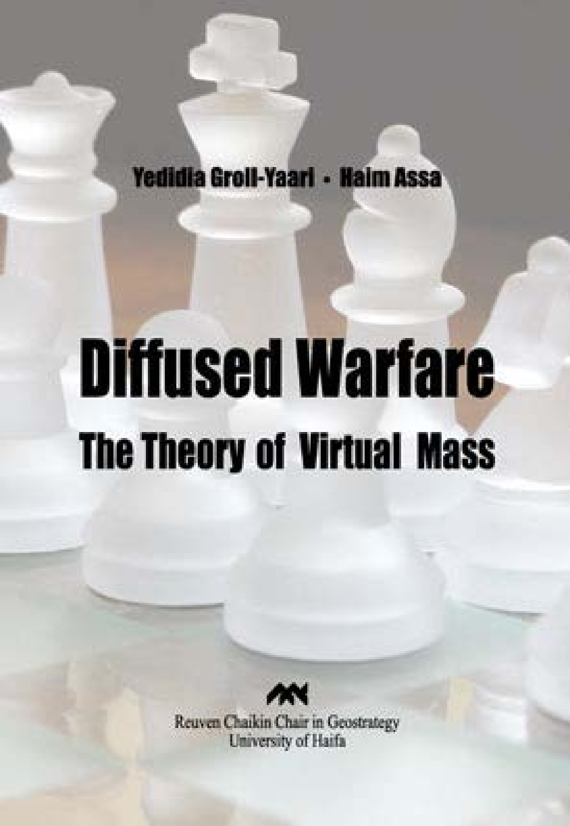

Yedidia Groll-Yaari • Haim Assa

Diffused Warfare

The Theory of Virtual Mass

Reuven Chaikin Chair in Geostrategy
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Haifa, February 2007

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Vice-Admiral (ret.) Yedidia "Didi" Groll-Yaari

Former Commander of the Israel Navy, 2000-2004. He embarked on his military career in special operations units of the Israeli naval commando, which he commanded from 1983 to 1986. He led dozens of operations and was twice wounded in action. A graduate of the USN Naval Command College, Newport R.I., he also holds a BA in Middle Eastern history from Haifa University and an MPA from Harvard's Kennedy School of Government. Presently he is President & CEO of Rafael, Israel's Armament Development Authority.

Haim Assa

Headed the (first) national security team of Israel's late Prime Minister Yitzhak Rabin from 1992 to 1995, later to formally become the National Security Council. He holds a BSc in Mathematics from the Hebrew University in Jerusalem and an MSc in Operations Research from the Technion in Haifa. He was a combat officer in the IDF Engineering Corps and was seriously wounded in action at 1970. He later served ten years as an analyst in the Operations Research branch of the Israel Air Force. He is a senior adviser to the Israel Defense Forces on military-strategic concepts and technologies. He is director of Nuomena for strategic research projects.

Reuven Chaikin Chair in Geostrategy, University of Haifa

This Chair is concerned with issues of national security that contain a spatial expression, such as natural resources and their distribution, population spread, physical infrastructure, and environmental elements.

The Chair publishes position papers, offers consultation to senior decision makers, initiates research projects, holds study days and conferences, publishes books and scholarly works, and assists research students in the fields listed above.

It likewise engages in the proliferation of these matters at high schools and academic institutions.

The Late Reuven Chaikin (1918-2004)

Reuven Chaikin was born in Tel Aviv, and became a senior partner in the Somekh-Chaikin accounting firm. He evinced deep interest in geography and geopolitics, and offered great assistance in these areas at the University of Haifa.

May his memory be for a blessing.

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Preface

This book was not initiated as an academic endeavor. It is based on ideas and notes accumulated during the spring and summer of 2003, while we were working as a 'red team' for Lieutenant-General Moshe "Boggy" Ya'alon, then Chief of the General Staff of the Israel Defense Forces (IDF). We thus forgo from the outset any aspiration to the scholarly perfection of systematic academic research.

We were not nearly as familiar with the writing and research of others in this area as one may rightly expect from academic researchers and, frankly speaking, we intentionally chose to ignore most of it, but for the fundamentals. The Palestinian Intifada was dragging on for the third year; operation Iraqi Freedom's first-phase showdown had just ended in a wave of professional admiration; and the task, as Lt.-Gen. Ya'alon put it to us, was to "tell us what we do wrong". So off we went straight out into the field to see if we could.

Not surprisingly, managing after a while to put our insights into comparable forms, we found a great deal of similarity in the writings of others in various military and geo-strategic capacities, which we referred to and considered as much as we were able. But these references can only hint at the range of references required to cover entirely what has been written on these difficult questions already.

We drew mainly on our own personal experience. The team, led by Vice-Admiral Yedidia "Didi" Groll-Yaari, then Chief of the Israeli Navy, had as its core Mr. Haim Assa, long time senior system analysis expert for the IDF, and co-author of this book, and Colonel Dror Ben-

David, an F-15 pilot and then head of operational requirements branch for the Israel Air Force (IAF). Long hours of brainstorming with Major-Generals Meir Klifi and Aviv Kochavi and with Colonel Nitzan Alon of the IDF ground forces brought in extensive experience and insights on land operations.

The core dilemma was the baffling phenomenon of incapacity of current military practice effectively to overcome and contain asymmetric threats. We felt that there had to be a way to reshape the huge advantage of modern military forces over their under-equipped diffused adversaries, such that it could make a meaningful victory attainable, despite the existing constraints on the use of force.

The practice of fusing vertical and horizontal lines-of-sight was born from concrete operational constructs and insights, by and large through trial and error. It was designed originally to flush out and track legitimate targets out of the 'noise-level'. Later it gradually developed into small-scale circles of shared real-time local pictures, which we finally enlarged and systemized into the concept of a network of 'world views'.

Much in the same way the lean, later 'molecular', force structure emerged. We were trying to optimize for asymmetric conflicts when we realized that these principles also applied to high intensity conflicts. That is, some variants of the diffused characteristics of asymmetric warfare, on various levels of applicability, will necessarily be part of future armed conflicts whatever form they take.

We ended up recommending some mix of linear and diffused force structures – although readers may feel that we have over-emphasized the weaknesses of linear warfare and perhaps over-stretched the advantages of diffusing the forces. True, we might have argued the case for Diffused Warfare somewhat too forcefully. But clearly, a balance between these two must be maintained and decided in each case, based on actual sets of concrete circumstances. And clearly, predicting in advance future requirements makes very little sense at this stage.

The point we do try to make in this book is that a great many deficiencies and irrelevancies present in the current linear mindset on force structure can not only be bypassed by the Diffused Warfare approach, but can also be transformed into a far more effective war-fighting structure.

Fault Lines or Fractures

Samuel Huntington's claim that the fault lines between civilizations will be the battle lines of the future has become a milestone in the analysis of contemporary international conflicts (Huntington 1996). The fault lines metaphor is taken from geology and connotes homogeneous tectonic plates – similar in structure and shape – colliding at the edges. Global politics however is much more complex, and Huntington's metaphor clearly provides only the outer contour of a more elaborate set of issues.

Perhaps one of the most profound outcomes of the processes described by Huntington from his perspective, as well as by others from macro-economics', is the apparent signs of change in the centrality of the nation-state as an entity in global politics. Fundamental socio-economic and demographic processes are increasingly placing limits on the practical power of single states.

They now find themselves constrained in their ability to exercise their legitimate right to use force; but beyond that, their ability to preserve their very identity seems impaired. We might in fact be witnessing a gradual process of ever-increasing challenge to nation-states' capacity to maintain their sovereignty.

In this book we do not intend to analyze global geopolitical and geo-strategic processes, or to deal specifically with Huntington's theory. Our focus narrows to current dramatic events in the evolution of warfare and to the structures of military force.

However, these macro-processes, whose effects are perhaps more noticeable in the internal turmoil in Third World and newly developing countries, have already made their mark in the West as well – and they imbue everything we have to say.

We no longer enjoy the luxury of safely assuming that the current nation-state system (embodied for better or worse in the UN) is a constant, while asymmetric conflicts, like the 'war on terror', constitute some sort of transitory phenomenon. In fact, we seem to be facing a reality in which the grave flaws in the immune system of the nation-states' structure are dramatically exposed, in the face of new 'viral', borderless, and stateless threats (Deleuze and Guattari 1988: 387).

On face value – as Friedman, Scruton, and many others point out, at work here are the effects of two main factors: globalization and terror (Scruton 2002). Yet as Philip Bobbitt argues, we may be in the midst of a much larger global movement that entails the transformation of the most fundamental tenets of the nation-state (Bobbitt 2003). Lebanon is perhaps the prime example of this process in the Third World. Under the veneer of a sovereign state, a constitutional democracy and a member of the United Nations a chaos of non-state armed organizations and ethnic groups exists, operated by domestic and external actors, which maintain tight control over national decision making. The Hezbollah, Iran, and until very recently Syria, maintain in Lebanon a global center for terrorism under the guise of a sovereign state that provides them with the necessary state legitimacy. The Lebanese armed forces subsist as a passive entity, while the Hezbollah with its Iranian consultants is deployed freely all over Lebanese sovereign territory.

Disintegration of state sovereignty at this high level is by no means the case in the West, of course. Presently it seems well nigh impossible. But so did September 11.

In Europe, the massive influx of Islamic minorities after World War II and the end of European colonialism have effected a fundamental change in the ethno-religious face of the continent. The underlying forces driving that change are still at work and the trend is not encouraging. Today the new European Islam is no longer a spiritual backpack carried in by the waves of immigrants from North Africa, Asia, and the Balkans that can conveniently be set aside and ignored. It has become an active, identity-defining mass, with a significant and increasingly militant presence.

The new European Islam flourishes within a European Christian society that itself underwent a centuries-long painful process of separation of Church and State. Canonic Islam does not recognize and cannot accept such a separation. Therefore, its strength and vitality as perhaps the only unifying force for the large immigrant communities in Europe, is immense, both because in this case, essentially, state does not imply homeland, and because on the most basic level state comes second to religion anyway.

True, this element was not yet at the forefront of the riots of November 2005 in France and Belgium. But these events, which exploded with such high levels of rage and frustration, clearly indicate that it would not take much for it to assume primacy in the future demographic reality of "Christian Europe".

So Huntington's fault lines are not the outer rim of the 'continental plates' of West and East, but are the fractures on the plate itself. That is, the friction is between neighborhoods in the same city, or among pupils at the same school.

Against this background, the prospects of Islamic minorities integrating into European societies in a way that places loyalty to one's new state above loyalty to one's old religion look even less promising. As we come to grips with current trends in Islamic militancy, the likelihood of these communities becoming a safe haven and nesting ground for future and much more volatile eventualities cannot be ignored. A process of significant decline in Europeans states' capacity to exert sovereignty over large portions of their populations is no longer unimaginable.

This is where terror, the second main factor, comes into play. As Roger Scruton points out, the Islamic international terrorist networks we face today are very different from the urban terrorist groups of the last century, in terms of their nationalistic and ideological rationales (Scruton 2002).

Osama bin Laden does not need a catalytic new theory to galvanize his followers, nor does he need a specific national struggle to pursue. Contrary to the anarchists or revolutionaries of last century he does not strive to lead society into some new phase in history's course. Rather, he urges his constituency to go back to, and reaffirm, their old roots.

The soil in which people like Osama bin Laden, Iman al-Zawahiri, Muhammad Atta, and Abu Musab al-Zarqawi thrive certainly underlies one specific civilization. But that in itself doesn't explain much. Shamil Basayev, the Chechen warlord responsible for some of the most gruesome terrorist actions of recent times, such as the Beslan school and the Moscow theater massacres, is hardly a member of their civilization. They do share religion and methods of terror, but for Basayev national freedom comes first and religion second (Murphy 2006).

What makes al-Qaeda's religious rationale so uniquely powerful is primarily its simplicity and the coherence of its message with the cognitive foundations of its constituency. If religion is the sole source of legitimate authority in an individual's life, than, when called upon to kill all infidels, this is precisely what he or she is obliged to do. The message is clear and uncompromising, and it springs directly from the teachings of the Prophet himself. It does not allow for interpretations and it receives renewed justification every single day – through the military, political, cultural, and socio-economic humiliation of the believers by the non-believers.

With such a powerful message further fueled by deepening ethnic-religious hostility against the Muslim world, that perpetual 'clash of constituencies' – rather than clash of civilizations – is bound to precipitate acts of global terrorism. Bin Laden is apparently justified in believing that he will never be short of Shaheeds (martyrs).

The result of all this is that our very concept of 'national security' stands before fundamental transformation (Bobbitt 2003).Until recently it was widely held that the existence of states could be threatened only by other states. This is no longer true. The threats posed by organizations dispersed among hostile or passive populations, and who have the ability to force their will on nation-states and even to topple governments – as occurred in March 2004 in Spain – are no less real. Al-Qaeda, or better, Islamic Jihad, is no less influential now in setting the world agenda than the G-8.

Somewhat paradoxically, the traditional aspirations of states to build their military and economic power may help to nurture the very processes that weaken their ability to maintain sovereignty in the contemporary world. For none of the main principles comprising the mindset of a balance of power or a hegemonic international system offers viable solutions to the challenges posed by asymmetric conflicts; in fact, these principles may only increase states' vulnerability. This is simply an altogether new threat requiring an altogether new approach.

In this book we focus on the military implications of the processes described above. We discuss how we believe these processes will affect the future battlefield, and to a lesser extent their impact in the civilian arena. It is already clear that the battlefield is undergoing significant changes, becoming more amorphous and global. To meet the challenges of the 21st century a fundamental revision of the parameters of military buildup and deployment is needed.

States' warfare doctrines need to be amended to encompass asymmetric threats. Regular state armies need to be equipped with new capabilities that allow them to adapt rapidly to changing conditions in the battlefield. Finally, the distinction between home-security and national defense is becoming increasingly blurred. Domestic and national sovereignty-enforcing agencies, such as the police, tax-collecting agencies, the national guard and the military, which already overlap in many areas of operation, will have to undergo fundamental changes in order to remain effective. These changes, inevitably, will put basic principles of civil rights to new tests (Bobbitt 2003).

Against this setting, states' military force structures are undergoing transformation. This book sets out to examine the merits of diffusion of the military's hierarchical-linear thinking and structure – a process that has already begun to take place, and to explore the implications of such diffusion on the nature and conduct of armed conflict in the future.

The Theory of Diffused Warfare

The military campaign in Iraq in March, 2003 provided, for the first time, the setting for a full-scale demonstration of the practical effects of the Revolution in Military Affairs (RMA), and particularly of Network-Centric Warfare (NCW).[1] The RMA, a thinking process that spanned most of the 1990s, has had a profound impact on almost every aspect of military thinking and conduct, and essentially has led to a paradigm shift, of which NCW is a key component (Blaker 1997; Vickers & Martinage 2004; Cebrowski & Garstka 1998; United-States - Department of Defense 2001; Onley 2004). The operations carried out by US and Coalition forces in different parts of the world since the early 1990s, particularly the current state of the war in Iraq and Afghanistan, and the more narrowly focused, yet occasionally more relevant experiences of the Israel Defense Forces (IDF) specifically in the last war in Lebanon and in the current conflict with the Palestinians, provide rich empirical data and combat experience for stocktaking of both RMA and NCW theory building and theory assessment.

This chapter summarizes the arguments for the next spiral in this revolution process, which we term Diffused Warfare, or Distributed Warfare (DW).

We base our theory on the premise, shared by many RMA thinkers, that the changes presently taking place in modern warfare reflect a fundamental shift from a linear mode of military thinking to a perception

1 A good starting point for understanding NCW is Network Centric Warfare: Background and Oversight Issues for Congress, by Clay Wilson. See: http://fpc.state.gov/documents/organization/33858.pdf

of diffused and distributed warfare; from war campaigns comprised of horizontal confrontations between rival forces massed along distinct battle lines (Clausewitzian centers of gravity) to diffused warfare that takes place simultaneously over the entire battle space, with the force mass distributed across a multitude of diverse pressure points (Clausewitz 2004: 48-56; Dunlup 2006: 42-48; Feynman, Leighton & Sands 1963; Watts 1996: 133).

We argue that this shift is essentially from perceptions of fighting by exerting *physical mass* to warfare that employs what can be term *virtual mass*.

If these statements seem to contradict widely accepted conventions of physical force – i.e., that highly concentrated forces makes for greater power – this is due to a common misperception, which we address more extensively later on, concerning linear warfare. In fact only a small fraction of the entire force, usually the very front of the formation, actually engages in fighting at any given moment.

On the other hand, the diffused forces of DW can be more powerful and effective than the concentrated blow of the classic linear approach, simply because they operate in parallel, as a network of "world views". The mass is diffused into many molecular forces distributed throughout the entire battle space as independent pressure points, but the tactical picture of each molecular component of the network is available to all the others, as well as to the Command and Control coordination center operating behind it. This way, the diffused structure is in effect controlled, and operates as if it were a unified force. Its 'virtual' mass thus constitutes a more efficient battle form than the physical and geographical concentration of forces of the linear approach, because the sum total of its engagement contacts is significantly larger.[2]

We argue, however, that in managing this shift much more attention should be given to the definition of its practical building blocks from bottom up; even in the most recent conceptions of NCW a benign spillover from past linear paradigms seems apparent. In a sense, the term *Network-Centric* itself is problematic – actually a contradiction in terms almost, since networks are essentially created to avoid the shortcomings of centrality.

Nevertheless, as important as working from the bottom up is, networks still require coordinators to operate them efficiently and effectively, and the network itself must also function as a command and control mechanism. Therefore we call the basic force-structure building-block in our theory the Dynamic Molecule. We chose this metaphor because of its biological connotations and our belief that the networks of DW will be better developed if inspired by models of natural structures rather than falling prey to high-tech marketeering hype with its short-lived lexicography.[3]

Although DW concerns 'asymmetric warfare' – the term typically used to describe armed conflict between states and guerrilla or other non-

2 We address this point in the following chapters. The sum of engagement effect also includes side effects of disorientation and lack of coherent comprehension of the battle situation on the opponent's side, as well as fragmented and distorted intelligence, inability to launch counterattack, etc.

3 We prefer not to use the more popular concept of Neural Networks; rather than trying to follow metaphors of the human brain we observe the way human body is structured.

state military forces, this phrase does not adequately capture the change that has taken place in the battlefield. Asymmetry is not only an attribute of armed conflict between state and non-state actors. The 1973 Yom Kippur War in the Middle East, for instance, was fought between the armed forces of nation-states yet it was totally asymmetric at the starting point; the recent military campaign in Iraq was a product of asymmetry, built systematically over a period of more than a decade and culminating in the American attack in March 2003. And fighting, if not asymmetric at the onset of war, inherently aspires to achieve the ultimate asymmetry of victory of one side and defeat of the other. Accordingly, we will try to avoid repeating the obvious, assuming that some degree or form of asymmetry exists in all conflicts.

What we do perceive as relevant in this regard is that the pace of change in the nature of conflict in recent years (e.g., between Israel and the Arabs; between various US-led coalitions and their opponents) is accelerating dramatically. The shifts are so drastic that they are becoming increasingly harder to foresee and harder still to translate into valid suppositions pertaining to force structure. Highly priced weapons systems at once become obsolete, and central force components are left with no missions. A prime example is the strategic submarine fleets of both the United States and the former Soviet Union.

Future military solutions in the current state of affairs, therefore, will have to be generic ones – in terms of major platforms, weapons and communication systems, and adaptable to rapidly changing conditions. Relevance, that is, the degree of adequacy of solutions to problems, will be the ultimate test in any given situation.

In this respect, the concept of DW is by its very nature generic in the broadest sense of the term. At the core of our vision lies the elementary nucleus of a multi-service, multi-dimensional molecular unit (the dynamic molecule), rather than the current linear military structures derived, sometimes arbitrarily, from diverse definitions of the 'unit of action', or even the current version of Joint that essentially has prevailed, with minor adjustments, since World War II.

In this book we attempt to look beyond Joint and current NCW, and offer more generic and adaptable ways of fighting the new types of wars ahead of us. Since the concept of diffused warfare not only reflects but also shapes the next evolutionary step in the development of the battlefield, it builds on the extant conceptions, trying to reshape them rather than totally rejecting them.

We thus now turn to examine the principal conceptual components of linear warfare – *maneuver, fire power, command and control,* and *territory occupation* – from the perspective of DW. This is followed by a discussion of the underlying differences, practical and theoretical, between the two approaches. But first a brief note on the modern battlefield itself is in place.

By the start of the 21st century the international legitimacy of armed conflict had become a dominant consideration in the decisions of states to go to war. The status, indeed the very existence, of *international* courts for war criminals is indicative of the primacy of this factor. Furthermore, domestic opposition to acts of military force that risk the lives of innocent civilians is no longer a marginal phenomenon and has come to have a significant impact on national decision making processes. Thus two factors – international legitimacy and the aversion to operations that intentionally or unintentionally endanger the lives of non-combatants – now largely determine the operability of concrete military actions.

Sophisticated precision-guided munitions currently allow the military better to meet the above requirements. This remains true even though in many cases such munitions were initially developed for other purposes, mainly the replacement of weapons based on wasteful amounts of inaccurate "statistic" firepower by "smart" and more economical armament.

The convergence of these two processes has created a new view of the battlefield. The focus is no longer on the enemy's territory but on legitimate targets within it. The battlefield thus becomes the sum of designated legitimate targets rather than a territorial quantity for conquest. The invasion and capture of enemy territory, which in the past constituted the main activity of war, can today be accomplished – to a degree we claim to be sufficient, all things considered – with relatively low levels of friction, as a by-product of stand-off campaigns.

This shift, of course, carries a price for the two complementary – military and political – dimensions of war campaigns in their post-victory stages, or in the "second campaign", as we painfully see happening in Iraq. DW can be applied here as well, as is discussed separately later in this book. Notable at this point is that the new battlefield lacks the concrete front lines that characterized previous wars, just as it also lacks a distinguishable home front.

Very few examples of the traditional geo-strategic military front lines of the past can be found today. These include Israel's border with Syria and Lebanon, the line dividing the two Koreas, and to a certain degree the Indo-Pakistani border. One will not find a military front in Kosovo or Afghanistan, or for all practical purposes, in Iraq. In today's chaotic reality the trend is gaining strength wherein the armed forces of states fight diverse insurgency and non-state military organizations, operating on their own or arbitrarily under the umbrella of a nesting-state – like the Hezbollah in Lebanon. There were and always will be *lines of contact*, but observable, full-fledged battlefronts are becoming increasingly scarce.

Thus, rather than defined by parameters of front lines and home fronts, the nature of future conflicts for nation states will be determined by legitimate objectives and desired effects in a *multitude of contact points* – be they military or civilian, infrastructure- or system-related.

Against this setting emerge the idea of Virtual Mass and the theory of DW, which as mentioned both reflects and shapes the 'next step' in the evolution of the battlefield. The theory provides the theoretical foundations for understanding what is, and for some time has been, taking place anyway in the realm of modern warfare. This is demonstrated in the next section, in which we present the main forms of linear warfare from the perspective of a diffused approach.

Maneuvering

From Hannibal's defeat of the Romans at Cannae in 216 B.C. to Schwarzkopf's 'Hail Mary' of Desert Storm in 1991, maneuver warfare constituted the heart of classic linear warfare. It provided the 'element of surprise' in the battlefield, and was the battle's main determining factor.

Basically, maneuver warfare reflects a military movement from point A to point B, on the assumption that the arrival at point B, or indeed the movement itself, will create a meaningful effect insofar that it will tip, perhaps decisively, the operative tactic or strategic balance in one's favor (Randall 2001).

In a linear system maneuver warfare is mainly a derivative of a larger military plan from which it assumes its strategic logic – a movement, say, from point C to point D. The pattern of the larger movement determines the pattern of the single maneuver. Therefore, once the enemy understands the one it can understand the other.

Practically, this is how the classic linear war system is created. The belligerents both know the starting point of the war, and by foreseeing the Grand Design or by gathering the relevant intelligence they assess the opponent's desired end-state. The force masses of both sides are then deployed to thrust or obstruct the opponent's grand maneuver by thwarting its partial movements.

DW, on the other hand, strives to create the effect of maneuver warfare from the nature of mobility itself. The maneuver is diffused into a series of simultaneous movements on the ground, in the air, and at sea. The movements are not committed to a unified pattern, yet their logic of conduct relies on the one objective of closing the sensor-to-shooter circle, that is, closing the chain of events that includes target detection, identification, firing, hitting, and damage assessment. The focus is on the specific targets themselves rather than on capturing the territory wherein they exist. From this logic of conduct the military commander derives the desired timeframe for the force to stay at a given location and the timing of its moving on to the next objective.

The main distinction between the two different conceptions of maneuver warfare is that contrary to the traditional perception, the main effect of the maneuver in DW is not necessarily derived from the main movement on the ground. The main effect is not exerted by the penetration of the enemy's lines to force him to retreat, leaving the captured area under one's control. The movement and firepower of molecular structures create instead an integrated multi-dimensional maneuver, whose effect is no less dramatic, since it occurs simultaneously throughout the theater of operations, rendering any given disposition of the opponent essentially irrelevant.

What makes this effect possible is first and foremost the fact that air power has matured from an auxiliary component to a decisive player in ground battle. The major part of maneuver in DW is executed from the air. The fundamental feature of DW and the necessary condition for its dynamic molecules is the multi-dimensional merging of surface – ground and sea – and air components. Molecules might rarely be based solely on air components, consisting, for instance, of UAVs and manned platforms; but as the last war between Israel and the Hezbollah proved, the surface component is critical for the overall results.

The operative model of the Coalition forces in western Iraq during Iraqi Freedom, in March 2003, illustrates this. A force of some 2,000 ground troops, operating in a diffused mode and in concert with integrated air components, in fact controlled a land mass the size of

Belgium. Although much of its main mission of preventing Iraqi Scud missile launchings against Israel was not actually put to the test in this campaign, the operation planners' perception that this indeed was *feasible* is very telling.[4] Conversely, though under altogether different constraints, Israel's failure to eliminate the devastating rocket barrages from the south of Lebanon into its northern region, during 33 days of fighting, is directly attributed to the lack of forces on the ground (Cordesman 2003).

In any case, that specific method of operation, reserved now almost exclusively for Special Forces, is currently the closest example available of the molecular perception of DW. The theory and practice need to be further developed and laid out systematically.

Firepower

The role of the softening phase of heavy statistic-fire commonly used in linear warfare, usually before a ground attack, is dramatically reduced in DW. Since linear warfare relies on massive movements of friction, its diffusion renders unnecessary a large part of the gunfire, particularly long-range, since more sophisticated air and land precision weapons provide more effective alternatives.

As noted, the perception of the battlefield as a dimension of legitimate tactical targets, rather than a real-estate asset to win, is fundamental to the conception of DW. In this respect, precision weapons are absolutely critical as their use is the only way to ascertain the required simultaneous

4 During the Gulf War of 1991 some 43 Iraqi Scud Missiles were launched against Israel, mainly in an attempt to muster Arab support by provoking Israel to attack Iraq in retaliation, thus shifting the focus from the invasion of Kuwait to the Arab-Israeli conflict.

destruction of targets disposed throughout the entire relevant battle space. This effect was coined Shock and Awe during the initial stages of the military campaign in Iraq (Cordesman 2003).

The use of precision fire against the Iraqi Republican Guard divisions that encircled Baghdad was the first full-scale demonstration of this perception. There is no record in the military history of the world of another event in which such a large number of diverse targets were destroyed within such a short period of time – with such impressive accuracy.

This dramatic improvement in the effectiveness of fire power has a profound impact on DW's perception of maneuver warfare. We observe a fundamental shift in the relative weights of traditional maneuver warfare and firepower. Moreover, in some respects the increased effectiveness of precision fire has made obsolete the need to conduct grand-scale maneuver warfare at all.

The current transformation reflects a shift from a centralized world of linear physical masses to the virtual mass of molecular diffusion, but also the movement toward lower levels of uncertainty in the battlefield. Essentially, classic maneuver warfare reflects the systemic intuitive response to fundamental uncertainties concerning the ability of one's offense physically to crush the power mass of the enemy's defense in a frontal thrust.

This uncertainty lies at the heart of the art of war regarding both the consequences of defeat and the actual price of victory. Throughout history this fundamental uncertainty in outcomes has been the main motivation behind efforts to push the opponent off balance; to trip him through a cunning maneuver rather than risk frontal confrontation. Conversely, it was also the basis for the classic military calculus of force ratio. In conversations with Liddell Hart, General Heinritzi, who conducted some of the more successful defensive battles of the German army along the Russian front between 1942 and 1944, and in Schlezia in early 1945, argued that the required offense-defense force ratio had to be at least six or seven to one in favor of the defender (Liddell Hart 1948: 225).

However, with the development of sophisticated weapons and sensors, the more precise and efficient our Battle Damage Assessment (BDA) becomes, the greater our level of certainty regarding the overall battle picture and the conduct of the war at large; hence the greater our ability to manage risks.

Thus, the defense-offense ratio question is becoming wholly irrelevant as regards size and quantities of force structure. The actual size of the Iraqi force that participated in the fighting against the US-led coalition in 2003 is difficult to ascertain. Yet whatever assessment we make, the American (military) victory clearly had nothing to do with any quantitative defense-offense ratio.

Precision weapons, however, are not without limitations. The most prominent is the need to maintain a constant line-of-sight with the target – at least in respect of mobile targets. This is because precision-guided munitions are targeted at distinct objects rather than their geographic location (as is the case with statistic fire). The process of 'closing the circle' when the target is mobile requires that the weapon's operator maintain constant visual contact with the target throughout all the necessary stages of the operation: target detection, identification, firing, hitting, and damage assessment.

The above requirement is not easy to meet. The solution naturally requires real-time fusion of intelligence-targeting sources, constant availability of the designated sensor-to-shooter cycle, and multi-channel control of the allocation of tasks and resources. Perhaps the most decisive element in this respect is the basic ability continuously to integrate vertical and horizontal lines-of-sight. Effective ‘closing of the circle’ is contingent on the commander’s ability to converge in real time all the lines-of-sight of the relevant sensors and shooters in a given situation.

A target monitored vertically from the air, for instance, will cease to be relevant the moment the line of sight with it is broken. To preserve its relevance in such cases, horizontal lines-of-sight – from either sea or land – must remain intact. Similarly, interchangeability between sensor and shooter must be sustained along the entire line of contact to ensure maximum flexibility for the shooting stage.

The notion of Dynamic Molecules is founded on this principle. Instead of relying on the current ‘units of action’ of the linear warfare approach, diffused warfare creates parallel structures defined by their capacity continuously to sustain vertical and horizontal lines-of-sight. These structures might expand – if one so wishes – to the size of the traditional units of action, such as platoons or even regiments. However, their uniqueness lies in their independence. Every molecule contains independent multi-dimensional sensor and shooter components, capable at all times of tying into the other molecular systems operating in its proximity.

The function of the dynamic molecule is not to be confused with the range-finding or air-support officers of the past, as each of its components can function either as the scout who identifies the target or the shooter who kills it. The structure's ability to sustain that interchangeability among its components, and the expediency with which it can close the circle, determines its overall effectiveness.

Command and Control

Diffused warfare relies on networks of "world views" rather than networks of verbal or textual data communication. In principle, every component in the molecular structure has access to the picture the other components see, and the controller sees the battle picture of all the molecules he or she controls, creating the common integrated world view of the entire relevant battle space.

The mode of operation in diffused warfare is based on 'open bidding'. All the elements in the structure – land, air or maritime – participate as sensors in creating the 'world view' and the moment a legitimate target is detected, ideally, the one best positioned for taking the shot will act as the shooter, thus closing the sensor-shooter circle.

The quality of fusion of the 'battle pictures' into one comprehensive world view and the speed of integration will, in most cases, determine its relevance. As in the example above, if vertical contact with an enemy target – say a target in an urban area monitored from the air – is disrupted, the line-of-sight will continue to be sustained by the horizontal elements of the molecule. The main sensor changes but the picture remains relevant. The same applies to the allocation of firepower for the firing phase.

However, if the above seems simple and straightforward in theory it is by no means trivial. The quality and speed of the fusion of the battle pictures will be determined by the effectiveness of the element coordinating and controlling the process. Technically, managing this multitude of channels and demand for bandwidth are major technological challenges still ahead of us. Clearly, the command and control dimension of diffused warfare, and the resulting command structure, are certainly one of the most complex hurdles of diffused warfare. Assuming we can overcome the technical obstacles, we will still face difficult questions, such as real-time hierarchy between multi-service elements in the network, issues pertaining to location of the controller, and command structure of the molecules.

On the other hand, let us not lose sight of the broader meaning of the network perspective in diffused warfare. To a large extent a network of ‘world views’ replaces the need for the massive investments in backups and reserves so typical of linear warfare. We are all familiar with the endless trails of land forces that often endure an entire military campaign without firing a single shot, while tracking after a small force that conducts the actual fighting.

It is this network of world views that allows us to operate in complete contradiction to General Heinritzi’s assessment of offense-defense force ratios, by dramatically reducing battle-space uncertainty. With the networked world views, commanders can monitor what is happening at every point of contact in terms of BDA at the moment of hit, and can also monitor the opponent's reactions afterward.

The main risk involved in the deployment of light molecular forces throughout the enemy's battle space is thus resolved by the ability to see and integrate in real-time the enemy's reactions in every area of deployment, and to respond rapidly. Taking into account also the internal backing provided by the other components of the molecule – air, ground, and sea – we actually end up with a system of forces that hardly has any significant physical mass as compared with traditional linear force buildups, but is capable of creating a much larger systemic effect while in principle not risking a greater degree of exposure.

Territory Conquest and Control

Essentially, as mentioned, the opponent's territories are conceptualized by diffused warfare as a ball park of relevant targets that are rendered legitimate to destroy, rather than a geographic quantity to be captured. Nevertheless, by and large, systemic objectives of territorial conquest and control cannot be achieved except by linear means. Clearly, the preservation of *some* linear capabilities will remain necessary in any future force structure plan. It is also reasonable that the two modes will be applied together in one campaign, particularly if the ultimate objective is to capture territory for an extended period of time, as in the American campaign in Iraq. However, as the battlefield and battle theory continue to evolve, the relative weight of linear elements will gradually decrease and the massive land forces will become increasingly decentralized.

The prime challenge for the linear approach today is reflected in what might be termed the ‘paradox of conquest’. The more rapid and overwhelming the victory and the process of territory capture, the more difficult and costly becomes the task of holding on to it. Rapid movement leaves in its path an abundance of defeated and fragmented opponent forces, which serve as the breeding ground for effective resistance, more often than not evolving into guerilla and terrorist activity. Israel found itself in such a position following the military campaign in Lebanon in 1982 as did the US in the aftermath of the 2003 military campaign in Iraq.

How does one apply the principles of diffused warfare to campaigns that include the conquest and control of territory for extended periods of time? This is indeed a key question – particularly since the grave consequences of stationing massive forces in occupied territories to control them through high-intensity linear warfare activities have become painfully evident.

In general, long-term occupation runs against the principles of diffused warfare. Indeed, diffused warfare in many respects renders land occupation unnecessary. But as a generic concept diffused warfare can be adapted to the task of territorial occupation. The molecule’s lack of massive signature, its attribute of versatility, and the enemy’s difficulty in detecting and predicting its patterns of conduct can provide an important edge in thwarting guerilla/terrorist actions typically conducted in occupied territories.

In this sense, the IDF’s success rate in destroying terrorist cells during the Palestinian Intifada is an impressive achievement. In many respects

Israel's current military conduct in the controlled territories already reflects some degree of diffused warfare – certainly in comparison with past wars.

A determining factor in the occupation of territory is the quality of intelligence. Nothing can replace a properly deployed intelligence infrastructure. However, such an asset is not obtained in a day. The unique capability of the molecule to integrate, in real time, the constant stream of intelligence from different sources into the network of 'world views' provides a critical benefit in the formulation of operational solutions for concrete events. In many cases this advantage compensates for the absence of in-depth intelligence. Moreover, it reflects the major shift of focus of the entire military intelligence discipline into a real-time mode, which is perhaps the most dramatic change DW entails. We will touch on this in a different section later.

At any rate, long-term occupation of territory is a very complex and sensitive task, ridden with unpredictable difficulties and obstacles. It will require a combination of linear force structures and a great number of diffused elements. The optimal ratio in each case will be determined by the specific circumstances. No two cases are the same: Kosovo is not Afghanistan, Afghanistan is not Iraq, and the Hezbollah with 12,000 rockets and state-of-the-art anti-tank munitions is neither.

The general trend though is clear. The experience accumulated from military occupations of territory, and the often subsequent threat of terrorism and guerilla warfare, show that diffused warfare is well equipped to fight in conditions of that specific asymmetry – most simply because it is capable of creating a state of counter-in-kind asymmetry.

To understand better the full implications of the above we may need to step back for a moment and have a look at the ways DW evolves from the classic linear approach of nation-state's regular armed forces.

Armies at a Crossroads

The shift in military thinking to a more diffused perception of force structure and warfare is prompted by more than the mere failure of the classic linear view adequately to meet the challenges of asymmetrical conflict

To be sure, the traditional massive force structures designed for confrontation between regular armies of states find it increasingly difficult to operate effectively in the highly volatile and chaotic environments of most contemporary armed conflicts. Yet these traditional conceptions, based on the World War II model, which with relatively minor changes remains the preferred model to this day, are suboptimal in conventional interstate conflict as well. Should interstate high intensity conflict reappear as the predominant form of warfare in the coming decades, these force structures will be wanting.

Hence, the ultimate test for the diffused warfare approach will lie in its ability to provide better solutions for both interstate confrontation and conflict between state and non-state actors. Failure to develop a military adequately prepared for either type of conflict will result in a nation's needing to rely on two distinct types of force structure. It is highly unlikely that any state in the world today could sustain the political and economic burden such an endeavor would require.

Two central processes that evolved concurrently yet separately after World War II contributed to the emergence of a new battle environment by the end of the 20th century.

The first was the dramatic increase in the lethality and destructive capacity of firepower caused through the extensive technological developments in the second half of last century. The probability of surviving a hit is today alarmingly lower than it used to be. Modern weaponry can make any cover on the battlefield unsafe, from the makeshift foxhole to the well defended armored vehicle and the ten-meter deep bunker.

At the same time, a worldwide trend of mass urbanization and – to borrow from Philip Bobbitt – the scars of the victory of Parliamentarism over Nazism and Communism during the "Long War" (1914-1990), contributed to the deepening and dissemination of social norms and values that increasingly placed ever-growing constraints on indiscriminate use of such fire-power (Bobbitt 2003).

The arsenal of nuclear weapons, the ultimate firepower, accumulated during the Cold War amply illustrates this process, in retrospect, almost to the point of absurdity. In the race to attain nuclear capability and deter the opponent, states invested bottomless amounts of resources in the development of a technology whose sole purpose was to ensure that not one of its products would ever be used.

On the other hand, if the objective of the bizarre logic of deterrence between superpowers was to prevent the use of nuclear weapons, the concomitant development of conventional capabilities had the opposite objective, namely to produce 'usable' ones.

Yet here too the growing public demand for states' discriminate use of force ultimately made the destructive power of much of the conventional weapons arsenal illegitimate. In a world of global media and international courts for war crimes, the criteria for using military force has become more complex than ever.

The need to avoid hitting non-combatants, for example, places significant limitations on the use of the full range of what is called in military jargon "statistic weapons". An entire arsenal of conventional bombs, rockets and shells, originally developed for the primary purpose of effecting massive indiscriminate destruction on the battlefield, are rendered practically unusable in asymmetric confrontations where military targets and civilians tend to be found in proximity.

The second central process cuts deeper into the fundamentals of classic warfare and concerns the very concept of the strategy of grand maneuver.

The conditions for what used to constitute the key factor in achieving military objectives in wars, the ground maneuver, changed dramatically in the urban reality of the late twentieth century. From an ever dynamic warfare conducted in an open-space battlefield environment, characterized by swift moves and long marches, ground-maneuver has deteriorated into a slow moving, high-friction mode of warfare, conducted in densely inhabited urban areas. That classic 'battle momentum' generated in the past by the strategy of swift grand maneuver, such as the German Blitzkrieg, is rendered meaningless in the narrow streets of modern urban warfare.

Military operations in urban terrain (MOUT) always posed a more difficult and complex challenge than fighting in the open battlefield.

History books are replete with accounts of battles in which "the momentum of the forces of General X ended at the gates of the City Y" (U.S Army, 2002). To be sure, military movement through urban terrain provides the defending forces with an infinity of hiding-places and options for deployment, enabling them to bring the attacker's advance to a standstill. Nothing is new about that.

However, unlike the past, anti-armor and anti-aircraft weapons are presently easily obtained hand-held weapons. The Russian invasion of Chechnya in 1994 is a classic case of RPGs being used effectively in MOUT. The Russians' effort to take Groznyi ended in disaster for the attacking Russian troops because they were channeled into a kill-sack, and then attacked by well-directed RPG and small arms fire from the top and basement floors of the buildings surrounding the Russian forces. RPGs and especially their anti-aircraft variants, such as the "Stinger" missile, were also extremely effective in the Taliban's struggle against the Soviet occupiers in Afghanistan (Thomas 1997: 51-59). And just recently, in the latest war in Lebanon the new generations of anti-tank guided munitions (ATGM), such as the AT-13 Metis-M and the AT-14 Cornet-E, proved extremely effective against most modern armored vehicles.

The constant attacks in urban terrain by insurgents armed with RPGs, and with the even more lethal means of improvised explosive devices (IED), created a decisive test of endurance for the Israeli forces in Gaza, and before that in Lebanon. At the time of writing this book, three years after the 2003 invasion of Iraq, such weapons remain the number one cause for casualties among the US and other coalition forces. The aforementioned campaigns give insight into the disastrous consequences this increase in the destructive capacity of the individual soldier will have if applied in confrontation between regular armies fighting in urban terrain.

These two factors then – the constraints on the use of fire-power and the problem of ground maneuver – have prompted defense communities worldwide to develop selective stand-off capabilities. New terminology such as 'smart bombs', 'precision-guided munitions' and primarily the evolution of the meaning of 'stand-off capability' from a mere capacity accurately to hit targets from a distance to a world view of network centric warfare (NCW), constituting a 'system of systems' –all are the product of these two processes, which mark a fundamental change on our perception of states' use of military force.

In this respect the perception of DW is applicable to conflict between regular armies no less than it applies to asymmetric warfare. Despite the differences in the main parameters of these two types of warfare, the basic distinction is essentially quantitative rather than qualitative. Indeed, the technology on which DW relies was initially developed to provide solutions to basic problems that emerged in confrontations between regular armies.

Thus the concept of the dynamic molecule as the nuclear component of a diffused force structure, we argue, is equally valid for interstate high intensity conflicts between regular armies and for asymmetric warfare.

Morover, contrary to DW, current force structure of linear interstate warfere is replete with systemic bottlenecks. Its main drawback is the weak points at which the different systems linearly conjoin to generate one comprehensive picture. A simultaneous attack on these points could precipitate a breakdown of the entire system. In addition, the effectiveness reached in operating from the vertical line of sight – most notably by air-launched precision-guided munitions – exposes ground infrastructure and forces, especially in armored campaigns, to the danger of total destruction within hours.

A stark demonstration of exploiting these weak points occurred in the Lebanon War in 1982. The Israeli air force's Electronic-Warfare (EW) means disabled Syrian anti-aircraft weapons and Syria's aerial imagery capability, thus essentially 'blinding' the Syrian forces; consequently the IAF destroyed all the Syrian air defense assets as well as any Syrian jetfighter that dared to take off. The US, in its conduct of the Gulf War (1991), in Operation Iraqi Freedom (2003), and in instating the No Fly Zone in the interim, took this effect one step further. The US 'blinded' the enemy, but also, as mentioned, massively destroyed the entire Iraqi ground forces from the air.

The dynamic molecule, and DW concepts in general, simply systemize these modes of operation with their resulting effects and integrate them into the force structure, thereby creating a systemic parallel approach to military affairs, rather than a serial linear one.

Yet the implications of a DW approach to modern warfare between regular armies reach far beyond mere identification and exploitation of the inherent vulnerabilities of the opponent.

The high degree of precision and the flexibility that stand-off weapons provide also create a new level of certainty with regard to the immediate results of the single military action and, by inference, with regard to the cumulative expected effect of the entire military campaign.

The virtually 'mythical' element of uncertainty involved in the conduct of war, that 'friction in war' Clausewitz referred to, which was an almost transfixing component in the mindsets of military thinkers and leaders, is rapidly clearing (Watts 1996). The 'fog of war' can no longer be a valid explanation for anything. Today the ability to carry out military operations in a multi-dimensional network of sensors attached to precision-guided munitions provides immediate and near-complete answers to the most fundamental questions that arise during battle: What really happens on out there? What is the real effect of our action? What is the opponent's response?

War and military conflict have been among the most inefficient and wasteful activities in human existence. War objectives inherently involve laying waste to the opponent's human and material assets, but due to imprecise weapons and uncertainty regarding the results of one's actions, wars have also been wasteful in the manner in which they were conducted.

Rough estimates based on the reported number of casualties versus ammunition supplied show that for every North Vietnamese soldier killed in the Vietnam War the US army expended approximately one million bullets. General Heinritzi's traditional offensive-defensive ratio of 1:7 for the defender is a prime example of how embedded this inefficiency was in the classical military thinking.

War campaigns were always considered endeavors that must be planned to sustain a maximum range of eventualities, at the highest level of robustness. This necessarily led to the establishment of grandiose and tremendously cumbersome military force structures, the necessity of which was considered a given.

The tremendous amounts of munitions, weapons and troops that were sent to confront the enemy in endless battle columns are legendary, particularly in light of the small number of troops and weapons which, in the end, actually engaged in fighting. This phenomenon is the unavoidable consequence of the classic linear warfare's friction of physical masses. The purpose of these endless columns, essentially, is merely to provide replacements for the grinding forces at the front end once they cease to function.

In many cases, particularly in the post-World War II era, these quantities are overwhelming also in relation to the success rates of the military campaigns themselves. For example, the estimated number of troops involved in the Korean War in 1951 exceeded 1.5 million people. The war ended at the 38th Parallel, almost exactly where it started.

Diffused warfare and the network on which it relies will for the first time provide the conditions for the conduct of military operations that will be more efficient and effective than ever before, but also, and perhaps more importantly, will be selective in the use of force, controlled and precise, reducing indiscriminate killing and destruction to a minimum.

Several factors support this proposition. First, by relying on a constant stream of accurate data provided by the network, commanders will be able to adjust military planning and force movement in real time.

It is quite astonishing fully to comprehend the impact that the ‘fog of war’ had in the past on the mindset of military planners and battlefield commanders. Even more astonishing is fully to grasp the number of errors, misperceptions, wrong and pre-mature actions, redundancies, and disastrously untaken actions – which were unquestioningly accepted as an unavoidable and inherent part of waging war, due to that ‘fog of war’.

Treating as too remote the countless instances of such cases in the last two world wars and Korea, a glaring modern example can be found in the 1973 Yom Kippur War.

On 15 October 1973, in a counterattack designed to put Egyptian forces back on the defensive and to seize a bridgehead for the crossing of the Suez Canal, erroneous intelligence vis-à-vis the Egyptian tactical order of battle and their position on the battlefield resulted in an Israeli battalion launching an attack on the Egyptian 16th Infantry and 21st Armored Divisions at the Chinese Farm experimental irrigation facility, near the southern end of the Suez Canal. This resulted in some of the fiercest fighting of the war with massive Israeli casualties.

Regardless of the version one accepts as to the details of this traumatic battle – there is still bitter debate over it – for DW such a scenario is highly improbable. A battle picture of diffused warfare, constructed by vertical multi-spectral sensors (positioned, in principle, from low altitudes in space down to a few hundred feet above ground) as well as by horizontal components installed on the ground and at sea, most probably would have prevented it.

This networked structure produces video streams of precise and unequivocal real-time battle pictures. By merging the vertical and horizontal lines of sight, a three-dimensional constantly updated world view of the battle area is generated, allowing military commanders to operate under totally different level of situational awareness, and with minimal uncertainty. If we constantly know, and can plan on constantly knowing, what the other side is doing – then indeed a whole range of new possibilities emerges.

Thus, the recurrence of a catastrophe similar to the Chinese Farm battle or, for that matter, any such disastrous misinterpretation of battlefield realty is less probable, at least in conflicts between regular armies, under DW philosophy.

Moreover, since by definition the diffused warfare network generates continuous real-time updating and dissemination of the tactical picture, and because most of its components have the capacity to serve as both sensor and shooter (gatherer and attacker), essentially the network will observe the military effects of the operation, but will also be directly involved and have an active role in shaping it.

This totally new dimension of real-time intelligence and its blurring of the boundaries between data gathering and the action it generates will no doubt be one of the more profound changes in the future.

However, in terms of efficiency and effectiveness its most important contribution is the dramatic shortening of the sensor-to-shooter cycle. The shorter it is the larger the overall engagement capacity becomes, because more legitimate targets can be engaged over shorter period of time.

This argument brings us to the more theoretical factor supporting our claim for DW potency to make good on its promises.

DW will be much more efficient in terms of its direct engagement capacity. If the overall effect of a given violent confrontation is determined by the sum total of effects produced at all its actual contact points, then DW's molecular structure will produce a significantly greater overall effect than linear structures, since it can create a vastly greater number of contact points. This argument was the basis for our initial assertion that the virtual mass of the molecular structure is in fact more effective than the physically and geographically concentrated masses of forces of linear warfare.

On the immediate practical level DW will certainly be much more efficient than classic linear structures, as the real-time network in many respects renders irrelevant the obsessive tendency of military commanders and planners constantly to amass large amounts of readily accessible reserves.

With the wide margins of uncertainty in fighting practically diminished, and due to the fact that DW is essentially a series of small movements rather than a large linear campaign, commanders will be able to rely on a unified pool of intelligence, fire-power and logistics support operated from the rear. Instead of dragging it along just in case, they should be getting it just in time.

Moreover, in a sense DW military missions can be perceived as targeting operations, accomplished from a distance with no need to directly engage the enemy. Destroying an armored brigade deployed around Baghdad or, for that matter, on the Chinese Farm, no longer requires an attack from the ground.

These forces may be obliterated from the air and the ground by means of precision-guided munitions shooting at a hit-rate statistic munitions could never match. In some cases the desired effect might simply be obtained by neutralizing the communications apparatus of an enemy brigade or by demolishing only a small number of its command posts, thus quashing its ability to communicate with the home-front command, as probably was partly the case in Iraqi Freedom.

So any way we look at it, ground forces today can be smaller and more flexible and still conduct prolonged and complex military campaigns with small equipment reserves. Again, DW and its molecular force structure are merely the derivative and inevitable conclusion of trends already at work in military affairs.

Finally, the sensors' network enables the commander to focus his destructive potential on military targets, bringing to minimum non-combatant casualties. Hopefully, this might take us to a type of war conduct closer to the legendary concept of noble war, wherein the scope and outcome of war were determined – or so we were led to believe – within the ranks only of those directly involved.

Diffused warfare does not require blanket bombings. Its rationale does not include the need to raze Dresden or Hamburg to achieve its objectives, and to all intents and purposes it is the complete opposite of Hiroshima and Nagasaki.

The pressing need to create a division between legitimate and illegitimate targets (e.g., non-combatant civilians) has produced technological solutions that make possible the transformation of high intensity conflicts from past mass destruction requisites to a much more selective form of war fighting. Along with this, it also provides answers to the unique requirements of asymmetric confrontation.

But the necessity to shift to a perception of DW and dynamic molecules with regard to high intensity conflicts between regular armies derives from yet another factor. The evolution of the main military platforms – sea, air, and ground forces – has reached a crucial crossroads. The populist analogy often mentioned in this respect – likening the major military platforms to dinosaurs – warrants serious investigation. This is the subject of the next chapter.

Twentieth-Century Dinosaurs

The 20th century witnessed the establishment of the greatest war platforms ever built. On the ground tanks and other combat vehicles were developed, whose size exceeded anything that ever traveled over land before. At sea aircraft carriers, battleships, submarines and cargo ships 20 to 30 times larger than their predecessors were launched. In the skies giant aircraft were sent aloft alongside advanced fighter planes.

Even if one factors out the effect of nuclear weapons on states' conduct of war, it is still fairly safe to say that the 20th century permanently changed the face of warfare. One of the main triggers for this was undoubtedly the acceleration phenomenon referred to in other contexts in this book, which was particularly profound and decisive.

The pace of technological developments in fewer than one hundred years of the last century, compared with the entire millennium preceding it, was wholly disproportionate. The overall scope of innovation in military means and the magnitude of change – even considering the emergence of air power and submarines alone – were unprecedented.

This dramatically accelerated evolutionary process, however, was not without end. By the close of the 20th century a point of economic and conceptual saturation seemed near, with the collapse of the Soviet Union more or less marking the turning point.

Today, when the existence of nation-states is very rarely threatened by other states – at least for the time being, parliamentary states' expenditures on 'security' or 'defense' measures have come to exert a disproportionate strain on their budgets that they find increasingly difficult either to sustain or to justify.

Warplanes such as the B-2 bomber, each with costing over $2.1 billion (United States - General Accounting Office 1997), are typical by-products of the Cold War and the bizarre dynamics of the nuclear arms race it stimulated. But even a squadron of frontline jetfighters, going for only $60 million apiece, can amount to a total of $4 billion – a figure expected more or less to double during the duration of its life cycle (Correll 2002).

A fully equipped missile frigate costs $700-800 million, a conventional submarine around $500 million, and the price tag for an aircraft carrier can reach up to $3 billion. These sums are clearly astronomic. Compounded by an increase in states' domestic-civilian expenditures and by the additional (and urgent) need to invest in countermeasures to global terror, such costs cannot long be sustained even by a superpower.

A conceptual and economic threshold has been reached. The fundamental gap between a state's national defense bill, and the perceived diminishing gravity of the national threats it is supposed to shield from has become too wide. An increasingly important element in the matrix of national decision-making is the fact that a more economical alternative perception of force structure – one that by definition ties into DW – is already taking shape.

In essence major military platforms – tanks, ships and airplanes – perform a fairly simple function. They move munitions from one point to another, or they carry troops with munitions from one location to another.

That is their basic task.

The need to protect these platforms to ensure their survivability, and the relative complexity involved in launching their munitions (tank shells, missiles, bombs), necessarily made them very large, technologically advanced, and consequently costly.

This need has grown over time, and increased in proportion to the threat posed by enemy systems, which for their part have become equally developed and sophisticated. In practice this is the dialectic that brought us, through the 20th century, to where we are today.

The difference is that today we possess global positioning systems (GPSs) – like the ones installed in our cars – that can guide us to any point on the globe, and cellular and satellite communications systems that allow us to communicate between any two points in the world. Combined, these two technologies create a global network that enables us to move objects of all sizes to any location in the world and to communicate with them unimpeded.

Thus, the conditions have been created for the replacement of the existing costly manned platforms with many – much smaller – autonomous munitions platforms that are relatively cheap and no less efficient.

This reflects a realistic possibility for an alternative based on simplicity and replication. That alternative is many small and relatively simple, largely unmanned, systems rather than the fewer but much larger and costlier major platforms we inherited from the arms race of the last century.

Air Platforms

From a purely economic viewpoint, the cost of airtime of a modern combat plane is simply unreasonable, particularly when compared with alternative means. To transport guided munitions from point A to point B we no longer need it to be flown under the wings of a manned combat plane worth $60-100 million (Pitts 2000; Poyner 2001: 58-62).

For an equivalent sum one could produce dozens of small aerial platforms that essentially have the same weaponry. Instead of buying the guided weapon an expensive airline ticket to get it from one place to another, it can be launched directly at the target at a much lower cost.

Theoretically one could produce the effect of an entire squadron at a cost equivalent to the price of roughly one plane. For example, four GPS-guided bombs, priced say at $30,000 each, could be carried to their destinations aboard one manned jetfighter; alternatively they could be configured to be launched autonomously as a missile or UAV. The first option would entail spending some $60 million on airfare, the second, in most cases, $3-5 million.

When one takes into account the overall cost of operating the entire range of combat planes required for a single given operation, that is, the cost of the attack formations, of the various defending formations, and of the refueling planes (in long-distance missions), the difference between the two options is staggering.

An attack on a typical major strategic target in an inter-state confrontation, using manned air power, can involve up to fifty – sometimes even more – platforms in the air that cost billions of taxpayers' dollars. The costs entailed in the alternative of employing autonomous munitions, performing the very same mission just as effectively, will be something like $10-15 million.

Using autonomous munitions also means that air forces will avoid the risk of losing pilots and planes, as well as the complications resulting from pilots falling into enemy hands. Many of the possible direct costs entailed in air battle, such as the loss of aerial platforms (including the deaths of pilots), and indirect costs incurred after the campaign, such as political costs of negotiating the return of prisoners of war or of rebuilding the force, will simply no longer apply.

Essentially, this approach leads to the transformation of centralized capabilities into small and autonomous 'force nuclei', which is, in fact, the basic notion of DW. With some adjustments it is also applicable to ground forces and navies, which is the main theme of this book. Airpower, however, is to a certain degree a somewhat special case that warrants special attention, as we explain below.

Air (and space) warfare constitutes the newest dimension of modern warfare, dated effectively to World War I. Nevertheless, it is the prime mover, and essentially the main reason, for the accelerated evolution of modern warfare in all its dimensions. The vertical dimension of the battlefield developed so fast during the last century that today it unquestionably dominates modern warfare (United States- Joint Warfare of the Armed Forces of the United States, 2003).

So significant is this dominance that the widely held view that militaries operate within a three-dimensional system – air-sea-ground – matured through the last century into a perception of the current system as in fact two-dimensional.

This two-dimensional system essentially consists only of a vertical and horizontal dimension. The ground and the sea (with the exception of submarines) provide the horizontal dimension of warfare, while the air provides the vertical one. This phenomenon has become markedly apparent in every conflict from Israel's war in Lebanon in 1982 and on.

Yet for all the spectacular developments in the air, modern warfare remains fundamentally anchored to the horizontal dimension of the ground and the sea; just as the eagle, despite all its grandeur in the air, needs the tree branch or mountain cliff to maintain its cycle of life.

Whether it is the jetfighter with its payload taking off from an airport or an aircraft carrier, or the traditional weapon systems and independent munitions launched from the sea or the ground, the starting point of the process is always on the surface.

The fundamental difference between the two dimensions is that the life-span of an operation in the air is relatively very short, and usually consists of departing from and returning to fixed bases. Ground and sea forces move their units in campaigns for weeks and months; air forces fly sorties that last several hours.

So for the time being, until it becomes possible to use airspace for permanent military support and munitions bases, the horizontal – ground and sea – dimension will remain the main functional foundation of military power.

At the same time, the munitions of all forces, regardless of their dimension, (again, with the exception of the submarine's torpedoes) are aerial. From the single bullet to shells, rockets and missiles, munitions reach their targets through the air. If the munitions flight is autonomous and can be controlled and updated remotely, and if the conditions of simplicity and replication are maintained, then the exact location from which the system is launched practically loses all meaning. It becomes irrelevant whether one shoots from the air, the ground, or the sea.

Under such circumstances it no longer makes sense to maintain the monopoly of airpower on the precision strike: the use of sea-borne guided munitions such as the Tomahawk missile in the two Gulf wars is a prime example of this change. The same evolutionary process is bound to happen with ground forces as well. We are undoubtedly moving into a much more diffuse regime of all-dimension *shooters*.

Yet the case of air forces is singular in that the vertical line-of-sight, that is, the bird's-eye viewpoint, will remain under all foreseeable circumstances our major *sensors*' dimension. The requirement of a constant and uninterrupted presence of relevant sensors is just as crucial as the dependency on ground and sea basing. To compensate for the short airtime of the individual aerial platform, manned or unmanned, a major perpetual process has to be produced, starting from satellites on the topmost levels and ending as low as few hundred feet above ground with small UAVs. In a sense this is the air-power equivalent of the ever-present nature of ground and sea forces. Not surprisingly, the most compelling justification of proponents of future generations of manned combat planes is rooted in the issue of air dominance (Tirpak 2005).

The ability to achieve air dominance is a precondition for full exploitation of the advantages provided by the vertical line-of-sight, and the manned aircraft is still the most efficient means available for achieving freedom of action and dominance in the air.

Since we have to invest in the manned fighter plane anyway, its ability to carry air-to-surface munitions and to affect directly the ground and sea battle turns it into a highly versatile 'all-in-one' asset. All things considered, it is the best cost-effective option available.

Yet true as this might be with regard to the economic assessment of current force structures, the farther we project our economic analysis into the future the more questionable it becomes. In fact, the F-22 aircraft, for example, which carries a price-tag of over $100 million, constitutes a conceptual and economic threshold, which would be pointless – if not outright detrimental – to overstep.

It is difficult to imagine the development of another manned plane with capabilities equivalent to those of the F-22; moreover, even the preceding generation of planes, developed 15 years ago and since then upgraded continuously, provides sufficient operational capabilities to achieve air dominance. The differentiators have simply shifted from the aircraft and its capabilities to the munitions, the avionics, and the command and control systems.

Rather than speed and maneuverability of the single airplane, it is the quality of the world view provided by the command and control network and the quality of the munitions and defense suite carried by the plane that will determine the outcome of an air battle, as well as its survivability vis-à-vis threats from the ground.

Judging by the direction of development pursued in the current Joint Service Fighter project in the US, it appears that the next generation of manned jetfighters will be cheaper and their capabilities will not exceed those of current combat planes. They will, however, have different capabilities, such as stealth technology, the ability to take off and land on short runways, and so forth – capabilities that make them more suitable for the emerging new battle-space conditions (Tirpak 2005).

Presumably, we are currently advancing toward radical changes in our perception of the main manned air platforms and their role in battle. Signs of such change – especially in the developing of advanced UAVs – are already evident in the USA and other countries.

The flexibility and range of possible changes at sea and on the ground are somewhat more limited. The prospects for transformation in the main horizontal platforms are slightly less promising than the possible revolution in the vertical dimension of warfare; but much remains to be done there as well.

Ground Platforms

On the ground, as mentioned, the contrast between what currently exists and its possible alternative is less remarkable than in the air, yet no less essential. Contrary to the manned aircraft, the 'queen of the battlefield', the tank, as the main platform of ground forces, has no immediate substitutes such as the UAV or the cruise missile.

There is, however, a wide range of precision weapons that can accomplish what tank shells accomplish. These start with the personal anti-tank weapon carried by the individual soldier, and progress to guided munitions installed on lightweight battle vehicles and on to attack helicopter missiles. In fact, today these measures provide an even greater level of effectiveness.

But there is a world of difference between aircraft and ground platforms, particularly tanks. The latter are conspicuous, highly visible ‘ever-present’ players on the battlefield, while the former operate evasively, moving in-and-out of the combat zone. Contrary to the jetfighter’s sorties, lasting an hour or so, tanks, as the center of the ground maneuver, are there all the time, leading the force throughout the entire campaign. Leaving with the forces on day-one, they return to their bases only sometime after the war is over. This is the reason why maximum self-sufficiency on the unit level is fundamental for ground forces in general, and armored units in particular. Essentially it is a precondition for their very existence as fighting forces.

Jetfighters complete their mission and go back to refuel and reload; tanks must have their support echelons, maintenance, spare parts and ammunition – dozens of trucks packed with everything they need to keep them going – available at all times, traveling at the rear of the column, sometimes for weeks.

This world of difference is thus expressed in the way their main platforms operate, but also in the basic ways war itself is experienced. Not surprisingly, the traditional linear perception of military force structure and ground warfare doctrines ultimately relies on the tank as the power nucleus of mobility and firepower. Compared with other carriers on the ground, the tank is perceived as the platform with the highest degree of survivability. Its protective armor and mobility provide it with a qualitative edge over all other existing measures of the horizontal dimension. For this reason it is still the core of the linear war perception of physical mass, whose main objective is the physical capture of enemy territory for prolonged periods of time.

At the same time, the fervent search for an alternative to the tank derives first and foremost from the recognition that in the face of the wide range of modern munitions and lines-of-sight, heavyweight mobile measures, including the tank, are all found wanting in survivability (Guderian 1952; Weeks 1972).

If the manned aircraft is considered overpriced in relative terms, the tank should be regarded as over-exposed in absolute terms.

This problem is enhanced by the increase in the complexity of the battlefield, particularly as the battlefield becomes more exposed to vertical lines-of-sight. Tanks and other armored vehicles were designed primarily to survive horizontal threats. The purpose of their low silhouette was to allow them to take cover easily. Their protective armor was designed to prevent penetration of tank shells, rockets and anti-tank missiles fired by enemy ground forces. But in open space they are completely exposed to the vertical line-of-sight.

One need only examine the satellite photos of the Iraqi ground forces' deployment in the two Gulf wars – a classic reflection of the linear warfare posture of the Soviet defense doctrine – to grasp how dramatic and essentially unbridgeable is the gap between the ground force's structure and the threats it currently faces (Cordesman 2003).

This immense army, with all its assets, is deployed against the wrong enemy. It is prepared for defensive action against a ground attack by an enemy force that is similarly built and operating under the same linear warfare conventions.

But from the vertical line-of-sight this entire force is virtually a sitting duck. It can be destroyed much more effectively from the air, which in the case of Iraq was exactly what eventually happened. One might of course argue that the Iraqi case was a total anomaly. The coalition's air dominance was absolute. The Iraqi air defense was completely disabled, and clearly, under such conditions ground forces would be totally exposed.

This may be the case, but it does not change the general diagnosis. On the contrary, the accelerated evolution of air dominance creates a permanent condition of acute exposure of ground forces to attacks from the air, including those against their air defense systems. So much so that the initial days in campaign planning today are earmarked for air activity, prior to which there is no real movement on the ground. In fact, the main theoretical debate in military forums nowadays centers on the claim of the air forces that victory can be achieved through the air alone

Even if it is argued that more advanced existing anti-aircraft weapons, professionally operated, can constitute a counterweight to air dominance it is still very doubtful that they will be able to provide a decisive answer to the plethora of small and autonomous platforms expected to enter the battle space in the near future.

However, this imbalance in threat-regime between the vertical and horizontal dimensions of warfare pertains mainly to high intensity conflicts between regular armies. The circumstances of asymmetric conflicts, particularly in urban areas, have exposed the ground platform to a new twofold threat, extremely difficult to counter, of personal anti-tank means like the RPG and improvised explosive devices (IED).

In terms of the attrition of forces, number of casualties, and rate of lethality, this is by far the worst threat any occupying force has experienced in the last 20 years or so. IEDs, for example, can come in any form and shape from a suicide car bomb to land mines hidden along roadsides, or remotely controlled charges disguised as innocent objects on the street. They can be extremely difficult to identify, and even when detected are very often impossible to diffuse in time.

The devastating impact of IEDs on the daily routine of forces, specifically in urban areas, is beyond comprehension for anyone who has not experience it first hand. There are cases where it altered the entire behavior of units, disrupting them to the point of outright paralysis (U.S Army 2002).

The technology for counter-measures to IEDs is only now emerging and has not yet matured enough to provide robust solutions. The upshot, however strange this may sound, is that foot soldiers essentially walk in front of their vehicles in an attempt to clear the way by spotting and checking suspected objects.

The armored vehicles that were designed to carry and protect the troops have become so vulnerable that the roles have been reversed: now the troops protect the vehicles.

All in all, whether we look at high intensity conflicts or the new environment of low intensity, asymmetric warfare, the sum total of the difficulties listed clearly implies that profound changes in the ground force structure and its main platforms are inevitable as well.

Here too the general direction seems to be to devise solutions on the principle of replication and simplicity, that is, a mix of a greater number of lightweight low-signature platforms and autonomous remotely controlled vehicles.

The latest technology of 'active protection' promises to provide effective protection for light vehicles and military personnel without the need for heavy armor. It is possible now to intercept incoming munitions before they hit the vehicle. Merging this technology with multi-purpose remotely controlled weapons stations, which incorporate missiles and medium caliber guns, may well yield the same level of survivability and firepower in a vehicle that is one fifth the weight of today's tank .

In terms of DW such a small vehicle, properly networked, immediately becomes a molecular entity in a molecular network, where every single unit of the structure has the capabilities of a tank in terms of protection and firepower, of motorized infantry in terms of mobility, and of Special Forces in terms of flexibility and signature.

The tank, like the manned aircraft, has reached a crucial crossroads. Realistically, both will probably continue to play an important battle role in the coming decades, because changes and paradigm shifts of the nature described above take place gradually, over long periods of time.

Still, the general direction, again, is clear. The relative weight of the 'supreme dinosaurs' of both the air and the ground will gradually but significantly decrease in the coming years. In fact, this process is already underway to a various degrees in quite a number of armed forces.

Naval Platforms

Several unique features distinguish the evolution of naval platforms. First, in contrast to the air and the ground, for the last 60 years or so there has been no major sea battle on the scale of the classic battles of last century's two great wars. A few small-scale sporadic confrontations have taken place at sea since then, such as the 1971 Indo-Pakistani war and the Falklands-Malvinas war in 1981. But essentially, the only sea battle to speak of between – at least theoretically – equal rivals since World War II was the missile-boats skirmishes between the Israeli and the Syrian and Egyptian navies during the 1973 Yom Kippur War.

Second, the strategic objectives of naval warfare have undergone a somewhat more profound transformation since World War II than both the air force and army. The foundations of modern naval doctrines as formulated by naval strategic theoreticians, such as A.T. Mahan and J.S. Corbett, were deeply rooted in the world of the late 19th century and the age of colonialism. While remaining fairly relevant until the end of the Cold War, such profound changes have taken place since then in the strategic environment of the international system that it is difficult to see how these perceptions can help produce solutions to the strategic challenges of the 21st century (National Academy of Sciences 1997).

On the one hand, classic strategic objectives such as control of Sea Lanes of Communication, crucial for colonial powers and for world war belligerents, cease to be a meaningful parameter in a world of asymmetric warfare.

On the other hand, completely new definitions of the strategic role of sea-power have been developed. Converting the submarine fleets of superpowers into a nuclear asset during the Cold War years, for instance, transformed major portions of naval might into a never-to-use 'second strike' insurance policy in states' defense posture – giving a totally new meaning to power-projection.

Like some other processes that we have already discussed, here too the key parameters simply changed. The classic maritime objectives of Sea Control and Sea Dominance became irrelevant as ends in themselves. Achieving both in an asymmetric conflict regime, where the superiority of one side over the other in the air and naval dimensions is a given from the outset, makes very little sense as a gauge for force structure viability.

The evolution of the naval battle environment and force structure resembles much of what happened to the ground forces when air power became the ultimate player on the modern battlefield. Since World War II, air forces have played such a crucial role in maritime and ground warfare that most of the changes in both are more closely related to the emergence of modern air power than to any other factor.

The appearance of the aircraft carrier in the naval battle arena, with its ever-available air power, wrought a profound change in naval warfare, bringing to an end the service of the glorious battleship, the flagship of the two world wars.

Internal technological factors in the evolution of naval force structure are no less important. For example, the introduction of surface-to-surface and surface-to-air missiles into the maritime battle arena completely severed the classic positive correlation between ship size and power.

The weapons systems of a modern corvette today are so much more powerful, and cover such greater ranges, that it far surpasses anything warships ten times its size could achieve only 25 years ago.

If we previously discussed the gradual decrease in centrality of the aerial platform's own performance – in the plane's total capability and effectiveness – at sea this process is much more profound. The naval platform's performance, namely its speed and maneuverability, has remained practically unchanged over the past 80 years. The destroyers of the Royal Navy that pursued the *Bismarck* in 1941 were no slower, nor did they have shorter ranges, than the frigates that presently sail the waters of the Persian Gulf.

Air platforms, by contrast, have developed during that time from single-rotor fighter planes, like the British Spitfire, the German Messerschmitt, and the US Mustang, to supersonic jetfighters such as the F-15 and F-22, or the Sukhoi 30 and MiG 29.

The main reason for this incredible difference is that naval platforms, throughout history, were always perceived as a 'floating infrastructure' for the troops, guns, and eventually the combat systems they carried. This in turn defined the platform's capabilities and relative value.

Putting aside momentarily submarines, where the main emphasis is still on the performance of the platform itself (as that is what preconditions its ability to remain a covert system), surface warships, particularly since the first appearance of seaborne artillery, have been evaluated by the capabilities of the munitions they carry. Parameters of speed, maneuverability, and range were by and large a factor of the size required by the number of gun decks, etc.

Nevertheless, like tanks and manned aircraft, warships have reached their own crossroads. The fundamental strategic shift, from obtaining control over sea-lanes to affecting the battle on the ground – or the move of ‘blue water’ navies to the littoral ‘green’ and ‘brown’ waters, has exposed naval forces to an old rival equipped with new capabilities: the enemy’s coastal defense lines.

Confrontation between forces at sea and their enemy’s coastline defense has changed radically over time. Operations like the bombardment of Acre by Napoleon’s naval fleet at the end of the 18th century, or the shelling of Beirut by the battleship USN *New Jersey* almost 200 years later, in 1983, would today take a much heavier toll. Disregarding this threat, in July 2006 INS *Hanit*, the Israeli navy’s most modern corvette, operating eight miles off the coast of Beirut, barely survived a hit by an Iranian-made coastal defense missile (Haaretz 16.7.06).

In many respects the rival forces are practically equal. They operate the same radars, missiles and electronic warfare capabilities. Modern coastline defense is at least as effective in its capabilities as the naval forces attacking it. In fact, in a sense it is even more effective since coastal defenses never sink.

Moreover, the coastal defense system possesses contingency forces, equipped with much better supply lines than the force at sea. It enjoys a much wider range of deployment options in terms of cover and camouflage that the forces at sea lack. Its reconnaissance systems face flat monolithic terrain conditions in which enemy targets can be detected at distances of hundreds of kilometers. Conversely, naval forces must invest enormous effort and resources to construct a parallel tactical picture of the opponent on land.

Whereas along the coastline one may spread out (and conceal) missile batteries over a virtually unlimited area, the warship, for all its capabilities, constitutes a large, highly visible, singular target. With the exception of submarines, which are largely invulnerable to these types of threats – yet highly endangered by mines - naval forces along the littoral dimension are more exposed today then ever before.

Innovative approaches to shipbuilding have been developed to cope with these issues. The Sa'ar 5 ships of the Israeli navy were the first vessels built with the intention of lowering the spectral signature of the warship on the littoral, by treating the electromagnetic, thermal (infrared), and acoustic signatures.

Based in part on Israel's experience, the USN Littoral Combat Ship (LCS) project represents an effort to develop a similar ship that is even less exposed to threats from the coastline, and at the same time is modular in its systems suites, thus able to perform a maximum number of tasks from a given platform.

The underlying idea of the project is that the vessel will remain a low-signature floating base, from which unmanned air and sea systems will be operated: in every respect a maritime derivative of the DW vision.

That said, in the final analysis the evolution of the naval platform is still notably different from that of the tank or combat plane. Fundamentally, the naval platform constitutes a much more basic layer of the military force structure than the other two. The ship is the platform's platform. It carries both the planes and the tanks, and in the future will operate their respective replacements from the sea.

In all its possible configurations the naval dimension as it evolves will clearly entail employment of mobile, multi-functional and multi-service moving bases, which allow the maximal number of mission options to cope with the maximal number of possible scenarios.

The naval platform as a floating base is potentially and concretely the most multi-functional platform of the Joint Force mindset. It promises to be the most resistant – more than any of its contemporaries on the ground or in the air – to changing conditions and circumstances. The naval platform is probably the one 'dinosaur' that will remain with us longer than the others, if only for its function as the basic layer of DW from the sea.

Comprising, along with the ground forces, the horizontal line-of-sight, the sea should be perceived as a seamless continuation of the land. With complete disregard for irrelevant facts of geography, the integration of sea-and-ground over the networked system of DW should be made as smooth as possible.

The network must be three-dimensional, where ships, combat planes, UAVs, ground vehicles, and infantry troops, are all independent entities, with equal functions and connectivity – all capable of playing effective roles in the sensor-to-shooter cycle.

The supreme dinosaurs of the 20th century have brought us to the present state of affairs. It is now time to proceed to a multi-service operation viewed as a single hemisphere of three dimensions, in which the classic parameters of size and strength are diffused and no longer carry the same meanings as before.

Somewhat similar to the way biological organisms evolved after the age of dinosaurs, the evolution in military affairs leads to a generation of means that are smaller in size than their precursors, yet are more autonomous, independent, and adaptive.

The Concept of Virtual Mass

One of the more controversial concepts of this book is the notion of Virtual Mass. Obviously, it perhaps challenges military strategists' and commanders' most fundamental premise of warfare down the ages. Indeed, the very concept of virtual mass seems utterly counter-factual, contradicting both the common sense of military thinking and the enormous amount of actual experience and historical evidence. "…there is no higher and simpler law of strategy than that of *keeping one's forces concentrated*", says Clausewitz (Clauzewitz 1984: 204).

Still, we insist that present realities shed new light on this robust legacy and that a totally different interpretation is needed for this principle. Whether due to the emergence of advanced asymmetric warfare, or quite simply to the evolution of airpower capabilities and their influence on the battlefield – it is necessary now to reexamine this bold Clausewitzian postulate and the mindset that formulates its modern versions.

For it is certainly not a physical mass of forces in terms of units, tanks, guns and so on that needs to be assembled now, not for engaging an elusive asymmetric opponent in an "empty" battle space or for effectively deploying against air attack, for example.

The principle of Concentration of Effort (sometimes 'Mass')[6] is a metaphor born of the legacy and images of colliding masses of armies through which one aspires to ensure a breakthrough, a decisive penetration of one's opponent mass. On the face of it, in practical

6 Different formulations exist for this principle. Some refer to Mass, some to Concentration of Effort, Concentration of Force, etc.

ground-force terms this means the aggregation of very large forces that move ahead in a concentrated and concerted effort designed to destroy anything that stands in their way. It has worked frequently in the past, mostly in conflicts between regular armies of warring nation-states; but it is going to be extremely difficult to repeat this type of campaign now, in the presence of modern stand-off precision-guided munitions. And in the case of asymmetric warfare, victory in this way proves meaningless, being limited to the first phase of the conflict only, as the war in Iraq convincingly shows.

The whole setup has changed. Mass per se has become the sum total of its own destroyable targets, and targets are destroyed much easier today.

So the relevant variables here are no longer the size and number of military units but hitting rates and killing capacities. A squadron of attack helicopters, a dozen armed UAVs, or even a well prepared ambush of a few dozen fighters with enough guided munitions can decimate a brigade. Let us then take a second look at the notion of virtual mass, and see if it really is as counter-factual as it seems at first sight.

What we argued in the preceding chapters is that the friction throughput, or engagement capacity, of molecular forces can be much larger than that of the concentrated linear mass of forces. This idea can be expressed in terms of the sum of potential contacts along the forces' surface, as in figure 1.

As the surface envelope can be made to express the sum total of potential contacts, or the engagement capacity of the force, theoretically the more small forces we deploy the larger the friction throughput we produce. When we apply this effect in parallel rather than in a linear sequential fashion, it also dramatically enlarges the throughput per given time frame. That is, the diffused structure produces more throughput per given area, and it does so over a shorter period of time. It 'compresses', or better, it *concentrates*, the friction throughput along the time axis, while extending it along the space axis, as in figure 2.

Figure 2 expresses this effect somewhat arbitrarily (obviously we assume too much here), on both axes. If t_0 represents the start of the conflict, and t_2 is a given linear stage in it, say three days, theoretically after three days the linear force covers approximately the same net area that the diffused force was already covering at the starting point (the crosshatched dark green). Moreover, half of it may still be on our side of the front line, and of its already engaged half only the outer envelope can be in contact with the opponent while the rest of the mass is essentially an idle potential.

We may be stretching the point a bit, but it certainly reflects evidential real-world experience and insights. There is no question, for example, as

- Assume friction output potential to be measured by size of the surface envelope.
- The total circumference of the small circles is greater than the larger one that encircles them

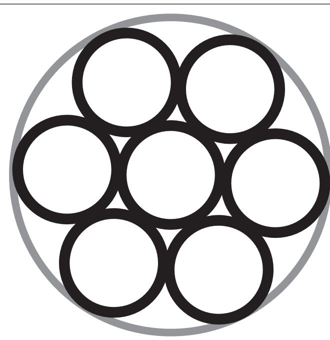

Figure 1: Friction Throughput Capacity

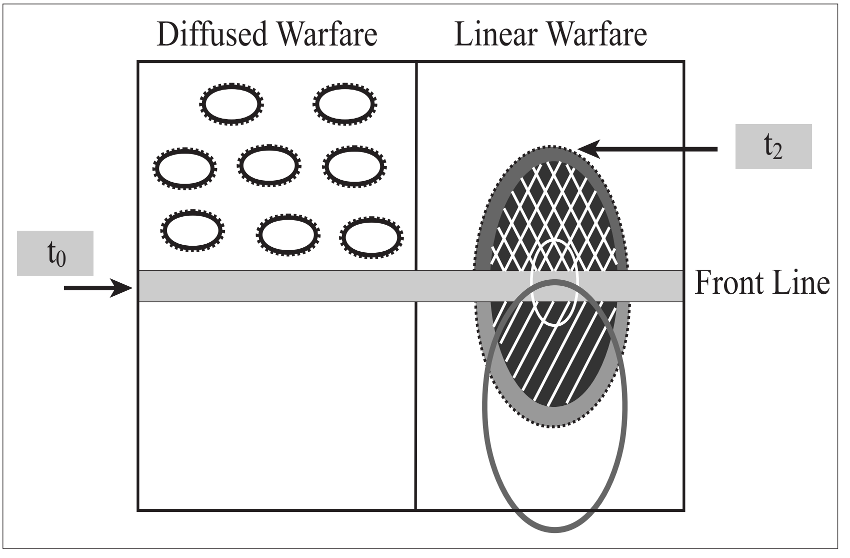

Figure 2: Friction Throughput Capacity

to the potential impact of behind-the-enemy-line operations. To a certain extent even the old flanking maneuver, performed thousands of times since the dawn of warfare, is somehow nothing but the 'linear expression' of this approach. Diffused warfare, with its concept of molecular forces, may be taking it farther away perhaps, but it is not totally detached from conventional thinking.

Likewise, there is no question that current force structure and the classic linear warfare approach inherently involve significant inefficiencies and wasted potential. This force is certainly large and powerful, but it is built to operate under certain assumptions which, as we have argued in the preceding chapters, are by and large no longer relevant. Other things being equal, the left pane of picture 2 can be said to be at least more efficient, in both time and space.

Still, one can rightly claim that these aspects are essentially only different shapes of the same perception of physical mass, applied at various levels of concentration in a sequential serial process, where whatever one does in parallel is necessarily more efficient. True, if the essence of the argument for virtual mass is limited just to the efficiency difference between parallel and serial processes, we may indeed have too little to warrant such a highly charged definition.

We did argue that 'virtual mass thus constitutes a more efficient battle form than the physical and geographical concentration of forces of the linear approach, because the sum total of its engagement contacts is significantly larger'. But there are also additional dimensions here to consider. For some of these we offered a few quantification examples in a separate chapter. Now we want to examine two more aspects more closely: the network effect, and real-time situational awareness.

These two are essentially linked in creating a rather new state of affairs where the former makes possible the latter. The end result of this new phenomenon, however, constitutes such a dramatic shift from past circumstances of warfare that it certainly deserves a careful definition.

The term 'network effect' refers to the state of affairs where each independent part of the system is constantly connected to the others in such a way that the multitude of spatially separate particles operates as a single entity at any given moment. That level of networking is very different from mere coordination, and is not to be confused with it. This is not the same thing. Radio and telephone networks fall under coordination, just like smoke signals, drums and trumpets. Armies have operated on various levels of communication systems throughout history, and the art of war was to combine the parts each time into an effective whole at the right moment. The system was coordinated using series of commands and signals, communicated through the chain of command down to the single unit, enabling it to operate as a whole in *specific* time frames.

But it was a normally separated system, that is, its various entities were supposed constantly to maintain a *potential* for linking to other entities in the system (in terms of communication capabilities) whenever required, or whenever they chose, to do so. To put it in more generic terms, the system was *normally* off-line and *conditionally* on-line.

In Net Centric Warfare (NCW) we do not coordinate the particles, we *integrate* them. The system is constantly linked, in spatial and in temporal dimensions. It is *constantly* on-line. This is a categorically different state of affairs and, as much as can be anticipated at this stage of its development, the implications are dramatic. It means that given an adequate hierarchy structure, potentially, the resources of the entire system are available to anyone at any given moment.

Availability, of course, still needs to be factored for the various levels of reaction time; ground forces are not available in the same sense that air power is, and so on. But in general, warfare becomes a case of a central real-time resource allocation to variable end-users, rather than a case of coordinating joint efforts of firmly fixed structures. At the same time the fielded particles of the system, sea, air, and ground, can now be molded differently, to utilize the resources of the network optimally; hence a 'molecular' force structure.

Real-time situational awareness is a direct derivative of this state of affairs. Since every sensor on the network is available on-line, each and every single sensor-to-shooter cycle can be monitored, either from the inner circle of participants or through stand-off resources, at any level of the chain of command. It means an altogether new level of BDA where uncertainty is reduced dramatically.

The results are not just a better sense of how we are doing, although this certainly is a very important contribution. The fact that we can understand in real time the impact of our actions, and the opponent's reaction to it, actually offers an option for a new form of force concentration. Clausewitz talked about spatial concentration of forces as the 'higher and simpler law of strategy' – NCW can probably talk about a *temporal* one.

Linear force structure wastes friction potential in its inefficient spatial formation, designed for the sequential destruction of the enemy's defensive lines, but it also has a temporal dimension of wasted potential. We exemplified this by comparing throughputs of parallel and serial activities. But there is a more basic layer still, pertaining to situational awareness.

Uncertainty in BDA is by far the largest time-consuming element of war. It starts with the single soldier who waits to see if his shot has hit the target, and ends at the supreme command waiting to see the results of a theater offensive initiative to decide the next move. If we could measure the ratio of *net friction time*, that is, the actual time of concrete fire exchange in a given conflict – as opposed to the overall downtime of no shooting within this time frame, the results would probably look absurd.

Odd as it may sound, war is more about waiting than anything else.

One reason for our insistence on defining the DW network as a network of ‘world views’ is precisely that. The greatest advantage of fusing vertical and horizontal lines-of-sight over the network is that it can instantly distribute legitimate targets and BDA across relevant domains. Utilizing this common comprehensive picture can eliminate big chunks of uncertainty and enable us to cut through hours – maybe days - of hesitation.

This is what we mean by saying that DW can compress the fighting sequence because it accelerates the chains of cause and effect across the battle space. When these micro processes are accelerated at the micro level and parallel activity accelerates them on the macro level, we do in fact get a new type of mass, and a new meaning to the old principle of war pertaining to concentration of force. We actually are trading off spatial concentration for temporal, by taking the opposite approach. Instead of concentrating the forces and efforts to distinct points in the battlespace geography, advancing them linearly from stage to stage, we want to spread them all over the arena and condense their simultaneous action into a distinct time frame, so to speak – looking more for a shock-wave effect rather than for a landslide.

Since the other characteristics of DW also involve a major shift from the heavy structures of the linear force (but not all of it), and since the level of resolution we chose to define its basic units goes down, figuratively, to the molecule, it seems we can rightly warrant this set of ideas as the concept of Virtual Mass.

Dynamic Molecules

We have thus far described the changes taking place in the battlefield and their underlying causes. We also set out our vision of DW, which we perceive as the next step in the evolution of warfare. We claimed that Diffused warfare is better equipped – than any of the models used today – to meet the challenges of asymmetric warfare as well as for the conduct of traditional inter-state armed conflict (Rogers, 2001) . This chapter sets out to describe – in almost technical terms – the structure of diffused warfare at the center of which stands the Dynamic Molecule (DM).

As mentioned, DW implies simultaneous rather than sequential engagement of enemy targets over the entire battle space, with the intention of disabling – rather than totally annihilating – the enemy's forces, in order to achieve the designated strategic objective. This might range from random individual retaliation missions or pre-emptive incursions to continuous suppression of para-military or terrorist organizations, and up to decisive campaigns against nation states' regular armies.

The operational rationale consists of both the physical effects of massive surgical attacks on significant enemy assets by the network of molecular forces, simultaneously and all over the battle space, and of the accumulated effect it has on the opponent's cognitive composure and decision-making mechanisms.

At the outer edges of the network are the basic units, the dynamic molecules, that operate in respect of the enemy targets. The molecules'composition and mode of operation are determined by the specific military missions they are tasked to carry out, the only precondition being that each must have a self-contained sensor-to-shooter capability.

Optimally, the typical molecule will consist of a ground team, an unmanned aerial sensor, and, in proximity of the shoreline, a seaborne element. This is to ensure that each molecule has in itself the capacity to fuse vertical and horizontal lines-of-sight, and that it operates at the required level of situational awareness.

In terms of situational awareness, the required systemic output of a well organized and properly positioned network of molecules is, basically, that we will always be first. The first to see, the first to understand, the first to decide, and the first to act.

As their name implies, DMs have the capacity to change form in terms of force composition and assigned functions as the balance of constraints and opportunities evolve during the actual fighting. They are 'ad hoc' netted entities comprised of aerial, ground, and maritime building blocks, designed for operational activity within enemy territory for limited periods of time.

This means avoidance of prolonged positioning in the same territorial cell, under the premise that the reason for forces to be or not to be somewhere, is ultimately the completion of the sensor-to-shooter cycle. The objective is to hit all the legitimate targets within the mission scope and get out.

The underlying assumption here is that the continuous hits inflicted in parallel all over the enemy's territory, leaving no distinct pattern and no tangible mass to hit back at, are much more difficult for the opponent to sustain than the shaped, massive maneuvers of the linear approach. So by and large DMs will be constantly on the move and constantly changing compositions, going in and out of action. In that respect, in a sense, we may look at the concept of DW as a strategy of perpetual raid.

Construction

In organizational terms, this molecular structure consists in effect of only three hierarchical layers: the layer of the individual molecules, the layer of the *molecule compound*, and the *battle theater* layer. The authorities above the battle theater commander may vary from case to case according to different national armed forces structure, and the various perceptions of the concept of military theater (Weisbuch 1991; Bossomaier & Green 2000).

A group of molecules with a set of missions, which together create a common battle rationale, form a *molecule compound*. Connected to each and every molecule and updated by a constant stream of (mostly visual) data, the molecule compound commander should be able to plan, adjust, support and coordinate the activities of each separate molecule in the compound, by sending in reinforcements, additional firepower, etc., or by defining new missions, modifying existing ones, and moving molecules in and out of action.

The molecule compound commander will be assisted by a support system responsible for the continuous analysis of the complex battle picture of the molecules under his command, which should provide him with the required level of situational awareness.

The battle theater commander is assigned responsibility for the molecule compounds operating in the designated theater. Based on his definition of the operative campaign objectives, the battle theater commander will determine the specific military missions and operations of the molecule compounds under his command. He will require a control system to allow him continuous analysis of the battle picture of the entire campaign upon which he can base decisions concerning the overall battle management as a function of the evolving circumstances in the battlefield.

In other words, a key requisite for the molecular force structure to be applicable to real battle scenarios is that it achieves *information and intelligence dominance*. As a ‘thin’ formation that lacks mass reserves, the molecular forces rely heavily on situational awareness. It must be constantly fed with the highest levels of information and intelligence so as to provide all its components with up to date and accurate battle pictures. Information and intelligence dominance implies the ultimate use of integrated real-time intelligence to facilitate the aforementioned four critical imperatives: to be first to see, understand, decide, and act.

The structure that should make this possible is as follows: the molecule commanders will have access to the detailed battle picture of their immediate surroundings, generated by the molecule’s own sensors. These commanders will operate in relation to a *desk* (see below) that provides additional layers of relevant information, collected from the overall range of sensors placed throughout the battlefield. The compound commanders, on the other hand, require a more interpretive picture of the overall operations conducted by the molecules in their compound.

For this they must be able to access the battle pictures of each and every molecule in the compound at all times. This is the task of molecule commander support system. Its function is to integrate the battle picture of the individual molecules in the compound, as it is produced by their separate desks, to a coherent whole.

The battle theater commander requires an even higher quality of integrated intelligence to manage the military campaign with maximum flexibility; to change and adjust the definition of top-level battle effects in response to the developing campaign. For this purpose his headquarters will use the stream of integrated battle pictures of the various molecule compounds, as well as every additional resource available at the national strategic level above the theater of operation (Keegan 2003).

Intelligence dominance for molecular force structure means a totally new level of systemic situational awareness in order to understand and to shape what goes on in the battlefield. It implies a network that allows an exchange of 'world views' within and between all levels of command – from the battle theater commanders to the molecule compound commanders, and down to the level of the single molecule in the field. For that, it requires a network that integrates real-time lines-of-sight of each separate component in the formation into a real-time 'database of perspectives' that is built as a layered structure of resolutions – from the particular to the comprehensive; from the molecule commander's local world view to the theater commander's all-theater inclusive world view.

With intelligence dominance, commanders at all levels will have the ability to make real-time operational decisions based on sound situational awareness; to modify mission definitions rapidly and effectively, to construct new molecules and molecule compounds, and to alter existing ones in response to the constant flow of new information. Lacking the linear structure's reserve margins, indeed, intelligence dominance is a defining feature of the molecular force conception.

To be sure, intelligence dominance is not only derived from the superior quality of the network as such, or the critical content of the intelligence gathered, generated and transmitted; it also necessarily entails cutting-edge command and control capabilities that mold it into the relevant world view by means of which the battle theater and molecule compound commanders can continually decipher events on the battlefield, predict their impact, and decide on their next move (Roger & Kline 2004).

None of this, of course, is in any sense new in military theory. The difference, again, lies in the molecular force's lack of a margin for error to compensate for insufficient or faulty intelligence, and the grave consequences this might have. What is new is the emphasis on the 'real-time picture' as the most critical element of intelligence work. It carries enormous implications for the existing intelligence organs and institutions, and requires nothing short of a complete paradigm shift to implement.

Unquestionably, achieving intelligence dominance in the sense described above is perhaps both the single most important element in making DW a viable concept, and the greatest challenge for its successful implementation.

The Components of the Dynamic Molecule

Following the presentation of a broad conception of the DM and its external prerequisites, this section gives a more detailed and technical description of the molecule components. These are inserted into the command and control system that serves as the network's operating mechanism. Designed to add or remove building blocks of sensors and weapon components, the command and control system can expand or contract the molecule according to changing needs in the battlefield. Such building blocks may include firepower resources, intelligence gathering equipment, maintenance components, ground forces, and aerial or sea components. The command and control system will rapidly unite the additional components with the others of the molecule. In most cases the attachment will not be physical, but will reflect an interchange of battle pictures, and/or entering the "open bid" of the sensor-to-shooter circle.

The above implies that all components of the molecule update and are updated, in real time, regarding:

a. the locations of the molecule and all its other components.

b. the locations of threats and /or the targets that were affected by the molecule and its other components

c. intelligence gathered by external means

From the moment the components unite each component that serves as a 'trigger' can shoot a target, through the command and control system. This applies both when the weapon is located in the battlefield with the molecule components and when it is located behind it, in the *Support*

Tier (see below). Likewise, due to its dual-use design, the molecule can receive designated intelligence gathering requests from the molecule compound commander or from the desk manager.

The Desk

Each molecule will be assigned a 'desk'. Subordinated to the molecule commander, the functions of the desk are defined as the following:

1. to receive and integrate the stream of intelligence coming in from the molecule components and external intelligence sources.
2. to designate targets based on the above data for the molecule components.
3. to mediate (when necessary) between the molecule component tasked to 'pull the trigger' in the battle field and the weapon resources situated in the Support Tier, while updating all the other elements in the molecule as to what is taking place.
4. to transmit intelligence gathering requests – from the molecule compound commanders, the battle theater commander, or other molecule components – to the molecule commander.

The desk need not be positioned in the battlefield. Its place – together with the other desks – is most optimally in the command centers, in the main intelligence deciphering center, or in other designated places to which information flows. At the same time, although the networks capabilities allow the desks to be situated anywhere, it is significant that the relevant desks be concentrated in one area in physical proximity to the battlefield.

The Support Tier

The Support Tier is an aggregate of intelligence, logistics, and firepower resources, designed to support this extremely light molecular system while physically detached from it – contrary to the conventions of linear warfare. The Support Tier, operated under the battle theater commander, will allow the molecules easy access to this pool of support resources, freeing them from the burden of physically carrying or "dragging" them along in the battlefield.

Thus, the Support Tier contains all the components that are not attached to the forces in the field – ground, air, and sea. As a 'service tier', the Support Tier is intended to serve all the molecules along several dimensions:

The intelligence dimension. For the most part, this dimension of the Support Tier will entail intelligence-gathering tasking of components outside the immediate circle of the molecule and delivery of the output through the desk to the molecule. To do this, the command and control network of the molecule will tie into the Support Tier for a limited amount of time and "download" the video stream or any other digital form of the data. For example, if a molecule encounters bad weather or bad visibility conditions and is thus in need of a picture created by a synthetic aperture radar (SAR), the Support Tier will supply the required tool (if available) through the desk.

Intelligence gathering components will be categorized into subgroups according to attributes of wavelengths and/or the platform that carries the sensors. For example, one subgroup may consist of intelligence-gathering micro UAVs with vertical electro-optic sensors; another may include UAVs and manned aircraft with diagonal-horizontal electro-optical sensors; yet another may be the subgroup of ELINT (electromagnetic intelligence) gatherers, COMMINT (communication intelligence) gatherers, and SAR.

Each and every intelligence gathering component must be able to transmit its data in real time to the desk of the molecule, which to all intents and purposes will have the capacity of an Integrated Targeting Team (ITT). This function of the desk is one of the first brainchildren of DW, and a direct outcome of its special perception of the battlefield as sphere of targets rather than a territorial quantity. Once we see it as such, ITTs become a necessary building block for DW effective execution.

The logistics dimension. The logistics dimension of the Support Tier will provide the necessary logistics for the molecule as defined in advance and in accordance with changing needs during battle. The capacity to provide logistic support in real time requires a system that is first and foremost “rapid response”, in addition to its function as a supply source for equipment and a means of transporting the molecule when a change of location is required. That is, the logistics dimension, which is tied to the network and uses the command and control system, must be just as accessible and responsive, say, as the different sources of firepower participating in the ‘open bid’ cycle of sensor-to-shooter.

In contrast to the past, when forces had to retreat to special supply points for rearmament, maintenance and supplies, the Support Tier must offer a logistic forwarding mechanism designed to support and sustain the diffused structure of the forces on a Just-in-Time basis.

This again is a newcomer. Linear warfare is essentially a Just-in-Case affair. It presupposes, in effect, the most extreme eventuality where everything happens to everybody at the same time. Forces move with just about everything they think they may need along the campaign, for fear of lacking something when the need arises. While each force component, say a division, may claim to be (optimally) self-sufficient, the support layers of the entire force are multiplied by the number of divisions deployed, to amount to an extremely costly redundancy. Since the support components of one division are rarely available to the others, it is often the case that at critical fighting junctures there is too much, or worse, too little (Davis 2001: 79).

The Just-in-Case logistic concept is actually a pressing challenge for armed forces anyway, regardless of force structure. It remains valid even if one chooses to reject DW perceptions altogether. But as regards DW it becomes a necessary condition. For forces to be diffused their support function must be pooled and centralized. Inevitably, it means pooling everything they may need and delivering it when they require it.

The firepower dimension. Accordingly, the lion's share of the firepower equipment is not carried by the molecule but is located in the Support Tier. This allows the molecule itself to remain as lightweight and as signature-less as possible. The range of support firepower systems in the Support Tier can include ground systems, air-launched guided ammunition from fixed-wing jet fighters or attack helicopters, unmanned air vehicles (UAVs), and maritime platforms. The firepower components in the Support Tier will also be classified into subgroups according to the different effects they produce, for example, the attack UAV subgroup, the surface-to-surface munitions subgroup, the air-to-surface missiles subgroup, and so forth. Firepower will be allocated by a management system that will also provide molecule and molecule compound commanders with a continuous stream of information regarding availability and readiness of the firepower resources of each subgroup. This way, information regarding insufficient supplies of a certain weapon will be included in the general world view, thus minimizing unrealistic expectations or demands. Once again, the "thinness" of the molecular structure dictates constantly updated and accurate real-time situational awareness.

The Support Tier and the Molecule

Let us take a closer look at the processes described so far. In principle DW is based on mobile molecules with very low signature, capable of producing effects that in linear warfare could have been produced most probably only through the disproportionate use of firepower. The term 'signature' here means the covert and stealth-like attributes necessary for this type of mass-less force structure. While the low signature requirement applies to all components of the molecule, it is particularly crucial for the ground forces. This is because although the molecule components are small and distributed throughout the battle space, they are optimally designed for stand-off operation; this is where their capabilities are indeed disproportionate to their size and weight. The downside is that once discovered, they are vulnerable to conventional attack by regular forces.

The ground, aerial and sea components of the molecules will all be intelligence gatherers on the one hand and 'trigger pullers' or 'shooters' on the other. As already noted, the molecule components have the capacity to fire on targets identified or 'created' for them, either from fire-sources situated inside the molecule, say, its airborne, or seaborne component, or by 'pulling the trigger' of weapon systems located outside the molecule operated as part of the Support Tier.

When a component functions as a gatherer, it is tasked to detect a threat or a target, or to pursue and transmit intelligence in real time to the desk, or indeed to any other relevant component that needs the information, such as an adjacent molecule. The intelligence required usually concerns the type of object detected (vehicle, hostile combatants, ammunition bunker, etc.), its location, and the time of detection. This information will immediately be transmitted to the desk, thus turning the object observed into a target for the other components of the molecule or for firepower resources in the Support Tier. This is essentially how an intelligence gathering component 'creates' a target. Furthermore, by merging the incoming information with the existing world view it possesses, the desk will be able to decipher the 'situation' and create additional targets.

When a molecule component functions as a 'shooter' it has the capacity to attack a target – almost any type of target, either directly by means of a personal weapon system or, again, by 'pulling the trigger' of a weapon located in the back lines, in the Support Tier. Firing at a target from the Support Tier requires that data regarding the target as well as information regarding the precise locations of all other components of the molecule be transmitted with utmost accuracy – to prevent hitting one's own forces.

As mentioned, a target may be 'created' by the desk or by any other component with intelligence-gathering capacity. Receiving a target by means of a component of the molecule, however, entails a process that runs somewhat in reverse to the gathering process described above. In this case the molecule component (which may be a single soldier) must receive accurate information regarding the location and type of target detected, and then, while establishing actual contact, it must *reaffirm* the information received and 'close the circle' by tracking it, transmitting its movements and reaching a decision to pull the trigger. If the given component for any reason is not able to attack, say, because of a faulty line-of-sight, the attack will be carried out by another component on the 'open bid' for which the target is still relevant.

Obviously, the relationship or connection between the Support Tier and the dynamic molecules is a critical element in the diffused force structure described here. The Support Tier serves as an operative framework and as a resource provider for the changing needs of the dynamic molecule. For example, if a molecule that has completed its mission is requested for operation at a new site and/or is requested to change its force composition or its sensor-shooter function structure, the change will be made possible – by the molecule compound or battle theater commander – through the Support Tier system. Thus, the commander will physically attach new forces simply by connecting them to the molecule on the command and control network and/or will remove the now unnecessary components of the molecule. Also, the Support Tier will provide the means, mostly airborne, for physically moving molecules to new locations for new missions.

In this sense one might describe molecules as integrative war entities, interconnected via a command and control system that contains all the range of intelligence and firepower components and support available in the theater.

The molecule can take many forms. A molecule may be comprised of ground combatants and integral airborne and ground intelligence gathering components such as man-portable micro UAVs, allowing combatants to create a short-distance picture of the battle space ‘around the corner’ or ‘over the hill’.

Likewise, a molecule may be based solely on airborne intelligence gathering and attack UAVs, in order to carry out defined missions. In this case the Support Tier will be used for additional firepower sources not provided by the molecule components themselves. A molecule might also be based solely on maritime forces with UAV and other gathering components. Finally, it may combine maritime force/platforms and ground components within a ground/sea molecule.

All in all, dynamic molecules should enable force structure design to be as adaptive and flexible as possible in respect of deployable components. The key to this lies in the efficiency and performance of the Support Tier. If the risk involved in transforming the linear force masses into molecular entities is to be tolerable it will be so because Net Centric Warfare can provide us with the means to build such Support Tiers that allow us to take the next step into DW.

Ending Wars

The business of ending wars and of stabilizing new geopolitical realities is traditionally perceived as the domain of diplomatic activity. If war, as Clausewitz claimed, is "the continuation of policy by other means", when military missions end the ball is returned to the court of statesmen (Clausewitz 2004). The purpose of initiating military action, according to this view, is to affect the existing balance of power such that more favorable political conditions are generated after the fighting ends – by transforming military achievements into political assets.

Accordingly – and as Clausewitzian rationale would have it – the greater the scope and depth of destruction served by the winning party in the military phase, the larger the 'range of political maneuverability' it enjoys in the post-war phase.

The harsh conditions of surrender imposed by the Allies on Germany and Japan at the end of World War II are a prime example of this relationship in modern history. Conversely, the lack of total defeat and destruction of Germany at the end of World War I accounts, at least partially, for the recurrence of war in the same region a mere twenty years later. In the latter case, the failure completely to destroy Germany impeded the victor's ability to translate its military successes into political assets.

One may also wish to view the last 60 years in Europe, with not a single military clash to speak of between nation-states despite the Cold War brinkmanship, as a consequence of the mutual internalization of the impact of the scope and depth of destruction of the last century's two world wars by both the victors and the defeated parties.

We present this somewhat simplistic description, which obviously only partially captures a relationship that in reality is much more complex, as the backdrop to our discussion on one of the most acute issues pertaining to military confrontations, especially in asymmetric conflicts: the task of ending war by instating a cease-fire and creating a physical separation – or rather disengagement – of forces.

More specifically, how does one create a military endgame that entails a separation of forces covering all the components of firepower involved in combat, in such a way as to reduce to a minimum the probability of their clashing again?

Attaining a disengagement of forces when the conflict involves the armies of nation-states is fairly simple. These types of conflict occur within well-defined conceptual and geographical boundaries, which in most cases also define the underlying causes of the conflict (i.e., the national assets under contention) as well as the basic parameters for its resolution. The 38^{th} Parallel in Korea and the removal of Iraqi military forces from Kuwait in the first Gulf War are two examples of straightforward military endgames of this kind.

However, when one takes a case like the return of Israel to its pre-1967 borders as a solution to the Arab-Israel conflict, which seemingly belongs to the same category of state conflicts as Iraq and Korea, and apparently is perceived by the international community at large as the only possible solution, a much more complex (and for now hypothetical) reality is revealed.

The main difficulty is that multiple entities claim to have a legitimate stake in the final end-state of the conflict, yet not all of these entities can be said to have internalized the scope and depth of destruction they suffered, to the extent that it created a 'range of political maneuverability' large enough to generate a preferred political reality (Rosenau 1997: 78-82). With Egypt and Jordan, for example, such end-states were apparently achieved, resulting in peace treaties between these two countries and Israel.

The conflict with the Palestinians, however, as well as the continued military conflict with Syria, which regardless of two severe military defeats by Israel (1967, 1973) and a defeat in Lebanon (1982), has opted to facilitate the conflict through the Hezbollah – are examples of the opposite.

Apparently, at least as regards the record of the conflict in the Middle East, simplistic Clausewitzian conventions of military action facilitating political solutions are, at best, only partially convincing.

Today the use of military endgames as a springboard for political processes clearly involves difficulties far beyond the perceived price of specific defeat, or the failure to establish clear borders between the fighting parties – although physical borders indeed constitute a necessary condition for the political end-state of war.

Israel's unilateral withdrawal from Lebanon to the international border in March 2000, which was supposed to constitute an acceptable, if not perfect, military endgame accepted by all parties involved, and in line with UN resolution (425), amply illustrates this point.

The real-world effect of this unilateral move by Israel was that the other key players – the Hezbollah and its two patrons, Syria and Iran – practically reorganized their forces along the reinstated border, as essentially their next military front line rather than an interstate border.

For six years, a de facto disengagement of firepower components did materialize, to some extent, but the situation remained explosive and bursts of heavy fire exchanges still occurred over several kilometers of disputed territory claimed by the Hezbollah. Yet compared with the daily toll of the Israeli military presence in Lebanon, caused by improvised explosive devices (IEDs) on the roads and constant firing on IDF strongholds, the rate of skirmishes along the new front line after the withdrawal fell, yielding weeks and months of calm. So it was until July 12, 2006, when a Hezbollah ambush that killed eight Israeli soldiers and captured two ignited the entire northern front, with 33 days of fighting in which massive destruction and casualties were inflicted on both sides.

Thus the problems involved in achieving a military endgame, defined here as a separation of combat components such that the possibility of future confrontation is minimal, is first and foremost contingent on the type of entity or entities involved.

Again, in interstate confrontations the separation of forces may be a trivial matter. The military end-state between Israel and Syria on the Golan Heights at the end of the 1973 Yom Kippur War was a military cease-fire, which led later to the disengagement agreements of 1974, which constituted a total separation of combat components.

Remarkably, this separation of forces between nation-states remained intact even when, in 1982, the two rivals confronted each other again in armed conflict in Lebanon. Not one single shot was fired along the Syrian-Israeli border, while some 80 Syrian jetfighters were shot down over Lebanon in one day, and the headquarters of their expeditionary forces, as well as a considerable number of ground units, were destroyed.

However, in cases of organizations such as the Hezbollah, stabilization of a separation of forces is much more difficult. The Israeli withdrawal from Lebanon in 2000, played to the Syrians interest in having that organization as an external warring tool to bypass the constraints of the disengagement agreements of 1974, and provided Iran with an the opportunity to continue its armed struggle by proxy against Israel. Despite this, it was not the interest of these two states at the time to oppose an effective separation of forces, which was the key enabler of the bristling status quo that emerged along the Israeli-Lebanese border. This was simply because it made it possible for both Syria and Iran to upgrade and arm the Hezbollah to the level of an effective and efficient military extension of their own, and to perfect the strategy of war by proxy.

The July war in 2006 posed for the Syrian leadership much less of a dilemma than the events of 1982. In fact, it vindicated the strategy of war by proxy, and fulfilled its objectives beyond all expectations. Israel failed sufficiently to eradicate the fighting potential of the Hezbollah, for various reasons, and the Syrians claimed victory.

In any event, the military endgame's effectiveness and the means of separation of the combat components, achieved through international diplomacy and the stationing of UN forces, are still not clear and remain quite fragile.

Clearly, the main obstacle is the fact that the key player, the Hezbollah, like any and all other non-state military entities, thinks and reacts like an organization rather than a state, even if it operates very much like an army. Its leaders claim to be fighting on behalf of the state, yet the cost of the scope and depth of destruction is not borne by the organization but by state organs – control of which in most cases is its next objective any way - and by the civil society, of which it is an integral part.

The last war between Israel and the Hezbollah is in some respects an entirely new phenomenon. It is a case of two nation-states using the means of military proxy against a third one, where the military proxy, essentially, is devised as the regular army of a state within a state, operated from the capital and functioning as a legitimate political entity.

Whether what we witnessed in Lebanon in July 2006 is the exception or the rule remains to be seen. However, this anomaly touches on strategic realities of future conflicts between nation-states, as much as it concerns non-state organizations. With more rockets and missiles falling on the north of Israel in 33 days than the sum of all German V1s and V2s hitting Britain in World War II, it certainly gives the notion of asymmetric warfare a new meaning.

Whatever the case, the acute problem remains achieving an effective military end-state when one's rival is an organization or a loose association of several organizations that claim the right to fight but accept no matching responsibility for the costs (Alberts & Hayes 2003).

Purely from a military standpoint, the problem before the armed forces of the USA and its allies in Iraq and Afghanistan, and the problem the Israel Defense Forces face in the West Bank – and experienced a few years ago in Lebanon and Gaza, are almost identical. Essentially, the challenge is to sustain a prolonged military presence on occupied and mostly hostile territory, sustaining minimal attrition to manpower and materiel, and avoiding non-combatant casualties – in a situation where a military endgame that provides effective separation of firepower components is practically unattainable.

The opponents in both cases consist of non-state organizations nesting in the hollow shell of an incapacitated or a would-be nation-state. In both cases, reaching a feasible and reasonable military endgame within the existing international 'rules of the game' seems unlikely, at least as long as the respective local governments fail to exert full internal control.

Israel's movement toward unilateral disengagement from the Gaza Strip and northern Samaria in summer 2005, in the absence of an agreement between the sides emerged against the backdrop of highly particular and complex geopolitical conditions, which are beyond the scope of this book to address.

However, the military rationale of unilateral redeployment as a means to instate a de facto state of disengagement is highly relevant to asymmetric conflicts in general (Davis 2001). Sooner rather than later it may well be on the agenda in Iraq and Afghanistan as well.

As was the case with Israel's unilateral withdrawal from Lebanon in 2000, this concept tried to incorporate a military endgame that seeks the conditions of a separation of all firepower components – even though for the time being the emerging Palestinian state does not have the power, or the intention, to enforce it. The situation of the Palestinian Authority in Gaza resembles in many respects the status of the powerless Lebanese government with its inert army vis-à-vis the shaky cease-fire between Israel and the Hezbollah, but without the UN peacekeeping force, which is now called on to try help the Lebanese forces maintain such a separation.

And again, very much like the case with Hezbollah, Israel's second attempt at a unilateral disengagement - from the Gaza Strip – ended a year later in endless rocket firing from Gaza into Israel, and in continuous military actions by Israel in an effort to stop it. So far at least, the notion of unilateral disengagement seems to be failing with respect to asymmetric conflicts.

In other words, in the current configuration of asymmetric conflicts, the military problem is to maintain an effective military presence that facilitates the transfer of power to the local authority, once this is established and stabilized. Should the local government collapse before this is achieved, the goal is to maintain viable options making possible either a continued presence or a pullout that incurs minimal political and military costs.

This is a truly problematic mission statement for fighting forces taught and trained to win battles. They may easily win the first phase of 'taking over', as in Kosovo, Lebanon (in 1982), and Iraq, but then trip up badly over the subsequent more complicated phases of transferring the power to the locals and pulling out (Bailey 2001).

In any case, the existing force structure, which was built to sustain high intensity conflict between armed forces of nation-states, is woefully inadequate for this. Its physical mass-oriented mindset is fundamentally counterproductive, its main heavy assets are largely irrelevant, and its use, time and again, incurs human and political results devastating in their cost. (Washington Post 31.7.06; Haaretz 9.11.06).

The fierce debate over the required strength of US ground forces in Iraq, which centered on the question if more would have been better, may have missed the point. Certainly, the Soviets' experience in Afghanistan does not support the argument that what essentially counted there was the number of troops deployed – and so perhaps is the lesson learnt from the experience of the current coalition forces in Afghanistan.

The war after the war, which arguably calls for the presence of massive force structure on the occupied territory, is often itself a cause of the occupier's inferiority. Such a deployment of forces naturally requires constant reinforcements and reserves to protect them, paradoxically only increasing their vulnerability by increasing the number of targets for the opponent. These vicious circles were experienced in Vietnam and Lebanon, effectively destabilizing rather than stabilizing the overall military postures.

Rather, at least from the Clausewitzian perspective, the problem is inherent in the peculiarity of the military mission statement of destroying one power system and establishing another in a *surgical manner*, that is, without the "supporting" mental effect of total destruction.

Given the current constraints of the international community and states' self-imposed limitations in the conduct of asymmetric confrontations, the concepts of DW seem to be the more promising option – perhaps the only one – for armed forces of democracies.

Employing its basic principles, i.e., networks of world views and the fusion of vertical and horizontal lines-of-sight in flexible, lightweight molecular frameworks of operation, DW can play an effective role in establishing control in the first phase, and in effectively supporting, or at least not hindering, the processes of transferring power from the military to local political bodies in the second phase (Moffat 2003).

On the battlefields of nation-states the DW principle of Virtual Mass, namely simultaneity of action on multiple engagement points, is intended to replace the relatively inefficient effect of physical mass.

In asymmetric conflicts the use of Virtual Mass is even more crucial as it facilitates, to a certain extent, some sort of a *virtual presence*. With its low-signature randomly appearing elements on the ground, the effectiveness of molecular force is in fact enhanced the more we reduce its visibility.

Yet contrary to the simultaneity required for high intensity conflicts, here we are talking about a prolonged sequential chain of causes and effects. The challenge is to repeatedly face a random rival found just around the corner, with a ready-to-shoot RPG rocket launcher in hand, or in the process of preparing an explosive device, while an innocent family looks down at him from the neighboring house just a few meters away – which we must not harm.

Military disengagement in asymmetric warfare implies the redeployment of ground forces with the aim of reducing to a minimum immediate friction with one's rivals, while increasing and improving the ability to see, interpret, and affect from afar all activities occurring on the other side. Its objective is to get as close as possible to a state of control without visible presence – diametrically opposite to the aim of the linear force structure. The relevant area of interest here is not the entire battlefield but a specific neighborhood or an even smaller area, such as a stretch of road or a single intersection.

In such circumstances we need a network of world views based on vertical and horizontal lines-of-sight, which can operate continuously in very small urban spaces for prolonged periods of time, and which have the capability to intercept enemy actions selectively with high levels of precision.

Molecular force structures, comprising networks of air, ground, and sea elements, have the ability to operate in urban environments with minimum exposure and maximum flexibility in terms of entering and exiting the battle space. Their presence can go virtually unnoticed.

The main difficulty with this does not necessarily concern the ability to build the power and means to cope with the daily challenge of sustaining control without physically being there, but the inherent fragility of the entire situation.

The legitimacy to conduct military operations in areas in which we no longer maintain a military presence, in the midst of transferring control to local authorities, is contingent upon our ability to accomplish whatever needs to be done without injuring non-combatants.

This means that defensive actions, like offensive ones, require the ability to distinguish combatants from non-combatants. Military responses to attacks, even when made from a defensive position – if they are unintentionally, yet unjustifiably, aimed at non-combatants might severely harm the legitimacy of the overall operation.

These requirements are amply met by the basic features of DW. The ultimate need for selectivity stands at the core of the shift from massive attacks aimed to conquer territory to surgical strikes on only the legitimate targets within it: from a world view of mass statistic firepower to an outlook of massive yet surgical use of precision weapons.

Finally, as future confrontations entail a growing number of conflicts with non-state opponents, the challenge of military disengagement will become the central deciding phase of armed conflict. The chances of the entire campaign culminating in a viable military end-game will depend on its success. In the face of a non-state rival, a singular act such as capturing the opponent's capital city or bringing down its regime does not constitute a decisive military outcome. This has become starkly clear in Iraq. One must assume that the 'war after the war' is an integral part of the campaign, which requires systematic treatment and structural solutions.

The test of the disengagement phase – especially a unilateral one - is one's ability to sustain an interception effect, unconditionally and over a long period of time, that is, unequivocal conveyance of one's ability to control and exert influence over a given area, even in the absence of physical presence on the ground. Practically, this means a network of molecular forces constantly capable of closing the sensor-to-shooter cycle over legitimate targets.

The threat that the military presence will, if necessary, be reinstated on the enemy's territory should be ever-present in the background. But the task of stabilizing and maintaining control until the time is ripe for a stable political solution must be accomplished along the lines of DW perceptions.

However remote it may be, this combination stands some chance of creating on both sides, even among non-state organizations, the awareness that a new military balance has been stabilized, and that the odds of changing it are too small relative to the costs. In this sense, it may be perceived as a viable military end-state, and hopefully the beginning of the diplomatic phase.

The first stage of the Intifada of September 2000 ended in Operation Defensive Shield in March 2002, in which the entire area of the West Bank, including all Palestinian major cities, was militarily captured. After that began the gradual process of reducing the massive military presence in the cities and towns and moving the forces to a smaller-scale and 'wiser' presence along the outer lines of the territory, while maintaining, and often exercising, the ability to re-enter the territory from any point and at any time – in order to intercept active terrorist cells and infrastructure.

This tactic proved much more effective and in practice it was a testing ground for DW concepts of molecular ground forces. It led also to the acceptance of the guidelines of the American Road Map to Peace, and essentially to the end of the Intifada.

This is, indeed, a very simplistic portrayal of the events, focusing only on the main military parameters of an extremely ferocious national, historic and religious conflict, which is just as difficult to end now as it ever was.

But the use and conduct of military operations in this conflict, which evolved into somewhat new forms, by and large demonstrated that it is possible to fight non-state military organizations, ensconced in a non-combatant civilian population, with a fair amount of selectivity and effectiveness, and with a constantly rising level of precision. Although we currently lack the necessary historical perspective to pass judgment, we may in the future end up determining the IDF's conduct of the Intifada as what led to a viable military end-state.

The similarity between the above and the war situations described in the preceding chapters is clear. The question therefore is not whether or not a given asymmetric conflict has a military solution, but whether the military means has the ability to bring the confrontation to a viable military end-game – from which the parties deem a political process sufficiently necessary to ensue. To stand the Clausewitzian platitude on its head, in asymmetric conflicts policy is the continuation of war by other means.

The principles of DW and the use of networked modular force structures suggest that feasible solutions to situations formerly too quickly classified as military problems with no military solutions may, in fact, be within our reach.

The perspective of DW emerges first and foremost from the need to overcome the constraints of linear warfare, not necessarily from the needs of limited warfare in urban environments. But the tools developed as part of this perception are usually effectively applicable to these situations as well.

The basic components are attainable today. What is needed is further technological development and sophistication of the operational perspective.

All through this book we have argued the case for the transformation of the current military force structure, for a variety of reasons. Of these, the question of fighting and ending asymmetric conflicts in a manner that facilitates non-military stable solutions later is perhaps the most acute. Nowhere else are the deficiencies of linear warfare postures so clearly demonstrated and exposed.

DW offers the most viable route to this required transformation: it is flexible and adaptive enough to accommodate in real time changes in the conditions and circumstances of warfare. At the same time it is generic enough to be as modular as is required to revert to past linear postures when needed.

July 2006

As noted in chapter 6, the second war in Lebanon (the first was in 1982), between Israel and the Hezbollah, was sparked by one of the periodic provocative actions of the latter organization on the international border between the two countries. Apparently neither it nor Israel intended the massive exchange of fire that followed the first clash to escalate into a full-scale war, believing that the previous pattern of only a day or so of fighting would ensue (Haaretz 14.07.2006).

Instead, the results were 33 days of mainly stand-off warfare, with relatively minor ground operations, with devastating consequences for Lebanon and Israel alike, ending in a UN resolution (1701), and with Israeli forces holding positions some 15 kilometers into southern Lebanon.

This chapter is being written only two months after the cessation of fire, and as both sides are still debriefing the events. Our focus however is on the implications of this quite unusual and extremely important war experience in regard to the theory of diffused warfare. Indeed, this war demonstrated the extreme strengths and the weaknesses alike of linear and diffused concepts of warfare in a real-world confrontation.

First let us look at Hezbollah. The military-political convention is to classify it as a terrorist organization. This perception seems to be driven mainly from the nature of its actions since it materialized as an armed organization in the early 1980s. The bombing of the US Marines barracks in Beirut in October 1983, and a considerable number of terrorist attacks against Jewish centers in Europe and in Argentina throughout the

1980s and 1990s, rightly accorded it that status. It certainly is a terrorist organization, among other things (Jaber 1997).

But it is also a totally new type of terrorist organization. Built according to a popular army's military standards, its structure somewhat resembles the Viet Cong/North Vietnamese model, in the sense that it is based on frontline cadres within the territory, buttressed by overt military support from an external nation-state. It is also similar in that its scope of military objectives is not limited to the mission of freeing its own country from an alleged illegitimate occupier, for example, like ETA or the IRA.

Instead it involves an overarching ideological agenda of new world order, in which the immediate fight is only the prologue for the main conflagration still to come.

Whether North Vietnamese Communism was ever as aggressive in its regional-global aspirations as Iran's Shiite Islamic agenda must remain a question for experts and historians. But the similarities certainly end here.

The level and quality of military support for Hezbollah from both Iran and Syria are unprecedented. As a non-state organization its weapons of choice are obviously not tanks and jetfighters. But as regards its arsenal of stand-off and anti-tank guided munitions (ATGM) means, as well as its communication and intelligence, bunker networks, mines and explosives, it was equipped like a full-fledged nation-state's regular force.

The estimated numbers of missiles and rockets are somewhat fuzzy, amounting to somewhere between 12,000 and 20,000 (United States-Department of State 2005) Their range exceeded 200 kilometers, and they included surface-to-surface anti-ship cruise missiles (Blanford, 2002). ATGMs were state-of-the-art Russian-made products, delivered by the Syrians. Communication and intelligence gathering electronic and electro-optic means were of the highest level that the Iranian Revolutionary Guards could supply. With personnel trained on Iranian facilities for more than six years in all modern military aspects, along with on-site support of Revolutionary Guards experts as part of their fighting force, Hezbullah is in fact a new type of regular army rather than a terrorist organization.

Even more intriguing is that it was built from scratch as a diffused military structure. The geographic layout of the organization's arena is independent districts or regions, with local commands and preset missions. Based in the urban areas in permanent secret locations, sometimes in the basements and garages of civilian houses and apartment buildings, and in a professionally structured web of underground tunnels and bunkers in the wild, this force structure is designed to store the ammunition and cover the preset rocket-launching sites. The operational rationale was to diffuse the fighting assets in a way such that it would be able both to engage Israeli forces in their thrust northward, along the terrain's rather limited possible routes, and maintain rocket firing volume into Israel under all circumstances. This deployment proved extremely effective in maintaining the firing capacity of the Hezbollah throughout the 33 days of the war, almost intact, at least as regards the light Katyushas (a light, 10 kilometer rocket that can be carried back-packed or on a donkey). The preset ambushes against Israeli forces were also generally very effective.

However, a fierce debate rages among Israeli professionals as to the tactics in quite a number of instances: these Hezbollah successes in obstructing Israeli tanks and infantry are claimed to be the result of outright Israeli professional blunders rather than an unanswerable move by a rival enjoying the advantage.

While this and many other lessons are still being debated, what can be said with certainty is that Hezbollah operated under a *defensive diffuse warfare* rationale, a common strategy for the inferior side in asymmetric warfare which, admittedly, has not been thoroughly discussed in this book. We assumed this element of the asymmetric conflict to be an inherent part of its basic disposition, in fact, the very essence of guerilla warfare.

The recent war in Lebanon, however, demonstrated for the first time the effectiveness and potential of merging defensive diffused warfare concepts with modern stand-off offensive capabilities. Hezbollah and its Iranian consultants created a new brand of fighting force, transforming guerilla concepts and tactics into a systemic, very potent, military structure. It certainly is a new challenge, specifically for linear warfare.

This new design aims at obstructing the opponent's masses in its thrust forward, while exerting massive stand-off pressure on its civilian centers and hinterland, thereby pressing simultaneously on both the rival's military front and its exposed civilian rear.

Indeed, the debate in the Israeli military in the aftermath of the war revolves around the stinging questions of how it should have dealt with these new challenges. More specifically, it centers on the question of the required operational mix of airpower, massive ground forces, and non-linear “molecular” elements that should have been brought to bear to counter Hezbollah effectively.

Israel’s main asset in this war was its superb air force. The rate of destruction from the air of Hezbollah rocket launchers immediately after their first salvo far exceeded anything done in the past by any other air force. In the two wars in Iraq, coalition air forces, operating against far fewer and heavier launchers, were unable to show a single launcher destroyed throughout the entire war. By contrast, although the exact numbers have not yet been released, it is believed that some 70% of Hezbollah heavy rocket launchers were destroyed from the air in real time, that is, within some five minutes of firing (www1.idf.il). Nevertheless, the sheer number of Hezbollah rockets and their diffused layout made it impossible to suppress its launching capacity solely from the air.

Some 4000 rockets were fired into the north of Israel in 33 days, averaging about 120 daily; on the last day of the war over 200 were launched (www1.idf.il). The impact of these barrages in casualties and damage to property was actually much smaller than might have been expected with such a large number of warheads landing on the Israeli side. More significant was the psychological impact of not being able effectively to suppress the firing, which harks back to the initial question of the right operational mix.

The Israeli air force constituted the main striking power of the IDF throughout the war, operating very effectively over Beirut and the Beqaa Valley. But with thousands of sorties flown over the south of Lebanon, where the bulk of Hezbollah forces were deployed, it could not affect decisively enough the tunnels, the bunkers, and the numerous civilian residences where the launching assets were hidden.

On the conceptual level the belief was that the war could be won from the air and committing ground forces could be avoided, simply by levering the accumulated damage to the Lebanese national infrastructure, and the painful direct blows on Hezbollah, up to the point where they would stop shooting (Haaretz 20.08.2006). In a sense, this was a mirror image of Hezbollah's strategy of attacking at the same time Israel's front and rear.

This approach apparently proved mistaken, and it is certain to remain at the center of a very prolonged debate in Israel, which we have no intention of entering in this book. Accordingly we prefer to omit the issue of winning-from-the-air entirely, as quite immaterial and irrelevant.

Be that as it may, the upshot, inescapably, was that a large-scale ground maneuver was needed to compensate for what air power alone could not deliver.

It was in the decision-making process on the ground maneuver that suddenly a real-time dilemma between linear and diffused warfare concepts became a central issue, again involving questions of the right operational mix.

Here too definitively analyzed data are still not available, but intimations of this debate were present in the media throughout the war. The question in very general terms was what should be the strategy against Hezbollah's diffused layout: a massive simultaneous linear thrust northward by divisional forces on three or four axes, or a forward deployment of light forces deep inside Hezbollah territory along the Litani river, which would contain the arena and hammer down southward against the anvil of heavy IDF forces coming up northward from below (www1.idf.il).

Leaving aside the fierce debates over concrete actions, concrete decisions, and actual events, some quite relevant insights are still to be found here at the level of theory, even if one may argue that nothing in these operational dilemmas is essentially new in any sense. Such considerations are common in any war. Yet in this case some nuanced reasoning is called for.

When the Allied Forces dropped paratroopers behind the German lines in their thrust eastward after Normandy (Harclerode 2000), the military rationale was to pulverize the enemy's defense lines from the rear. The purpose was to create havoc in its logistic support channels, to block its retreat routes, and to bring about panic and disorder. The operational dilemma involved questions of how to defeat extremely well organized linear forces, deployed in doctrinal, masterly arranged linear defensive lines – a circumstance in which the mere creation of disorder was deemed a significant asset.

By contrast, the IDF's rationale for forward deployment of light forces was first and foremost to suppress rocket launching into Israel better. Above all it was meant to improve the destruction of legitimate targets, and only then to work on the foe's disposition – which in any case was diffused to a point where it was practically unaffected.

So unlike the Allied armies' challenge to fracture the huge, very visible, German layered defense of the Low Countries, the IDF faced an 'empty battlefield' whence every day hundreds of rockets and missiles were fired at Israel cities, from within the territory of a nesting-state whose government claimed to be non-combatant.

The asymmetry here lies in the different military challenge, but also in the different terms of legitimacy involved. In an outright conflict between nation-states such a dilemma would most probably have been solved by the option of retaliation: city-for-city carpet bombing, generally speaking. This was the case in WWII, as well as the Iran-Iraq war of 1980-1988.

Certainly, the terms of legitimacy under comparison here are entirely different. Israel's bombing of Beirut exclusively targeted the secluded Hezbollah quarter, and went as far as retaliation per se could go. The remaining targets destroyed to the north of southern Lebanon were infrastructure assets, part of an effort to prevent reinforcements and supplies reaching the south. The large-scale destruction of towns and villages in the south was mainly due to urban fighting with Hezbollah forces, after most of the civilian population had fled north.

At the end of the day the IDF's dilemma regarding the ground maneuver directly involved the question of the linear versus the diffused approach, and the required operational balance between the two. In the last days of the war, on August 12, the decision was taken and light forces were forward deployed by helicopters along the Litani River while large armored and infantry forces crossed the border in the south and started moving northward. A ceasefire, some 36 hours later, brought it all to a halt; military-wise the question of the required shape of a ground maneuver against a diffused opponent remains open.

We do have fragmented experience of diffused elements of the IDF operating sporadically, and extremely effectively, in countering light Katyusha launchers. But regarding the engagement in large-scale diffused warfare, the war in Lebanon provides no clear answers.

What it does provide is ample evidence supporting diffusion theory, if we also draw on the Hezbollah perspective. By defusing their forces into 'molecular' units, maintaining a fair level of communication, they were able to counter a much superior force quite successfully, for a prolonged period and with no significant reduction in volume of operational output.

Their heavy rockets were badly suppressed and their long-range missiles were destroyed before ever being launched; but the medium and light rockets were able to maintain and even increase their capacity, up to the last day. ATGM 'molecules' inflicted very serious casualties in tanks, armored vehicles, and troops, in urban area engagements and in well executed ambushes over the many terrain bottlenecks of south Lebanon, shooting sometimes from bolt-holes stretching for up to four or five kilometers on the hilltops.

After six years of fighting the Palestinian Intifada, the IDF forces were apparently rather rusty in conducting a full-scale linear offensive; in quite a number of instances Hezbollah's success with their diffused warfare tactics should be factored in for basic mistakes on the Israeli side. But we should also factor in the fact that they could succeed without the benefit of real-time networks, with no air assets whatsoever, and without any means to threaten Israeli total air superiority. Frankly speaking, one would have to be blind to ignore or deny the effectiveness of this division-plus sized diffused force structure in full-scale action for the first time – particularly under such limitations.

If applied by more sophisticated actors, using networks of 'world views', where each molecule could see the picture of the others, and vertical and horizontal lines of sight were fused in real time – such a force would undoubtedly be able to counter any linear rival.

On the other hand, the weaknesses of Hezbollah's diffused structure directly derived precisely from its essential diffusion. They had almost no way of supporting their separate 'molecules' when they were trapped or engaged. With very few exceptions, each unit had to fend for itself logistically and operationally. Likewise, their capacity to counter attack was limited, and materiel was in rather short supply. The bunkers held more stores of food rations and ammunition, but were often out of reach because of Israeli air raids and artillery fire.

Thus an IDF countering 'molecular' force, leveraging the advantages of networks of vertical and horizontal lines of sights, could have been deployed very successfully in the very same area at relatively minor risk.

Such force could have been highly effective against the light Katyushas' crews, as both a sensor and a shooter.

In other words, at least on the theoretical level, based on a two-side perspective and on critical assessment of both sides' performances, diffused warfare is here to stay. It is here to stay as a challenge for linear forces in future asymmetric conflicts; lessons have certainly been learnt on both sides. But even more so, it is here to stay as the coming stage of NCW. With all its ambiguities, the second war in Lebanon clearly demonstrated that the linear approach to forces structure is simply not delivering what is needed.

Some Quantitative Aspects

The Battle of Britain

A team of researchers working with the Operations Department of the British Army on a series of projects during the Second World War (including the Enigma project) formulated the force ratio needed to counter the German air attacks that had wrought so much destruction on the British nation.

The researchers found that in order to attain a decisive victory in any given air battle, the British must put in the air twice the number of German planes. The Royal Air Force adopted this approach and subsequently concentrated its efforts only on air battles in which it could guarantee the 2:1 ratio. In these battles the RAF indeed obtained the upper hand – while losing battles in which it could not supply the required number of planes. The result was increasing attrition of the German air force until overall British victory in the air was finally attained. (Houg & Richards 1989).

The 2:1 combat plane ratio was only one in a long list of war equations developed by British operations researchers. They formulated a set of functions – the Lanchaster Equations – on which western armies would base the size of their forces for different military missions in the coming decades. At the time, the most important player in the air was the radar. British radar, which was perhaps the first radar put to military use, provided the necessary intelligence from which the quantitative calculations such as the air-attack force ratio were derived. Recall that in those days the air force had to rely on human pilots in planes already airborne to detect and identify enemy planes. Thus chaos in the air prevailed as the air force had no ability to plan force ratios in advance. All this changed with the radar.

Radar enabled the British to detect the German attackers en route, their course, and the number of attacking planes. Only with this information could the RAF foresee the expected battle areas and determine if they had the capability to provide the 2:1 plane ratio. (Ray 1996; Townshend Bickers 1997; Overy 2001).

Accordingly, this first radar became a critical intelligence component that constituted a (Boolean) parameter to the extent that if the radar worked, the equations were of significance – and if it did not they were useless.

On the other hand, the mathematics of the Lanchaster Equations was not sensitive to the quality of intelligence that streamed in during military operations. The main determinant was reached by quantifying the combat platforms, determining a constant for their firepower effect. Essentially, it was real-time mathematics, as opposed to the customary practice of extrapolating quantities.

The above reflects the fundamental flaw in contemporary military doctrines. Many of today's military planners and thinkers were educated in the famous ratio of three attack units for every defense unit. Developed as early as World War I, these numbers received reinforcement in World War II, and for some, like General Heinritzi, would in fact be doubled.

Besides the danger entailed in the application of the analysis of past events to future wars, reliance on the Lanchaster Equations also represents a stark example of stagnant military thinking. Until recently the Lanchaster Equations served as convenient quantitative backing for most western armed forces (even for the German army in the post-World War II era).

With these qualifications in mind, this chapter presents some insights, considerations and basic assumptions on the basis of which we develop mathematical formulas for assessing the effectiveness of diffused force structures, with the element of real time factored in. The aim is to acquire tools for assessing the size and force structures needed for a typical military operation, especially a tool for pre-planning operational force buildup.

As mentioned, the DW approach generally requires a much smaller order of battle than that needed by the linear approach by its present form. The composition of forces and the concept of their operation, in particular those intended directly to engage the enemy, are quite different from what we are familiar with today. They include logistics components, technological capabilities, and above all networked qualities, which add up to an entirely new future system.

Acceleration, Uncertainty, and Contingency Forces

The main components that have the capacity to effect a change in battle order were discussed in the preceding chapters. Consider, for example, the operation of forces in a parallel and diffused manner – each operating almost independently of the others – thus increasing the friction in a given campaign by two to three exponents.

This implies that whereas the friction generated in a linear-style campaign is a function of the contact made by the frontline forces, in DW the rate of friction is a function of the contact made by the different molecules with all the targets present throughout the battle space. For example, consider a battle space with fifty target concentrations, of miscellaneous size and in sundry environmental settings, which require the engagement of say fifty molecules – also of diverse size and composition (as determined by the type of operation of each molecule and by the battle environment – urban terrain, open terrain, villages, etc.). The diffused perception assumes simultaneous engagement of all fifty targets. In such a scenario all the molecules will operate over the entire battle space regardless of range. And as a rule, but not always, the operation of one molecule will not depend on the success rate of any other molecule.

Each molecule comes into friction, contact, with the components of the target concentrations, so that an acceleration effect is obtained exponentially greater (to the power of 10 to 30) than what is usual today. This is similar to calculating the speed of a parallel computing as opposed to regular computing.

As argued, the main reason for this is that by the linear approach only the frontline troops directly engage the enemy, while the remaining forces constitute contingency or support troops. A small part of the latter serve as direct support forces for the frontline troops, while all the others are, essentially, maintained as contingency forces necessitated by the basic uncertainty involved in warfare.

This element of uncertainty on the strategic-operational level is a fundamental feature in any type of warfare but, particularly for the sequential approach of linear warfare, it necessitates a very significant mass of contingency forces. Such uncertainty concerns the enemy's response, the size and capabilities of the its forces, its ability to mount a counterattack at an unknown time and location, its ability to concentrate forces at an unknown place and time enabling it to carry out a surprise attack, and so on. A considerable portion of the contingency forces is also used to hold on to captured territory and in support of the frontline forces after the fighting.

Consequently, the proportion of troops that engage the enemy directly is much smaller than the total amount of forces allocated to a given ground maneuver. In fact, no more than 20 percent of such forces on the campaign level are likely to come into direct contact with the enemy. Usually the percentage is even lower.

This implies that in a linear perception of warfare a close positive relationship exists between the level of uncertainty and the amount of backup and contingency forces needed. Essentially this is true of any significant activity that entails uncertainty.

Models developed in the late twentieth century show that one can assess the size of demand for capabilities or backup forces needed for a mission. One of the mathematical theories developed in this context is Inventory Theory.

Inventory Theory models were developed to assess the quantities of spare parts needed for combat planes, warships and submarines so that damaged parts of the platforms could be either fixed or replaced quickly and so that any disabling of equipment would last minimal time. (Porteus 2002; Zipkin 2000).

These models are also used to estimate the quantity of munitions and other essential materiel needed at combat rearming points, on the assumption that supplies depleted during combat will be needed to continue operations. (The models are equally applicable to calculate the number of newspaper copies a publisher needs to print every day given a certain demand rate for that newspaper.)

We demonstrate the above through an example taken from the field of medicine. Based on the statistical consumption distribution of a certain medication, the organization responsible for supplying the medication must ensure the availability of a sufficient amount over a prolonged period of time. In the event of an increase in demand there is a risk that the medication will run out, creating a shortage with possible fatal implications. On the other hand demand may decrease, in which case a surplus will be created, resulting in a significant waste of medication due to the passing of expiration dates.

The greater the uncertainty regarding future demand rates, the larger the quantities of medication the organization will have to supply and the greater the probability of wasted resources. The more crucial the medication is for human life, the lower the risk the organization will want to take, resulting in an uneconomic yet justifiable supply policy.

On the other hand, the more the organization knows about the demand rate for the medication, hence the lower the uncertainty regarding future demand, the greater the organization's ability to formulate a more efficient supply policy, lowering the probability of large quantities of surpluses.

In terms of demand under high levels of uncertainty, military backups and contingency troops are analogous to crucial (life-saving) medications. A critical mass is needed to compensate for the levels of uncertainty, even if the end result is that the majority of the backups and troops are not put to use.

In linear campaigns uncertainty levels rise increasingly from the moment the first shot is fired. The reason for this is the enemy's ability to organize its forces and carry out counterattacks since it is not tied down in all of its elements, as would be the case in DW. A linear campaign is therefore based – and justifiably so – on immense quantities of backups and contingency forces. The fact that when they are needed they are critical, compounded by high levels of uncertainty, creates the need for immense quantities of reserves.

Occasionally the presence of such a large force, comprised mainly of contingency forces, might make the impression of a strong force with excellent maneuvering capabilities. But in fact, as the disparity between the contingency forces and the forces directly engaged with the enemy becomes wider, the probability of such imbalance, creating inefficiency and even weakness despite (or rather because of) the overall force size, increases.

Diffused warfare reverses the linear model. Parallel military activity preoccupies most of the enemy's elements, creating a state of "battle blindness" for the enemy and preventing it from organizing and concentrating its forces for a counterattack.

The above suggests that the levels of strategic-operational uncertainty in the operation of a diffused campaign are considerably lower than those involved in linear (or sequential) activity. The main reason for the difference in the two types of warfare is found in the amount of time available to the enemy to organize its forces, or conversely, in the lack of time for force organization due to the highly accelerated friction of diffused activity.

There is no doubt, however, that in diffused warfare too commanders might make erroneous operational and/or tactical estimates. Consequently, there will always be some degree of uncertainty that makes necessary some quantity of reserve and contingency forces. Still, the quantities in DW are clearly considerably smaller. There are two reasons for this. First, some of them may already exist as an integral part of the forces themselves due to the ability of the molecule to alter its composition and to move rapidly from one type of mission to another. Second, and perhaps more importantly, the Support Tier essentially creates a central contingency supply for all the molecules, in terms of firepower and logistics.

Moreover, the battle order that comes in contact with the enemy forces will in fact be significantly greater in diffused warfare than in linear warfare. This advantage of diffused warfare is stressed in several places throughout this book. On the face of it one would think increased friction required one to increase – not reduce – backups. But because the effective outputs of intelligence elements – technologically and human-generated – increase significantly in diffused warfare, where the molecules and the Support Tier together generate an integrative world view in real time, the level of uncertainty is reduced – as we demonstrated in the preceding chapter.

This means that as the forces that come into direct contact are larger and better trained, and operate more on the basis of accurate real-time intelligence, so the level of uncertainty decreases, causing a significant fall in the quantity of reserves needed.

In any case, there is a threshold beyond which the quantity of reserves becomes a handicap and a threat to the entire campaign. The large numbers of reserves and contingency forces the military was used to in the past have become a burden rather than an asset.

The Relationship between the Battle Order and Contingency Forces

The classic models of Inventory Theory are based on complete information on demand distribution and on resource supply rate. These models are linear or exponential. The assumption of linearity allows a linear prediction of demand. Usually linearity is assumed on the observation of stable increase or decrease in demand over a prolonged period of time, an assumption that is not reasonable for the battlefield. We therefore assume an exponential increase or decrease in demand whose main parameter is the rate of demand per time unit, denoted by λ. (By parameter we mean a factor on which the outcome depends. Here this factor is the average rate of estimated demand, but it can change markedly in either direction.)

By an exponential relationship we mean that as the levels of certainty about what we know of demand levels rise (i.e., we have a better level of information) the size of reserves needed decreases exponentially. This means that if at the start of the military action our levels of certainty in linear and diffused warfare are equal regarding the enemy's deployment across the battlefield, as the fighting continues the certainty level in linear warfare will fall, while in diffused warfare it will rise.

For the sake of argument, if the difference in information levels or in levels of uncertainty is a factor of two in favor of diffused warfare (with forces operating in parallel and with an exponentially larger system of intelligence components), as opposed to linear activity operating sequentially, then the quantity of contingency forces needed for diffused activity is smaller by a factor of 8 to 10 than those needed for linear activity. This is based on the assumption of exponential behavior we made earlier.

For according to the linear inventory models the difference in size will be a factor of 2, whereas under the assumption of exponential behavior the difference in size will be a factor of 4.

We argue that the assumption of exponential behavior more closely reflects the realities of war. If we add to this the ability of molecules to alter their composition and the assumption that a certain percentage of the molecules will complete their missions before the designated timeframe, these molecules will then be able to serve as quick contingency forces for others bogged down by the fighting. The frontline forces acquire this capability from the flexibility of the command and control systems they possess their capacity rapidly to contract and expand according to need, and their high level of connectivity.

If we assume on the one hand that approximately 10 percent of the molecules complete their missions sooner than planned due to overestimation of the intelligence component, and on the other hand that 20 percent of the molecules get bogged down in a confrontation more complex than what was predicted by the intelligence components, then a large part of the molecules that have completed their mission will become backups for the bogged down molecules. This will decrease the size of the contingent "inventory" needed for the overall military mission by an additional 3 to 6 percent.

We again stress that the above numbers are presented for the purpose of demonstration, in particular to clarify the main components of the diffused approach. By quantifying war environments we are also better able to compare the different types of warfare. At the same time, any operational activity is a unique event and must be analyzed within the relevant context.

Nevertheless, support for the assumptions made and the theoretical values derived from them is enhanced as the diffused forces structures operate more effectively. The combination of the molecules with intelligence, firepower, and the logistics of the Support Tier yields a system in which the activity of each of the components contributes to the effectiveness of the overall effort.

The inventory theory is not the only organizational-economic model that can be applied here. Consider, for example, the Just in Time

(JIT) Theory. According to this theory, reduced uncertainty levels due to intelligence superiority, particularly real-time intelligence, prevents wasteful logistical operations and enables one to supply aid when and where it is needed. (Zipkin 2000).

Thus precise firepower too allows effective use of ammunition, hence a lower need for rearmament. Air dominance and effectiveness of the network facilitate easy mobility of forces and air transport of logistical elements among the molecules dispersed throughout the battle space, exactly according to the JIT model, and as dictated by developments in the battlefield.

Regardless of one's perspective, we are confident that the combination of the different components of the diffused perspective described above creates organizational synergy, at least to the extent that it allows more effective warfare and a more efficient force structure. It is hard to determine at this point if the above integration will also be less costly. It is clear that the construction of an effective diffused structure will involve significant costs. But in the long term it is also highly likely that a more efficient force structure will require a smaller budget to maintain.

Acceleration, Effectiveness, and Intelligence Dominance

Diffused warfare relies on several assumptions regarding the military's ability to produce – in advance and continuously – information outputs based on tactical and strategic intelligence. These assumptions are based on the premise of intelligence superiority, that is, superiority in creating intelligence and targets, and in disseminating intelligence in real time to all the relevant fire-power components. Such superiority, called "intelligence dominance", also furnishes the ability to affect the power balance on the intelligence level. The system supplies the required intelligence, but it also affects the opponent's ability to generate an accurate world-view of what is going on in the battlefield (this is achieved by the other components of the system as well, not the intelligence components alone). Intelligence dominance is a relative concept and implies one's ability to be the first to detect, understand, decide, and act. (Clark 2003; Lowenthal 2000).

Intelligence dominance has a profound impact on the battle order needed to carry out a specific military mission. Generally, the size of the battle order needed to defeat an enemy of given size will decrease exponentially as intelligence dominance increases. Conversely, the effectiveness of a force of given size will increase exponentially with the enlargement of its intelligence dominance. We explain this below.

The above applies to local conflicts (on the tactical level). If we project this trend to an all-out campaign, in which the rate of friction with the opponent's threat components also increases exponentially (due to the parallel acceleration), we can make a rough estimate of the overall battle order needed and the anticipated duration of the campaign.

A force's effectiveness in a given mission is inversely related to the time needed to accomplish it. In general (but not without exception), the time required to carry out a mission decreases as the effectiveness of a force increases (within certain limits, and depending on circumstantial constraints). So based on the nature of parallel activity (which exponentially increases the rate of friction) and on the assumption of intelligence dominance (which significantly increases the effectiveness of a force's tactical friction), the time required to carry out campaigns according to the principles of diffused warfare will apparently decrease exponentially. To illustrate this, consider a campaign's friction rate that increases by the power of two in diffused warfare, causing the acceleration rate to increase by a factor of 50. This means that a campaign whose duration in classic warfare was estimated at 500 days will be shortened to a mere 10 days. Moreover, the quantity of forces required will decrease exponentially according to the intelligence level ratio between the two sides.

The reason for this is as follows. Under the assumption of intelligence dominance that generates (for illustration only) an intelligence ratio of 2:1 in favor of the offense (e.g., against a terror threat)**(?)**, the effectiveness of the offense will increase by a factor of 8.5; if the intelligence ratio becomes 3:1 the effectiveness will increase by factor of 25.

We emphasize that these numbers are presented only for the sake of illustration and to indicate general trends. In reality many constraints and exceptions to the rule are of course present that one must take into account.

In any case, if in the past the relationship between the number of forces allocated to a mission and the effectiveness of the forces was based, essentially, solely on raw firepower, today we must assign a corollary weight to the level of intelligence of the forces or the ratio between the levels of intelligence both sides can generate.

Information and intelligence have become the focal point, while firepower, whose size and quality are considered given has, in fact, been pushed to the sidelines of analysis. (Firepower is usually found in the Support Tier and is considered indirect or fire that does not necessitate direct contact between the firepower platform and the target.)

Information and Intelligence Levels

In diffused warfare, therefore, the level of intelligence can be perceived as the joining of two types of intelligence (not in the mathematical sense): Base-line, pre-gathered and processed intelligence, and real-time intelligence, gathered during battle or during presence in the field.

Recall that a diffused approach assumes that the lion's share of the firepower is lodged in the Support Tier and in real time is attached to the force in direct contact with the enemy force. In this sense the intelligence component or the level of intelligence becomes a critical feature of warfare, equal in importance to the operative elements. Today intelligence is deemed a factor that supports operative activity, whose increase – quantitative or qualitative – is considered a desideratum but not an imperative; in diffused warfare the intelligence actors are equal in weight to the firepower actors. In fact, we are now progressing toward a situation where the battle order needed on the ground depends directly on the level (quality) of Base-line intelligence and on the quality of real-time intelligence gathered during combat.

We maintain that the level of intelligence generated by a molecular force operating against a standard enemy force (i.e., overt targets such as tanks and armored personnel carriers deployed in an open space) will make it possible for a relatively small ground unit to destroy much larger enemy forces. This new relationship is brought about by the intelligence generated by the molecule itself, but still more by the firepower provided by the Support Tier that contains varied air combat platforms, sophisticated command and control components, and high-speed processing systems.

So by the DW approach a few dozen small groups of ground troops (operating within a networked structure with intelligence-gathering and processing abilities as described above) are capable of fighting against forces the size of standard armored battalions and brigades, regardless of the quality of the tanks and their capabilities.

In Military Operation in Urban Terrain (MOUT) these ratios change because the defender has a significant "intelligence coefficient". This is due to its low signature and its strategy of blending into the local civilian society; also, the terrain component makes it very difficult for the attacker to operate. Therefore, in urban terrain force ratios are again reduced to so-called "sane" ratios. (U.S Army 2002).

To break this down further, let us assume that L1 and L2 represent the levels of intelligence of player 1 and player 2 respectively, where L1 denotes the intelligence level of the attacker and L2 denotes the intelligence level of the defender. The relationship between the two players reflects the intelligence superiority of the attacker along two dimensions:

A. In terms of Base-line intelligence: strategic intelligence that provides the attacker with knowledge as to the method and logic of the enemy's conduct, the location (roughly) of the enemy's power concentrations, and the enemy's response mechanism.

B. In terms of real-time intelligence: intelligence that provides the active attacking forces with the necessary information and targeting data, in real time.

In addition, by his diffused molecular offense, L1 the attacker, causes his opponent "battle blindness", such that the value given as L1/L2 increases. Essentially, the estimated ratio between the level of intelligence of the attacker and the defender is no longer linear or cumulative, but exponential. The ratio in operational effectiveness, we believe, changes similarly – also exponentially. That is, as the difference in levels of intelligence between the players increases, so does the difference in operational effectiveness between the two sides. Considering that the difference between the intelligence levels increases over time due to the direct contact along the aforementioned dimensions, it is reasonable to say that the ratio of ground forces needed also changes exponentially.

Why is the increase in the effectiveness ratio exponential? Mainly because of the way the components contribute to each other. For example, the intelligence components directly enhance the effectiveness of the combat force engaged directly with the enemy; and the more effective the combat force, the more capable it is of blinding the opponent and increasing the gap between the intelligence levels of the sides. Such processes, which intensify over time, are called exponential. They grow through the increase of their main parameter. Here the main parameter, denoted by, represents the ratio between the intelligence levels of the two players. The basic model is given as e^{λ}.

In sum, the size of the force needed for a mission decreases (down to a certain point of course) as the ratio of intelligence levels increases in favor of the attacker. Intelligence level, as demonstrated, is a function of the level of advance-information the player possesses and the level of intelligence-gathering and processing regarding targets and threats on the tactical level, plus the ability to distribute the information (command and control systems) in close to real time to the firepower components.

However, since in the initial stages it will be practically impossible to establish perfect systems, able to do all that by our theory a DW approach can do, all we can say now is that as we approach the achievement of the above capabilities we will also approach the ability to make accurate numerical assessments. In the coming decade achieving fifty percent of the capabilities put forth theoretically seems possible, an accomplishment that in itself can significantly improve all the elements involved in the engagement of forces in asymmetric warfare for the duration of a campaign.

Another extremely important parameter in this context is that parallel military activity preoccupies most of the opponent's forces and prevents it from enhancing its forces and concentrating its efforts. This has an additional significant impact on the basic dimensions of asymmetry in size and in missions between the two approaches to warfare examined here. We discuss this further in the next section.

Intelligence Gathering – The Shift from Defined Territories to Chaotic Spaces.

The world is closely acquainted with wars fought between nation-states or between armies representing nation-states, where the rival sides are nearly always divided by a physical borderline, distinguishing friend from foe for each side. The location of a combat unit defines its affiliation pretty well for sure. A tank positioned on the Syrian side of the Israeli-Syrian border will be classified as a Syrian tank, leaving no need to specify the precise identity of the tank or of its intentions. The same applies to large structures too, such as brigades or divisions.

This is not the case in the world of asymmetric warfare. In that environment no physical frontier exists separating the state from the organizations that threaten it. The physical border between Lebanon and Israel does not create a clear distinction between friend and foe. A borderless war space, combined with the furtive or stealthy attributes of terrorist organizations and their activists' merging into the societies of the nesting states, constitute a chaotic battle space, lacking any clear boundaries or territorial definitions.

The difficulty entailed in intelligence gathering in asymmetric environments arises because physical boundaries have ceased to be relevant. The need to identify targets, and especially to respond to them immediately, requires an intelligence gathering mechanism whose overall output is greater by at least two exponents than what is produced in classic (linear) warfare. The logic behind this figure is that the shift from a perception of clear borders to a perception of chaotic spaces essentially means a shift from intelligence gathering along a clear line of contact, and the clear deployment rationale (front and back) derived from it, to intelligence gathering throughout an area whose size is larger by two exponents. Recall that the area of a space is given as ΠR^2.

If we add to the above the fact that tactical intelligence – gathered during military contact or friction – constitutes the critical intelligence mass that essentially makes possible military contact in the first place, we get a squared value times a coefficient, where the coefficient is determined by the type of environment wherein the contact takes place. An urban environment will have a larger coefficient than that of an open battle space.

The above concept can be expressed mathematically as follows. If [N^2] represents the amount of intelligence gathering components needed to occupy an area whose size is defined by its radius [R], the number of intelligence gathering components needed for a molecule operating in territory of the same size by the diffused warfare method (against specific targets) will be given as $K(N^2)$, where K is determined by the type of terrain. As noted, [K] of urban terrain will be greater than [K] of open space.

The relationship between the size of a space (a function of [R]) and the number of intelligence components is linear in classic warfare and exponential in diffused warfare. This means that with an increase in area size from R to 2R, the number of intelligence components required by the linear approach of territorial occupation will increase from N to 2N. The number of components required by the diffused approach will increase to $2K(4N^2)$. For example, if ten tactical intelligence components are operating in a given scenario, and if the coefficient is 2, the same structure will increase to a size of 200 components! (product of 10^2x2).

Certainly, the figure 200 is a general estimate and not a discrete outcome. Yet, the principle that a given intelligence structure of ten components will have to increase greatly is clear. But what constitutes an intelligence-gathering component still remains to be settled. Does a pair of binoculars count as an intelligence-gathering component? Are certain systems or devices equivalent say to ten pairs of binoculars? Leaving this question to be dealt with some other time, suffice it to say at this point that the final outcome must maintain an increase in intelligence output by a factor of 10 to 200 in order to meet the requirements of diffused warfare. This parameter is a necessary condition for the perseverance of molecular force structures.

Whichever way we approach the subject, the role of intelligence, even quantity-wise, is clearly becoming equal to that of any purely combat component. Intelligence is undoubtedly developing into a major asset in the new battlefield.

A Quantitative Analysis

The Friction Power Gained by the DW Campaign Vs. The Linear Campaign

Operational Assumptions

1. The theatre is asymmetric

2. The Theatre is presented by a circle – as presented in Fig.1. The Linear campaign is a maneuver from point **A** to point **B**.

3. Enemy mass-points are isolated and being in contact with molecular units in the "circular cells".

4. The time needed for a complete maneuver is **T**.

Physical Definitions

5. ***WORK*** - In Newtonian physics is "Power" multiplied by the length of the way in which the "Power" is operated.

   W=F*dx

   Where:

   F is the power (pressure x area) operated along a path of length dx.

   W is the Work done by the power F along a path of length dx.

   (Persson 2000; Bowden & Tabor 1954)

6. ***WORK*,** is a physical concept adapted to that operational concept and it is "the quantity of the operational effect stemming from the friction

of the combat force operating on the area (or along the path)”.

7. In fact, it may be said that in our definition ***Work*** (which is a physical concept) **is equivalent to the product of the friction or the action of the friction itself,** of a combat force of **given mass** activated against an enemy on **an area** of given size.

8. ***FRICTION,*** in the military world is **“activation of a force** (measured as the pressure arising from a physical mass) **against the enemy in the specific area under consideration, for a time leg that will be defined”** (Clausewitz 2004; Watts 1996; Beyerchen 1992).

   In a linear maneuver **-** ***Work*** is not arising from friction but in applying ***Power*** all along the movement; in diffused warfare**,** ***Work*** is the friction produced in cells of areas (Figure 3).

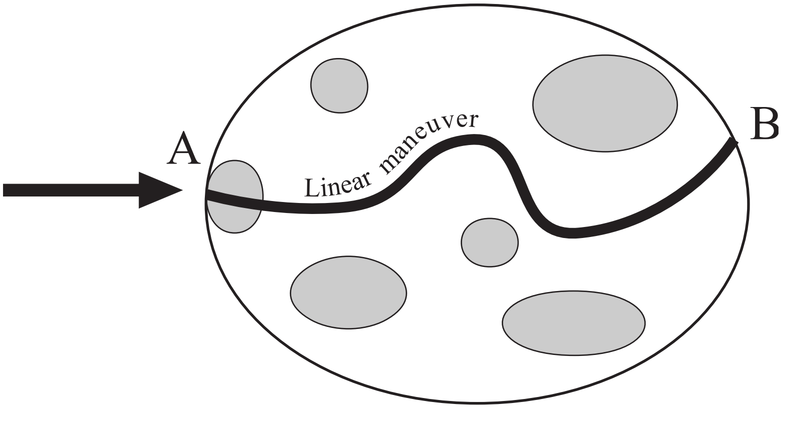

Figure 3: The linear maneuver from A to B and the cells where the molecules are operating

Work (Operational Effect) in a Linear Operation

9. The ***EFFECT*** achieved in an operation, that is, the outcome of the activation of a military mass on an enemy along a path (linear maneuver) **whose length S is:**

$$\mathbf{W_{Lin} = \text{operational effect along the entire path} = \int^{S} F(s)dx = \text{work}}$$

Because warfare is not conducted along the movement, work in the linear maneuver equals the integral of **delta functions** at the penetration points, that is, equals one if there is penetration warfare at one place, two if there are two points of penetration warfare (as in the example in Figure 1), and so on.

<u>**Note**</u>: In asymmetrical warfare there will be no penetration combat but ambushes, in which the power of the warfare is small (therefore the size of the integral will be less than one).

Work (Operational Effect) in Diffused Warfare

10. **F** In the Newtonian physical world is the force of the ***Friction*,** where this force is the multiplication of a friction coefficient **μ** with the area size in which the mass **G** is activated**,** (along path **dx**) (Marion & Thornton 1995; Fowles & Cassiday 1999).

That is:

$$F = \mu \times S \times G$$

Where **μ** is the ***Friction*** coefficient (depending on the level of exposure of the enemy, level of awareness and the level and depth of tactical intelligence invested in the specific area). And, **S** is the size of the area in which the force or the mass, virtual or other, is operated. (In the diffused concept **S** is the size of the territorial cell).

The mass G is applied in area S (including firing activity from the Support Tier)

11. Hence the outcome (operational effect) generated on the enemy force in a territorial cell whose size is S:

$$W_{Mol} = \int F dx = \int \mu x S x G dx$$

Length of Path Equals "Speed of Action" X "Time"

12. Action of the molecule **constitutes turbulence in the territorial cell**, therefore activity along the path **dx** can be converted to **speed of turbulence x "time"** in which this action is performed – **dt**.

13. That is, it is possible to make the following conversion:

dx=Vxdt (Where V is Speed)

and the total of all work will be:

$$W_{Mol}=\sum\int F dx=\sum\int \mu_x S_x G dx=\sum\int \mu_x S_x G V dt$$

Where the friction is high, and the speed is very high along much time, greater energy of friction (or work) is obtained.

14. Hence all of it is the result of **W**mol: the operational effect of the action of mass **G** on an area of size **S** in time **T**. (We assume that the time of the **diffused action** is the same as the time of action of the **Linear maneuver T**, until reaching the point **B).**

The Systemic Diffused Achievement

15. According to the diffused concept, friction indeed exists, and at a very great force (speed) in every terrain cell. The reason is parallel activity. That is, the enemy has no ability to get out of one terrain cell and into another, as it does in the linear confrontation. That is, both the ***FRICTION*** coefficient is high (1) and also the ***FORCE*** (physical speed) is close to 1.

16. Therefore, the outcome **(W_{Mol} = Work)** or the operational effect created from the friction in every terrain cell is very high – especially along the time in which actual friction is created (the friction coefficient is still high). Conversely, when the Power of friction decreases, due to the enemy being struck or paralyzed, the friction product decreases significantly and this involves some waste of ***"Power", G.***

17. If we assume that the action is optimal, that is, the force is operating as long as there is "high" friction, and moves on to another mission when friction declines significantly, then, if we look at the model of (Inventory) complement of forces in the following sub-section, we can estimate that the force of friction of diffused parallel activity is **greater at least by one order of magnitude** (10 times) than linear one (the explanation is given in the following sections), for forces of the same (general size.

18. In fact, the operational effect or outcome of the friction in every terrain cell in which high friction exists, for the duration of the time relevant to the existence of the friction (until the breaking of the enemy, or the opposite), is positive, and it can be estimated by a

number devoid of physical or operational meaning, namely 1. That is, the operational effect in every area cell is about 1 (assuming that friction lasts throughout the time relevant to the existence of the friction in that area), so that if 30 molecules have been activated, we get achievement number of 30 as the total effect, and as the minimum achieved in that activity – in terms of systemic achievement.

19. This is the minimum because a significant residual effects exist on account of the parallel activity, which are expressed in the **isolation** of the area cells, in pinning down forces to the area cells and, mainly, **in disrupting the opponent's prepared plan** or design.

Systemic Linear Achievement

21. The linear systemic achievement, by contrast, is measured as a maximum of 1 throughout the entire linear maneuver that it carried out.

22. The reason for this is that in asymmetric warfare at the penetration stage, or first contact, of the linear force into the battle area (the circle enclosing the battlefield), we can say that its significance in terms of the operational effect is 1 at the most. Throughout the way (A to B) the friction coefficient is almost 0 or very near to zero because in this phase the opponent's main activity is to "disappear". Hence the outcome of the linear maneuver is at most 1. Moreover, the disappearance of the diffused opponent forces in the first phase after point A creates for them an "Intelligence Dominance" (see below) throughout the way to B. That is, their "absence" versus their opponent's linear forces presence, not only decreases friction but

also allows the other side to initiate friction to his advantage.

23. So we got a systemic achievement of 30 to 1, if we suppose that 30 molecules will be operated in asymmetric conflict. And, clearly, in case we want to apply this to a conventional warfare scenario, between regular armies, the friction coefficient will rise again to 1, and systemic achievement will be determined by the relevant number of molecules versus distinct linear units in the equation. The very argument of DW.

Intelligence Dominance (the Case of Guerilla)

A Theorem: Work produced by friction of two sides will be fully gained by the side which has Intelligence Dominance over its rival.

24. Side A has Intelligence Dominance over side B, if side A forces has the information needed to fulfill their plan, while side B has no information about side A forces (place or deployment or intentions).

25**.** In the Linear case this friction **(*WORK*** in our physical analysis**)** will happen – but it will be triggered by the initiative of the guerilla forces – in the second phase. That means – they can concentrate forces by time and place, so they can attack wherever and whenever they choose their opponent's linearly maneuvering forces, with a full **intelligence Dominance**. So the friction outcome will be totally "the gain of the attacker**" (*work*).** That means – the guerilla gain**.**

Conclusions

By way of concluding this book we might look at the concept of Diffused Warfare (DW) from a slightly different angle. We may define the key question confronting states' armed forces today as the challenge of conducting armed conflicts in a way such that the scope and outcomes of the actual fighting are decided – to the highest degree possible – amongst those, and only those, who are directly involved in it.

The first decade of the 21st century is unquestionably being shaped by the dramatic events of September 11, 2001, and the joint actions that followed in Afghanistan and Iraq. However, future endeavors of extreme Islamic international terrorism are surely to be expected; and the emergence of the Hezbollah as a military extension of nation-states' armed forces, combining asymmetric entity with nation-state firepower, is a totally new phenomenon to reckon with.

The drift of actual events may merely be on the surface of a much larger and deeper oceanic undercurrent, whose shape is still insufficiently visible for us to apprehend.

Yet some features of this slow-moving historic tsunami are already distinct. Globalization and terrorism undoubtedly play a major part in it. So do the world media, the increasing weight of international public opinion, and the growing centrality of the UN Security Council in world affairs. Whether these too are only the upper layers of a newly formed "Gulf Stream" which indeed is nothing less than a clash of civilizations – may be too early to tell.

At any rate, more than ever before the constraints of legitimacy are already conditioning the initial processes of states' positioning on the use of force, as well as the actual execution of armed conflict by military forces under concrete engagement circumstances. Any state agent that uses lethal weapons today is bound to apply concrete means to distinguish legitimate from illegitimate targets. Effecting intentional and/or unjustified collateral damage, to humans or to property, is criminal under international law. Commanders and subordinates face growing risks of being tried and convicted for such actions.

Thus, on the practical level the challenge of operating legitimately, combined with the dynamic technological advancements of recent decades, is indeed a major driving force behind the profound changes in the conduct of current and future war-fighting.

The concept of Dynamic Molecules refers to the basic units of military force structure under the perception of DW. Their actual construction is still to be determined, most probably through prolonged trial and error, but the principal "molecular" properties of each unit are mandatory and consist of full connectivity to the network, and self contained sensor-to-shooter capability.

Built this way, the basic unit allows the general force structure to be maximally modular and flexible. Moreover, with the particular type of connectivity that exchanges and integrates the lines-of-sight – the "world views" – of each basic unit into an integral picture of a given battlefield, the force structure becomes modular and flexible *in real time*.

The single most important element, perhaps the only one that will truly revolutionize war fighting, is the transformation of the battlefield into a real-time domain. The fusion of the real-time pictures of every single element on the battlefield into a comprehensive whole raises us to an entirely new level of comprehensive situational awareness.

Without this, the argument that nothing here is actually new would be perfectly justified: a contemporary platoon already has connectivity to the network. To some extent it also possesses sensor-to-shooter capabilities. It is equipped with binoculars and other image-intensifying optics, and it has long-range infantry capabilities such as rocket launchers and Anti Tank Guided Missiles (ATGMs).

The point of departure from the old linear sequential military perceptions to the concepts of diffused warfare is precisely here, in the real-time conversion.

If one can consistently know, or consistently plan on knowing, in real time, what the other side is doing a whole range of new possibilities emerges. Since we expect the network to give us precisely this consistency of knowledge, the approach – indeed the necessity – of optimizing force structures to make the most of this new reality is obligatory. In this respect dynamic molecules are merely a new type of platoons, optimized for DW.

Moving now back to the claims we made in the preceding chapters, arguing for the superiority of DW over linear warfare, there are additional benefits this optimization provides, which are no less important.

Perhaps the most important of these is the departure from the illusion that mass equals victory in war fighting. The classic myth of a powerful fist, the ever-sought massive concentrated strike as a physical and geographical aggregation of means, is relevant only in linear warfare – and even then it is a pretty wasteful proposition. DW, by contrast, perceives mass as the combined outcome of simultaneity of occurrences and the sum of engagement points. In other words, it is the larger capacity of parallel – as opposed to serial – activity, and the largest sum total of friction outputs, derived from multiple small engagements, contrary to what is given by a singular central thrust.

As trivial as the obvious geometrical proof of this proposition may be, the combined effect of simultaneous engagements over multiple pressure points is anything but trivial. What we have here is a fairly new phenomenon in the battlefield which we coin “virtual mass”, affecting the physical and cognitive capacity of the opponent, but also accelerating the chain of cause and effect, thus creating a prospect of “compressing” the time frame of actual fighting.

Operating as a virtual mass replaces the centuries-old Clausewitzian notions of ‘decisive battles’ as the ‘center of gravity’ of war. Consequently, a whole range of past conditioning factors can be removed. For instance, real-time comprehensive situational awareness dramatically reduces uncertainty – that legendary ‘fog of war’, rendering significant parts of the obsessive quest for reserves and contingency forces unnecessary. This has a major impact on the entire planning process, from the “thin” layout of the molecule, through the construction of the various support tiers around and behind it, and up to the overall logistical planning and assembly of military stocks of munitions, fuel, etc.

Reduced uncertainty makes possible a smaller order of battle, a smaller fleet of major platforms, more economic support systems, and smaller investment generally in defense on the national level.

Comprehensive situational awareness is the DW dictum of *be first to see, to understand, to decide*, *and to act*. This is the main reason why self-contained sensor-to-shooter capability is made a mandatory property from the level of the single most basic element of force structure in DW.

In general, closing the sensor-to-shooter cycle will require all four imperatives to be maintained. Once this happens the degree of uncertainty may drop to an almost negligible level. But even with lesser results on a single or even a series of particular instances, the embedded properties of the molecule, as both a sensor and a shooter, still ensures better situational awareness than any other existing framework.

Yet another benefit of the optimization for DW is that the forced departure from the old arsenal of statistic weaponry, made irrelevant by requirements for legitimacy, creates an opportunity to conduct much more selective and discriminating war campaigns in both high- and low-intensity conflicts. DW has a significantly greater potential to effectively engage those who are directly involved in an armed conflict and to avoid harming those who are not. This is what it is designed for, and what comprises one of its main advantage over the classic linear perception.

A byproduct, again, is the emergence of more economic engagement patterns, based on the minimal sufficient level of striking power required per given target, which the precision of its means makes possible, rather than the wasteful and indiscriminate statistic certainty-of-destruction war patterns associated with classic linear warfare.

Finally, the molecular force structure approach of DW is probably the most generic methodology to confront the chaotic turbulence of warfare evolution in our time. Ultimately, the results of the immeasurable amounts of resources invested in building nation states' armed forces in recent decades are not encouraging. We ended up with far too many extremely expensive answers to far too many seemingly irrelevant questions. No nation can long sustain this type of mismatch.

DW with its molecular mindset is inherently better equipped to meet such challenges and devise adequate solutions to new requirements. For better or for worse, this is the name of the game today.

Reference

Fault Lines or Fractures

Bobbitt, Philip. *The shield of Achilles: war, peace, and the course of history*. New York: Anchor Books, 2003.

Clausewitz, Carl Von. *On War*. New York: Barnes & Noble Books, 2004.

Deleuze, Gilles., Guattari, Felix. A Thousand Plateaus. N.Y: Continuum, 1988.

Huntington, Samuel P. *The clash of civilizations and the remaking of world order*. New York: Simon & Schuster, 1996.

Murphy, Paul J. *The Wolves of Islam: Russia and the Faces of Chechen Terror*. Washington D.C: Potomac Books,. 2006.

Scruton, Roger. *The West and the Rest: Globalization and the Terrorist Threat*. Continuum International Publishing Group Ltd, 2002.

The Theory of Diffused Warfare

Basil Liddell Hart. *The Other Side of the Hill: Germany's generals, with their own account of military events, 1939-1945*. London: Cassell, 1948.

Best, Richard A. *Intelligence to Counter Terrorism: Issues For Congress*. Washington, DC: Congressional Research Service, Library of Congress, 2002.

Blaker, James. *Understanding the Revolution in Military Affairs: A Guide to America's 21st Century Defense*. Washington DC: Progressive Policy Institute, 1997.

Cebrowski, Vice., K, Arthur., Garstka, John J. "Network- Centric Warfare: Its Origin and Future" *Proceedings*, January 1998.

Clausewitz, Carl Von. *On War*. New York: Barnes & Noble Books, 2004.

Cordesman, Anthony H. *The Iraq war*. Washington DC: CSIS, 2003.

Dunlup, Charles j, Jr."Neo-Strategicion: Modernized Principles of war for the 21st century". *Military Review* March-April 2006: 42-48.

Feynman, Richard P., Leighton, Robert B., Sands, Matthew. *The Feynman lectures on physics*. Reading, Ma.: Addison-Wesley, 1963.

Vickers, Michael., Martinage, Robert. The Revolution in War. Center for Strategic & Budgetary Assessments, December 2004.

Onley, Dawn S. "Net-Centric Approach Proven in Iraq" *Government Computer News*, Vol. 23, No. 10, May 2004.

Randall, Bobbie L. *Sun Tzu: the Art of Network Centric Warfare*. Carlisle Barracks, PA: U.S. Army War College, 2001.

United States- Department of Defense. *Network Centric Warfare- Report to Congress*. Washington, DC: Department of Defense, 2001.

Watts, Barry D. *Clausewitzian Friction and Future War*. Washington: National Defense University, Institute for National Strategic Studies, 1996.

Armies at a Crossroads

Bobbitt, Philip. *The shield of Achilles: war, peace, and the course of history*. New York: Anchor Books, 2003.

Thomas, Timothy L. "Air Operations in Low Intensity Conflict- The Case of Chechnya" *Aerospace Power Journal* (Winter 1997): 51-59.

United States- U.S Army. *Doctrine for Joint Urban Operations*". Joint Publication, 2002.

Watts, Barry D. *Clausewitzian Friction and Future War*. Washington: National Defense University, Institute for National Strategic Studies, 1996.

Twentieth-Century Dinosaurs

Cordesman, Anthony H. *The Iraq war*. Washington DC: CSIS, 2003.

Correll, John T. "The Air Force and the Cold War" *Airforce* (September 2005).

Guderian, Heinz. Panzer Leader, New York: E. P. Dutton, 1952.

Melman Yossi. 'The Intelegence had no information that HIzzbulla had missiles' Haaretz *16 July* 2006.

Pitts, Larry. *Joint Doctrine in a Combined Operations World: The JFACC*. Washington: National War College, National Defense University, 2000.

Poyner, D. Robert. "Organic Versus Joint: Thoughts on How the Air Force Fights". *Strategic Review Vol* 29. (Winter 2001): 58-62.

United States - General Accounting Office, *B-2 Bomber: Cost and Operational Issues*. Letter Report 14/8/1997.

United States- Joint Warfare of the Armed Forces of the United States. *Air Force Basic Doctrine- Document 1*. Washington, 2003.

United States- U.S Army. *Doctrine for Joint Urban Operations*". Joint Publication, 2002.

United States- National Academy of Sciences. *Technology for the United States Navy and Marine Corps, 2000-2035 Becoming a 21st-Century Force*. Washington, D.C: Naval Studies Board, 1997.

Tirpak, John A. "Paths to Air Dominance" *Air force magazine* November 2005, Vol. 88, No. 11.

Weeks, John. Men Against Tanks: A History of Anti-Tank Warfare. New York: Mason Charter, 1975.

The Concept of Virtual Mass

Clauzewitz, Carl Von. *On War*. edited and translated by Michael Howard and Peter Paret. Princeton, N. J.: Princeton University Press, 1984.

Dynamic Molecules

Bossomaier, Terry., Green, David. *Complex systems*. New York: Cambridge University Press, 2000.

Davis, Paul K. *Effects-Based Operations: A Grand Challenge for the Analytical Community*. Santa Monica: Rand, 2001.

Keegan, John. *Intelligence in War*. New York: Knopf, 2003.

Roger Z, George., Kline, Robert. *Intelligence and the National Security Strategist: Enduring Issues and Challenges*. Washington, DC: National Defense University, 2004.

Rogers, Paul. *Political Violence and Asymmetric Warfare.* Washington, D.C: Brookings Institution, 2001.

Weisbuch, Gerard. *Complex systems dynamics: an introduction to automata networks*. Ryckebusch Redwood City, Calif: Addison-Wesley Pub, 1991.

Ending Wars / Disengagement

Alberts, David S., Hayes, Richard E. *Power to the Edge*. Washington, D.C: CCRP, 2003.

Clausewitz, Carl Von. *On War*. New York: Barnes & Noble Books, 2004.

Davis, Paul K. *Effects-Based Operations: A Grand Challenge for the Analytical Community*. Santa Monica: Rand, 2001.

Harel Amos. 'Beit Hanun is the Palestinian Kfar Kana' *Haaretz* 9 December 2006.

Moffat, James. Complexity Theory and Network Centric Warfare. Washington, D.C: CCRP, 2003.

Kathleen, Bailey. *Iraq's Asymmetric Threat to the United States and U.S. Allies.* Fairfax, VA: National Institute for Public Policy, 2001.

Cody Edward, Finer Jonathan. 'Israel Moves to Suspend Air Attacks for

2 Days After Strike in Lebanese Village Kills 57 Civilians' *Washington Post* 31 July 2006.

Rosenau, James N. "Many Damned Things Simultaneously: Complexity Theory and World Affairs" in *Complexity Global Politics and National Security* (Alberts and Czerwinski eds.) National Defense University, 1997.

July 2006

Hala, Jaber. *Hezbolla, Born With a Vengeance*. N.Y: Columbia University Press, 1997.

Blanford, Nicholas."Hizbollah Two years after the Withdrawal". *Strategic Assessment*, Vol.5, No.2, August, 2002.

Hasson Nir, Khoury, Jack, Amos Harel, Aluf Benn, and Gideon Alon. 'Israel targets Hezbollah stronghold in Beirut suburb'. Haaretz 14 July 2006.

Harclerode, Peter. Arnhem: a tragedy of errors. London: Caxton Editions, 2000.

Harel, Amos. 'Hezbollah kills 8 soldiers, kidnaps two in offensive on northern border'. *Haaretz*, 14 July 2006.

United States- Department of State. Country Reports on Terrorism, 2004. Washington,

D.C: Department of State Publication, Office of the Coordinator for Counterterrorism, 2005.

http://www1.idf.il/DOVER/site/mainpage.asp?sl=HE&id=7&docid=56765.HE

http://www1.idf.il/DOVER/site/mainpage.asp?sl=HE&id=7&docid=56649.HE

The Battle of Britain

Beyerchen, Alan, "Clausewitz, Nonlinearity, and the Unpredictability of War" *International Security*, Winter 1992, pp. 63.

Bowden, F.P., Tabor, D. *The Friction and Lubrication of Solids*. Oxford: Clarendon Press, 1954.

Clark, Robert M. *Intelligence Analysis: A Target-Centric Approach*. Washington, DC: CQ Press 2003.

Clausewitz, Carl Von. *On War*. New York: Barnes & Noble Books, 2004.

Fowles, G. R., Cassiday, G.L. *Analytical Mechanics*. London: Saunders College Publishing, 1999.

Hough, Richard., Richards, Denis. *The Battle of Britain: the greatest air battle of World War II*. New York: Norton, 1989.

Lowenthal, Mark M. *Intelligence: from secrets to policy*. Washington, DC: CQ Press, 2000.

Marion, Jerry., Thornton, Stephen. *Classical Dynamics of Particles and Systems*. Australia: Harcourt College Publishers, 1995.

Overy, Richard. *The Battle of Britain: the myth and the reality*. New York: W.W. Norton, 2001.

Persson, Bo. N.J. *Sliding friction: physical principles and applications*. Berlin: Springer, 2000

Porteus, Evan L. *Foundations of Stochastic Inventory Theory*. Stanford, CA: Stanford University Press, 2002.

Ray, John. *The Battle of Britain: new perspectives: behind the scenes of the great air War*. London: Arms and Armour, 1996.

Saaty, Thomas. *Elements of Queueing Theory: with applications*. New York: McGraw-Hill, 1961.

Townshend Bickers, Richard. T*he Battle of Britain: the greatest battle in the history of air warfare*. London: Salamander Books, 1997.

United States- U.S Army. *Doctrine for Joint Urban Operations*. Joint Publication, 2002.

Wagner, Harvey M. *Principles of Operations Research: with applications to managerial decisions*. Englewood Cliffs, N.J: Prentice-Hall, 1975.

Watts, Barry D. *Clausewitzian Friction and Future War*. Washington: National Defense University, Institute for National Strategic Studies, 1996.

Zipkin, Paul H. *Foundations of Inventory Management*. Boston: McGraw Hill, 2000.