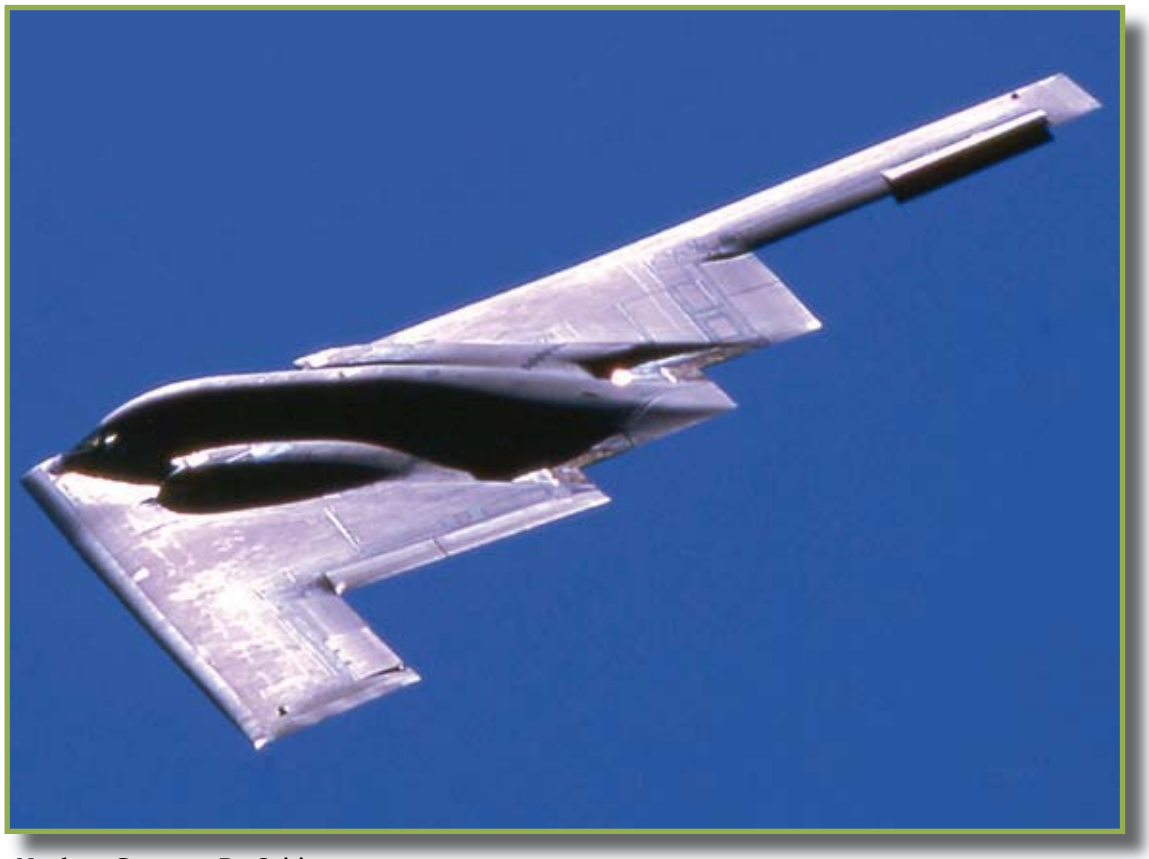
Perspectives on the Revolution in Military Affairs and Network Centric Warfare:

Challenges for the UK network enabled capability programme

By Wg Cdr S W Wray

Network Enabled Capability (NEC) has its roots in the concept of Network Centric Warfare (NCW) that is a central theme of the ongoing Revolution in Military Affairs (RMA) debate. This paper will argue that the UK is right to pursue NEC for the Armed Forces, although there is a need for careful management and leadership as it is a multi-faceted and challenging programme that carries high risk. In doing, so it will broaden the scope of the analysis beyond the UK perspective and argue that the RMA is more evolutionary by nature and that the advantages of NCW are likely to be transitory. It will show that, in the complex and fluid post-Cold War security environment, military force has greater utility and will be used on a broad spectrum of military tasks in which NCW has varying degrees of effectiveness. It will expose some of the pitfalls of relying on technology and consider the wider challenges to the NCW concept. It will



Northrop Grumman B-2 Spirit

The increasing use of advanced information systems and the proliferation of information technology, indicate that information may be achieving a more direct and decisive role in warfare

then address the findings with specific reference to the UK NEC programme, highlighting the key issues that must be addressed if it is to be successful.

The late 20th century and early years of the 21st century are widely considered to be the beginning of a new epoch in human history. It is commonly accepted as being the beginning of the information age and commentators are speculating upon the impact that this will have on societies and economies.[1] In the military arena similar debates are taking place amidst arguments that we are on the cusp of a Revolution in Military Affairs (RMA) brought about by the information era. Cebrowski argues that, 'this is the most important RMA in the last 200 years and that it is a natural progression in military evolution with its organizing principle antecedent in modern economies'. He argues that, 'Information Technology has undergone a fundamental shift from platform-centric to network-centric computing and as dominant business competitors have made the shift to network-centric operations and translated information superiority into competitive advantage, so must the military'. 'Just as in the business world, network-centric operations allow a detailed understanding of the competitive space allowing a shift from attrition style warfare to much faster war fighting characterised by speed of command and synchronisation.'[2] Much of this theory appears to be supported by experience in conflicts in Iraq, Kosovo and Afghanistan where superior information technology, sensors,

precision-guided munitions and stealth technology have all contributed towards decisive military victories. RMA theorists suggest that, 'the increasing use of advanced information systems and the proliferation of information technology, indicate that information may be achieving a more direct and decisive role in warfare'.[3] One key RMA concept is that of Network Centric Warfare (NCW).[4] This term contrasts with 'platform centric warfare' where emphasis is placed upon numbers of weapon platforms such as tanks, ships and aircraft and focuses not on individual assets but on the interconnected whole.[5] The principal perceived benefit is that it enables smaller more mobile forces to act with disproportionate effect as shared awareness among them improves situational awareness allowing the generation of overwhelming tempo and manoeuvre.[6] 'Combat power is concentrated using netted sensors and information, coupled with agile forces, precision munitions and combined command and control connectivity to spin decision loops so fast that the enemy is paralysed.'[7]

The US is committed to pursuing a bold NCW programme and most of the militaries in the West, particularly those that are potential coalition partners, are considering what NCW means for them. The UK announced its intent to pursue the benefits of NCW in the Strategic Defence Review-New Chapter and since then has evolved the thinking to create the concept of Network Enabled Capability (NEC). This embraces the concepts of NCW, yet is less ambitious than the US programme. Nevertheless, the perceived benefits of both programmes are synonymous and thus much of the analysis centred on US thinking is applicable to NEC. UK NEC is planned to have initial interconnection in 2007 leading to maturity in 2025-2030. It is still early days and many challenges remain, the principal one being affordability.[8] Since the end of The Cold War, the Defence Budget has been under pressure to reduce expenditure and the potential for NEC to deliver military effect with fewer platforms is therefore seductive to both the military and politicians alike.

Proponents of NCW argue that we must embrace the concept ahead of any potential adversaries given the widespread access to advanced technology. Indeed, US General H Shelton remarked, '*The proliferation of advanced technology is so extensive that many of our adversaries in the next century will have capabilities they could only dream about in this one*'.[9] These arguments seem compelling. However, there are sceptics in equal number who offer equally convincing thoughts. Some question the validity of the RMA and the assumptions of the advantage offered by NCW.[10] The Force reductions associated with the introduction of NCW systems alarms others who argue the continuing need for ships to enforce embargoes, soldiers to enforce peace and aircraft to patrol no fly zones.[11] 'For some the concept is nothing more than a military mirage where defence convinces itself falsely that technology will change everything.'[12]

This paper will evaluate whether the UK is right to pursue NEC, particularly as it is likely to place considerable pressure on the Equipment Programme requiring significant reductions in platform numbers to fund its introduction. NEC thinking has its roots in the RMA and, in doing so, it will broaden the analysis to consider the wider origins and assumptions of the RMA and evaluate whether this is truly revolutionary or evolutionary, drawing on historical examples to support the argument. It will then examine the factors affecting the post-Cold War security environment and consider the utility of military force in the contemporary world before evaluating the effectiveness of NCW enabled forces in carrying out the types of military tasks that are likely in the future. Finally, it will outline some of the risks of reliance on technology including potential strategic and political considerations. It will then draw these threads together with a specific focus on the UK NEC programme highlighting the key challenges that must be addressed if this programme is to be successful.

The revolution in military affairs

The recognition of a RMA is fundamental to accepting fully the benefits that the proponents of NCW have declared. Many of the arguments that surround its validity remain unanswered: despite this, many western military and political leaders,

led by the US, have already accepted that NCW will revolutionise conflict in the future. Under the pressures of shrinking defence budgets in the post-Cold War era, they are already planning force reductions whilst offsetting the increased operational risk against the perceived benefits of NCW. The US is fully committed to NCW and in May 2001, President Bush called for '*a future force that is defined less by size and more by mobility, swiftness and one that relies more heavily on stealth, precision weaponry and information technologies*'.[13] The UK has accepted a similar vision laying out a view where 'combat power is not measured in terms of numbers of platforms and people but in an ability to measure effect with a robust network at the core, linking key capabilities and force multipliers'.[14] The reductions in platform numbers may yet be premature whilst the RMA debate remains inconclusive. 'Revolution' is a heavily loaded word that may be misused by those attempting to influence policymakers.[15] This section will outline what constitutes a RMA, disclose the origins of the current RMA debate and examine whether it constitutes a revolution or merely an evolution. It will draw upon historical examples to illustrate the importance of this distinction and the implications for the future of NCW.

Many contending definitions of a RMA have been made: that offered by the Office of the US Secretary of Defense is clear, stating: '*a RMA is a major change in the nature of warfare brought about by innovative application of new technologies which, combined with dramatic changes in military doctrine and operational and organisational concepts, fundamentally alters the character and conduct of military operations'*.[16] It is recognised that RMAs comprise four main elements: technological change, system development, operational innovation and organisational adaptation.[17] Their nature is such that warfare is transformed in profound ways and, throughout history there have been a number of such revolutions. Gunpowder produced an early military revolution transforming both land and naval warfare and, during the 19th Century, industrialisation transformed warfare through railways, the telegraph, steam engines, rifled guns and ironclad ships. More recently, mechanization led to the development of Blitzkrieg, carrier aviation, amphibious warfare, and strategic bombing.[18] These changes were rooted in technology, but are dependant upon new operational concepts, doctrine and organisation to realise their benefits.

Origins and evolution of the current RMA debate

The current term, RMA has evolved from an earlier one, used by Soviet military theorists who used the term Military Technical Revolution (MTR). They identified 2 periods of fundamental military change in the 20th Century: one driven by the emergence of aircraft, motor vehicles and chemical warfare in World War 1 and the 2nd driven by the development of nuclear weapons. In the early 1980s, they argued that advances in microelectronics, precision guidance and automated control systems would bring about the next MTR.[19] The success of coalition forces in Operation Desert Storm convinced many of the validity of this view where the use of an impressive array of high technology weapons allowed a US-led coalition to defeat the world's 4th largest army in a remarkably short period of time.[20] The use of precision weapons captured the attention of the world's media and shaped mass perceptions of the war as being characterised by advanced technology enabling a decisive victory.

The orthodox view of the victory focuses on the coalition strengths and, especially its superior technology. It suggests that surveillance, air defence suppression, stealth and precision guidance systems gave coalition aircraft total command of the sky and the ability to find and destroy Iraqi ground forces at will. This in turn enabled the Coalition to destroy the Iraqi's equipment and morale in a six-week air campaign without exposing itself to a potentially costly land battle. Similar arguments are applied to the use of technology in the ground war where advanced systems such as thermal sights and more advanced tanks allowed the Coalition to strike with virtual impunity. Others argue that the Coalition's manoeuvre warfare concepts, enabled by advanced navigation and communications technology, allowed them to outflank the static Iraqi defenders.

An F/A-18 Hornet armed with GBU-12 Paveway II laser-guided bombs

Future war will be characterised by precision attack and the struggle for information supremacy will replace the breakthrough battle as the decisive action

Critics of these views have argued that Iraqi shortcomings and not coalition strengths were the main reason for the defeat. In particular, they argue that an unmotivated, dispirited Iraqi army simply did not fight back. Poorly led and with low morale and inadequate training they were little match for the well equipped, professional Coalition forces.[21] Each of these views has validity, but it was in the information domain that the most revealing observations can be made. The war saw a comprehensive use of information and its denial to the enemy. Information was at the hub of all Coalition activity and the destruction of Iraqi command, control and communication networks led to their inability to employ their forces effectively.[22] The initial air attacks destroyed much of Iraq's ability to defend itself and early targeting of radar sites and command and control centres aimed to deprive them of useful information from the outset. With their information networks paralysed, Iraqi forward units found themselves dislocated from their leaders and at the mercy of Coalition forces. In contrast the coalition made use of advanced communication systems, airborne surveillance and satellites to gather detailed information for their commanders.[23]

Operation Desert Storm was understandably dubbed the first information war. Despite this, the reasons for the ease and decisiveness of the Coalition victory have been the subject of much debate and are probably attributable to a combination of factors alluded to above. The overall impression of the part that technology played is perhaps misleading. For example, more 'dumb' than 'smart' bombs were used and the effectiveness of the Patriot air defence missile was overstated. Despite the wide range of surveillance systems available, targets were not always found or destroyed and collateral damage not always avoided. In practice, the fusion of sensors and communications data, which is the essence of NCW, was far from complete and in many cases improvised, leaving important deficiencies. Notwithstanding this, it was evident that the concept of information warfare could be developed and taken further and so the RMA debate was born.[24] The broad assumptions of those who support the case for a RMA are that future war will be characterised by precision attack and the struggle for information supremacy will replace the breakthrough battle as the decisive action.[25]

Information revolution or evolution?

Information has always been a critical factor in war. Clausewitz said, '*imperfect knowledge of the situation . . . can bring military action to a standstill'* and viewed information as, *'a factor more vital than any other'*.[26] The dominant argument in the RMA debate is that 'information dominance' will alter the nature of future wars. Many analysts argue that information is synonymous with the RMA as it is technology that provides the means to exploit it.[27] Indeed, this assertion is central to the concept of NCW; information is the enabler that allows the commander to exploit tempo, manoeuvre and to break the enemy decision cycle. The computer provides the ability to collate, analyse and distribute data in huge volumes and at high speed to multiple recipients simultaneously. Moreover, multiple sources of data can be fused, manipulated and displayed faster than ever before and therefore it would appear that the value of information to the war fighter has been magnified to a new level.[28] However, closer consideration would seem to dilute this view, as military commanders have always understood the value of information. Field Marshal Slim noted its importance in the Burma Campaign where he attributed the Japanese early success to their possession of sound information compared to his almost total lack of useful information on their strength, movements or intentions.[29] Sun Tzu identified deception and the need to deny the enemy information as a key facet of warfare and numerous other historical examples illustrate its importance. The use of smoke screens to conceal movement on medieval battlefields and elaborate deception operations during World War 2 illustrates both the enduring nature and importance of information dominance. Therefore, we must conclude that the value of information remains a constant, but it is the utility of modern technology in managing it that is magnified in importance.

Access to advanced information technology is not the right of wealthy nations with technologically advanced militaries. In the information age, in contrast with the historical norm, civilian markets and not military ones often drive state-of-the-art technology. The newest weapons increasingly employ commercial off-the-shelf technology and secure communications, access to global positioning and high-resolution earth observation satellites and advanced computing technology are widely available.[30] This ease of access makes it almost inconceivable that adversaries of NCW-enabled militaries will not seek to develop similar capabilities or effective countermeasures. Admittedly, the cost of technology may preclude many actors from gaining access to the most advanced systems. However, many argue that rogue enemies will be able to develop readily available information technology in to a range of innovative responses in what Barnett terms, '*The Radio Shack scenario'*.[31] NCW proponents flirt with the deniable assumption that an enemy will lack the ingenuity to disrupt a network and to validate the claims of delivery of revolutionary advantage they have assumed a predictable enemy.[32] The danger of underestimating the enemy is as perilous as overestimating our own ability. Sun Tzu said, '*Know your enemy and know yourself; in a hundred battles you will never be defeated'*.[33] These words seem particularly relevant when considering

Blitzkrieg in action: German armoured vehicles advancing (AHB RAF)

Co-ordination of firepower from armour, infantry, artillery and air, coupled with concentration, surprise, speed and continuity were its strengths

the grand assumptions of NCW that have yet to be tested.

Advanced information technology will provide a framework for NCW and if integrated with changes to doctrine and operational concepts it could deliver significant military advantage. However, the accessibility of technology makes it highly likely that competitors will also seek to utilize this to their own advantage. Revolution has been described as the logical progression of an existing system or framework, while revolution connotes a fundamental break with precedent.[34] The enduring importance of information to the military commander and the likely widespread development of technology-based military capability suggests that the move in to the information age is perhaps more evolutionary than revolutionary.

Warnings from history

Robert F Baummann notes that, '*Thinking deeply about the future requires careful reflection on the past'* noting that, '*by its very nature, war exhibits much continuity amid change'*.[35] This is certainly true if we consider historical perspectives on the likely impact of NCW. History is filled with examples where technological breakthroughs have had a profound impact on warfare, such as the introduction of gunpowder, the combination of gun and sail, and the advent of the machine gun to name a few. In all these cases, new technologies provided a basis for advantageous shifts in doctrine, organisation and strategy enabling the innovator to avoid exhausting attritional battles and to pursue a form of decisive warfare.[36] These changes share one common feature in that none has delivered an advantage that has been enduring. The spread of technology and/or the development of countermeasures has ultimately eroded the advantage of the innovator and history offers two examples that indicate that we should expect the advantages offered by NCW to be short lived: The German Blitzkrieg and the Royal Air

Force defensive network made famous during the Battle of Britain.

Blitzkrieg

Blitzkrieg or 'Lightning War' overwhelmed the armies of Europe in 1939 and 1940. It is often interpreted as a RMA in its own right, but its life and effectiveness were short-lived as the Soviet Army eventually exploited its weaknesses at the Battle of Kursk in1943. It had its origins in 1918 when, in the dying days of The Great War, the trench stalemate had been disrupted by the introduction of the tank and by the influence of ground support air operations. Following The War, Lt Col Heinz Gudeirian studied armoured warfare and, as a General in 1938, he was the architect of the Panzer Divisions. Guderian had specialised as a signals officer between 1914 and 1917 and it was at his insistence, that every tank was fitted with a radio and armoured command vehicles provided for divisional commanders. The Panzer concept was purely offensive and relied on armoured units driving a wedge through defences and bypassing centres of resistance as they moved toward their objective. The commander controlled the battle from just behind the main thrust and units could respond immediately to orders given over the radio network.[37] Armour, however, was only one aspect of Blitzkrieg and co-ordination of firepower from armour, infantry, artillery and air, coupled with concentration, surprise, speed and continuity were its strengths.[38] These principles remain relevant today and are enshrined in the manoeuvrist theory demonstrating how the original concept has evolved. Nevertheless, Blitzkrieg relied on tanks that could not move without the complex support of other arms. The Red Army eventually evolved their own tactics to defeat the overstretched German tank formations with the highly effective and plentiful T34.[39] Blitzkrieg was enabled by technology through the advent of mechanized warfare, radio communication and integration of air power. The doctrinal innovation of Guederian gave the Germans a significant advantage in 1939, but the Soviet success indicates how tactics can be devised to defeat the strengths of the innovator once the critical weaknesses are understood.

Battle of Britain

The Battle of Britain campaign made the Spitfire and Hurricane fighters of the Royal Air Force into legends, but the keystone of the British defence was the complex machinery of detection and command and control that ran the battle. This was known as the 'Dowding System' after its chief architect Air Chief Marshal Sir Hugh Dowding. In 1936 he was charged with the task of building an air defence force capable of stopping daylight bomber raids and created a system utilising radar and other visual reporting methods that is widely recognised as the worlds first integrated air defence system.[40]

Dowding's system began with early warning detection of incoming raids by radar stations lined along the coast. They would also be tracked visually from a network of ground stations that picked up aircraft that penetrated the radars. Reports were passed to Fighter Command Headquarters where the information would be plotted allowing controllers to co-ordinate a response. This simple yet ingenious system allowed the RAF to concentrate their fighters where they were needed achieving high rates of interception. The Germans had also been developing radar since 1934 and had achieved considerable sophistication by 1939, but had failed to realise its significance and potential.[41]

The Dowding System integrated emerging technology into an innovative command and control structure and fighter doctrine that maximised the combat effectiveness of the limited RAF fighter assets and thus, it had all the key components of a RMA. However, radar technology was already available to the enemy and, once they had recognised its potential they were able to develop their own integrated air defence system. By the time of the Allied Combined Bombing Offensive against Germany in 1943, they had developed a complex system involving radar, reporting stations and anti-aircraft artillery. Today integrated air defence relies on more advanced technology, but the essential elements of detection and command and control remain at their core indicating how the proliferation of technology can erode the advantages of the innovator.

McDonnell Douglas F-4J Phantoms of US Navy Squadron VF-194, flying from the *USS Coral Sea*, intercept a Tupolev Tu-95RT 'Bear D' over the Pacific, March 1977

During the Cold War, international security was dominated by the militarized confrontation between the West and the East where the bi-polar rivalry was intense, the danger of war was real, and the military dominated the security agenda

As we enter the information age, it is clear that advanced information technology will transform our ability to exploit information. Its value has been understood throughout history and it is, therefore, inevitable that enemies will utilise readily available technology to develop NCW

capabilities or effective countermeasures. This indicates an evolutionary change in the nature of warfare where the advantages of the innovator are likely to be eroded as indicated by contemporary historical examples.

Future security threats and the utility of NCW

This paper has postulated that the information age will herald an evolution rather than a RMA and that the advantages offered by NCW will be eroded. The impact of the technology is as real as it is irreversible and information systems and complex weaponry are a reality for the future. Force reductions and re-structuring of the remaining elements is the immediate impact for militaries that embrace NCW and, although the concept is to lessen the advantages of size, there is considerable operational risk as the key proponents agree that it will take years of careful leadership to make NCW work.[42] This is an important point as the post-Cold War era has brought a new range of security threats that have heralded a period of unparalleled uncertainty. Moreover, the role of Western militaries has been expanded beyond conventional war fighting to include a range of tasks classified as Operations Other Than War (OOTW).[43] In critically assessing the wisdom of acting on the assumptions of the RMA, it is important to consider the potential threats to security in the future and the suitability of NCW enabled forces to address these.

Post-Cold War security environment

The end of the Cold War had a profound impact on the international system and consequently, the concept of security underwent dramatic changes. During The Cold War, international security was dominated by the militarized confrontation between the West and the East where the bi-polar rivalry was intense, the danger of war was real, and the military dominated the security agenda. There now exists a multi-polar world in which there is neither a major ideological divide nor a dominating power rivalry. The US is the sole remaining superpower and in this new international environment, military and political security is no longer a predominant concern. Instead, economic, societal and environmental security assume greater prominence for many countries in the world. If the security issues during The Cold War were primarily related to bi-polar ideological and military rivalry between the East and the West, then the security concerns after the Cold War are more rooted in the economic disparity between the wealthy and poorer nations.[44]

The effects of globalization and the continuing influences of decolonization make the complexity of the new security environment worse where the increasing blurring of borders and the diffusion of political and economic power is eroding the position of the nation state as the principal foundation of international order.[45] The net effect is to change the character of the participants in the international arena and, although nation states remain the primary actors, international organizations such as the United Nations, the European Community and non-governmental organizations such as, Médecins Sans Frontières, play increasingly important roles. In addition, trans-national actors such as, the media, multinational corporations, terrorist groups, drug cartels and countless others, are able to exercise considerable influence on international relations.[46]

This new world order is characterized by multi-actor, multi-dimensional, multi-regional security agendas that are more complex, more fluid and more uncertain. In the short term, large scale inter-state conflict appears unlikely as the spread of liberal democracy increases interdependency and makes it in the interests of neither protagonist. The principal threats arise from failing states where ethnic tensions, economic insecurity and mass migration promote intra-state conflict. Western powers are likely to intervene in so-called, 'wars of choice' in what Hirst terms, '*cosmopolitan law enforcement*'.[47] In the longer term, the geo-strategic balance of power may be disrupted, perhaps by the emergence of China as a great economic and military power, or through a resurgent Russia acting alone or in an alliance. Tensions are likely as nations compete for scarce resources such as oil, food and water. The effect of global warming and environmental changes may have a prolific effect on nations leading to greater instability in international order. Finally, the proliferation of

weapons of mass destruction (WMD) will promote regional and global tensions that could also alter the balance of power.[48] The threats are plentiful and diverse and will continue to challenge military planners in the future. Military operations seem more complex in this fluid environment and the tasks more diverse. In addition, military forces will have to interact with a wider range of agencies and may find themselves working alongside coalition partners or non-governmental agencies.

Utility of military force in the new era

At the end of The Cold War, many hoped that military force would have diminishing relevance to international security. That hope now seems to have been misplaced, war is being threatened or waged in various regions and the remaining super-power is showing greater propensity to use military force. The removal of the constraints that the Cold War enforced appears to have led to an increase in the utility of military power.

It is difficult to imagine a nation that could become a peer competitor to the advanced Western militaries, particularly a US led coalition. However incredible this may seem, a strategic view of the potential rise in the military strength of China or India, for example, would not exclude the possibility

A Sukhoi Su-30K Flanker of No 24 Squadron, Indian Air Force, landing at Gwailor during Exercise Cope India 2004

The current international system rests on an order dominated by the USA. The loss of the inherent military tensions of The Cold War has already seen examples of the increased utility of force through focused Western intervention in the former Yugoslavia and by Russian Forces in Chechnya. In The Cold War, the risks of the spread of conflict were so high that they made such actions unlikely. The events of 11 September 2001 added a further dimension to contemporary conflict and the subsequent 'War on Terrorism' has heralded a new type of warfare where the traditional views of victory and defeat are being challenged. Despite this, US policy towards these issues has military force as a central element of its strategy and her willingness to use military force, as witnessed in Afghanistan and Iraq, leaves little doubt as to the importance of force as an instrument of policy. Therefore, the persistence and utility of conventional military power in the international system seems assured, at least for the near future.

NCW in the new security environment

The complex post-Cold War security environment presents a number of challenges for military planners characterized by the increased spectrum of military tasks, the increased utility of military force and the uncertainty and instability in the international system. How well does NCW fit the various forms of conflict likely to be faced in the near future? The available material concentrates on high-intensity, high-tempo war fighting which is understandable as many of the relevant technologies had their origins in the Cold War period. Moreover, the importance of Operation Desert Storm to the RMA debate has ensured that high-intensity operations remain a central focus for discussion. Notwithstanding this, concentrating on this form of warfare at the exclusion of all others is a mistake as, in the post-Cold War era, high-intensity warfare is not the only form likely to be encountered and certainly not the most likely. The broad spectrum of military operations will see high-intensity combat at one end of the spectrum with routine military presence at the other.[49] Even if Western powers face a diminished threat of major conflict with another state they would be wrong to ignore this as it could take at least 30 years for NCW to reach its full potential.[50] During this time, the geo-strategic situation could have altered markedly given the range of potential longer-term threats to international security. Nevertheless, in the shorter-term, collective intervention under international legitimacy or humanitarian operations represent the most likely use of military force.[51] It would, however, be misleading to characterize such operations as low intensity or non-combat in nature. They could involve belligerents with formidable conventional forces and, even the most modest of operations, could involve short periods of high-intensity fighting.[52] Accepting that there is the potential for a broad spectrum of operations, it is necessary to consider the utility of NCW enabled forces in meeting the various tasks that might be faced.[53]

NCW theorists concentrate much of their attention on war fighting operations that are characterised by, 'force on force' combat with opposing forces where the immediate objectives sought are largely military.[54] In such an action, the potential impact of NCW is well documented. The ability of sensors to identify and target enemy forces for destruction using highly accurate weapons whilst long-range weapons strike a vast array of strategic targets simultaneously could be devastating to an enemy. The impact could easily shock and dislocate his forces rendering them incapable of effective resistance allowing a brief and decisive campaign.[55] However, Barnett is disparaging of such a vision doubting that NCW will meet an enemy worthy of its technical prowess. In support of this view he highlights that the US spends more on information technology than all but a couple of powers spend on their entire military budget.[56] It is difficult to imagine a nation that could become a peer competitor to the advanced Western militaries, particularly a US-led coalition. Nevertheless, however incredible this may seem, a strategic view of the potential rise in the military strength of China or India, for example, would not exclude the possibility. History provides many examples of potential competitors rapidly elevating themselves to peer competitor status and Japan and Germany prior to World War II offer just such an example.[57] Regardless of the emergence of a peer competitor, the advantages that NCW allows in a, 'force on force' encounter is likely to be relevant to a broad

range of operations. Many OOTW could involve short high-intensity clashes; the recent US counter-insurgency operation in Falujah during the post conflict phase of Operation Iraqi Freedom is a good example. However, the advantage that NCW could offer in combat is potentially eroded by the sociological complexity of modern warfare. Self-imposed restrictions of a political, moral or legal nature complicated by public intolerance of casualties (both friendly and enemy) and the intense media coverage of modern conflict could potentially force restraint on operations that would negate some of the benefits that NCW offers.[58] A fight against an enemy who possessed even a modest NCW capability of his own could erode the advantage yet further but notwithstanding these points, modern information technology is here to stay and the conflict environment is changing. The information age will not bypass warfare and there is the opportunity to gain a war fighting advantage. To ignore this may pass the advantage to others who choose to take the initiative and, having argued that the impact of information technology is evolutionary rather than revolutionary, it seems essential that the initiative is not lost. Thus in the context of high-intensity war, there seems little alternative but to embrace the concept of NCW.

OOTW include most military activity other than, 'force on force' encounters. Such operations are unlikely to require the defeat of enemy forces but rather some objective that does not necessarily require the use of violence. Activities may include relatively benign operations such as deterrence, power projection, peace enforcement, humanitarian relief or the evacuation of non-combatants from crisis zones. In the emerging broader security context, they might also include operations against criminal organizations or terrorist groups and opponents could include paramilitary or guerrilla forces.[59] Any of these could involve an element of combat in line with Krulak's concept of what he termed, 'The 3-block war'.[60] In any case, they are likely to be more challenges involving coalitions with broader political involvement and restrictive rules of engagement. Furthermore, casualty tolerance is likely to be a more prominent concern and the international media will undoubtedly be present. Recent examples of the type of operations that can be expected include the UN intervention in Bosnia and the US/UN involvement in Somalia. Assistance to the Kurds in Northern Iraq and interventions in Sierra Leone and East Timor are further examples that illustrate both the diversity and potential frequency of such operations. Their nature is such, that the core war fighting capabilities that NCW enables, are less effective. However, even modest advances in sensor technology and the ability to collect, analyze and disseminate intelligence will improve situational awareness and be of importance in these demanding scenarios.[61] Barnett argues that, 'a correctly structured NCW enabled force would, in the non-combat environment, be able to establish an information umbrella to boost the transparency of everyone's actions'.[62]

Clearly, many common support activities such as logistics and force protection would benefit from aspects of NCW and the importance of these should not be overlooked.[63] The most significant weakness of NCW with respect to non-combat operations is the reduction in force sizes required to pay for it. Non-combat operations require troops to be present on the ground to establish a degree of direct contact between intervening forces and the local population and the concept that NCW could eliminate such a need is fanciful.[64] Experience in operations in Kosovo, Bosnia and the post-conflict phase of Operation Iraqi Freedom bears out this view. Without the presence of significant numbers of troops there would be a very real danger of winning the war, but losing the peace.[65] The value of NCW in OOTW is therefore less clear. The principal advantages of NCW are best suited to combat although improved situational awareness and support operations also has much to offer in a non-combat environment. The rub is that the payoff for enabling NCW is force reductions. Presence is an essential element of non-combat operations and there will continue to be a need for, 'boots on the ground' in what are likely to be the most demanding and frequent of future operations.

The attacks on New York and Washington

in September 2001 were a startling instance of asymmetric warfare and since then it has become a prominent concern of policymakers. It is frequently spoken of as a new and emerging threat, but in reality it is nothing new as the term simply means fighting an enemy by using forces, tactics or strategies that are dissimilar to his.[66] Asymmetric attacks are relevant to the entire spectrum of the security environment and could be employed by states, non-state actors, terrorist groups or individuals. Western states present tempting targets for asymmetric attacks due to the openness of their societies, sensitivity to casualties and dependency on complex social and economic infrastructure. Furthermore, the effects of globalization, modern communications, ease of travel, proliferation of weapons technology (including WMD) and the presence of global news networks have all increased the potential impact of asymmetric actors.[67] The disparity between the conventional military capabilities of the major Western powers and potential enemies dictates that asymmetric attacks are likely. Paradoxically, any additional military advantages that are offered by the introduction of NCW could increase the attraction of an asymmetric response from enemies who cannot threaten directly the superior forces.[68] This conundrum, however, need not be considered as the important question is what strengths and weaknesses NCW will have in the face of such threats.

The inherent flexibility, situational awareness and responsiveness of NCW-enabled military forces will, in some respects, decrease their susceptibility to asymmetric attacks as rigid and inflexible organizations present greater opportunity for an enemy to act asymmetrically. Moreover, having considered the advantages that NCW offers in non-combat operations, it is intuitive that similar advantages will be applicable to asymmetric threats. We have already seen the success that conventional forces can have in combating irregular, non-linear forces in the US intervention against the Taliban in Afghanistan. Information and access to it will always be an important aspect of any military action and NCW could offer advantages against asymmetric threats at all levels of conflict. It is important, however, to consider the vulnerability that NCW could introduce. Modern military forces are already highly dependent on information networks for command, control and logistic support. Operations are dependent on uninterrupted availability of a complex system of networks and they will become more so as NCW evolves.[69] The concept of '*Cyberwar'* introduces a significant threat to this reliance and a significant opportunity to the asymmetric enemy. Cyberwar involves disrupting if not destroying information and communication systems to alter the balance of information knowledge in one's favour especially if the balance of forces is not.[70] It does not necessarily require the presence of high technology, is not dependent on kinetic effect and may involve electronically blinding, jamming deceiving, overloading and intruding into adversaries systems.[71] The spectrum of potential adversaries' is expanded markedly when considering that the entry level to such activity may require nothing more than a computer. As NCW theory and the supporting technology evolves it is difficult to envisage what shape such threats might take but the vulnerabilities were revealed when a teenager using a personal computer hacked his way in to the US military computer network gaining access to information on the dispute with North Korea over its nuclear programme.[72] To simply assert that such threats will be negated by enhanced security measures is to assume the ascendancy of technology and ignore the ingenuity of man.

In an age where the security environment is uncertain and where there is increased utility of military force, advances in information technology will continue to offer enhancements to weapons and other military systems. It therefore seems essential to embrace the opportunities offered by NCW to maintain the military advantage and to retain the initiative ahead of potential competitors. NCW may offer greatly improved effectiveness in high-intensity combat and an element of this can be expected, to some extent, across the entire spectrum of military tasks. Moreover, greater situational awareness and improvements to common activities, such as logistic support, suggest that NCW could have a positive effect in all types of operation. Notwithstanding this, there is a need to retain awareness of its limitations.

Numbers are important and there will remain a need for boots on the ground in all operations. Moreover, in an era where asymmetric attacks seem increasingly likely, we must remain alive to the vulnerability that NCW systems may inadvertently expose.

The technology trap

The Western militaries, led by the US, have historically sought technical solutions to security threats and have devoted costly resources to an expanding range of opportunities and now find themselves less able to afford to develop and procure the most complex modern weapons. This is what Garden termed, '*The Technology Trap*'. 'It has as its bait the neat solution, just like the cheese in a mousetrap'.[73] The costs of NCW enablement will be made affordable through reductions in platform numbers and this will be offset against NCW's effect as a force multiplier. With these benefits not yet fully clear, such a move carries a significant risk. Furthermore, technology alone cannot deliver the full benefits of NCW and major changes to force structures and military culture are required. In addition, NCW could impact significantly the interoperability of forces from different nations and have important implications for the alliance politics of the future. We must guard against technology as a means to itself rather than a means to an end and be aware of the potential pitfalls of over-reliance on technology. There are many of these that impact both the military and political sphere and this section will highlight a few of the most significant.

The integration of advanced information technology into military networks is central to the NCW concept, although we must take a cautious view of the, 'cheese in the mousetrap'. If the assumptions of NCW proponents are correct, it will allow smaller, more agile forces to act with disproportionate effect. The US is leading the way but as John Arquilla noted, '*American military power is so far beyond its nearest competitors today that it seems senseless to pursue the latest technological advances'*.[74] This is countered by the argument that the fact that no adversary currently threatens the military advantage should not slow preparation for new competition, as the comfort drawn from the size of forces, will be misplaced in an era of NCW as the whole idea is to lessen the advantages of size.[75] This counter argument assumes that a potential adversary will seek to develop NCW concepts and has some credibility as China is widely reported to be devoting considerable resources to the development of offensive information warfare capabilities to complement its improving conventional forces.[76] The question must be whether this is self-generated or in response to US intent. To pursue an answer to this would be wasteful of time and thought. Technology has, and will, continue to impact military thinking and in the information age it is implicit that advanced information technology will be embraced in some way. It could be argued that the concept of NCW is a pro-active visionary response to this inevitability. Even if NCW delivers the benefits it predicts, we must guard against the seduction of technology and consider the wider potential follies.

In the NCW environment, smaller forces will be deployed that will rely on the power of the network for their combat effectiveness. As a result, each platform or node becomes a high value asset and the loss of a single one could markedly degrade the effectiveness of a force. This highlights an obvious vulnerability and, in wars of choice, even modest losses of critical assets could have important strategic implications as the military options may be reduced to escalation or withdrawal.[77] Furthermore, in a NCW environment, the odds of technological failure are all the greater, particularly as opponents are likely to actively seek to confuse and disrupt the strength of the network.[78] Thus, there is a need to provide redundancy and strength in depth and not to expose obvious operational centres of gravity at the heart of the network. As deployed forces become lighter and rely more on non-organic fire support and taut logistics chains, the greater the risks in the failure of the network resulting in what Benbow called, '*a computerised Arnhem-style bridge too far or a digital Dien Bien Phu'*. [79] Finally, deterrence through the presence of armed forces is an important military task that is likely to retain a key role in OOTW. A reduction in platform numbers and force structures may have a counterproductive deterrent effect, as

smaller lightly armed forces could be less able to intimidate a target audience in the traditional way.[80] These examples graphically illustrate the dangers of the seduction of technology and the need to consider new vulnerabilities and any broader unintended secondary effects of its introduction.

Advanced information technology is at the heart of NCW, yet its introduction will not in itself realise its advantages. Future military success is not assured by the procurement of high technology platforms and military structures must be effectively organised to maximise the benefits.[81] NCW has the potential to flood the battlespace with information; however, the commander does not necessarily want more information, he wants better information delivered where and when he needs it.[82] NCW could become too technically complex and information could overwhelm the commander if the system is not constructed and organised properly.[83] Poorly managed information could lose wars and thus changes in military doctrine, training and operational and organisational concepts will be fundamental to the introduction of NCW systems.[84] It is true to say that this fact is recognised both in the US and the UK, but work in these areas is in its early stages. Despite this, NCW is in common military parlance and the term is liberally banded around. Without a proper understanding that NCW is as much about doctrinal innovation and changes to military culture as well as technology, the term could mean anything or nothing and this lack of clarity must be eliminated at the outset of any NCW programme. It seems counterintuitive that without a clear view of what these changes might be, the procurement of future systems is underway under the NCW banner. Unless the broader soft issues are understood and addressed, the introduction of costly and complex equipment may yet be another, 'technology-led military chimera'.[85]

The alliance implications of NCW are a problematic topic since it is influenced from matters that are purely technical to issues at the broadest political level. Alliance politics is a constantly evolving and complex subject that is inevitably subject to a large degree of speculation.[86] For this reason consideration here will be restricted to the issues associated with NCW interoperability. There is no doubt that the US is largely setting the agenda for NCW. They are, however, sympathetic to their allies concerns over interoperability and in their, 'Joint Vision 2020' document they state: '*Since our allies will have varying levels of technology, a tailored approach to interoperability that accommodates a wide range of needs and capabilities is necessary*'.[87] Notwithstanding this statement, maintaining parity with the US is likely to be prohibitively expensive for most nations and it is likely that many will have to find some form of compromise. Suggestions have included the development of national forces into smaller niche capabilities able to carry out specialist roles alongside the US. This solution appears attractive but requires a high degree of co-operation and understanding at the grand strategic and political level if such a move was to be practical. Another solution might involve a concept of two-tier forces where an upper tier of relatively small, high technology forces maintains interoperability with US forces whilst the second-tier of less advanced units is held back for less demanding operations.[88] This strategy also appears appealing, offering a skilful trade between affordability and the ability to remain fully engaged with the US on the military political stage. However, neither would seem suitable to any nation that wishes to retain an indigenous mix of balanced forces and the ability to act independently in a security operation. Freedman introduces the notion that '*The most important allies of the US will aim to stay abreast of technologies to gain access to US policy making in times of crisis and war*'.[89] This is certainly true and the desire to remain engaged with NATO, whilst also developing the Common European Security and Defence Policy framework will present many European nations with a dilemma. The UK may be more inclined to align herself with the US if there were diverging trans-Atlantic capabilities, although it is less clear what stance other European nations might take. Until a clearer picture of such programmes starts to emerge it is not possible to assess the alliance tensions that may be introduced by the prohibitive costs of NCW technology. Interoperability must be addressed at a political, as well as military level, for all nations who aspire to work in the alliances

of the future.[90] Alarmingly, little work seems to have been focused in this area to date.

Policy makers appear to have already been seduced by NCW technology. This section has sought to expose some of the dangers in relying on this as the panacea. It has highlighted a few potential strategic, cultural and political implications of the pursuance of NCW to illustrate this. These have not been analysed in depth and are by no means comprehensive. However, it is clear that nations who aspire to develop NCW capabilities must not address it as a purely technical initiative but rather a major programme with impact on a wide range of activities and across government.

Implications for the UK NEC programme

The UK has made clear its commitment to pursue NEC for the Armed Forces. This aspiration will continue to be challenged by affordability in an environment that is unlikely to see a decrease on the pressure on defence expenditure. Whilst it is less ambitious than the NCW programme favoured by the US, NEC shares its origins as a facet of the so-called RMA. History shows us that military technological advantages have tended to be transitory and given the likely gestation period of the NEC programme, we could see the advantages it offers eroded significantly by the time it reaches maturity. Thus, the reduction in platform numbers and force sizes required to fund the current aspirations could expose operational risks in the future in the light of the evolving capabilities of potential adversaries. The short-term challenge will be more acute as significant reductions are already planned in the early stages of NEC development and the additional risks that this exposes must be acknowledged and managed appropriately.

We have seen an increase in the deployment of UK forces, particularly on OOTW, since the end of The Cold War. This is not unexpected given the increase in the utility of armed force and the challenges and threats posed in the more complex and fluid international security environment. The trend can reasonably be expected to represent the norm for the foreseeable future although, in the longer term, changes in the geo-strategic balance of power and new security threats may change this. Although NCW and thus NEC's principal strengths lie in high-intensity combat, we can expect its introduction to benefit the full spectrum of military tasks. Nevertheless, the force reductions planned in advance of its delivery will place additional pressure on some elements of the Armed Forces that are already over-stretched. Without some reduction in current commitments, it is difficult to see how activity levels can be sustained and this will present a continual challenge prior to NEC reaching maturity. Moreover, fiscal pressures will mean that the UK will be forced to procure relatively small numbers of advanced platforms and systems. Therefore, even in the mature stages of NEC, UK forces may be vulnerable to disruption of their network and thus even limited attacks by conventional or asymmetric means could achieve a considerable effect severely limiting their combat effectiveness. The net effect of reduced force sizes and limited platform numbers could therefore create a number of critical weaknesses exposing obvious centres of gravity to adversaries.

NEC offers an attractive technologically based solution to the challenge of re-structuring the UK forces in the post-Cold War era and, although Western militaries have tended to favour such a strategy, there is risk in pursuing this route. Technology cannot provide an answer in itself and major doctrinal and cultural changes will be required to realise the benefits of NEC. At present UK doctrinal thinking appears to lag behind technology by some margin, although the term NEC is already in common use. Unless there is a clear vision for the development of NEC across the Forces, there is a real danger of the technological tail wagging the dog. Merely increasing the volume of information available is not the goal, but effective information management to meet a commander's needs is. This requires a clear understanding of the changes required to optimise command structures, develop networked operational concepts and training regimes to support them as well as ensuring maximum interoperability between force elements, and the ability to exploit information through

coherent hardware and software configuration management. These, 'soft' issues may prove more challenging than those that are purely technical and, therefore, priority should be given to their development in advance of the procurement of equipment under the NEC banner. To do otherwise is counterintuitive and risks a strategy driven entirely by available technology that fails to maximise the potential offered by NCW concepts. The UK military must guard against the temptation to be seduced by technology and recognise that the development of NEC is a major multi-faceted change programme and that the most important lines of development may not be technical. Interoperability, in both technical and doctrinal terms, with the US and European countries will impact on Alliance politics and will be a further challenge that could prove particularly difficult for the UK given its schizophrenic approach to US and European relationships. This issue highlights that the development of NEC should not just be a military lead activity as it has wider implications that require careful management across Government Departments. Moreover, we have argued that NCW delivers less obvious advantage in non-combat operations and in some traditional military tasks such as deterrence and power projection, smaller network-enabled forces may be less able to achieve the effects desired from a political perspective. These and other less obvious potential disadvantages must be considered throughout the development of the NEC programme and it is clear, therefore, that there is a need for high-level, cross-government involvement in the planning process and that this must be engaged from the outset.

Regardless of these issues, NEC is an essential aspiration for UK Forces and having argued the case for a technological evolution, it must be embraced if the UK is to maintain credible Armed Forces in the 21st century. Moreover, in order to remain a European ally of choice for the US there is little option but to follow their lead. However, realism must come in to play and affordability is the critical factor; the NEC vision is, without funding, a mirage. The success of the programme will depend on strong military and governmental commitment from the outset. The network will only be as strong as its weakest link and therefore, despite budgetary pressures, an integrated equipment programme must be developed and protected if NEC's full potential is to be realised and, more importantly, if potentially critical weaknesses through capability gaps are to be avoided.

The NEC programme presents both opportunity and risk. The Vice-Chief of the Defence Staff has stated that '*NEC is at the heart of our transformation to defend against the principal security threats of the future*'.[91] The recently published *JSP 777* outlines a structure for NEC project governance and recognises that it is a long-term programme subject to incremental development over time with broad stakeholder involvement. If it is to be successful, it must address fully the issues that have been highlighted here and there must be a clear understanding of the risks and opportunities at the highest level of government. If viewed purely as a military technological enhancement programme, there is a real risk that limited funding and ambiguous strategic guidance could derail the initiative and the UK could find itself with sub-optimal forces and subsequently marginalised by its key alliance partners.

Conclusion

NCW offers the potential for smaller more agile forces to act with disproportionate effect and is a key tenet of the ongoing RMA debate. History shows us that the military advantages gained through technological advances have tended to be eroded by the proliferation of technology or development of tactical countermeasures and we should expect the advantages of NCW to be transitory. The post-Cold War security environment is increasingly uncertain with a broad range of threats and we have seen an increase in the utility of military power where forces are engaged in a wide spectrum of military tasks. NCW has its principal strengths in high intensity combat, but improved situational awareness will benefit the full range of military tasks and, having argued that this is an evolutionary change, NCW should be introduced to retain the initiative. We must remain aware of its limitations including the

need for adequate forces to conduct certain types of OOTW and of the vulnerability of networks to asymmetric attack.

Western militaries have tended to favour technological solutions to problems, but there is a need to guard against the seduction of technology as reliance upon it as a panacea introduces risks. The vulnerability of critical platforms and nodes may provide opportunities to aggressors as their loss could degrade significantly the overall combat effectiveness of deployed forces. Moreover, smaller force structures may have less deterrent effect reducing their value in some types of operation and there is a need to recognize the potential strategic implications of these secondary effects of NCW enablement. Interoperability and its effect on alliance politics is a key issue that appears to have received little attention to date. This is a complex matter requiring high-level political involvement and has implications for NATO and the emerging CESDP.

The UK is right to pursue its own NEC programme to maintain credible forces in the modern environment. It is, however, a challenging programme with both risk and opportunity that requires high-level cross-government support in order to address the wider strategic issues. The dominant concern will be affordability and force reductions, as an offset to cost, will be a key area of risk requiring careful management. The NEC initiative must not be viewed as a technology enhancement project but as a major multi-faceted change programme requiring political and military leadership. If the programme fails the UK could fail to optimise its Forces and be marginalized among the key Western allies.

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Notes

[1] Lonsdale (2004) p 1.
[2] Cebrowski & Gartska (1998) p 1-5.
[3] Lonsdale (2004) p 2.
[4] In this context, NCW is taken to mean a type of warfare characterised by network-enabled operations and not the defence programme of the same name favoured by the US DoD.
[5] Benbow (2004) p 82.
[6] Burridge (2004) p27.
[7] Lescher (1999) p 58.
[8] Unattributable discussion 25 Oct 2004.
[9] Lescher (1999) p 58
[10] McColl (2004) p 52
[11] McColl (2004) p 55
[12] ibid p 52
[13] Mahnken (2001) p 1.
[14] Strategic Defence Review - A New Chapter (2002).
[15] Andrews (2002) p 1.
[16] Schneider & Grinter (1998) p 56.
[17] Krepinevich (1994) p 30.
[18] Schneider & Grinter (1998) pp 65-66.
[19] Galdi (1995) p 4.
[20] Arquilla & Rondfelt (1997) p 80.
[21] Biddle (1996) pp 3-4.
[22] Schneider & Grinter (1998) P188.
[23] Freedman (1998) p 30.
[24] Freedman (1998) pp 31-32.
[25] Biddle (1996) p 1.
[26] Arquilla & Rondfelt (1997) p 142.
[27] Benbow (2004) p 104.
[28] Schneider & Grinter (1998) p171.
[29] Lonsdale (2004) p2.
[30] Lescher (1999) p 59.
[31] Barnett (1999) p 37.
[32] Thomas (2004) p 9.
[33] Shibling (1993) p 106.
[34] Arquilla & Rondfelt (1997) p 80.
[35] Baumann (1997) p 1.
[36] Arquilla & Rondfelt (1997) p 24.
[37] Perret (1983) pp 55-75.
[38] Hallion (1989) p 145.
[39] Glantz & House (1999) pp251-254.
[40] Probert & Cox (1990) p 3.
[41] Terraine (1985) pp 173-179.
[42] Lescher (1999) p 63.

[43] Taken to mean the broader spectrum of military tasks including peace support, peace enforcement and humanitarian aid etc.

[44] Buzan (1991) pp 431-451.
[45] Benbow (2004) p77.
[46] Arquilla & Rondfelt p 87.
[47] Hirst (2001) p 87.
[48] Hirst (2001) pp 79-109.
[49] Benbow (2004) pp 132-133.
[50] Hirst (2001) p 90.
[51] Ibid p 96.
[52] Benbow (2004) p 135.
[53] Ibid pp 136-137.
[54] Benbow (2004) p 137.
[55] Ibid p 138.
[56] Barnett (1999) p 36.
[57] Schneider & Grinter (1998) p 71.
[58] Benbow (2004) p 152.
[59] Benbow (2004) pp 143-144.
[60] Krulak (1999) pp 1-7.
[61] Benbow (2004) pp 143-151.
[62] Barnett (1999) p 37.
[63] Benbow (2004) pp 147-153.
[64] Benbow (2004) p150.
[65] McColl (2004) p 53.
[66] Benbow (2004) pp 154-155.
[67] Ibid p 161.
[68] Benbow (2004) p 168.
[69] Podlesny (1999) p 51.
[70] Arquilla & Rondfelt (2004) p 30.
[71] Id.
[72] Schneider & Grinter (1998) p 192.
[73] Garden (1989) p 6.
[74] Arquilla (1998) p 42.
[75] Lescher (1999) p 62.
[76] Benbow (2204) p 161.
[77] Barnett (1999) p 38.
[78] Benbow (2004) p 92.
[79] id
[80] Arquilla & Rondfelt (2004) p 51.
[81] Ibid p 62.
[82] McColl (2004) p 54.
[83] Lescher (1999) p 60.
[84] McColl (2004) p 54.
[85] Ibid p 55.
[86] Benbow (2004) p 172.
[87] Benbow (2004) p 189.
[88] Ibid p 190.
[89] Freedman (1998) p 72.
[90] The constraints of this essay do not allow further analysis of this complex subject. However, 'Mind the Gap' addresses the subject in detail and offers potential strategies to address what is a key strategic issue.
[91] Foreword to JSP 377.