerostats and especially the Global Hawk could also be deployed overseas in support of coalition operations.

The JORN system became operational in April 2003 and provides a surveillance capability extending 2000 km off the Australian coast from West of Perth to North of Cairns, covering large parts of the Indian Ocean, Indonesia and PNG (see Figure 6). Its unclassified range is 3000 km from the transmitter/receiver stations at Longreach (Queensland), Alice Springs (Northern Territory) and Laverton (Western Australia), although the RAAF admits that the system can operate beyond this.

Figure 6

JORN Coverage



Source: Jindalee Project Office, reproduced in Ray McNally, 'Jindalee Operational Radar Network Project,' *Audit Report*, no.28 (Canberra: Australian National Audit Office, 1996), p.4.

JORN was originally designed to detect movement of aircraft and has been reconfigured to also provide surveillance of maritime traffic.[234] It operates in the High Frequency (HF) band, whose waves are reflected between the surface of the earth and the electrically charged ionosphere, and thus is able to 'look' beyond the horizon. JORN is a doppler radar that can determine the speed of moving targets. Yet wavelengths between 10 and 100 m do not normally allow high resolution, and the received signals need to be separated from a high amount of background clutter.[235] A National Audit Office report stated in the mid-1990s that JORN would "not give the accurate resolution necessary to vector fighter aircraft precisely onto air and naval targets."[236] Yet, during 1999, data from the stations at Alice Springs and Longreach reportedly made it possible to observe RAAF aircraft turning on their landing approach to Dili Airport.[237] According to some reports, the system is accurate enough to detect low-flying cruise missiles and ballistic missiles.[238] In 1997, BMDO and DSTO conducted a joint scientific experiment called DUNDEE (acronym for Down Under Early Warning Experiment) that evaluated the capability of Jindalee to detect ballistic missiles in their boost-phase. Four two-stage test missiles (of 13.95 m length) were launched in Northwest Australia,[239] and simulated the radar cross section of SRBM.[240] US officials at the time maintained that JORN technology could, in the long term, become a component of the American BMD system.[241] JORN thus has a value for the Australian BMD system in two respects: First, it has the capability to provide early warning and possibly tracking data for an Australian NMD system against seaborne attack, SRBM launched in the Indonesian archipelago against Australian forces, and possibly even direct attack by MRBM and ICBM. Secondly, Australia could use its long experience in OTHR technology to contribute in a significant manner to the BMD program in the United States.[242]

SEA 4000 and Ballistic Missile Defence

With the retirement of HMAS Brisbane, the last Australian guided missile destroyer, the RAN does not have a destroyer-class ship any more that would be capable of providing area air defence for deployed units and in the defence of the maritime approaches to the continent. As the ANZAC frigates are too small to provide the capability and endurance necessary for such a mission, the procurement of a new Air Warfare Destroyer (AWD) is necessary to regain lost capability.[243] The Defence Capability Plan (DCP) 2001 contains the SEA 4000 project to procure at least three new AWD, with a projected year of decision in 2005/06 and a first in-service delivery in 2013.[244] The AWD has been "depicted as a Lego block construction involving separate hull, propulsion and combat system designs," but whether its development will be based on the integration of various systems into a completely new design (similar to the Collins submarine) or the mere modification of existing vessels (similar to the ANZAC frigate) has not been decided.[245] Several ships based on existing designs have been proposed for the new AWD capability: The German F-124 and very similar Dutch LCF, the Spanish F-100 and Gibbs & Cox's 'International Frigate' based on the USN Arleigh Burke destroyer. The French-Italian Horizon and British Type 45 Daring destroyer are also build for similar missions. None of these vessels fully meets the RAN requirements, especially with regards to range and the availability of a second gun, but the 'International Frigate,' the F-100 and the F-124 have been mentioned as favourites for SEA 4000 among existing ships.[246] Besides operational requirements, factors such as the technological risk, the required lead time, logistics and training considerations, suitability for Australian build and purchase cost will be major factors in the final decision.[247] According to a recent media report, the Department of Defence is considering delaying the SEA 4000 project because of budgetary pressures. The FFG frigates would be phased out and replaced by three leased USN Aegis-class destroyers in the meantime.[248] In the current shipbuilding program, the US Navy will receive three DDG-51 in FY 04 and another three in FY 05. After that, the new DD(X) destroyer will begin joining the fleet.[249] Australian could thus take delivery of new DDG-51 from FY 06 when the production line for this type is no longer occupied by domestic contracts. Although it is unlikely that the US Navy will have spare Aegis destroyers to hand over, the integration of DD(X) and the Littoral Combat Ship into its force structure from FY 06 on could lead to reductions in the destroyer fleet. Yet it is also possible that the report does not actually refer to ships equipped with the Aegis system, but to the four Kidd class destroyers that had been ordered by the Shah and were not completed before the Iranian revolution. They have half of their service life left and the United States had offered them to Greece and Australia in the late 1990s and to Taiwan in 2001. Yet the negotiations on their transfer have been stalled recently because of inaction on the part of the Taiwanese government.[250]

The advantages of sea-based BMD assets are widely known and have been briefly discussed above, and the RAN requires the SEA 4000 to be upgradable to a BMD mission.[251] The ship has been repeatedly mentioned as a promising opportunity to acquire BMD capability for Australia,[252] including in statements by Defence Minister Senator Robert Hill.[253] While it still remains unclear what design will be procured as a new AWD and when the first ship will get into service, some general remarks on the BMD mission for the new vessels as sensor and interceptor platforms can nevertheless be made.

A minimal BMD role for the AWD lies in its capability to detect ballistic missiles and to provide radar tracking data to Australian and / or US and allied interceptors. If limited to such a role, the SEA 4000 would be similar to the USN Arleigh Burke Aegis-destroyers which are fitted as sensor ships for the SM-3 (deployed on USN cruisers) and for the GBI. In June 2003, the RAN awarded a contract for the development of the Auspar active phased-array radar for SEA 4000, a high-powered version of CEA Technologies' CEA-FAR phased array sensor. Auspar is designed for both air and theatre missile defence requirements.[254] Provided with the necessary software, Auspar would be capable of tracking ICBM even if its frequency and bandwidth were probably not able to make a discrimination of the RV within target clusters in space possible. Similar new naval radars — as discussed in Chapter IV — have been developed for most of the European AWD vessels that have been mentioned as alternatives to an indigenous Australian design for SEA 4000. F-100 and the 'International Frigate' use the Spy-1D radar, which is technologically less advanced than the new radars and will most likely be out of date by SEA 4000's projected in-service date of 2013.[255] Should Australia receive DDG-51 from the United States within the coming years, the Spy-1 radars could, with relative ease, be brought up to the same standard as the US Navy's version and thus take part in the BMD system. The Kidd-class destroyers are equipped with the outdated AN / SPS-48C radar, which uses a combination of mechanical scanning and electronic beam control. While the radar might be sufficient as an interim solution for air defence applications, an upgrade to a missile defence role would, if at all, only be possible with significant modifications. Unless equipped with a modern radar system, Kidd-class destroyers are thus not suitable as a BMD platform.[256]

A major contribution of SEA 4000 to an Australian BMD system would also lie in its capability as an interceptor-platform. Terminal defence against ballistic missiles is a logical extension and complementation of its primary role as a vessel providing area air defence for naval and amphibious forces. A 'Timor plus Scud' scenario of ADF operations in the Australian neighbourhood has been repeatedly mentioned as one of the situations where the RAN would have to be able to provide area defence against ballistic missiles.[257] As noted in Chapter IV, two or three interceptors are available to be fitted on future AWD: The European Aster-30, the US SM-3, and — depending upon the in-service date of SEA 4000 and the progress of its development program — the BMDS Interceptor. The capability of the latter is not yet known and the missile will therefore not be further considered here, but it should be kept in mind as the likely state-of-the-art system of the next decade. Similarly, navalized versions of PAC-3 missile could be suitable for the RAN, should they be developed in the coming years. Unfortunately, both of the interceptors available today would pose technological and operational difficulties for the RAN to an extent that makes their value questionable.

As mentioned in Chapter IV, the Aster-30 is a missile designed for endo-atmospheric terminal defence against SRBM, dual-capable against aircraft and cruise missiles, and thus highly suitable for the area air defence mission. Unfortunately, as a European missile family, it is in service neither with the US Navy, nor the RAN. Since it is fired from the French Sylver VLS and used in conjunction with the Aster-15 in the air-defence role, Australia would probably have to use a fully European missile arsenal for its AWD if it chose the Aster-30, including European land attack cruise missiles that are fitted to the Sylver VLS. European navies using the Aster can rely on their own and other NATO logistics assets, but Australia as the only user of the Aster-30 in the Pacific would probably find replenishment overly difficult as these missiles are not available in the US Navy supply system. The use of SM-2 and the Tomahawk land-attack cruise missile family would be possible if the Aster-30 was integrated into the Lockheed-Martin Mk 41 VLS (or the American missiles into the Sylver), but Australia would have to foot the bill for the integration of Aster-30 and SM-2 into one air defence battle management system.

As an interceptor designed for exo-atmospheric use, the SM-3 has significant shortfalls if used for BMD area defence. It now has a limited capability against SRBM, but this is contingent on an engagement in lower space and thus excludes both Scud-class missiles on a depressed trajectory as well as shorter range missiles like the widely proliferated Frog and SS-21. SM-3 therefore cannot replace land-based Patriot (or SAMP/T) protecting harbours or amphibious forces. SM-3 is capable of intercepting MRBM and IRBM in their ascent phase, but this is also contingent on a suitable launch geometry. A BMD area of negation can be geographically distant both from other naval assets requiring area air protection and from launch areas for strike missions with land-attack cruise missiles. A vessel on a BMD patrol might therefore not only be precluded from executing other functions, its sustainment can also be a significant logistical problem if it has to operate far from oilers capable of replenishment at sea.[258] The longer endurance of USN Cruisers compared to the smaller Arleigh-Burke-class destroyers is a main reason why, under current plans, only the former will carry SM-3 interceptors. The SEA 4000 project was initiated after Australian frigates were found unsuitable for the area air defence role of the AWD, and it is therefore rather unlikely that an introduction of a smaller ship class with improved air defence capability would AWD them for BMD duties, as a recent Sea Power Centre Working Paper suggests.[259] Should the future AWD be equipped with SM-3, it is therefore likely that the ship would carry the missile on 'normal' missions like area air defence and land attack, and only be able to 'take a shot' at ballistic missiles if it happens to be in a fortuitous position. But this capability would cause significant opportunity costs in monetary (the SM-3 reportedly costs $US 25m per missile)[260] and operational terms since SM-3 compete with land-attack missiles (e.g. Tomahawk) for limited VLS space. Since an exchange of SM-3 and Tomahawk is not possible at sea, the AWD are likely to either not be equipped with a BMD capability when ordered to a crisis region which presents a ballistic missile threat, or be faced with an enemy who does not have such capability while superfluous SM-3 occupy VLS space that could otherwise hold land attack missiles.[261] In addition, the intercept of MRBM and IRBM would probably require tracking data from other sensors, for example Aegis ships, and could therefore only be reliably achieved in a coalition operation with the US Navy.

At this time, there is no suitable BMD interceptor for SEA 4000. The Aster-30 could be operated without US sensor data and would be of interest to the US Navy, which lacks similar capability, but to operate it would prove highly problematic from a logistical point of view. The SM-3, though a highly capable piece of equipment, does not correspond to any Australian strategic requirement: Being 'too big' for area defence and 'too small' to protect Australia from ICBM, it is hard to see what operational value the RAN would derive from this missile.

Australian National Missile Defence

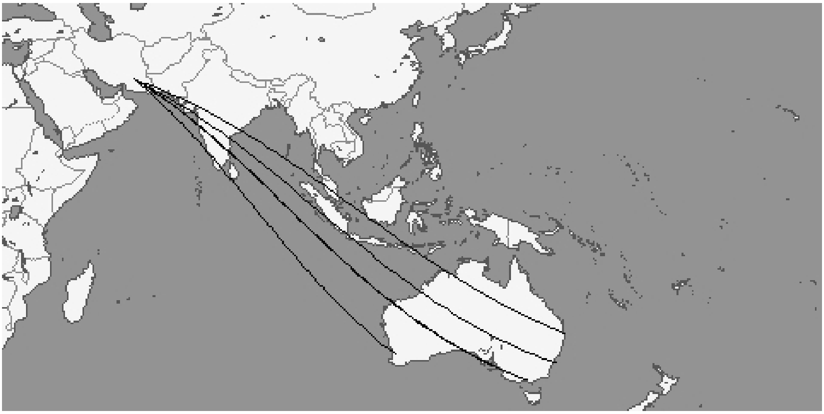
Defending Australian population centres from ballistic missile attack requires systems to intercept both ICBM and seaborne missiles. As noted above, the United States will probably, by the middle of the next decade, have a limited capability for boost-phase intercept with the ABL and possibly the BMDS Interceptor. Seaborne missiles could be intercepted by a variety of US systems, but neither of these will be available in such quantities that batteries could be deployed to Australia. This last section therefore examines architecture options for both pillars of an Australian National Missile Defence.

Ground Based Midcourse Defence

The missile trajectories of ICBM from Iran and North Korea to the five major Australian cities are shown in Figure 7. All missiles that evade the — rather light — first US layer of boost-phase intercept systems have to be

Figure 7

Missile Trajectories from Iran and North Korea



Trajectories to Perth, Adelaide, Melbourne, Sydney and Brisbane from North Korea (Pyongyang) and Iran (Iranshahar, the centre of the Southeastern Iranian province of Baluchestan). Not adjusted for the rotation of the earth.

Source: Modified map produced with the 'Great Circle Mapper' available at http://gc.kls2.com/

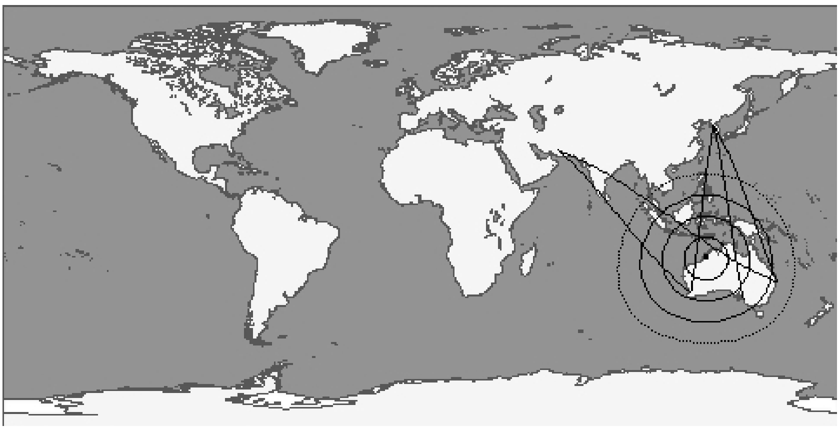
intercepted by an Australian GBI. Since US and eventually other allies' boost-phase intercept systems will primarily be located in a way to intercept missiles on trajectories towards those countries, Australia has to anticipate both the technological and operational limitations of a boostphase defence layer in the theatre.[262] The GBI system architecture must be capable of establishing a track-file on the target cluster flying toward Australia, discriminating the RV from decoys and debris, and intercepting the warhead. Given ICBM trajectories, the technological capabilities of sensors and interceptors, and geography, some observations regarding the setup of the GBI architecture can be made.

The establishment of a track-file will not be possible without substantial US forces in the region from where the ICBM is launched. The US early warning radars in Alaska are too far from North Korea to observe any missiles flying south, and no such installation is anywhere near Iran. As described in Chapter IV, DSP/SBIRS satellites cannot establish track-files with sufficient accuracy themselves but direct other available sensor systems to the missile. Data from modified Spy-1D, AWACS and THAAD battery-, and BMDS radars, ABL sensors and available SSTS satellites could determine the exact direction, height and speed of the missile, and allow calculation of its intended target and flightpath. The ADF could contribute to the sensor network, but can provide neither the coverage, nor global data transmission capability necessary for this task.

Concurrently with the establishment of the track-file, information about the composition of the target cluster that will form in space, once launch debris is separated and possible decoys are activated, has to be obtained to discriminate the RV.[263] The necessary radar data can only be generated with high-resolution X-band systems as used for THAAD, the US GBI program radar and the future BMDS radar, and probably — to a limited extent — by a combination of other radar data. Once deployed in space in sufficient numbers, SSTS satellites will make it feasible to gather IR data on the target package throughout its flight. An Australian GBI system will probably be confronted with a gap in radar data:[264] THAAD radars will only be available within the theatre (since THAAD batteries are designed for the intercept of MRBM and IRBM), and BMDS radar and US seabased X-band radars will most likely be positioned to observe the areas that missiles have to fly through on their way to the United States or Europe. They will therefore most likely be able to observe only the first part of the ICBM trajectory towards Australia.

The positioning of an Australian X-band radar should fulfil three requirements: First, it has to be able to provide coverage both toward North Korea and China, and toward the Middle East. Second, its observation time of ICBM midcourse flights has to be maximised.[265] Third, it has to be positioned in a way that the optimal resolution along the boresights of its faces can be used and missiles do not, if possible, pass through blind spots or areas of limited resolution in critical phases. One way of achieving this would be a sea-based radar on either a ship or oil-rig-like structure. The former would be advantageous because of its high speed which makes rapid deployment possible, but would probably require more stabilisation than the platform chosen by the United States. A land-based radar is always available and cheaper, but could not be optimised for incoming missiles from both North and West at the same time while two such radars would add significantly to the price of the overall system.

Figure 8 shows the coverage of an X-band radar in the North of Western Australia. Land-based radars in locations optimised for the observation of trajectories either from Iran or North Korea would only have a limited advantage over this position. The lower edge of the radar beam, assuming a 3^{o} inclination, is 1,360 km high at a distance of 4000 km. Since the apogee of ICBM from Iran or North Korea would be around 1,400 km, the radar will only be able to observe the missiles after they are closer than the outer ring shown on the map. Earlier observation is thus clearly one advantage of a sea-based system. Two faces with boresights oriented towards the northeast and northwest should provide good coverage and high resolution in the intercept areas for most trajectories.



Height of Radar Dead Space over Earth (Lower Beam Angle of 3°)				
Range (km)	1000	2000	3000	4000
Lowest beam height (km)	130	410	830	1,360

Trajectories from Iran (Iranshahar, the centre of the Southeastern Iranian province of Baluchestan) to Perth and Brisbane, and from North Korea (Pyongyang) to Perth, Adelaide and Brisbane. Radar located at 17.5 S 122.5 E in Northern Western Australia, each consecutive ring denotes a range of an additional 1000 km. Not adjusted for the rotation of the earth.

Source: Modified map produced with the 'Great Circle Mapper' available at http://gc.kls2.com/ Beam height data from David Tanks, *Assessing the Cruise Missile Puzzle: How great a defense challenge?* (Washington D.C.: Institute for Foreign Policy Analysis, 2000), p.20.

There are a few cost estimates for such a radar in the open literature. The Congressional Budget Office estimated in 2002 that a new, stand-alone X-band radar would cost about $US 500m and the radar platform about $US 200m. It also priced a ship-based X-Band radar (without development cost) between $US 1 billion to $US 2 billion, depending upon the capability of the radar and the self-defence capability of the vessel.[266] These estimates seem to be rather high compared to the FY 2004 budget of MDA, which includes a total of $US 808.7m for the development and construction of a relocatable X-band radar on a semi-submersible platform, including the IFICS terminal to transmit targeting data to interceptors.[267]

Both the track-file and the target discrimination data ultimately have to enable an interceptor to destroy the RV. To determine the optimal location of interceptor bases in one or several points in Australia is beyond the scope of this paper, but several general remarks can be made. First, the kill probability is higher if perpendicular intercept courses are avoided, since these reduce the kill vehicle divert envelope.[268] Second, the launch site should not be too far from the ICBM trajectory so that it is easier to use shoot-look-shoot tactics. Third, the Interceptor cannot chase the target cluster as it is only slightly faster than an ICBM. Fourth, a concentration of all interceptors in one or a few sites that can defend all targets prevents a deliberate 'selective' emptying of one site by the enemy. Fifth, the interceptor booster has to be able to fully deploy the kill vehicle, whose IR sensors need to be oriented towards space as a background. Intercepts are therefore only possible at a certain minimal distance from the GBI launch point.

Australia is geographically in a relatively favourable position, since the incoming ICBM follow a limited number of trajectories (unless the enemy employs FOB), and most targets (with the exception of Brisbane and Perth) are in the southeastern corner of the country. GBI bases situated along the western to northern coastline would permit an early engagement of the incoming missile, maximising intercept opportunities. Better target discrimination with X-band radar data would favour later intercepts from bases in central and central southeastern Australia. A two-base system with one launch base in northern Western Australia, to protect Perth and provide early intercept opportunities, and a second base further in the southeast to act as a second layer, therefore seems like a possible solution. If the initial track-files are accurate enough, the first base should — like the second — be able to employ shoot-look-shoot tactics.

As noted above, the number of interceptors that have to be deployed will depend upon the quantity and quality of the enemy arsenal, especially whether China is included, the confidence in early track-files to make salvo-firing unnecessary, the target discrimination capability of the X-band radar, and whether the system is designed to defeat only 'warning-shots' or a full attack. If it is assumed that Australia has to use three interceptors to achieve the desired kill probability, 30 interceptors could provide a significant level of protection against either Iran or North Korea. The cost of such an arsenal can only be roughly estimated since there is no production line for booster or kill vehicle. The United States will procure 25 interceptors in FY 2004 and FY 2005 for $US 642m. This does not include the cost of five boosters and three silos which had been previously acquired.[269] A total cost of somewhere around $US 1 billion for 30 interceptors and their basing structure therefore seems a reasonable assumption.[270]

In addition to interceptors and radar, a battle management system with the necessary command and control facilities has to be available. Since the Australian GBI system is fully dependent upon access to US data generated from radars and other sensors in the launch region, and space-based sensors and communications equipment, it should be considered to integrate the Australian missile defenders into a combined operations centre located at STRATCOM.[271] Such an arrangement could not only save Australia significant cost, but would also be advantageous from an operational standpoint. Data fusion and analysis from US sources is taking place at STRATCOM, and a combined battle management would make it easier to focus US sensors on missiles flying to Australia. Australia would profit from all US upgrades and ad-hoc changes likely to be made in crisis situations, and it would presumably be easier to integrate the Australian GBI with other US layers of the overall BMD system. Fire decisions for Australian GBI should be made by Australian officers located at STRATCOM Since they have to provide access to their data and equipment, the United States would in any case have a de-facto veto power over Australian intercepts, whether the fire button is pushed in Colorado or 'down under'.

A GBI system consisting of one X-band radar, either sea-based or on the Northwest coast, and one or two interceptor bases is inherently vulnerable to preemptive attack. The system can defend itself against direct attack with ICBM of course, but it could in theory be defeated with conventional or nuclear means delivered by sea-borne special forces or SRBM and MRBM. Yet the likelihood of such an attack is questionable. First, ship-based SRBM and MRBM (and Chinese SLBM) could be used directly against population centres without the need to strike the GBI system. Attacks with special forces on a radar near the coast seem possible but have a high chance of failure, and it would be difficult to approach the coast without access to submarines with a long endurance. Finally, the act itself and especially the intent demonstrated by it make a response in the form of — possibly nuclear — retaliation very possible.

Defence Against Seaborne Attack

As mentioned in Chapter IV, the defence against seaborne SRBM and MRBM is primarily a financial and operational challenge. This is especially applicable to Australia, given the relatively small size — in absolute terms — of any Australian defence budget, and the geographical distribution of the Australian population in a relatively large number of coastal cities. Any direct defence against seaborne missiles thus has to be as cost effective as possible, and other solutions — as examined below — will have to be studied. Cost effectiveness would rule out systems like SAMP/T and Patriot that have only a limited coverage area and are not capable of intercepting MRBM like the No Dong or Shahab III. SM-3 on the future AWD could defend against seaborne attack if the ship patrolled off the coast, but these vessels are neither available in the near term, nor will they be in the distant future in sufficient quantity. In addition, their use for such a mission would be a gross waste of combat capability, and they could not be continually on station. If the SM-3 enters service on the new vessels, they will be capable of ‘coastal BMD’ in emergency situations when intelligence information points at an imminent attack. Yet they are not a suitable platform for the mission from a financial or operational point of view. Of the two suitable land-based systems, THAAD is probably less suited than Arrow, as its superior capabilities are not necessary for ‘coastal BMD’. First, THAAD has advanced target discrimination capabilities with its X-band radar. But the missiles used for seaborne attack will most likely be SRBM or possibly MRBM of the first generation, which pose a relatively easy discrimination challenge. Second, THAAD is a deployable (though not mobile) system, but a relocatable system like Arrow is fully sufficient for a stationary battery.

Third, THAAD will not be available for at least two years, while a production line exists for Arrow and Israel already has operational experience with the system. The total requirement to defend Perth, Adelaide, Melbourne, Sydney and Brisbane would thus be a system of five batteries with radars and battle management systems. If one assumes a maximum of two incoming missiles, an absolute minimum of four missiles would be required per battery.[272] Israeli Arrow batteries are estimated to cost around $US 170m,[273] but since these have 36 missiles in six launchers, Australia might be able to procure five batteries for less than that sum ($US 850m for five batteries).

The high cost of interceptor batteries for the protection of the capital cities makes a study of alternatives imperative. Compared with ballistic missile launchers in hostile territory, a TEL on a surface ship off the Australian coast is highly vulnerable to 'pre-boost-phase intercept'. This is especially the case since an attack is most likely in crisis situations, and would probably be directly or indirectly threatened by the rogue regime for the purposes of deterrence or coercion of the Australian Government and its allies. Luckily, Australia is — for several reasons — in a relatively fortuitous position to prevent a seaborne missile attack or to 'divert' it to unprotected allies by a system of maritime surveillance and interdiction.

First, no major international shipping routes pass through the potential launch areas (see Figure 4). The density of ship traffic is thus relatively low compared to — for example — the two US coasts or the European seas in the Atlantic, North Sea, Baltic and Mediterranean.[274] Second, the traffic patterns in the area which has to be kept under surveillance are relatively predictable as most legitimate ships will enter Australian waters in the West or East and follow the coastline. Third, and possibly most importantly, Australia already has excellent technological and operational experience with maritime surveillance.

The JORN coverage (see Figure 6) could be extended with one or two new radar stations to cover all sea space up to 2000 km from the Australian coast. If the French authorities in New Caledonia cooperate, no major islands will provide cover for an unnoticed approach. Scud and No Dong-class launchers are of a significant size, and a ship firing them has to be big enough to lie sufficiently stable in the water so that its remaining movement can be mechanically compensated. Any vessel below a certain size, which would be larger than most recreational and many fishing boats, can thus be discounted as a threat. A ship database and tracking system that includes data from port authorities would make it unnecessary to control ships after they entered the observation area and were found legitimate. Once the maritime surveillance centre has assembled a database of ships and ship traffic, vessels that are coming from trustworthy destinations and are known to authorities could probably be cleared without inspection.

Actual boarding or visual inspection of the remaining suspicious ships would only have to be undertaken in times of international tension. Some of this activity could be conducted worldwide by RAN and its coalition partners within the 'Proliferation Security Initiative' and similar international arrangements of surveillance of rogue state ship traffic. An unidentified ship detected 2000 km off the Australian coast is still at least 700 km further from Australian cities than the range of the No Dong and Shahab III. Sufficient time would be available to make visual contact by helicopter, F-18 or P-3 Orion maritime patrol planes that could also carry sufficient firepower to disable ballistic missile launchers. Australia already has experience with coordinating the vessels of various government agencies and the armed forces for such missions through its experience in the North. Since RAN and RAAF assets would probably have to be redeployed from their normal surveillance missions to the 'coastal BMD' mission, it is possible that a temporary surge in illegal immigration could occur. Yet, since "one nuclear missile can ruin your whole day,"[275] this does not seem an unreasonable price to pay for the protection of Australia's population centres.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Ballistic missiles give rogue states a means to deter and coerce Western nations in regional conflicts. They pose a threat and danger as much to the population centres at which they can be launched, as to the freedom of decision of the Australian Government and its friends and allies to intervene and oppose rogue regimes. The worldwide missile proliferation is progressing, and the threat is increasing in terms of quantity and quality. While various types of Scud class missiles were the major concern during the 1990s, Australian and allied troops participating in coalition operations against rogue states will today be confronted with the No Dong and Shahab III. The closer North Korea and Iran come to their goal of being able to directly target the United States with their ballistic missiles, the closer they are to being able to hit Australia, as well.

Among the states of greatest concern to Australia, China has by far the most advanced and extensive missile arsenal. A Chinese strategic nuclear strike on Australia may seem a remote and receding possibility, but the PRC's capability to do so is becoming more robust. Because of geography, Australia is under threat not only from Chinese ICBM but also from the new DF-31, and thus faces an even greater missile spectrum than the continental United States. North Korea and Iran may soon join the list of states which are able to target Australia directly. Their capability will be much less in terms of quality and quantity than that of the PRC, but it is nonexistent today and thus more prone to lead to a change in the strategic realm, to the detriment of Australia. North Korea has the advantage of geography and a more advanced technology over Iran, and could reach Australia with a three-stage Taepo Dong I, or the Taepo Dong II in either its two or three stage version. Iran is further behind, but the long history of cooperation between both states suggests that its technological advances will not be independent from those of North Korea.

When and with what kind of missile both states will achieve their goals cannot be forecasted with certainty. Both states engage in deception and conceal their development programs. Both have proven to take approaches to technological problems untypical for the programs that Western intelligence services are familiar with, and to deploy systems before the development program is complete. Uncertainty and the real possibility of additional surprises are thus a basic element of the threat assessment.

Nevertheless, openly available intelligence information suggests that both Iran and North Korea will achieve a deployed capability, if only rudimentary in nature, to hit Australia within the 2010 to 2015 timeframe, with the date for the former probably being later than that for the latter. Yet, this does not exclude the possibility that either state could target Australia in a rather unconventional way. North Korea seems ready to test the Taepo Dong II and could use these developmental missiles in emergency situations, while a seaborne attack with SRBM or MRBM by Iran and North Korea and other states is a possibility that already exists today.

Australia relied on the threat of US nuclear retaliation to deter a ballistic missile attack during the Cold War. But deterrence through punishment is a policy with an inherently high susceptibility to friction, which makes it much less reliable against rogue states today than it — allegedly — was in the case of the Soviet Union. The US extended deterrent, which protects Australia under the alliance with the United States, is also subject to these problems, which cause the United States and several of its key allies to shift towards a posture of deterrence through denial of ballistic missile threats. BMD systems thus have a central role in a modern deterrence posture, and Australia has to adapt its own deterrence policy to this development. If Australia relied on an 'extended missile defence' by the United States, as a part of the US extended deterrent, it would be placed in a situation of immediate strategic dependency and the burdensharing arrangement in the alliance would be severely disturbed. Relying on a shield consisting solely of US assets presupposes that the United States is willing to incur significant monetary and opportunity cost in crisis for the protection of Australia.

A sovereign Australian BMD capability would, in principle, alleviate these problems. Since the threat from ballistic missiles is primarily a risk incurred because of Australia's engagement against rogue states outside its immediate neighbourhood, the integration of Australia's capability in a wider US-allied system would be compatible with a doctrine of self-reliance. This includes the dependence upon certain US assets whose use by Australia does not cause significant marginal costs to the United States, for example space-based sensor and communications infrastructures. An Australian missile defence capability, in the form of sensors and/or interceptors, and integrated into a larger US-Allied system, would strengthen the interoperability of US and Australian forces, contribute to the security of both sides and thus strengthen the alliance.

Unlike most weapon systems that can operate and fight as a stand-alone platform, a missile defence shield requires different elements to function as a true 'system of systems'.[276] Patriot and similar tactical systems unite sensors, battle management and interceptors into one battery, but even these are connected to the early-warning system based on DSP and SBIRS. Defending against MRBM and longer-range missiles requires BMD sensors, battle management and communications assets and interceptors that are based in great distance from each other on land, sea, in the air or in space, and yet work together as one system. The nature of BMD as a 'system of systems' has some important implications for Australian policy:

First, it is not necessary for one platform to combine sensors, battle management and interceptors to be a valuable asset in the overall system. On the contrary, the large distances involved in optimal intercept geometries lead to the situation where a sensor-carrying platform in the right spot can often generate better data for an interceptor-carrying platform somewhere else than for interceptors co-located with the sensor. BMD therefore should not be associated with one platform only.

Second, Australia will not be able to procure a robust stand-alone system that would be fully independent from US assets and at the same time be able to defeat anything beyond very short range missiles . BMD systems require extremely expensive sensor networks in space (notably STSS and SBIRS) to provide reliable tracking and target discrimination data against advanced missiles employing countermeasures. These missiles are not within the technological capability of rogue states today, but are deployed in China and Russia and will be used by other states as their experience and the sophistication of commercially available technology grow.

Third, a BMD system is more than the sum of its parts. The system architecture determines to a large degree the overall effectiveness of the system. The ability to use shoot-look-shoot tactics — within one layer or between layers — is crucial to prevent a rapid depletion of the numbers of available interceptors. Also, a multi-layered system provides more certainty that the system does not allow 'leakers' to get through the screen, and is more robust against enemy countermeasures or systematic failures by providing different interceptor systems. Australia should therefore assess the value of BMD assets in relation to the overall architecture and not only as stand-alone systems.

Fourth, the 'system of systems' will experience technological obsolescence of some elements as newer versions are developed and deployed, or as their mission can be better fulfilled by different assets. BMD is a technology that is too young to know for certain which technological direction will emerge as optimal in the future, and it is highly likely that there will be a relatively high rate of new elements being introduced and old elements being modified or scrapped in the coming one or two decades. The Australian defence budget does not allow investment into extremely expensive systems which might be technically obsolete in the near future, leading to the non-availability of US replenishment stocks and spare parts. It is therefore necessary to carefully study the future growth potential and relative strength and weakness of any system before committing to a purchase.

The first step in the development of an Australian BMD policy has to be the definition of strategic goals that the system should achieve. The intercept of a ballistic missile is almost never a military end in itself, but the capability to do so enables other forces to accomplish their missions.[277] Similarly, acquiring a BMD capability should not be a goal in itself but part of a coherent program to develop military forces capable of achieving certain missions defined by the political leadership. In the case of Australia, BMD can contribute to three major military-strategic goals: first, the defence of the Australian territory, of Australia's population and the freedom of its decisionmakers from political-military coercion ('NMD'); second, the defence of expeditionary troops that can deter, coerce and enforce Australia's wishes against the will of others ('Expeditionary Warfare'); and third, the strengthening of the US-Australian alliance as the base of Australia's security.

TABLE 3

AUSTRALIAN BMD REQUIREMENTS AND OPTIONS

Mission	**US Capabilities by 2010-15**	**Assets to be procured by Australia**	**Importance for**		
			NMD	**Expeditionary Warfare**	**US Alliance**
Defence against direct attack with rogue state ICBM	Low: Probably some ABL, possibly BMDS Interceptor	GBI	Very high	Low	Low (unless Australia is deterred)
'Coastal Defence'	Low: Technically SM-3 and THAAD; operationally next to none	Maritime surveillance and interdiction system, possibly Arrow	Very high	Low	Low (unless (Australia is deterred)

'Timor plus Scud' (BMD for crisis in the neighbourhood)	Medium: Technically with SM-3, THAAD, Patriot, if Australia invokes ANZUS treaty	Patriot or SAMP/T at bases in the North, SM-3 possibly THAAD or Arrow	Medium	Medium	Low
Defence of expeditionary forces	High: SM-3, THAAD, Patriot, ABL, possibly BMDs Interceptor	SM-3, Patriot or SAMP/T, THAAD, possibly BMDS Interceptor	Low	Very high	High
Sensor integration both within the ADF and with US Forces	High: Integration of SBIRS, Spy-1, AWACS, Early Warning Radars, X-band Radar, possibly BMDS radar and SSTS	Software and hardware upgrades on JORN, Wedgetail, AWD, possibly Global Hawk	Very high	Very high	Very high

The importance of the ADF's military capability to perform a certain BMD mission can only be determined in reference to these three goals, as shown in Table 3. Also, the United States will be able to perform certain missions better than others in the 2010-2015 timeframe. Both of these factors, in addition to the cost of their procurement and operation, determine the relative value of different BMD systems for Australia. As a general summary, area and theatre defence systems will be most important if expeditionary warfare and the strengthening of the US alliance are Australia's major goals. But these systems will already be available to some extent in the United States and among US allies, so the Australian contribution to a coalition BMD system will always be relatively minor. At the same time, future Australian participation in coalition operations and other expeditionary warfare might be contingent on the capability to protect the Australian population from an enemy's retribution. This reinforces the already high importance of the capability to defeat direct attacks on the Australia continent.

While a political decision on what to achieve with Australian BMD is still pending, some general recommendations can therefore nevertheless be made to guide the Australian BMD effort:

(1) Maintain a close dialogue with the United States and other US allies on BMD:

The intelligence on the ballistic missile threat to Australia is incomplete and probably partly false. A constant reassessment in the light of new information gained by Australian, US or allied services is therefore necessary. The US BMD system is evolving rapidly both in its technological and operational capabilities. Australia should be aware of these developments to identify where it would be able to contribute to the overall US system, to assess US capabilities that could be used to defend Australia, and to evaluate the suitability of US and US allies' systems for Australian requirements. With its experience in OTHR technology, Australia has the potential to become a more significant partner in the US missile defence program than the size of the Australian economy and armed forces would suggest. Maintaining a close dialogue with the US and its allies on technological, operational and strategic questions of missile defence might be facilitated by the creation of a Missile Defence Office in the Department of Defence.

(2) See BMD as a network and not as a single-service mission:

A BMD architecture is more than a mere upgrade or extension of existing air defence capabilities. Given the importance of sensor data in missile defence, even a basic BMD system will require assets operated by at least two services. The architectures described in this paper all require the integrated operation (not only joint operations) of equipment from RAAF (Wedgetail AEW&C aircraft, Global Hawk UAV, JORN), RAN (SEA 4000 radar and interceptors), and possibly even the Army which could operate GBI and other land-based interceptor batteries.[278] There is a danger that the SEA 4000 project could, with tacit support from the Navy leadership, be seen as 'the' Australian BMD option and that other BMD architectures and the contribution of RAAF sensors do not receive due attention. BMD always requires a network of sensors and shooters on different platforms. Sea-based systems are not optimal for all BMD missions, and the limited value of both Aster-30 and SM-3 for Australia have been mentioned above. Also, decisions upon the integration of Australian BMD systems with US assets and the prioritisation of those BMD threats that Australia might need to defeat have to be taken by the political leadership on advice from the Department of Defence. The responsibility of the single services in their BMD mission should be limited to the operation of their platforms, and not extend into the design and development of the overall architecture. This is another reason for the creation of a Missile Defence Office.

(3) Proceed with the integration of ADF sensors into the US BMD system:

The integration of sensors is of a high importance for any BMD architecture (see Table 3). Australia has, or will have, potent systems like the Wedgetail AEW&C aircraft, Global Hawk UAV, JORN and the SEA 4000 radar, which can provide valuable data both to Australian, US and other allies' BMD interceptors. These systems are being procured primarily for air defence and surveillance missions that could also profit from an integration. The necessary upgrades or modifications that would enable these systems to participate in BMD would thus provide much capability for relatively little money and strengthen the Australian "Knowledge Edge."[279] An integration with the US system seems imperative. Although the ADF should be able to operate the network-function independently, the use of US data would significantly raise the capability and survivability of Australian assets in coalition operations. Even if Australia does not buy BMD interceptors yet, operating Australian assets in the US BMD sensor network will give the ADF operational experience in BMD, make a participation of Australian forces in coalition operations more important for the United States, and would be another way (in addition to JORN) of getting access to, and participating in, the US BMD development program.

(4) Develop a maritime surveillance and interdiction system against seaborne attack

A seaborne ballistic missile attack on Australian cities could happen today. It is well within the technological capability of several states currently hostile to Australia, and the mere threat of such an attack would have significant strategic consequences: If North Korea or Iran for example announced that ship-based Scud were stationed off a handful of Western cities, and possibly showed television footage of a test launch, the Australian Government and its allies would be under significant pressure to appease and seek a peaceful solution to the crisis. Since the success of such a strategy relies on secrecy, rogue states will do everything to prevent a detection by Western intelligence and it could therefore come as a surprise. Due to its geographic location and experience with maritime surveillance, Australia can protect its population centres and prevent coercion of its government with a technologically simple and relatively cheap solution. A surveillance and control system based on JORN and a ship traffic database, with input from port authorities and other relevant sources, would make the interdiction of all suspect vessels in times of crisis possible. RAN, RAAF, customs service and police already cooperate closely in the maritime surveillance of the Northern waters, and have gained experience in inter-agency cooperation on which the new system would be based. A ship database and traffic control centre could probably be operational within months after a decision to do so, providing initial capability if connected to existing surveillance assets. Once the new JORN stations are constructed and incorporated into the system, Australia would be more prepared for seaborne attack than its allies.

(5) Study the feasibility and cost of an Australian NMD based on GBI

The capability of North Korea and Iran to hit Australia in direct attacks with ICBM will grow significantly within the next decade and could lead to a decline of Australia's strategic situation. The US BMD system will be incapable of providing a reliable capability to defend Australia, but provide protection to the United States, Japan and Europe, and thus potentially make Australia attractive as a 'hostage'. Nuclear deterrence does not provide an answer to this threat since there could not be much confidence in its success. An Australian NMD system based on X-band radar and GBI could defeat rogue state attacks and prevent such a situation. Although it would be of a similar budgetary importance as other major procurement programs, such a system would not be prohibitively expensive and Australia could provide itself with this capability without causing unacceptable distortions in its budget. A detailed study should be undertaken of the strategic, technological, financial and operational aspects of an Australian GBI system, to provide the basis for debate on the risk of accepting the nation's future vulnerability.

(6) Concentrate area and theatre defence efforts on the SEA 4000 project

Australian expeditionary forces need a BMD capability against SRBM and MRBM in operations against rogue states, and bases and population centres in the northern part of the continent could come under threat from such weapons in the future. But US forces will provide a BMD system in coalition operations and both are technologically and operationally capable of assisting Australia in any future crisis with an Indonesia armed with ballistic missiles. The requirement of the ADF for an area and theatre defence capability, whether based on land or at sea, is thus not a pressing one. The new AWD could be a suitable platform for interceptors and provide area or theatre defence capability at a lower cost compared to land-based batteries, which also do not provide the flexibility of a seabased system. If Australia decides that it needs such capabilities, it should concentrate its efforts on the SEA 4000 project. In any case, current and future interceptors should be evaluated whether they fit Australian requirements. Yet, these requirements are such that no program currently in development — after the cancellation of the SM-2 IVA — fulfils them sufficiently to merit the expense of significant funds. The SM-3 is too 'big' for area defence against SRBM, the most likely BMD mission for Australian destroyers, and too 'small' for a reliable defence of Australia proper. The Aster-30 can provide area defence, but poses problems with logistical support and interoperability within the RAN and with the US Navy. Unless the US Navy agreed to provide SM-3 interceptors in the few cases where Australian vessels might use them in an operationally sensible role, the primary role of the AWD in the Australian BMD system should therefore be seen in connection with its radar.

Notes:

I. Introduction

1 Ronald Reagan, *Address to the Nation on Defense and National Security*, 23 March 1983, <http://www.reagan.utexas.edu/resource/speeches/1983/32383d.htm> (19 August 2003).

2 The program was immediately cancelled by the Clinton administration upon taking office.

3 Federation of American Scientists, 'Iran-Iraq War (1980-1988), *FAS Website*, <http://www.fas.org/man/dod-101/ops/war/iran-iraq.htm> (2 September 2003); Special Assistant for Gulf War Illness, *Iraq's Scud Ballistic Missiles*, <http://www.gulflink.osd.mil/scud_info_ii/scud_info_s02.htm> (2 September 2003).

4 Ballistic Missile Defence,' *Post Note* no. 72 (London: Parliamentary Office of Science and Technology, January 1996), p.2.

5 Brigadier General Emery, *Statement to the House National Security Committee, Subcommittees on Research & Development and Procurement*, March 19, 1997.

6 Roy Eccleston, 'Come into our missile shield: US,' *The Weekend Australian*, 12 July 2003, p.1.

7 For the use of airpower against mobile Transporter-Erector-Launcher (TEL), see Robert W. Chandler, 'Counterforce: Locating and Destroying Weapons of Mass Destruction,' *Occasional Papers* no. 21 (Colorado Springs: US Air Force Academy Institute for National Security Studies, 1998). For further information concerning the air operations against mobile and time critical targets in general, see Alan Vick, Richard M. Moore, Bruce R. Pirnie and John Stillion, *Aerospace Operations Against Elusive Ground Targets* (Santa Monica: RAND, 2001); Myron Hura, Gary McLeod, Richard Mesic, Philip Sauer, Jody Jacobs, Daniel Norton and Thomas Hamilton, *Enhancing Dynamic Command and Control of Air Operations Against Time Critical Targets* (Santa Monica: RAND, 2002). For background on special operations in this mission, see for example William Rosenau, *Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War* (Santa Monica: RAND, 2001).

8 Defence Minister Senator Hill has mentioned an involvement in the US BMD program as a promising opportunity for Australian industry. 'Hill targets millions in missiles,' *Canberra Times*, 2 August 2003, p.4.

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9 Tom Mueller, 'Royal Australian Navy & Theatre Ballistic Missile Defence,' *Working Paper* no. 12 (Canberra: Sea Power Centre Australia, 2003), p.16.

10 For a good discussion of asymmety in strategy, see Steven Metz and Douglas V. Johnson, *Asymmetry and U.S. Military Strategy: Definition, Background, and Strategic Concepts* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2001).

11 It is doubtful that the Soviet Union ever had the same policy. The Soviet BMD system did not protect its strategic forces from a first strike, but Moscow, and the Soviet Union undertook significant investments into civil defence and recovery

capabilities. Also, its heavy missiles (especially the SS-18) were designed for a counterforce role and threatened the US second strike capability.

12 Lawrence Freedman, 'The Revolution in Strategic Affairs,' *Adelphi Paper* 318 (London: International Institute for Strategic Studies, 1998), p.39.

13 China is not usually considered a rogue state, but many of the comments on asymmetric strategy apply to Chinese thinking on warfare as well.

14 Adapted from: Kenneth F. McKenzie, 'The Revenge of the Melians: Asymmetric Threats and the Next QDR,' *McNair Paper* 62 (Washington D.C.: Institute for National Strategic Studies, National Defense University, 2000), p.2.

15 For a variety of definitions and uses of the word 'asymmetry' in a security context, see Steven Lambakis, James Kiras and Kristin Kolet, *Understanding "Asymmetric" Threats to the United States* (Fairfax, VA: National Institute for Public Policy, 2002), pp.59-64.

16 Historically, the Western willingness to incur casualties has been higher than is often assumed, see for example Mark J. Conversino, 'Sawdust Superpower: Perceptions of U.S. Casualty Tolerance in the Post-Gulf War Era,' *Strategic Review* XXV, no. 1 (Winter 1997), pp.15-23. But a rogue state will base its decision on its perception and might fail to realize the true extent of Western commitment. In this respect it is interesting to remark that rogue states with a track-record of irresponsible behaviour below a threshold provoking reaction or retaliation have an advantage in credibility when explicitly threatening or only suggesting to impose costs in crisis situations.

17 Christopher C. Harmon, *Terrorism Today* (London: Frank Cass, 2000), p.52. For a rather optimistic, pre-9/11 view of defence against terrorists, see K. Scott McMahon, 'Unconventional Nuclear, Biological, and Chemical Weapons Delivery Methods: Whither the 'Smuggled Bomb'', *Comparative Strategy* 15, no. 2 (April-June 1996), pp.123-134. Even if 9/11 is a reason for caution, the subsequently enacted legislation and preventive measures have certainly improved the situation.

18 U.S. Congress Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*; OTA-BP-ISC-115 (Washington D.C.: Government Printing Office, 1993), pp.206-207.

19 Edward N. Luttwak, 'Toward Post-Heroic Warfare,' *Foreign Affairs* 74, no. 3 (May/June 1995), pp.109-122.

20 McKenzie, *op. cit.*, pp.5, 8-9.

21 W. Seth Carus of the of the Counterproliferation Center of the National Defense University, cited in Ibid., p.4.

22 Fred C. Iklé, 'The Next Lenin,' *The National Interest* no. 47 (Spring 1997), pp.9-11.

23 Williamson Murray and MacGregor Knox, 'Thinking about revolutions in warfare,' in *The dynamics of military revolution, 1300-2050*, eds. Williamson Murray and MacGregor Knox (Cambridge: Cambridge University Press, 2001), p.11.

24 It would lead too far off the subject to enter in debates about the countervalue vs. counterforce emphasis of actual US warplans during the Cold War. Compared to the low levels of collateral damage considered normal today, the argument

that the pre-war Soviet society itself would have been destroyed in any case nevertheless seems defendable.

25 With drastic words, Carl von Clausewitz warned nearly 200 years ago that there is no bonus in war for unilateral restraint: "The fact that slaughter is a horrifying spectacle must make us take war more seriously, but not provide an excuse for gradually blunting our swords in the name of humanity. Sooner or later someone will come along with a sharp sword and hack off our arms." (Carl von Clausewitz, *On War*, edited and translated by Michael Howard and Peter Paret (Princeton: Princeton University Press, 1976), p.260.)

26 Greg Sheridan, 'North Korea: live and let die,' *The Australian*, 17 July 2003, p.9.

27 Commonwealth of Australia, *Defence 2000: Our Future Defence Force* (Canberra: Ministry of Defence, 2000), pp.31-32.

28 Commonwealth of Australia, *Defence 2000: Our Future Defence Force*, pp.31-32.

29 Commonwealth of Australia, *Australia's National Security: A Defence Update 2003* (Canberra: Ministry of Defence, 2003), p.17.

30 Data from Australian Bureau of Statistics, *Australia at a Glance*, ABS Catalogue no. 1309.0, 24 January 2003, p.2.

31 The CEP measures the radius of a circle around the mean point of impact within which 50% of all missiles fired at a target will fall. The distance between mean point of impact and the actual target is the bias of the missile.

32 For the concept of critical infrastructure see John Moteff, Claudia Copeland and John Fischer, 'Critical Infrastructures: What Makes an Infrastructure Critical?,' *Congressional Research Service Report for Congress* RL31556, 30 August 2002.

33 Desmond Ball, 'The strategic essence,' *Australian Journal of International Affairs* 55, no. 2 (July 2001), p.240

34 Defense Support Program (DSP) satellites on geosynchronous orbits, to be replaced by SBIRS (Space Based Infra-Red System)-high satellites in coming years. The system also includes two new SBIRS-high sensors on — classified — host satellites on High Elliptic Orbits (HEO) and overflying the polar regions, whose classified launch dates are reportedly in 2002 or 2003. David R. Tanks, *National Missile Defense: Policy Issues and Technological Capabilities* (Washington D.C.: Institute for Foreign Policy Analysis, 2000), pp.3.10-3.13.

35 Ball, 'The strategic essence,' *Australian Journal of International Affairs* , pp.237-243.

36 Malcom Fraser, 'US missile shield a call to nuclear arms,' *The Australian*, 18 July 2000, p.13. See also Mark Dunn, 'Aussie nuke warning,' *Herald Sun*, 19 June 2003, p.9.

37 Ball, 'The strategic essence,' *Australian Journal of International Affairs* , pp.237-243.

38 In some respects this point reflects the Cold War debate on flexibility in nuclear targeting plans and the lacking credibility of a threat of massive targeting of Soviet urban areas. For a concise discussion of flexibility and deterrence in this context see William R. Van Cleave and Roger W. Barnett, 'Strategic Adaptability,' *Orbis* XVIII, no. 3 (Fall 1974), pp.655-676.

[39] Iraq for example attacked Israel during the second Gulf War to — among other reasons — put pressure on the United States. See Robert E. Harkavy, 'Triangular or Indirect Deterrence/Compellence: Something New in Deterrence Theory?,' *Comparative Strategy* 17, no. 1 (January-March 1998), pp.63-81.

[40] For a short systematic overview, see Bruce B. Berkowitz and Allan E. Goodman, *Strategic Intelligence for American National Security* (Princeton: Princeton University Press, 1989), pp.185-192. For the possibilities of deception and self-deception, see for example Robert L. Pfaltzgraff, Uri Ra'anan and Warren Milberg, eds. *Intelligence Policy and National Security* (Hamden, CO: Archon Books, 1981).

[41] See for example Avigdor Haselkorn, *The Continuing Storm* (New Haven: Yale University Press, 1999), esp. pp.1-33. Former UN weapons inspector David Kay writes that "Iraq should serve as an enduring monument to the fallibility of international inspection and national intelligence when faced by a determined, clandestine proliferator." (David Kay, 'Denial and Deception: Iraq and Beyond,' *American Intelligence Journal* 16, no. 1 (Spring/Summer 1995), p.79.)

[42] Lambakis, Kiras and Kolet, *op. cit.*, p.11.

[43] Larry A. Niksch, 'North Korea's Nuclear Weapons Program,' *Congressional Research Service Report for Congress* IB91141, Updated 9 June 2003, p.6.

[44] Doug Struck and Glenn Kessler, 'Hints on N.Korea Surfaced in 2000,' *Washington Post*, 19 October 2002, p.A19.

[45] George Tenet, *DCI's Worldwide Threat Briefing (As Prepared for Delivery): The Worldwide Threat in 2003: Evolving Dangers in a Complex World*, 11 February 2003 <www.cia.gov/cia/public_affairs/speeches/dci_speech_02112003.html> (7 March 2003).

[46] Joseph S. Bermudez, 'North Korea's Nuclear Program,' *Jane's Intelligence Review* 3, no. 9 (September 1991): p.410.

[47] Glenn Kessler, 'Pakistan's N. Korea Deals Stir Scrutiny,' *Washington Post*, 13 November 2002, p.A01. For a more detailed overview on this exchange see Sharon A. Squassoni, 'Weapons of Mass Destruction: Trade Between North Korea and Pakistan,' *Congressional Research Service Report for Congress* RL31900, 7 May 2003.

[48] Ze'ev Schiff, 'North Korea producing enriched uranium in Iran,' *Ha'aretz Online Edition*, 21 October 2002.

[49] Michael R. Gordon, 'Inspectors in Iran Examine Machines to Enrich Uranium,' *New York Times Online Edition*, 23 February 2003. <http://www.nytimes.com/2003/02/23/international/23IRAN.html?pagewanted=print&position=top> (23 February 2003).

[50] Dani Shoham, 'Poisoned Missiles: Syria's Doomsday Deterrent,' *Middle East Quarterly* IX, no. 4 (Fall 2002), p.14. "Syria's achievements in CBW development and production are impressive," he writes about that country, "[y]et they stand in striking contrast to the very low level of Syria's technical and scientific infrastructure." (Dani Shoham, 'Guile, Gas and Germs: Syria's Ultimate Weapons,' *Middle East Quarterly* IX, no. 3 (Summer 2002), p.58.) Besides an optimal integration of their covert objective and overt program, he attributes this proficiency to the host of international suppliers the Syrians managed to tap.

51 Commission to Assess the Ballistic Missile Threat to the United States, *Executive Summary of the Report of the Commission to Assess the Ballistic Missile Threat to the United States*, 15 July 1998, <http://www.house.gov/hasc/testimony/105thcongress/BMThreat.htm> (7 May 2003).

52 For an open source study with a similar methodology, see David R. Tanks, *Exploring U.S. Missile Defense Requirements in 2010: What are the Policy and Technology Challenges?* (Washington D.C.: Institute for Foreign Policy Analysis, 1997).

53 Commission to Assess the Ballistic Missile Threat to the United States, *op. cit*.

54 For details, see U.S. Congress Office of Technology Assessment, *op. cit.*, pp.197-255.

55 Commission to Assess the Ballistic Missile Threat to the United States, *op. cit*.

56 Commonwealth of Australia, *Defence 2000: Our Future Defence*, p.7.

57 Robert D. Walpole, *Testimony on the CIA National Intelligence Estimate of Foreign Missile Development and Ballistic Missile Threats through 2015 before the International Security, Proliferation and Federal Services Subcommittee of the Senate Governmental Affairs Committee*, 11 March 2002, Q&A session.

58 For the classification of ballistic missiles according to their range, see the beginning of Chapter IV.

59 Shirley A. Kan, 'China: Ballistic and Cruise Missiles,' *Congressional Research Service Report for Congress* 97-391 F, Updated 10 August 2000, pp. 7-12.

60 US Department of Defense, *Annual Report on the Military Power of the People's Republic of China* (Washington D.C.: Department of Defense, 2003), p. 29.

61 For an overview on the Chinese export of missiles and missile technology, see for example Shirley A. Kan, 'China and the Proliferation of Weapons of Mass Destruction and Missiles: Policy Issues,' *Congressional Research Service Report for Congress* RL31555, Updated 26 February 2003.

62 Kan, 'China: Ballistic and Cruise Missiles,' pp. 12-15.

63 National Intelligence Council, *Foreign Missile Developments and the Ballistic Missile Threat Through 2015*, December 2001, <http://www.cia.gov/nic/pubs/other_products/Unclassifiedballisticmissilefinal.htm> (10 January 2003).

64 Ibid.

65 US Department of Defense, *Annual Report on the Military Power of the People's Republic of China*, p. 31.

66 For an history of the No Dong, see Joseph S. Bermudez, 'The rise and rise of North Korea's ICBMs,' *Jane's International Defense Review* 32 (July 1999), pp.57-59.

67 On the unanticipated third stage in the Taepo Dong I launch see for example Robert D. Walpole, *Speech at the Carnegie Endowment for International Peace*, 17 September 1998, <http://www.cia.gov/cia/public_affairs/speeches/1998/walpole_speech_091798.html> (1 August 1998).

68 Bermudez, 'The rise and rise of North Korea's ICBMs,' pp.60.

[69] North Korea has announced it may reconsider its offer to extend the moratorium beyond 2003. Central Intelligence Agency, *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions*, 1 January Through 30 June 2002, April 2003, p.7.

[70] National Intelligence Council, *op. cit*.

[71] Walpole, *Testimony on the CIA National Intelligence Estimate of Foreign Missile Development and Ballistic Missile Threats through 2015 before the International Security, Proliferation and Federal Services Subcommittee of the Senate Governmental Affairs Committee*, Q&A session.

[72] National Intelligence Council, *op. cit*.

[73] For a short overview on the state of North Korea's nuclear program, see for example Niksch, *op. cit*.

[74] For details see for example Kenneth Katzman, 'Iran: Arms and Weapons of Mass Destruction Suppliers,' *Congressional Research Service Report for Congress* RL30551, Updated 3 January 2003.

[75] See for example Andrew Koch and Alon Ben-David, 'Iran's nuclear work revealed,' *Jane's Defence Weekly* 39, no. 25 (25 June 2003), p.2.

[76] Robert D. Walpole, *Testimony on Iran's Arms Proliferation before the Senate Government Reform Committee*, 21 September 2000; Central Intelligence Agency, op. cit., pp.2-3.

[77] *Sankei Shimbun*, 6 August 2003, quoted in in Ilan Berman, ed., *Missile Defense Briefing Report* no. 115 (Washington D.C.: American Foreign Policy Council, 15 August 2003), <http://www.afpc.org/mdbr/mdbr115.shtml> (19 August 2003).

[78] Henry L. Stimson Center Working Group, *Theater Missile Defenses in the Asia-Pacific Region* (Washington D.C.: Henry L. Stimson Center, 2000), p.19.

[79] Walpole, *Testimony on Iran's Arms Proliferation before the Senate Government Reform Committee*.

[80] Walpole, *Testimony on the CIA National Intelligence Estimate of Foreign Missile Development and Ballistic Missile Threats through 2015 before the International Security, Proliferation and Federal Services Subcommittee of the Senate Governmental Affairs Committee*, Q&A session.

[81] These would merely require launch pads, which can be constructed within a year. Walpole, *Testimony on the CIA National Intelligence Estimate of Foreign Missile Development and Ballistic Missile Threats through 2015 before the International Security, Proliferation and Federal Services Subcommittee of the Senate Governmental Affairs Committee*.

[82] Steven J. Zaloga, 'Sea Scorpion: a poor man's ICBM?,' *Jane's Intelligence Review* 10, no. 11 (November 1998), pp.5-7. See also David Miller, 'Sea delivery: a rogue state's third option,' *Jane's Intelligence Review* 8, no. 5 (May 1996), pp.236-238.

[83] National Intelligence Council, *op. cit*.

[84] Kenneth Timmerman, 'Trumped by Iran's new missile,' *The Washington Times*, 5 May 1999, p.A17; Scott McMahon, 'Ship-Based Missiles Surface as Potential Terror Weapon,' *Defense News* 14, no. 10 (15 March 1999), p.27.

85 16 to 19 ships were struck by sea-mines of unclear origin in the Red Sea in 1984. It was later determined that they were most likely laid by the Libyan roll-on/roll-off ship *Ghat* which had passed through the area in the days before. Since the evidence was only circumstantial and the attacks were only traced to Libya weeks after the deployment of the mines, no retaliation took place. Office of the Chief of Naval Operations, *Expeditionary Warfare: Mine Warfare: Mine Warfare During "Low-Intensity Conflict"*, <http://www.exwar.org/1800_history/mine/low_intensity.htm> (19. November 2002).

86 See for example Henry F. Cooper, *Defending America from Offshore Missile Attack* (Washington D.C.: George C. Marshall Institute, 2002); William R. Graham, *Statement on Missile Defense before the House Government Reform Committee, National Security, Veterans Affairs, and International Relations Subcommittee*, 16 July 2002.

87 Bob Preston, Dana J. Johnson, Sean Edwards, Michael Miller, and Calvin Shipbaugh, *Space Weapons, Earth Wars* (Santa Monica: RAND, 2002), pp.11-12. See this publication for the orbital mechanics of (conventional) orbital bombardment systems.

88 It is interesting in this respect that North Korea insisted that its Taepo Dong I test over Japan in 1998 was a failed satellite launch — a statement that if true would not be very reassuring given the unlimited range achievable with FOBS.

89 Mark Schweikert, 'TBMD and the RAN,' *The Navy* 62, no. 3 (July-September 2000), p.11.

90 David Ottaway, 'Saudis Hid Acquisition of Missiles,' *Washington Post*, 29 March 1988, p.A13, cited in U.S. Congress Office of Technology Assessment, p.234.

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91 Commonwealth of Australia, *Defence 2000: Our Future Defence Force*, p.29.

92 Commonwealth of Australia, *Australia's National Security: A Defence Update 2003*, p.9.

93 Ibid., p.15.

94 Commonwealth of Australia, *Defence 2000: Our Future Defence Force*, p.24.

95 Commonwealth of Australia, *Australia's National Security: A Defence Update 2003*, p.23.

96 Ibid., p.25.

97 Ibid., pp.15-17.

98 Australian Defence Force, 'Doctrine,' *Australian Defence Force Publication, Operations Series (ADFP)* 1 (Canberra: Defence Centre, 1993), para. 337; cited in Michael Evans, 'Conventional Deterrence in the Australian Strategic Context,' *Working Paper* 103 (Canberra: Land Warfare Studies Centre, 1999), p.18; Joint Chiefs of Staff, *Department of Defense Dictionary of Military and Associated Terms* (Joint Pub 1-02) (Washington D.C.: Government Printing Office, 1989), p.113.

99 For some basics of deterrence theory, see Keith B. Payne and C. Dale Walton, 'Deterrence in the Post-Cold War World,' in *Strategy in the Contemporary World*, John Baylis, James Wirtz, Eliot Cohen, and Colin S. Gray, eds. (Oxford: Oxford University Press, 2002), pp.161-164.

100 Evans, 'Conventional Deterrence in the Australian Strategic Context,' pp.25-26.

101 See for example Keith B. Payne, *Deterrence in the Second Nuclear Age* (Lexington, KY: The University Press of Kentucky, 1996), p.158; Colin S. Gray, 'Deterrence and Regional Conflict: Hopes, Fallacies, and 'Fixes',' *Comparative Strategy* 17, no. 1 (January-March 1998), p.58; Robert G. Joseph, 'Nuclear Deterrence and Regional Proliferators,' *Washington Quarterly* 20, no. 3 (Summer 1997), p.167.

102 See for example Keith B. Payne, 'Post-Cold War Deterrence and Missile Defense,' *Orbis* 39, no. 2 (Spring 1995), pp.201-223.

103 Office of the Press Secretary, *National Policy on Ballistic Missile Defense Fact Sheet* (Washington D.C.: White House, 2003), <http://www.whitehouse.gov/news/releases/2003/05/print/20030520-15.html> (31 May 2003).

104 Colin S. Gray, 'Deterrence and the Nature of Strategy,' *Small Wars & Insurgencies* 11, no. 2 (Autumn 2000), p.23.

105 Evans, 'Conventional Deterrence in the Australian Strategic Context,' p.47.

106 Walpole, *Testimony on Iran's Arms Proliferation before the Senate Government Reform Committee*.

107 The Western position today is in this respect more parallel with the Soviet Union's during the Cold War than with that of NATO.

108 See for example Gary Brown and Gary Klintworth, 'The US National Missile Defense Program: Vital Shield or Modern-Day Maginot Line?,' *Research Paper* 16 (Canberra: Department of the Parliamentary Library Information and Research Service, 2000), p.24.

109 Ministry of Defence, *Missile Defence: a public discussion paper* (London: Ministry of Defence, 2002), p.25.

110 Office of the Press Secretary, *op. cit*.

111 Commonwealth of Australia, *Defence 2000: Our Future Defence Force*, p.36.

112 Keith B. Payne, *The Fallacies of Cold War Deterrence and a New Direction* (Lexington, KY: The University Press of Kentucky, 2001), esp. pp.111-113.

113 Deterrence differs in this respect from dissuasion, an otherwise closely related concept. Deterrence addresses current and existing threats, while dissuasion aims at preventing the emergence of new capabilties.

114 Payne, *Deterrence in the Second Nuclear Age*, pp.37-78.

115 Steven J. Cimbala, *Clausewitz and Chaos* (Westport, CT: Praeger, 2001), p.121.

116 Janice Gross Stein, for example, concludes that US efforts to deter the invasion of Kuwait by Iraq in 1990, and to compel Iraq to withdraw by building up forces in the region and posing an ultimatum prior to the Second Gulf War, failed because of a profound conviction on the part of Saddam Hussein that the United States was determined to destroy his regime: "On a superficial level, Iraq's Revolutionary Command Council did not distinguish carefully between public comment and private commentary in the United States and had difficulty decoding the cacophony of signals that emanated from multiple American sources. More fundamentally, the United States had been portrayed for so long as an imperialist power, conspiring against the Arab people and populist Arab leaders, that it was

all too easy for Saddam to interpret new information as consistent with this deeply rooted and easily available stereotype." (Janice Gross Stein, 'Deterrence and Compellence in the Gulf, 1990-91,' *International Security* 17, no. 2 (Fall 1992), p.165.).

117 Defense Threat Reduction Agency, *U.S. Coercion in a World of Proliferationg and Varied WMD Capabilities: Final Report for the Project on Deterrence and Cooperation in a Multi-Tiered Nuclear World* (Ft.Belvoir, VA: Defense Threat Reduction Agency, 2001), pp.10-20.

118 Robert G. Joseph and John F. Reichart, *Deterrence and Defense in a Nuclear, Biological and Chemical Environment* (Washington D.C.: National Defense University Press, 1999), p.18. An example of the influence of WMD capability upon the failure of deterrence is the Iraqi invasion of Kuwait: Saddam Hussein is reported to have overestimated the deterrent value of his chemical warfare capability. He thought in particular that the effects of Iraqi binary weapons were sufficiently demonstrated during the war with Iran. In addition, Hussein apparently underestimated the Western lack of intelligence about his biological warfare program. Haselkorn, *op. cit.*, pp.18-33.

119 Dean Wilkening and Kenneth Watman, *Nuclear Deterrence in a Regional Conflict* (Santa Monica: RAND, 1995), pp.14-17.

120 Barry R. Schneider, *Future War and Counterproliferation* (Westport, CT: Praeger, 1999), pp.63-66.

121 For some examples, see Barry Wolf, 'When the Weak Attack the Strong: Failures of Deterrence,' *Rand Note* N-3261-A (Santa Monica: RAND, 1991), pp.7-8.

122 For a good overview, see Evans, 'Conventional Deterrence in the Australian Strategic Context.'

123 For a critical overview over this argument, see Dennis M. Gormley and Thomas G. Mahnken, 'Facing Nuclear and Conventional Reality,' *Orbis* 44, no. 1 (Winter 2000), pp.109-125.

124 Kathleen C. Bailey, 'Responding to the Threat of Biological Weapons,' *Security Dialogue* 26, no. 4 (December 1995), p.393. According to open source publications, the classified Nuclear Posture Review states: "Today's nuclear arsenal continues to reflect its Cold War origin, characterized by moderate delivery accuracy, limited earth penetrator capability, high-yield warheads, silo and sea-based ballistic missiles with multiple independent reentry vehicles, and limited retargeting capability. . . . New capabilities must be developed to . . . find and attack mobile and relocatable targets, . . . to improve accuracy and limit collateral damage." (US Department of Defense, *Nuclear Posture Review Report 2001*. The original is a classified document, for the quoted exerts see <http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm> (3 June 2002).

125 C. Paul Robinson, *Maintaining a Viable Nuclear Weapons Program in a Test Ban Environment: A Strong Technical Foundation in the Laboratories, Speech at Nuclear Security Decisionmakers Forum*, 28 March 2000, <http://www.sandia.gov/media/speeches/NSDMF2000.doc> (6 June 2002). As a possible remedy to self-deterrence in regional conflicts, the development of battlefield nuclear weapons with a yield of around 1000 tons equivalent TNT or less has been proposed

already in 1991, but these proposals have not led to new weapon designs so far (see Thomas W. Dowler and Joseph S. Howard, 'Countering the Threat of the Well-armed Tyrant: A Modest Proposal for Small Nuclear Weapons,' *Strategic Review* 19, no. 4 (Fall 1991), p.34-40. See also C. Paul Robinson, *A White Paper: Pursuing a New Nuclear Weapons Policy for the 21st Century*, (Albuquerque: Sandia National Laboratories, 2001) <http://www.sandia.gov/media/whitepaper/2001-04-Robinson.htm> (7 August 2002); Bailey, *op. cit.*, p.393.) The Bush Administration has taken tentative measures to address this problem, with the study of modified nuclear weapons (Robust Nuclear Earth Penetrator, which is not a low-yield weapon), steps to reduce the time needed to test a weapon (from currently five years), and the proposed lifting of a ban on the development of weapons with a yield of less than five kt.

126 Although the new Bush administration did not take up the development of this technology as a high priority, space-based kinetic interceptors and space-based lasers are being favoured by several experts (see for example Commission on Missile Defense, *Defending America* (Washington D.C.: The Heritage Foundation, 1999); Cooper, *Defending America from Offshore Missile Attack*; Robert Kagan and Gary Schmitt, 'Now May We Please Defend Ourselves?,' *Commentary* 106, no. 1 (July 1998), pp.23-24., Gregory Canavan, *Space-Based Missile Defense: Has its Time Come?*, Remarks presented at the George C. Marshall Institute Roundtable on Science and Public Policy, Washington D.C., 16 May 2001.) and could still be deployed in the future.

127 Office of the Press Secretary, op. cit.

128 See for example Hans Binnendijk and George Stewart, 'Toward Missile Defenses from the Sea,' *The Washington Quarterly* 25, no. 3 (Summer 2002), pp.193-206.

129 Ball, *op. cit.*, p.246.

130 Ibid., p.137.

131 John Baker and Douglas H. Paal, 'The U.S.-Australian Alliance,' in *America's Asian Alliances*, eds. Robert D. Blackwill and Paul Dibb (Cambridge, MA: The MIT Press, 2000), pp.90-95.

132 Commonwealth of Australia, *Defence 2000: Our Future Defence Force*, pp.25-36.

133 For details on the US cooperations see J.D. Crouch, *Statement on Missile Defense Program Progress before the Senate Armed Services Committee*, 18 March 2003.

134 The system could be operational by fiscal year 2007: *Yomiuri Shimbun*, 22 June 2003, quoted in Ilan Berman, ed., *Missile Defense Briefing Report* no. 109 (Washington D.C.: American Foreign Policy Council, 26 June 2003), <http://www.afpc.org/mdbr/mdbr109.shtml> (10 July 2003).

135 *Korea Times*, 19 June 2003, quoted in Berman, *Missile Defense Briefing Report* no. 109.

136 *NATO Prague Summit Declaration*, 21 November 2002, §4(g).

137 The Assembly of the Western European Union, the interim European Security and Defence Assembly, *Recommendation 703*, adopted 5 December 2001, contained in *Antimissile defence: the implications for European industry*, Document A/1759, p.3.

138 Eccleston, *op. cit.*, p.1.

139 James Bennett, 'The Emerging Anglosphere,' *Orbis* 46, no. 1 (Winter 2002): pp.111-126.

IV. Technology of Ballistic Missile Defence Systems

140 For background on this and the following sections, see Missile Defense Agency, 'Ballistic Missile Defense Challenge,' *MDA Fact Sheet*, April 2003, pp.1-2; *Tanks, National Missile Defense: Policy Issues and Technological Capabilities*, pp.3.1-3.6; Michael A. Dornheim, 'Missile Defense Design Juggles Complex Factors,' *Aviation Week & Space Technology* 146, no. 8 (24 February 1997), pp.54-56; Richard L. Garwin, 'Technical Aspects of Ballistic Missile Defense,' *American Physical Society Forum on Physics & Society* 28, no. 3 (July 1999), <http://www.aps.org/units/fps/newsletters/1999/july/index.html> (17 July 2003); American Physical Society Study Group, *Report on Boost-Phase Intercept Systems for National Missile Defense* (College Park, MD: American Physical Society, 2003), pp.345-350.

141 Sophisticated missiles like the SS-27 can manoeuvre during midcourse.

142 For details see the Space and Missile Defense Technical Center (SMDTC) website at <http://www.smdc.army.mil/TechCenter/KEID/ADLT.html> (16 July 2003).

143 Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.3.6-3.10.

144 The beams of phased array radars are electronically steered and not mechanically directed by a rotating dish.

145 U.S. early warning radars loose 30% resolution if the beam is directed 45^{o} from their boresight.

146 For a detailed discussion of different radars see American Physical Society Study Group,*op. cit.*, pp.173-187. The study mostly considers issues of range and speed of detection, not requirements for midcourse intercept.

147 Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.3.20-3.26.

148 Besides their obvious advantage of being lethal over a longer range than conventional warheads, nuclear-tipped missile interceptors could also reliably neutralize incoming biological warheads. Dowler and Howard, *op. cit.*, pp.34-40.

149 See for example the examples of THAAD cueing in Commission on Missile Defense, *op. cit.*, pp.30-32. For technical background on cueing, see Dror Cohen, Eitan Yariv, and Ayala Gur, 'External Cueing,' in *Theater Ballistic Missile Defense*, ed. Ben-Zion Naveh and Azriel Lorber (Reston, VA: American Institute of Aeronautics and Astronautics, Inc., 2001), pp.181-204.

150 See especially Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.3.15-3.18.

151 Dornheim, *op. cit.*, p.55.

152 John B. Peller, *Testimony before the Senate Armed Services Committee on Missile Defense Programs*, 24 February 1999.

153 For background, see for example the testimonies before Congress by MDA Director Ronald T. Kadish, *Testimony on Ballistic Missile Defense Acquisition before the Senate Armed Services Committee, Prepared Statement*, 13 March 2002; Ronald T. Kadish, *Senate Appropriations Committee, Defense Subcommittee, U.S. Senator Daniel Inouye (D-HI) Holds Hearing on FY 2003 Defense Appropriations*, 17 April 2002; Ronald T. Kadish, *Statement before the Senate Armed Services Committee on Missile Defense Program Progress*, 18 March 2003.

154 For background, see for example the discussion on risk in US Department of Defense, *Quadrennial Defense Review Report* (Washington D.C.: Government Printing Office, 2001), pp.57-66.

155 Kadish, *Statement before the Senate Armed Services Committee on Missile Defense Program Progress*.

156 Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.4.15-4.18.

157 Dror Cohen and Eitan Yariv, 'Interoperability Between Defense Systems,' in *Theater Ballistic Missile Defense*, ed. Ben-Zion Naveh and Azriel Lorber (Reston, VA: American Institute of Aeronautics and Astronautics, Inc., 2001), p.174.

158 For background on the block-structure and the BMD program, see: Missile Defense Agency, 'Fiscal Year (FY) 2004/FY 2005 Biennial Budget Estimates Submission,' *Press Release*, no date given.

159 For background on the relative capabilities of various sensor systems in BMD roles, see American Physical Society Study Group, *op. cit.*, pp.159-204.

160 US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment),' *FY 2004 Budget Justification Material*, February 2003, p.79.

161 Binnendijk and Stewart, *op. cit.*, pp.193-206.

162 For details see US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment),' pp.107, 108, 114, 120.

163 Ibid., pp.22-23.

164 Kadish, *Statement before the Senate Armed Services Committee on Missile Defense Program Progress*; Michael Sirak, 'DoD eyes new ballistic missile defence radar,' *Jane's Defence Weekly* 39, no. 6 (12 February 2003), p.6.

165 David Foxwell and Joris Janssen Lok, 'Naval TBM defense matures,' *Jane's International Defense Review* 31 (January 1998), pp.33-34.

166 Jeremy Stocker and Robin Ranger, 'Re-thinking ballistic missile defence,' *Global Defence 2000*, <http://www.global-defence.com/2000/pages/seabalst.html> (22 July 2003).

167 Foxwell and Lok, *op. cit.*, p.32.

168 The satellites rotate and the IR scanner is oriented at an angle to the rotation axis, so that it is sweeping over the surface of the earth in a circular movement. The revisit rate of the scanner of a given area on this circle, i.e. the rotation rate of the satellite, is 10 seconds for the DSP satellites.

169 Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.3.12-3.13.

170 US Department of Defense, 'Under Secretary of Defense Aldridge Roundtable,' *News Transcript*, 2 May 2002, <http://www.defenselink.mil/news/May2002/t05022002_t0502aldridge.html> (7 June 2002).

171 For background on SSTS, see for example Missile Defense Agency, 'Space Tracking and Surveillance System (STSS),' *MDA Fact Sheet*, April 2003.

172 'Early Warning Sats Set,' *Aviation Week & Space Technology* 158, no. 11 (17 March 2003), p.36.

173 Missile Defense Agency, 'Ground Based Midcourse,' *MDA Fact Sheet*, April 2003, p.2.

174 Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.3.15-3.17-18.

175 For details on the GBI program, see US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment)'.

'176 For a short overview see Missile Defense Agency, 'Aegis Ballistic Missile Defense,' *MDA Fact Sheet*, April 2003.

177 Ballistic Missile Defense Organization, *Summary of Report to Congress on Utility of Sea-Based Assets to National Missile Defense* (Washington D.C.: Department of Defense, 1999), pp.11-12.

178 US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment),' p.124.

179 Binnendijk and Stewart, *op. cit.*, p.202.

180 Commission on Missile Defense, *op. cit.*, p.70.

181 Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, p.5.7.

182 While the current LEAP has a significant capabilities against SRBM, MRBM and IRBM in low space, it is doubtful that it could intercept anything but a massive first-generation ICBM warhead without countermeasures, and only if it was delivered in front of its intended target. (Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.5.6-5.7.) Even if fitted with a booster with 4.5 km per second burnout velocity, the SM-3 would have difficulties in defeating ICBM during their ascent phase since the launch ship has to be within a certain area relative to the launch point of the ICBM. An interceptor launched under the ICBM trajectory and 600 km downrange from the launch point of the ICBM would for example nearly inevitably miss since it is not known where the ICBM will be at the end of its boostphase, and the LEAP does not have enough divert potential nor speed to make significant corrections to its course. Waiting for a preliminary track-file to be established after the burnout of the ICBM would not be possible since the missile would be too high for the interceptor to reach it at that time (at around 1.100 km). The only possibility for destroying an ICBM with a 4.5 km per second interceptor thus lies in launching several interceptors from about 1,200 km downrange of the targeted missile at possible intercept points, which have to be determined mostly by guesswork, and hope for the best. (For a

detailed discussion of this problem see Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.5.11-5.13.) Because of this launch-geometry problem, SM-3 would not be a reliable system for the intercept of ICBM (unless they are flying on depressed trajectories). Solid-fuelled ICBM which boost faster than liquid-fuelled missiles will have an even better chance of survival. See also the summary of various think-tank proposals and BMDO reports on the ICBM-intercept capability of the SM-3 in P.K. Ghosh, 'Naval NMD: The Concept of Expanding NMD Seawards,' *Strategic Analysis* XXV, no. 8 (November 2001), pp.897-919.

183 For a discussion of possibilities of defending against ICBM with NTW, see Ballistic Missile Defense Organization, *op. cit*.

184 US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment),' p.79.

185 For a good overview, see Foxwell and Lok, *op. cit*., pp.28-34.

186 US Department of Defense, 'Under Secretary of Defense Aldridge Roundtable.'

187 US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment),' pp.79-82..

188 For a good overview on US systems (including the cancelled Navy Area Wide system), see Henry L. Stimson Center Working Group, *op. cit*., pp.3-14.

189 Joris Janssen Lok and Richard Scott, 'Lines are drawn for transatlantic launcher battle,' *Jane's Defence Weekly* 37, no. 22 (29 May 2002), p.30.

190 Christopher F. Foss, 'Aster 30 missile to receive ATBM capability,' *Jane's Defence Weekly* 32, no. 4 (28 July 1999), p.10; Stocker and Ranger, op. cit.; Nicholas Fiorenza, 'European Missile House,' *Armed Forces Journal International* (August 2002), pp.18-19; John D. Morrocco, 'Aster 30 Air Defense Missile in Countermeasures Test,' *Aviation Week & Space Technology* 155, no. 1 (2 July 2001), p.71; 'New Exocet, ATBM Aster Set,' *Aviation Week & Space Technology*, 157, no. 18 (28 October 2002), p.35; 'Aster integration picks up speed as tests near completion,' *Jane's International Defense Review* 32 (November 1999), p.6.

191 Federation of American Scientists, 'Patriot TMD,' *FAS Website*, <http://www.fas.org/spp/starwars/program/patriot.htm> (28 July 2003); 'Patriot Missile Air Defence System, USA,' *army-technology.com*, <http://www.army-technology.com/projects/patriot/index.html> (28 July 2003).

192' Arrow 2 Theatre Ballistic Missile Defence System, Israel,' *army-technology.com*, <http://www.army-technology.com/projects/arrow2/index.html> (28 July 2003); 'Israel's Arrow Missile Defence: Not Ready for Prime Time,' *Center for Defense Information Website*, <http://www.cdi.org/missile-defense/arrow.cfm> (28 July 2003).

193' 'THAAD Theatre High Altitude Area Defense Missile System, USA,' *army-technology.com*, <http://www.army-technology.com/projects/thaad/index.html> (28 July 2003).

194 Kadish, *Statement before the Senate Armed Services Committee on Missile Defense Program Progress*.

[195] US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603881C Ballistic Missile Defense Terminal Defense Segment),' *FY 2004 Budget Justification Material*, February 2003.

[196] The aircraft has three laser systems: A small laser, guided by IR sensors in the aircraft, determines the distance between the aircraft and the missile. Based on this information, a second laser measures the atmospheric turbulences in the line of sight between main mirror and the missile, and generates the data necessary for their compensation by the adaptable mirror. The third laser is the main laser which is delivering the energy that destroys the missile (by penetrating its hull or by expanding it and creating an aerodynamic asymmetry).

[197] Kadish, *Statement before the Senate Armed Services Committee on Missile Defense Program Progress*.

[198] American Physical Society Study Group, *op. cit.*, pp.xxxix, 131-144.

[199] Details on the BMDS interceptor can for example be found in Michael Sirak, 'USA works on kinetic energy interceptor,' *Jane's Defence Weekly* 39, no. 1 (8 January 2003), p.2; 'US proceeds with enhanced ballistic-missile interceptors,' *Jane's International Defense Review* no. 36 (May 2003), p.2.

[200] A recent study by the American Physical Society doubted the possibility to achieve kinetic boost phase intercept of ICBM. (American Physical Society Study Group, op. cit.) But its assumptions and results are not uncontested. See for example Henry F. Cooper, 'APS Study On Space-Based Interceptors: Garbage In, Garbage Out!,' *High Policy Strategic Policy Issue Briefs* no. 87 (17 July 2003), <http://www.highfrontier.org/2003_issue_briefs.html> (30 July 2003).

[201] On air-based kinetic kill vehicles for boost-phase intercept, see David R. Vaughan, Jeffrey A. Isaacson and Joel S Kvitky, *Airborne Intercept: Boost- and Ascent-Phase Options and Issues* (Santa Monica: RAND, 1996).

[202] For an overview on the Brilliant Pebbles program which developed a space-based kinetic interceptor system and was validated in the Clementine missions to the moon, see Cooper, *Defending America from Offshore Missile Attack*.

[203] US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment),' p.114.

[204] On the one hand, MDA is working on advanced miniturized kill vehicle technology which would make higher velocities with existing (or future) boosters possible. On the other hand, it is not clear whether existing ships and VLS can structurally support 6,5 km per second boosters, (Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, p.5.8.), nor whether faster boosters would fit into existing VLS.

[205] Gopal Ratnam, 'Pentagon Pursues Mini Missile Killers,' *Defense News* 18, no. 24 (16 June 2003), p. 32.

[206] Robert Wall, 'Pentagon Eyes Additions To Anti-Missile Arsenal,' *Aviation Week & Space Technology* 156, no. 23 (10 June 2002), pp.20-21.

[207] Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.5.13-5.17.

[208] Graham, *op. cit*.

[209] For details see David Tanks, *Assessing the Cruise Missile Puzzle: How great a defense challenge?* (Washington D.C.: Institute for Foreign Policy Analysis, 2000), pp.26-28.

[210] Barbara Opall-Rome, 'Israel Eyes Solar-Powered Airship Abilities,' *Defense News* 18, no. 28 (14 July 2003), p.14.

[211] Gopal Ratnam, 'Radar to Scan Australian Skies, Waters for Threats,' *Defense News* 18, no. 20 (19 May 2003), p.23.

[212] Cooper, *Defending America from Offshore Missile Attack*, pp.42-47. The possibility of converting SM-2 IV has also been found possible in American Physical Society Study Group, *op. cit.*, pp.xl, 94-96.

V. Australian Ballistic Missile Defence

[213] Defence Minister Senator Hill has mentioned both the protection of expeditionary forces and some form of national missile defence as 'a value' for Australia. Robert Hill, *Interview with David Bevan*, 16 July 2003.

[214] Commonwealth of Australia, *Defence 2000: Our Future Defence Force*, pp.29-32.

[215] Commonwealth of Australia, *Australia's National Security: A Defence Update 2003*, p.17.

[216] Although this could suddenly change in case of a worsening of relations with states that can afford to import missiles (see Chapter II).

[217] See on this point Paul Dibb, 'Australia's Alliance with America,' *Melbourne Asia Policy Papers* 1, no. 1 (Melbourne: University of Melbourne, 2003); Paul Dibb, *Does Australia need a new defence policy?*, Blake Dawson Waldron Lecture, Australian National Museum, Canberra, 22 July 2003.

[218] Ball, *op. cit.*, pp.238-239.

[219] In fact, Australia "lost its innocence" in BMD 25 years ago with the use of DSP data passing through the Narrungar facility to US Safeguard interceptors in North Dakota. See Ron Huisken, 'ABM vs BMD: The Issue of Ballistic Missile Defence,' *Working Paper* 357 (Canberra: Strategic & Defence Studies Centre, Australian National University, 2001), pp.11-16.

[220] Crouch, *op. cit*.

[221] Kadish, *Statement before the Senate Armed Services Committee on Missile Defense Program Progress, Q&A session*.

[222] Crouch, *op. cit., Q&A session*.

[223] E.C. Aldridge, *Testimony on Missile Defense Program Progress before the Senate Armed Services Committee, 18 March 2003, Q&A session*.

[224] The convoy of maintenance troops that was attacked by Iraqi forces after taking several wrong turns near Nasiriyah on 23 March 2003, the fourth day of the war, was on its way to support Patriot batteries near Najaf, which was only reached by the bulk of the division the following day: 'Iraq Analysis,' *Jane's Intelligence Review* 15, no. 7 (July 2003), pp.12, 15.

[225] Robert Wall, 'Dangerous Missile Mix Sparks Scrutiny,' *Aviation Week & Space Technology* 159, no. 1 (7 July 2003), pp.47-48.

226 Crouch, *op. cit*.

227 The US Navy E-2 Advanced Hawkeye aircraft will for example be integrated into the missile defence network. Jason Sherman, 'Hawkeye Plan Moves Forward,' *Defense News* 18, no. 20 (19 May 2003), p.22.

228 Unless a missile is attacked by several boost-phase intercept systems simultaneously (e.g. ABL and BMDS Interceptor). But since both systems will be using the same track-files for the targeted missile, their success probability will be more correlated than between two layers which attack in different flight phases.

229 Department of Defence, *The Australian Defence Force Capability Fact Book* (Canberra: Department of Defence, 2000), p. 4; Department of Defence, 'AEW&C Contract Signed," Press Release MIN390/00, 20 December 2000, <http://www.defence.gov.au/dmo/ascd/air5077/min390_00.cfm> (8 August 2003).

230 Sherman, 'Hawkeye Plan Moves Forward,' p.22.

231 For a discussion of S-band AWACS radar capability in the boost-phase intercept role, see American Physical Society Study Group, *op. cit.*, pp.180-185.

232 Department of Defence, *Defence Capability Plan, Public Version* (Canberra: Department of Defence, 2001), pp.117-118.

233 Martin Agüera, 'Global Hawk Goes To Europe,' *Defense News* 18, no. 25 (23 June 2003), p.25.

234 Michael Sinclair-Jones, 'JORN assures Early Warning for Australia,' *Defence Systems Daily*, 29 February 2000, <http://defence-data.com/features/fpage37.htm> (8 August 2003).

235 Don Sinnott, 'Introduction to Over the Horizon Radar,' in *Data Visualisation for DSTO Over-the-Horizon Radar R&D*, ed. Rod Barnes, <http://www.rsinc.com/AppProfile/idl_es_dsto.cfm> (8 August 2003).

236 Ray McNally, 'Jindalee Operational Radar Network Project,' *Audit Report*, no.28 (Canberra: Australian National Audit Office, 1996), p.3.

237 Sinclair-Jones, *op. cit*.

238 Ratnam, 'Radar To Scan Australian Skies, Waters for Threats, p.23.

239 Missile Defense Agency, *Project DUNDEE Fact Sheet*, August 1997, <http://www.acq.osd.mil/bmdo/bmdolink/html/dndefs.html> (6 October 2003).

240 'DUNDEE,' *Global Security.org Website*, <http://www.globalsecurity.org/space/systems/dundee.htm> (6 August 2003).

241 Gregor Ferguson, 'Australia, U.S. Discuss SBIRS Collaboration Effort,' *Defense News* 14, no. 42 (25 October 1999), p.10.

242 At the time, the Keating government relaxed the refusal to participate in any BMD development to allow the DUNDEE testing, which was seen as a part of 'politically correct' TMD research. Huisken, *op. cit.*, p.13.

243 For a short discussion of Australia's need for an AWD capability, see J.P.M. Shervlin, 'Maritime Air Warfare for the RAN,' *The Navy* 62, no. 1 (January-March 2000), pp.22-24.

244 Department of Defence, *Defence Capability Plan, Public Version*, pp.263-264.

[245] Mark Thomson, 'Setting a Course for Australia's Naval Shipbuilding and Repair Industry,' *Australian Defence Magazine* 11, no. 6 (June 2003), p.28.

[246] Roger Thornhill, 'SEA4000, Where to from here?,' *The Navy* 63, no. 2 (April-June 2001), pp.3-5.

[247] Andrew Robertson, 'The RAN and Air Warfare Destroyers,' *The Navy* 64, no. 2 (April-June 2002), p.5.

[248] Patrick Walters, 'Defence's $2bn blowout threatens firepower,' *The Australian*, 6 August 2003, p.1.

[249] Department of the Navy, *Highlights of the Department of the Navy FY 2004 President's Budget* (Washington D.C.: Department of Defense, February 2003), p.3-3.

[250] Jason Sherman, 'Pentagon Suggests Taiwan Shop for Used European Sub,' *Defense News* 18, no. 28 (14 July 2003), p.3.

[251] Thornhill, *op. cit.*, p.3.

[252] See for example Schweikert, *op. cit.*, pp.7-11, which concentrates on the now cancelled SM-2 IVA, and Mueller, *op. cit*.

[253] Shane Green, Mark Riley and Mark Metherell, 'Nuclear chill stirs China to action,' *Sydney Morning Herald*, 16 July 2003, p.1.

[254] Gregor Ferguson, 'Australian Navy To Fund Advanced Radar,' *Defense News* 18, no. 24 (16 June 2003), p.20.

[255] Thornhill, *op. cit.*, p.5.

[256] On the Kidd-class destroyer, see Federation of American Scientists, 'DDG-339 KIDD-class,' FAS Website, <http://www.fas.org/man/dod-101/sys/ship/ddg-993.htm> (19 August 2003). On the AN/SPS-48C, see Federation of American Scientists, 'AN/SPS-48C Radar,' *FAS Website*, <http://www.fas.org/man/dod-101/sys/ship/weaps/an-sps-48.htm> (19 August 2003).

[257] Schweikert, *op. cit.*, p.11; Mueller, *op. cit.*, p.10.

[258] Charles C. Swicker, 'Theater Ballistic Missile Defense From The Sea,' *Newport Paper* 14 (Newport, RI: Naval War College, 1998), pp.30-33. See also Ballistic Missile Defense Organization, op. cit.

[259] Mueller, *op. cit.*, p.21.

[260] 'Japan sets sights on $25m US missiles,' *Canberra Times*, 23 August 2003, p.19.

[261] Swicker, *op. cit.*, pp.33-36, 48-50.

[262] This limitation does not concern space-based systems.

[263] For an intercept of the most basic ICBM without decoys or reduced signature, the capability to discriminate is not vital: The US block 2004 capability, for example, will be able to function — albeit with a lesser kill probability — without the sea-based X-band radar. But the track-files for intercepts by Australian GBI have to be calculated without data from early-warning radars, a reduced kill probability is only acceptable as an interim situation, and the sophistication of ICBM technology will make improved target discrimination capability necessary in the future. Australia therefore has to include a X-band radar capability into its GBI architecture.

[264] Such a gap could also occur in the target tracking function, but is less likely since more systems can contribute to this function.

[265] It should therefore be forward located from the interceptor battery. Kadish, *Statement before the Senate Armed Services Committee on Missile Defense Program Progress, Q&A session*.

[266] Congressional Budget Office, *Letter to the Honorable Thomas A. Daschle on Estimated Costs and Technical Characteristics of Selected National Missile Defense Systems*, 31 January 2002, pp.12, 19.

[267] US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment),' pp.22-23, 42.

[268] Tanks, *National Missile Defense: Policy Issues and Technological Capabilities*, pp.4.16-4.17.

[269] It does though include the refurbishment of the three silos. US Department of Defense, 'MDA Exhibit R-2A RDT&E Project Justification (PE 0603882C Ballistic Missile Defense Midcourse Defense Segment),' p.25.

[270] The Congressional Budget Office only published combined estimates for interceptors, battle management systems and radars. Yet it estimated that a site with 150 interceptors, added in 2012, would add a cost of $US 5 billion to $US 6 billion between 2002 and 2015, including development and operation. (Congressional Budget Office, *op. cit.*, p.11.) Under the somewhat dubious assumption of scalable costs, this would indicate a price of between $US 1 billion and $US 1.2 billion for development, production and three-year operation for 30 interceptors.

[271] Australian officers are already working there on US DSP/SBIRS data. Ball, *op. cit.*, p.243.

[272] Arrow is designed to have a 90% single-shot kill probability. Leslie Susser, 'Will the Arrow Find Its Target?,' *Jerusalem Post*, 4 November 2002, p.18.

[273] 'USA to fund third Arrow battery for Israel,' *Jane's Defence Weekly* 29, no. 17 (29 April 1998), p.3.

[274] In 2000-2001, 3.244 commercial cargo ships made 21.542 visits to Australian ports. Bureau of Transport & Regional Economics, 'Australian Sea Freight 2000-02,' *Information Paper* no. 48 (Canberra: Department of Transport and Regional Services, 2003), pp.43-45.

[275] Slogan at: Claremont Institute, *Ballistic Missile Defense Website*, <http://www.missilethreat.com/frameset.html> (19 August 2003).

VI. Conclusion and Recommendations

[276] For a short overview on the idea of a 'system of systems,' see articles by William (Bill) Owens, 'The Emerging System of Systems,' *Proceedings* 121, no. 5 (May 2002), pp.36-39; 'The American Revolution in Military Affairs,' *Joint Forces Quarterly*, no. 10 (Winter 1995-96), pp.37-38.

[277] The only exception would be use of BMD in the defence of the nation against a regime that is intent on destroying Australia as a goal in itself, and not to use this threat 'merely' for coercion or deterrence.

[278] It is interesting that even in a publication by the Land Warfare Studies Centre on the future Australian Army 'Ground-based Aerospace Defence,' the only system mentioned in connection with missile defence is the SEA 4000. David Connery, 'GBAeD 2030: A Concept for Ground-based Aerospace Defence in the Army-After-Next,' *Working Paper* 119 (Canberra: Land Warfare Studies Centre, 2002), p.21.

[279] Michael Evans, 'Australia and the Quest for the Knowledge Edge,' *Joint Forces Quarterly* (Spring 2002), pp.41-51.

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