INFORMATION-BASED REVOLUTION IN MILITARY AFFAIRS

A CASE STUDY OF SECOND GULF WAR

By

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Supervised By
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A dissertation submitted in partial fulfillment of the requirement of the degree of Masters of Philosophy in Defense and Strategic Studies.

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CERTIFICATE

This is to certify that we have read the dissertation submitted by Shafaq Aqil, entitled, "Information-Based Revolution In Military Affairs: A Case Study Of Second Gulf War", in partial fulfillment of the requirement of the degree of master of philosophy in Defense and Strategic Studies. We have evaluated the dissertation and found it compatible with the requirement in its scope and quality for the award of the degree.

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Dedicated

To

My Best Friend

ALLAH

In The Name Of

ALLAH

The Most Munificent

The Most Compassionate

ABBREVIATIONS

1.	AAM	Air-To-Air Missiles
2.	ABM	Antiballistic Missiles Weapons
3.	AC2IS	Army Central Forces Command and Control Information Systems
4.	ARM	Anti-Radiation Missile
5.	ASAT	Antisatellites Weapon
6.	ASM	Anti-Ship Missiles
7.	BDA	Battlefield Damage Assessment
8.	CALCM	Conventional Air-Launched Cruise Missile
9.	CENTCOM	Central Command
10.	C4ISR And	Command, Control, Communication, Computers, Surveillance Reconnaissance
11.	COMINT	Communication Intelligence
12.	DCS	Defense Communications System
13.	DES	Digital Encryption Standard
14.	DMSP	Defense Meteorological Satellite Program
15.	DSCS	Defense Satellite Communications System
16.	DSP	Defense Support Program
17.	ECCM	Electronic Counter-counter Measures
18.	ECM	Electronic Counter Measures
19.	EMP	Electromagnetic Pulse
20.	ELINT	Electronic Intelligence
21.	ESM	Electronic Support Measures
22.	EMCON	Emission Control
23.	EW	Electronic warfare
24.	GDP	Gross Domestic Product
25.	HARM	High-Speed, Anti-Radiation Missile
26.	HERF	High Energy Radio Frequency
27.	ICBM	Intercontinental Ballistic Missiles
28.	JASSM	Joint Air-to-Surface Stand-off Missile
29.	KTO	Kuwait Theater of Operation
30.	MIRVs	Multiple Independently Targetable Re-Entry Vehicles

31. OPEC	Organisation of Petroleum Exporting Countries
32. PKE	Public Key Encryption
33. RHAW	Radar Homing And Warning
34. RMA	Revolution in Military Affairs
35. RPV	Remotely-Piloted Vehicle
36. SAM	Surface-To-Air Missiles
37. SATA	Surveillance And Target Acquisition
38. SHF	Super-High Frequency
39. SSM	Surface-To-Surface Missiles
40. TLAM	Tomahawk Land Attack Missile
41. TNT	Trinitrotoluene
42. TTPS	Tactics Techniques And Procedures
43. TWAAM	Theater-Wide Air-to-Air Missiles
44. VHF	Very High Frequency

INTRODUCTION

PURPOSE OF THE STUDY

The purpose of this study is to analyse the dynamics of information revolution as it relates to military technology and its impact on the nature and conduct of warfare. As military observers and strategists consider the second Persian Gulf War as a portent of current revolution in military affairs, in this research, therefore, I have discussed the second Persian Gulf War 1991, as a case study of the current RMA that how military history took a new turn by the manifestation of advanced military technology in this first major war of post-cold war era.

The history of mankind is dotted with revolutionary changes in military affairs. In the modern age, systematic scientific research has developed new technologies and innovations for both civil and military use by affecting all dimensions and all levels of warfare. Scientific and technological advances though slow and gradual in 18th and 19th centuries, were dramatic in 20th century. The development in iron clad ships in the 1860s, the machine gun in 1890s, the manned aircraft and tanks in 1920s-1930s, the German Blitzkrieg in the opening campaigns of World War II; British air defense during the Battle of Britain, the aircraft carrier and radar in 1930s-1940s, the German use of submarines in the Battle of Atlantic, nuclear weapon in 1940s-1950s and the US-led war against Iraq are some of the important signposts in evolution in military technologies.[1] Innovations in technology have invariably led to changes in tactics, techniques and procedures (TTPS) and sometimes even in doctrines. Recent developments in surveillance and target acquisition (SATA), technologies in precision-guided munitions (PGMS) have ushered in what has been described as revolution in military affairs (RMA).[2] Each of these developments has revolutionary effect on the conduct of warfare. The driving force behind these radical discontinuities in the nature of warfighting is

"technological push". Military historians have referred these discontinuities or technological innovations as military revolutions or revolutions in military affairs.[3]

The second Gulf War shows the picture of such a military revolution based on information technology. The Gulf War 1991 gave an indication of some of the key components of the current revolution in military affairs and initiated an intense debate in the United States and other developed countries over the existence of a "revolution in military affairs" (RMA). Several features of the Gulf War 11 make it unique among the armed conflicts of this century, and of the most prominent one is its technological aspect. The Gulf War, with its extensive use of computers, satellite based communications systems, stealth technologies, precision guided munitions (PGMs) and other technologically dense weapons, clearly demonstrated the importance of technology. The latest advances in computer communications technology were put to their first wartime test in Operation Desert Strom. During this war, the military use of information technology was at its peak, and information technology was used to improve the effectiveness of all aspects of warfare from logistics to command, control, communications, and computers, intelligence, surveillance, and reconnaissance (C4ISR).[4] The Gulf War also demonstrated how information could be both a weapon and a target. Right at the start, 78 pre-selected command and control nodes were the first ones to be struck with missiles and bombs. Technology and information systems based on computers and communications coordinated the air campaign and best contributed to the victory of allied forces in the Persian Gulf War. Without those systems, it was not possible to apply combat forces so skillfully and effectively and the outcome of war might have been different.

In the aftermath of the Gulf War 11 and the lessons learnt by this war convinced the advanced nations that the nature of war is undergoing radical changes and another revolution in military affairs known as info-RMA based on rapidly developing information technology. The Tofflerian theory of "three waves of warfare" gave further impetus to the idea and the term " information warfare" gained currency involving exploitation of the information spectrum.[5] Alvin and Heidi Toffler's theory on three waves of warfare distinguishes between agrarian, industrial and information age societies. They suggest that societies wage war in the same way they make money, animals and labour were the valued resources of the agricultural age; machines and fossil fuels had the same impact for the industrial age, while information would be the crucial resource of the current third wave.[6]

The current RMA is made possible by sensors, communication infrastructure, space-borne navigation, reconnaissance and the proliferation of advanced information technology is the technological catalyst of RMA. Information superiority gives competitive advantages in military operations.

INFORMATION WARFARE

This information revolution has given birth to a new kind of warfare called information warfare. Information war is a radically new form of conflict and it is an important adjunct to RMA in which information is a strategic asset, and computers and other communications and information systems become attractive first-strike targets. It involves any action taken to delay, exploit, corrupt, or destroy the enemy's information esp. computer-processed information and its functions, to impose one's will on an enemy, while protecting own side against those actions. The side, which attains "information dominance", would gain success in information war.[7] Information warfare is an electronic

conflict in which information is a strategic asset, which is worthy of conquest or destruction.

Technological improvements however, do not alone constitute a revolution in military affairs. It also requires profound changes in military doctrines and organizations. A Revolution in Military Affairs combined with a drastic change in military doctrine, operational concepts and organization, causes a considerable change in the manner of warfare as well as this alters the fundamental character of military operations. This new revolution in military affairs is designed not just to equip troops with new weapons and information but also to improve the efficiency through organizational and doctrinal and tactical reforms.

In order to fully exploit the outcome of this impending RMA, the U.S policy makers has given the concept of "Joint Vision 2010". "Joint Vision 2010"is based on four concepts:

Dominant Maneuver: It is defined as a positioning of forces, integrated with precision strike, space warfare, and information war operations to attack decisive points, defeat the enemy's "center of gravity" and accomplish war objectives.[8] These centers of gravity are key points in command, organization, resources, transport, etc., whose loss would severely erode an opponent's ability to wage war.

Precision Engagement: It means attacking a target with great accuracy by precision guided munition (PGM), assessing the effectiveness of the attack by accurate data collection, and striking again when necessary. [9]

Full Dimensional Protection: It is based on the concept of controlling the battle space so the forces can maintain freedom of action during deployment, maneuver and engagement.[10]

. It also includes providing multi-layered defenses for forces at all levels. Full-dimensional protection will enable the effective employment of friendly forces while degrading opportunities for the enemy.

Focused Logistics: Focused logistics means getting the right supplies to the right place at the right time with minimum effort.

Information warfare can be conducted both against a country's military forces as well as its society. Although the objectives of infowar are the same, the methods differs somewhat in these cases. There are seven forms of warfare or conflicts that involve the protection, manipulation, degradation, and denial of information: Command and control warfare (C2W), Electronic warfare Intelligence-based warfare (IBW), Info-economic warfare, Psychological warfare, cyber warfare, and Computer hacking.

ROLE OF TECHNOLOGY IN THE GULF WAR

Military technological revolution driven by information technology also revolutionized the way weapons are produced and used. These technologically-dense weapons have the potential to change the entire mode of warfare. During the past three decades, an entire new class of weapons has emerged, and new guidance technologies have given birth to an effective new family of precision-guided munitions (PGMs). These munitions can be delivered with remarkable precision. It include: Air Borne Warning And Control System (AWACS), Joint Surveillance And Target Attack Radar System (JSTARS), stealth, sensors, global Positioning System (GPS) and satellites, laser guided bombs, missiles and artillery projectiles with single-shot kill probabilities from ten to a hundred times greater than unguided missiles. These guidance technologies have reduced the circular error probability (CEP) of delivery vehicles to 20 miters or less. All these technologically-dense weapons and superbly trained and skilled military commanders and their personnel played key role to US success in Gulf War.

SIGNIFICANCE OF THE STUDY

Information revolution is increasingly becoming a prominent worldwide phenomenon. For both military planners and political leaders who have political incentive for waging war, it is not only necessary to understand the changing nature of war and conflicts but it is also essential to evolve precepts to meet any future challenges.

This study includes analysis of information-based technological revolution, the place of this information technology in military affairs, and how this information revolution causes a major shift in the manner in which nations enter conflict or wage war. Besides these, this study have also analyzed the nature, implications and utility of RMA in the Gulf War that made this war a mile stone of the highway to future wars and new warfare areas, which are the product and outcome of this info revolution.

Some of the specific questions to be raised in this study dealing with the information-based revolution in military affairs include:

1. Has RMA altered organizational and conceptual framework of war?
2. Will this impending information-based RMA follow the traditional means and pattern of war or will it introduce new kinds of warfare areas too?
3. Whether the Gulf War really portrays a new form of warfare revolution in military affairs or it is a mere hypothesis?

STRUCTURE OF THE STUDY

This study is comprised of five chapters. First chapter is based on the dynamics of RMA that what is RMA per se, what are the constituents of this current RMA? What is information revolution and what is its significance as relates to military technology, how it brings alteration in the conduct of warfare, and how technology and current information-based revolution altered the conceptual and organizational structure.

In second chapter we will observe how this ongoing information revolution has given birth to some unique kind of information warfare areas. In this chapter, we will study what might be the future forms of warfare? What are the future implications of these warfare areas? How computer hacking, virus-writing and crashing data information systems may and likely to become core military skills? What role these warfare areas played in Operation Desert Strom?

Third chapter reviews the past military revolutions, what were they all about, the origin of micro revolutions of past in military sphere which brought radical changes in the overall conduct of warfare particularly in future warfare. Besides these, this chapter has also analyzed the factors, which contributed to enhance those past military revolutions, and how those micro revolutions of history gradually transformed into the future macro military revolutions whose glimpses we observed in the Gulf War.

The fourth chapter is based on the exciting developments in weapon technology that have taken place since 1980s, and the revolutionary character of these weapon systems that changed the course of history. How these weapon technologies have affected the conduct of warfare and ultimately paved the way for the victory of Allied forces in the Gulf War of 1991, this is all discussed in this chapter.

In the fifth chapter, we will discuss how these computerized weapon systems have changed the course of the second Gulf War, what role these weapon systems including, precision guided munitions (PGM), AWACS, JSTARS, laser guided bombs, stealth, sensors, global Positioning System (GPS) and satellites, played in this war, and how this ongoing RMA and computer-based advancements in military technologies and weaponry contributed in coalition victory in this war.

METHODOLOGY

This study is based on the description and analysis of the causes and factors behind the RMA and its dynamics, so both descriptive and analytical methods have been employed to conduct this research. Secondary resources have been used to conduct this research, which include books, reviews, publications, and scholarly research articles published in journals like Foreign Affairs, Military Review, Strategic Analysis, Strategic Review, Indian Defense Review, Security Studies, Strategic Survey, Washington Quarterly etc. Modern techniques of the Internet have also been used during the course of research.

This study is based on the careful review of the available literature on the subject in different libraries and research institutes. Besides the central and departmental libraries within the Quaid-i-Azam University, all major libraries and research institutes have been visited and utilized. These are: National Library, Library of American Center, Army Central Library (GHQ) Rawalpindi, National Defense College (NDC) Library, Institute of Strategic Studies (ISS), Institute of Regional Studies (IRS), Area Studies Center (QAU).

END NOTES

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CHAPTER 1
DYNAMIC OF CONTEMPORARY RMA

No period of human history is devoid of war. War is perhaps the most important facet of international politics. It is so important that men fight war over 4130 years out of the 4360 years of recorded human history. The development of human thoughts originated the struggle among various class due to various factors including, personal interests, socio-economic factors, ethnic and religious factors and dreams of absolute power. All these struggles ended on wars. War was a foreign policy tool for states and their rulers throughout the history. "War is a conflict between political groups (nations, states, governments, or factions) involving hostilities of considerable duration and magnitude".[1] Col Richard Szafranski defines warfare as "the set of all lethal and nonlethal activities undertaken to subdue the hostile will of an adversary or enemy". [2]

The Gulf War 11 of 1991 is also a fine example of the modern age war, which change the mode of conducting future wars to a larger extend. The U.S. and its Western allies have aggressively pursued superior information war capabilities for the last three decades in competition with the Soviets in order to overcome Soviet quantitative advantage while simultaneously causing the disruption and disorganization of the operations of the larger Soviet forces.[3] All their endeavors in the regarding information technology culminated in the second Gulf War.

Iraq's invasion of Kuwait on August 1, 1990, triggered a series of events that led to one of the largest-scale conflicts of the modern age. On January 18, 1991, history took a new and unique turn and a paradigm shift occurred in the conduct of warfare. Allied forces manifested a different sort of warfighting tools and techniques in the Gulf War 11.[4] Most of these techniques and tools used in Operation Desert Strom were evolutionary and new

though many of them were based on the second wave industrial age technologies and ideas. With the end of the cold war and the coalition victory in the Persian Gulf War, the claim has been increasingly fashionable that war is being transformed due to increasing use of technology such as computers and satellites in actual conduct of warfare and the technologically advanced countries particularly the United States are in the midst of a revolution in military affairs. Many strategists and policy makers considered the Persian Gulf War of 1991 a manifestation and representation of an impending RMA that caused historic change in the nature of armed conflict. Iraqi military forces were proficient and well equipped with modern weaponry (tanks, artillery, and air defense systems) at the time of invasion on Kuwait. The entire world was excepting a fearsome military struggle. But the pervasive and effective use of stand-off deep strike systems, precision munitions, and space-based target acquisition systems brushed aside the Iraqi forces with minimal human lose. Strategists argue that space-based information systems processing and stealthy long-rang precision strikes provided glimpse of a new high-tech war. And they assert that these factors are the very elements that really made the Gulf War an RMA. Some have called the Gulf War the last "Industrial Age" war others have called it the first "Information War".

In order to understand the nature of this contemporary RMA, in this chapter, we will discuss the dynamics and constituents of current military revolution first, on which the Gulf War was based and of whom glimpses were apparent in the Operation Desert Strom This discussion will clear the picture of this ongoing debate to the larger extend.

INTERPRETATION OF THE CONCEPT

It is difficult to precisely and consistently define the term revolution in military affairs. In the course of military history, military historians have referred technological innovations

as military revolutions or RMA. Sometimes, such innovations have more profound effects in a way, that take warfighting beyond the established paradigm by radically transformed the prevailing instruments, ideas and institutions of warfare. These radical discontinuities in the nature of warfare are called "revolutions in military affairs or RMA". There are many reasons for the occurrence of such revolutions in history. The most important one is the "technological push".

Michael Roberts in his seminal work on military revolutions titled "The Military Revolutions 1560-1610" in 1955 first proposed the concept that there had been systemic changes in the art of warfare throughout history to produce military revolutions [5] Accordingly, the term military revolution or RMA evolved since 1955 into the following holistic definition:

> "The major change in the nature of warfare brought about by the innovative application of new technologies which combined with the dramatic change in military doctrine and operational and organizational concepts fundamentally alters the nature and the conduct of warfare". [6]

According to Alvin and Heidi Toffler:

> A true revolution goes beyond that to change the game itself, including its rules, its equipment, the size and organization of the "team," their training, doctrine, tactics, and just about everything else. It does this not in one "team" but in many simultaneously. Even more important, it changes the relationship of the game to society itself. [7]

The Defense Agency of Japan had defined the concept of RMA as:

> " The transformation in military affairs, including equipment, organisation, tactics and training, design to make quantum leap in efficiently achieving military objectives, sparked by the application of advanced technologies to the military sphere, with information technology as its core". [8]

In other words, the RMA is not just equipping troops with new weapons or computerizing information. It is the transformation of the existing military by changing its organisation and tactics on the bases of advanced information technology, and making a quantum leap in efficiently achieving military objectives by utilizing precision-guided

munitions. A mere application of information technology to military affairs does not automatically lead to an RMA.[9] The essence of an RMA, is not the rapidity of the change in military effectiveness against opponents, but rather the magnitude of change compared with preexisting military capabilities.[10]

So, we can say that an RMA is a rapid and radical increase in the effectiveness of military units that alters the conduct of warfare and changes the strategic environment.[11]

REALIZATION OF CURRENT RMA

Soviet military practitioners were the first who advanced the notion of an emerging revolution in military affairs. In the early 1970s the Soviets had identified two periods of fundamental military change in the 20th Century: one driven by the emergence of aircraft, motor vehicles and chemical warfare in World War I, and the second driven by the development of nuclear weapons, missiles and computers in World War II. The most vocal proponent for changing military conditions was Marshal Nikolai Ogarkov, Chief of the Soviet General Staff from 1977-84. During 1970s and 1980s, he wrote a series of papers, which advanced the notion that the nature of warfare would shortly be transformed due to an imminent technical revolution. The Soviets noted that the emergence of advanced non-nuclear technologies was creating a new form of revolution in military affairs. They particularly focused on the incorporation of information sciences into the military sphere. The Soviets defined the impending transformation of warfare as a Military Technical Revolution or MRT involving advances in microelectronics, sensors, precision-guidance, computers and communication, automated control systems, and directed energy.[12] They argued that these new capabilities produced a qualitative change in conventional warfare. That change made non-nuclear weapons virtually equivalent to very low-yield nuclear weapons in military effectiveness.

However, it soon became clear that "military technical revolution" was a narrow and limited approach to understand or define the nature and importance of the transformation in the warfare. So, the idea of a "Military Technical Revolution" evolved into a more holistic concept of a revolution in military affairs.

It was the high-tech success of the Persian Gulf War that brought the idea of contemporary RMA to the forefront. The Gulf War 11 proved somewhat the Russian hypothesis of MTR and Operation Desert Storm 1991 proved a turning point for the transformation in the way war is waged. The victory in the gulf war 1991, has led the United States and other advanced countries to conclude that the nature and the conduct of warfare has been transformed. They are convinced that the rapid advances in science and technology have given birth to the revolution in military affairs (RMA) based on computer advancements and simulation and information technology.

INFORMATION REVOLUTION

The main aspect of this Third Wave revolution in military affairs beginning in the early 1970s, which has played a catalyst role in bring changes in the ideas, instrument, and institutions of warfare among a number of social and technological changes is information revolution. This Information-Revolution is a product of advances in computerized information and telecommunication technologies and related innovations in management and organization most of which have place in civil society. This revolution has many aspects and characteristics, but those most relevant to the revolution in military affairs are how information is collected, stored, processed, communicated and presented.[13]These technological advances in the realm of information have increased our ability to collect vast quantities of precise data; to convert that data into intelligible information; to rapidly and accurately transmit this large quantity of information; to

convert that information through responsive, flexible processing into near-complete situational awareness, and to allow accurate predictions of the implications of the decisions that may be made or actions that may be taken.[14] The creation of the Internet and microchip has deepened this effect.

WHAT IS INFORMATION

Information is a derived data from observable facts and events. Interpreting data leads to the development of information. The ultimate interpreter is a person receiving data. Machines are prepared to reduce data into a manageable and comprehensible set because at times, an observed.event is become too complex for the human mind to grasp.[15]

Information is becoming as valuable and influential strategic resource in the postindustrial era as capital and labour have been in the previous industrial age. Today, far reaching changes are occurring in how information is collected, stored and processed, and disseminated and also in how organizations could take advantage of this increased availability of information.[16]

INFORMATION WARFARE

Information is believed to be as a powerful and effective instrument in war. It is becoming increasingly important to the power and wealth of modern society and information superiority gives competitive advantage over adversary.[17] The increased speed and precision of modern weaponry make information the heart of RMA and an essential dimension of warfare. This idea is adopted by the strategists and called information warfare. Information war is a radically new form of conflict and it is an important adjunct to RMA.

From the historical perspective, the control of information and communication has been very important. For example, in the second Punic war of the third century B.C., Carthaginian forces under the command of Hannibal regularly stationed observers with

mirrors on the hilltops in order to keep their leaders informed to Roman movements, while the later remained ignorant of this. Better communication contributed a lot in winning a series of victories over a sixteen-year period for Hannibal's forces.[18] In the case of Mongols, their military success was based almost entirely on the knowledge of the location of military adversaries while keeping their own location a secret. Thus in their clash against Polish-Prussian coalition forces at the battle of Liegnitz, the Mongols defeated a four times larger enemy.

The US Department of Defense (DOD) issued a Directive TS3600.1, "Information Operations" in 1992, which formally launched the concept of information warfare and offered general guidance along with many other policies.[19] In January 1994, the first significant government explanation of information warfare was issued in the annual report of the Secretary of Defense. According to the report:

> Consist of the actions taken to preserve the integrity of one's own information systems from exploitation, corruption, destruction, while at the same time exploiting, corrupting, or destroying an adversary's information systems and, in the process, achieving an information advantage in the application of force.[20]

There are three, interrelated, definitions of information warfare: The first, and clearest, involves either attacking, influencing, or protecting military reconnaissance, surveillance, dedicated communications, command and control, fire control, and intelligence assets. The second definition, involves protecting, influencing, or attacking the basic communications links of a society: voice, video or data transfer, electric power or telephone system control commands, etc. The third involves what formerly were called psychological operations. These involve using television, radio, or print media to attack, influence, or protect the attitudes of soldiers, civilian populations or leaders.

In any kind of infowar, each side would try to impose one's will on an enemy, while protecting own side against those actions. Each side would try to shape enemy action by manipulating the flow of intelligence and information. The side, which has attained

"information dominance", would gain success in information war. It can be defined as the struggle between two or more opponents for control of the information battle space.[21]Information revolution is caused by the applications of microelectronics, digital compression and high-speed data transmission-based technologies to military command, control and communications.[22] These advanced technologies provide the commanders with greatly enhanced ability to collect and process information and allowed them to perform these functions with unprecedented effectiveness. Weapons are now being transformed into "mobile data links", navigated, maneuvered, aimed by streams of data provided by remote sensors on the battlefield or from satellites.[23] Through global positioning system, space-based communications, AWACS and JSTARS aircraft and battlefield computers commanders are now able to grasp the battle much more quickly and precisely. A war involving a participant possessing the elements of this vision of an RMA would take place at a very rapid pace, involve battlefield awareness, the use of very lethal precision guided weapons, control of the entire electromagnetic spectrum, and be highly integrated among all the components and services. So we can say that the shape of warfare after twenty years will be based on the changes in warfare created by the information revolution.

Information warfare will not be less violent than industrial age conflicts rather they will be more chaotic.[24] The future warriors will fight as fiercely as their predecessors and information will enhance the way they operate on the battlefield. With help of information age weapons, these warriors will engage an enemy precisely and decisively and quickly outflank and outmaneuver an enemy with knowledge of its position and combat situation. [25]

COMPONENTS OF RMA

RMA is made possible by mutually supportive changes in technology, concepts, and organizations. The operational possibilities of a new technology into military capabilities can be possible by mean of a new doctrine. Doctrine gives rise to operational concepts and forms of organization and as well as it change the nature and shape of organisations.

So a careful analysis of technological developments, new operational concepts and new organizations is now needed here so we might realize and understand the full potential of these new technologies, concepts and systems.

In may 1996, the U.S. department of defense (DOD) published a document entitled "Joint Vision 2010" (JV2010) describing how armed forces should expect to conduct warfare in the early 21st century.32 JV 2010 anticipated great advances in the adoption of new technology, concepts, and organizations.

TECHNOLOGICAL DEVELOPMENT

In the modern age, systematic research in the field of science has developed new technologies and innovations for both military and civilian use. These technologies have left deep impacts both on society as well as on the nature of warfare. New technologies are modernizing the world and improved performance of computer, digital technology and equipments are creating enhancement in many areas.[26] In this way, these technologies both in civil and military spheres have given birth to a revolution in military affairs. Scientific advancements and technological innovations in the field of information technology, sensors, communication infrastructure, space-borne navigation and reconnaissance have made the current RMA possible. Most of the core technologies are now associated with RMA, could be listed by the early 1970s: precision guidance; remote guidance and control; munitions improvement; target identification and acquisition;

command, control and communication; and electronic warfare. Satellites were in use for reconnaissance purposes by 1961 and for communication (in Vietnam) in 1965. The first tactical computers were used in 1966. The Internet can be traced back to a Pentagon backed project to link together computers in the 1960s.[27] Smart weaponry was first used by US Air Force (USAF) in Vietnam War.

PROPOSED ELEMENTS OF CURRENT RMA

ADVANCED COMPUTER TECHNOLOGIES

Computer technologies are the most powerful element of RMA and the continuous, rapid advances in this category are driving all of the other elements in the RMA. This information-based computer technology is the technological catalyst of RMA. The advent of cheaper, smarter and faster computers, coupled with the tendency for miniaturization, has profoundly transformed many aspects of life in the late twentieth century. The fundamental driving force behind the computer revolution has been the rate of technological development at which silicon-based devices have continued to improve. The ability to model or simulate processes, activities, or objects has grown exponentially in the recent past. Between 1981, when IBM's original computer was introduced, to 2002, processor speed for personal computers have increased several hundred-fold, doubling every 2 years.[28] The personal computer has had increases in standard memory configurations (from 64,000 to 8,000,000 bytes), hard storage systems (from 10 mega bytes in 1984 to the more common gigabytes today) and modem speeds from1.5 million bits per second to 155 million bits per second.[29] Such improvements in capacity will not cease but it will continue in the future. The post-cold war development of the digital computer and its mass production is transforming the world into a modern information age. The combination of digital computer technology base with the well-established

technologies of analogue communications provided the basis for the modern digital communications network, and ultimately the Internet.[30]

The fundamental change that rose with the proliferation of computing and digital technology is the speed with which knowledge can be transmitted and processed. Whether we replace cheques and letters of credits, email correspondence or research data, or delink target, coordinates between bomber and guided weapon, the digital technology base allows almost instantaneous and almost error free transmission of knowledge.[31]The increases in computer speed and reliability, combined with new or more sensitive types of sensors, has made possible dramatic increases in weapons accuracy and lethality, intelligence gathering and dissemination, and communications. These types of developments will continue to be helpful in the future battlefield and make it possible to equip every soldier with high-performance computational and communication devices.

SYSTEM OF SYSTEMS

The heart of U.S. concept of RMA is the "system of systems". System of systems is based on a combination of three technological changes. First in the area of Intelligence, Surveillance, and Reconnaissance (ISR technologies). These permit a full situational awareness of the battlefield. Second are Command, Control, Communication, Coordination, and Intelligence (C4I) technologies. These technologies will enable continuous intelligence acquisition, immediate command decisions, instantaneous response at high political level, and finally real time engagement of targets.[32] Third, are precision force technologies, which enable pinpoint destruction of targets from long distances. System of systems is design to bring about a multiplier effect by systemizing individual systems into an integral whole.[33] During the Gulf War, the linkages of various systems-the reconnaissance and surveillance systems (such as JSTARS) and the precision attack system such as Tomahawk missiles have achieved excellent military results. The

U.S. sought to fortify the linkage among various systems by drawing upon the lessons learned from that operation.[34]

SYSTEM OF SYSTEMS [35]

ISR	C4I	Precision Force
Intelligence, Surveillance, Reconnaissance	Command, Control, Computer Applications, Communications, Intelligence Processing	
AWACS	CGCS	SFW
RIVET JOINT	JSIPS	TLAM (BLK III)
JSTARS	DISN	ATACMS/BAT
HASA	C4IFTW	SLAM
SBIR	TADIL J	CALCM
ATAR	TRAP	HAVE NAP
TIER 2+	TACSAT	AGM-130
TIER 3-	JWICS	HARM
TARPS	MIDS	AIR-HAWK
MTI	SONET	SADARM
REMBAS	LINK-16	HELLFIRE II
ISAR	DMS	JAVELIN
FDS	SABER	THAAD

System of systems is a world in which many kinds of sensors, from satellites to ship-borne radar, from unmanned aerial vehicles (UAVs) to remotely planted acoustic devices, will provide information to any military user.[36] Technological advances are usually a requisite for an RMA, however, technological improvements, no matter how revolutionary, do not alone constitute a revolution in military affairs. It also required profound changes in military doctrines and organizational practice. In order to fully exploit the information as a catalyst of RMA and to sustain their power and confirm their worth, doctrinal and organizational changes must occur. New technology requires modification in organizational structures and doctrine for efficient and proper employment of technological innovations on each level of war.

OPERATIONAL CONCEPTS

Most military analysts now agree that advances in military technology required a fundamental reappraisal and revision of operational concepts in order to take full advantage of them. This combination of technological advances and revision in operational concepts represent a revolution in military affairs. To bring a revolution in military affairs and to fulfill the requirements of this revolution, an appropriate operational concept is just as important as technological invention. And it is imperative to train military organizations to use and improve these operational concepts.

JV 2010 introduces four new operational concepts:

DOMINANT MANEUVER

One of the recently identified potential new warfare areas is dominating maneuver. Maneuver has always been a key element in military operations, but the RMA offers the ability to conduct maneuver on a global scale, on a much compressed time scale.[37] Dominating maneuver is defined as a positioning of forces, integrated with precision strike, space warfare, and information war operations to attack decisive points, defeat the enemy's "center of gravity" and accomplish war objectives. These centers of gravity are key points in command, organization, resources, transport, etc., whose loss would severely erode an opponent's ability to wage war.[38] In the course of the 20th century, the complexity of war has increased. Dominating maneuver seeks to exploit the increasing complexity and nonlinearity in warfare by striking directly at the enemy center of gravity in order to disrupt his cohesion and cause his collapse.

Dominating maneuver is different from traditional concepts of maneuver in many ways. Maneuver refers to the "employment" of forces on the battlefield through movement in combination with fires, to achieve the position of advantage. While dominant maneuver refers to the positioning of forces, not necessarily their employment. Forces can be

positioned any where in a theater, not necessarily on the battlefield. It goes beyond combination with fire by integrating with precision strike, space warfare and information warfare. The main purpose of dominating maneuver is to directly achieve campaign and war objectives. It conducts synchronized operation from dispersed locations rather than a few large bases or camps. According to JV 2010:

"Dominating maneuver will be the multidimensional application of information, engagement, and mobility capabilities to position and employ widely dispersed joint air, land, sea, and space forces to accomplish the assigned operational tasks. Dominant maneuver allows to gain a decisive advantage by controlling the breadth, depth and height of the battle space. It allows to apply decisive force to attack enemy's center of gravity at all levels and compels an adversary to either react from the position of disadvantage or quit. Dominating maneuver will require forces that are adept at conducting sustained and synchronized operations from dispersed locations. They must be able to apply overwhelming force in the same medium and create asymmetric advantages by attacking cross-dimensionally, such as air and sea against ground or ground and sea against air defenses. These forces must have the ability to outpace outmaneuver the enemy. Increasingly direct and indirect fire systems, with longer range and more accurate targeting, will increase the punch of these forces as they maneuver".[39] Dominating maneuver could allow ground forces to operate successfully in the situations where they cannot dominate the entire battlefield.

So we can say that in order to fully implement the dominating maneuver in its true sense, new operational concepts will require in future that consider the decisive importance of time. Therefore, in order to attain operational and strategic objectives in future wars, simultaneous information warfare, space warfare, precision strike, and maneuvers will be essential instead of a series battles against enemy forces.

The Gulf War 11 is a glaring example of dominant maneuver. Coalition forces with the help of information-based modern and technologically-dense weaponry, precision strikes, surveillance through space-based sensors, maneuver etc., soon prevailed over the entire war and in surprisingly short time brought the Iraqi forces to their knees.

PRECISION ENGAGEMENT

The second key operational concept is precision engagement and long-rang precision strike is a dominant operation approach. Precision engagement is broader concept that means more than just striking targets more accurately rather it would be based on a system of systems, which would allow locating a target, providing responsive command and control, attacking it with great accuracy, assessing the effectiveness of the attack, and striking again when necessary.[40] With the help of precision delivery system, precision engagement will shape the future battlefield even from extended ranges. It will be possible by widely dispersed forces which will be coordinated through highly capable information distribution systems. These forces will enhance the protection of forces against enemy as well.

In the present day socio-political scenario, long-range precision strikes are even more essential. Today, political leaders and strategists need some way to coerce or punish an enemy or at least disrupt their plans, without the wholesale destruction of infrastructure or killing of noncombatants.[41] All this is possible by information operations because these operations will give the assurance of desired effects, lessen the risk of forces, and minimize collateral damage. This is the reason that precision is such an integral element of the current revolution in military affairs.

Precision engagement requires advanced weapons and munitions and enabling support of an advanced C4ISR (command, control, communication, computers,

surveillance and reconnaissance). Precision engagement is based on intelligence of about enemy forces and expert judgment regarding the correct forces or weapon in order to generate the desired effects. The precision strike dramatically increases the capabilities to strike strategic targets. In 1943 the US Eighth Air Force prosecuted only 50 strategic targets during the course of the entire year. In the first 24 hours of Desert Storm, the combined air forces prosecuted 150 strategic targets--a thousand-fold increase over 1943 capabilities. By the year 2020, it is possible that as many as 500 strategically important targets could be struck in the first minute of the campaign representing a five thousand-fold increase over Desert Storm capabilities.[42] Operation Desert Storm provided a glimpse of the revolutionary potential of precision strike. These and related technologies provide commanders continuous wide-area surveillance and target acquisition, near-real-time responsiveness, and highly accurate, long-range weapons. The Gulf War demonstrated the potential for such deep strike systems not only to create a maneuver differential, but at least potentially to be decisive in themselves.[43]

It is envisioned that precision strike will be able to achieve similar effects to those of nuclear weapons but without the risk of escalation to intolerable levels of destruction. Such technologies by themselves have the potential to change dramatically the way wars are waged. Integrating precision strike capabilities with dominating maneuver and information war may create an especially potent RMA.

FULL-DIMENSIONAL PROTECTION

Full-dimensional protection means protecting friendly forces and facilities them by all means available from enemy information warfare, missile attacks and other threats.[44] Full-dimensional protection includes defense against asymmetric attacks on information systems, infrastructure, and other critical areas, vulnerable to nontraditional means of

attack or disruption. A full-dimensional protection includes defense not only against physical attacks but also against all other forms of attacks including against chemical and biological weapons attacks. According to JV 2010:

The primary prerequisite for full-dimensional protection will be control of the battle space to ensure friendly forces can maintain freedom of action during deployment, maneuver and engagement, while providing multi-layered defenses for forces at all levels. Full-dimensional protection will enable the effective employment of our forces while degrading opportunities for the enemy. It will be essential in most cases, for gaining and maintaining the initiative required carrying out decisive operations. The concept will be proactive, incorporating both offensive and defensive actions that may extend well into areas of enemy operations. Full-dimensional protection will be built upon information superiority, which will provide multidimensional awareness and assessment, as well as identification of all forces in the battle space.[45]

FOCUSED LOGISTICS

The importance of logistics in warfare cannot be overstated. The combat power of modern military forces depends critically on the capacity to produce, procure, transport and distribute the means resources (munitions, fuels, supplies and water) to wage war. The delivery of appropriate supplies to the right place at the right time is vital during an operation. Focused logistics means basically getting the right supplies to the right place at the right time with minimum effort. JV 2010 introduces the concept of "focused logistics" to meet the demands of military operations in the early 21st century. According to JV 2010:

Logistics will be responsive, flexible, and precise through the fission of information, logistics, and transportation technologies. The goal of focused logistics is to be able to

track and shift assets even while reroute and to provide support in hours or days rather than weeks thus will be capable of supporting rapid unit deployment and employment and will better support the battlefield commander by eliminating redundant requisitions and reducing delays in the shipment of essential supplies.[46] As far as the capacity to generate resources and logistic is concerned, the coalition forces had substantial advantage over Iraq In six months the USA had had to move 5000,000 tons of material and 430,000 soldiers from the American continent to the Gulf. Since August 1991, the nations railways had moved 15000 car loads of M-I tanks, cannon shells and food t the supply depots.[47] The most critical and complex function was the management of inventory, maintenance of force, replenishment of war wastage rates, and transportation of stores from different parts of the globe to specific destinations in the theater of operations within specific time parameters. If there were not electronic means, the logistic efforts to support the coalition forces in Iraq would have upset with disastrous effects on the conduct of battle.[48]

ORGANIZATIONAL CHANGE

An appropriate operational concept is just as important as technological invention in bringing about a revolution in military affairs. The ongoing advancements and developments in weapons technology require restructuring of armed forces. History is replete with examples of armed force that failed because they did not change with the changing time or they made wrong changes. With increasing networking, to take advantage of better communications in the information age, the military and civil society need to review their structures and reorganize where possible in order to increase efficiency and reduce vulnerabilities.[49] People are needed who can develop, operate, maintain, and repair advanced surveillance, communications, and information processing

systems and particularly advanced weapons. This requires changes in recruitment procedures, training, advancement, and organisation.

On account of the advancements in military sphere, now commanders can command the large staff and other organisations and formulate plans for actions without being physically present on battlefield. The decentralization of command authority would be another feature of information warfare. The post-modern era warfare will require major innovation in organizational design, in particular a shift from hierarchical to information network structures.[50] These information networks will potentially enable soldiers and seamen at the lower levels to know as much as the senior commanders know about the combat situation throughout an entire theater of warfare. They will know about enemy targets, what they will encounter in any direction and potential threats to their own survival, and the locations and status of their own forces. The use of computer simulations in the future battles, will give alternative solutions to decision problems. In effect, small units can operate more independently. In this way, information technology will give unprecedented opportunities for initiative and independent operations to individuals and small units and it has been termed as "decentralized empowerment".[51] Moreover, shorting the time period for decision and action will also require decentralization of command authority and associated relaxation of control downward from top.

Additionally, The information revolution will replace the traditional hierarchies of organization with fluid networks. These multi-organizational networks will consist of often small organisations and even individuals will be linked together often on *ad hoc* basis. The information revolution will support the growth of such networks on the basis of higher quality information to communicate, coordinate and operate together across greater distances.[52] Desert Strom gave the picture of the future shape of military

organisations. In the gulf war, great autonomy was given to field commanders. The central headquarters supported the field commanders but did not micromanage them.[53]

Since the Industrial Revolution there has been a stream of new technologies that intentionally or otherwise have had military applications. Technological change has always been a defining and unavoidable characteristic of a revolution in military affairs. At the same time, rapid societal change and organizational adaptations by military forces are taking place. It is the synergistic effect of these three preconditions that leads to an RMA. History suggests that the combination of technological developments, doctrinal innovation and organisational adaptation could enable full realisation of RMA.

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CHAPTER 2

METHODS OF INFORMATION WARFARE

War is clash of arms such as artillery, ships, bombs and tanks in which armed forces of two states try to overcome their challengers through a physical defeat. However, in the twentieth century, it has been clearly demonstrated that war is no longer solely the matter of states, nor does it necessarily require the use of physical means of destruction. War exists even without the use of weapon that causes physical destruction because war is an act of force to compel our enemy to do our will and a variety of means may help to persuade, coerce, or compel an enemy. These methods by achieving war objectives may not result in the physical destruction of the enemy.

Information warfare has also introduced some different and unique methods of warfighting. Martin Libicki, an expert on RMA, in an article opined that:

> "Information warfare as a separate technique of waging war, does not exist. There are instead, several distinct forms of information warfare, each laying claim to the larger concept." [1]

KINDS OF WARFARE

Information warfare can be waged both against a country's military force as well as its civil society. Although the objectives of information are the same, the methods differ somewhat in these cases. There are seven forms of warfare or conflicts that involve the protection, manipulation, degradation, and denial of information. Although the basic objectives of information warfare remain the same whether it is aimed at the military or society, the methods differ to an extent. Against the military, infowar could primarily consist of command and control (C^2) warfare, electronic warfare, and intelligence-based warfare (IBW). Against society, the methods used may be info-economic warfare and

cyber warfare. Psychological warfare and computer hacking operations would be common features in war against the military and society.

According to a dominant militaristic view information warfare is an assortment of seven forms of warfare comprises of:

1. Command and control warfare (C2W)
3 Electronic warfare
4 Intelligence-based warfare (IBW)
5 Info-economic warfare
6 Cyber warfare
7 Psychological warfare
8 Hacker warfare

COMMAND AND CONTROL WARFARE

The U.S. Department of Defense (DoD) issued a Combined Joint Chiefs of Staff (CJCS) Memorandum of Policy 30 in March 1993. This policy defined Command and Control warfare as:

> The integrated use of operations security, military deception, psychological operations, electronic warfare (EW) and physical destruction mutually supported by intelligence to deny information to, influence, degrade, or destroy adversary's command and control capabilities, while protecting command and control capabilities against such actions.[2]

This Memorandum presents command and control warfare as a subset of information warfare that specifically attack and defend the command and control target. Its stated purpose is to decapitate the enemy's command and control from his body of force, to paralyze them and invalidate any potential advantage the adversary may have.[3]

Gunning for the commander's head is an old aspect of warfare, attempts to find Mohammed Aideed in Somalia or like direct strikes at Saddam's military command centers in order to destroy or isolate the Iraqi leadership and cut it off from its troops in the field during the Gulf War.[4] The task was to disrupt the brain and nervous system of the Iraqi military. The idea of decapitation occupied a high place in the minds of military planners. If the opposing commander could be killed or captured, then the forces under him often failed to operate coherently and victory could not be achieved. With the introduction of communications in the battlefield, however, the enemy commander could afford to remain in contact with his troops without being physically present in the battlefield. This situation has changed a lot in the last three decades with the development of precision munitions.[5]

The aim of command and control warfare (C2W) is to use physical and electronic attacks against enemy information systems to separate the force from the leadership. It consists of attacks against enemy ability to generate commands, and hence is directed at the leadership and its ability to direct/control. Strikes on enemy's command and control systems, for example, could hamper enemy ability to employ forces effectively by interfering with the leadership's ability to collect, process, and disseminate information.[6] In some ways, the Gulf War represented the first attempt to implement such a strategy. Coalition air campaign planners hoped to strike at Iraq central nervous systems to paralyse the regime in Baghdad. We might destroy its capability to resist by massive, coordinated strikes on a range of key targets networks.[7] Information has expanded the concept of C2W from largely being aimed at the commander to targeting the functioning of the entire command and control system. It may no longer be enough to decapitate a force, headless troops may still be able to

operate effectively in many scenarios. There may be three distinct possibilities here. If the C2 structure was hierarchical in nature, then this command and control system would be highly vulnerable to disruption by decapitation if the leadership is attacked. On the other hand, if the command and control system is essentially non-hierarchical (for example in case of a number of non-state actors or terrorist organisations), the system would be flexible and C2 warfare is unlikely to yield desired results easily due to the collaterals available. A non-hierarchical system is the product of the information age and relies heavily on information technology such as cellular telephones, facsimile machines, and computer networking in order to organise on networked lines. The command centers are diffused in networked organisations and hence, less vulnerable to C2W. If the information flow is based on a non-hierarchical system, the ability to interfere with the enemy command and control functions would be severely curtailed.[8] A non-hierarchical system is one that would allow data transfer directly from the dissemination agency to the user without the need to traverse intermediary nodes. The method to conduct infowar through C2 warfare, would necessarily involve the identification of information flow channels of the adversary, assessment of it vulnerability to anti-C2 operations, while designing its own C2 system on a non-hierarchical basis to safeguard the system against the enemy's C2 operations. C2 warfare is likely to play a vital role in infowar operations against the military forces.[9] A third possibility may be a hybrid design where a mix of hierarchical and non-hierarchical structures is incorporated. C2W against these hybrid designs requires careful analysis to determine which part of the structure needs to be targeted. C2W, therefore, has expanded in scope as part of information warfare. The information age is likely to see more of this kind of C2W.

ELECTRONIC WARFARE

With the advent of the radio in the First World War, the electromagnetic spectrum became a determinative new war fighting media, with the direct force multiplying on existing weapon systems and the management of forces. Some systems such as radar, radio jammers and direction finding equipment were developed and utilized during the Second World War. Since than, electronic warfare has become an intrinsic and inescapable part of the weapon systems deployed to wage war. It substantially enhances the destructive potential of ground, air and naval forces. If an army can be seen (visually or electronically) on the battlefield, it can be hit. And if it can be hit it will most likely be destroyed.

Electronic warfare is one of the key elements of modern battle scenario, protecting one's own forces from attack, denying information to the enemy, and intercepting and disrupting his own voice communication and datalinks. EW is a combination of space, C^4I, electromagnetic spectrum and many other factors. When these elements are combined with today's technology, the result is information warfare.

Militarily, Electronic warfare is a military action taken to determine, exploit, reduce or deny the use of the electromagnetic spectrum to hostile forces while retaining the ability to use it oneself. It includes the use of signals intercepting, locating, identifying, detecting, jamming, disrupting, receiving, protecting, analyzing, and cryptanalyzing.[10] The object of electronic warfare is to provide intelligence or combat power like jamming, disruption, and deception, to eliminate or reduce the effectiveness of target by interrupting, modifying or blocking the information flow. This may be achieved through hard kill (bombs or anti-radiation missiles) or soft kill (computer intrusion, jamming or deception). This basically means that the endeavor is to deny,

degrade, delay, or disrupt information in order to create a false picture so that incorrect action results.

In the land-based role much of EW is dedicated to passive electronic intelligence role, and to disrupting the communications links and surveillance systems of the other side. The prime role of naval EW is the protection of the units or fleets from aircraft and missiles attack along with intelligence gatherings. In the airborne application, EW is employed both for intelligence gathering and for protect of the aircraft from surface and air-launch missiles. In space the major powers have developed a number of ELINT satellites for overall surveillance of the radar and radio frequencies.

There are three basic types of electronic warfare:

a) Electronic Support Measures (ESM)
b) Electronic Counter Measures (ECM)
c) Electronic Counter Counter-measures (ECCM)

ELECTRONIC SUPPORT MEASURES (ESM)

The first ESM task is search and intercept. ESM involve collecting and analyzing electronic emissions. There are two basic types of ESM: Electronic Intelligence (ELINT) and Communication Intelligence (COMINT). ELINT deals with radars (both search and target), jamming and counter-jamming. It is dedicated to the interception and analysis of radar emissions from surveillance, fire control or missiles guidance radars. ELINT plays a vital role particularly in airborne and shipborne application. In that, it provides not only direction finding but also of the incoming signals to provide immediate warning of threat radars, including surveillance, fire control, targeting and missile guidance systems.

COMINT is intended for the interception of communications, whether by voice or datalink.[11] It provides interception, direction finding and analysis of hostile transmission. EW against the communicators is generally more difficult to wage than EW against

radars. Anti-link measures are essentially directed against communication links between the sensors and the information processing system or the information dissemination system and the shooter.

The combination of ELINT and COMINT is known as Signals Intelligence. Analysis of the signal provides much valuable information of the intentions for command and control purposes including the ability to detect and analyse the unusual and complex signals.

Electronic Counter Measures (ECM)

Electronic counter measures (ECM) are the dynamic element of electronic warfare. ECM consists of active countermeasures that involve radiating electromagnetic energy and passive countermeasures. It is intended to disrupt the surveillance system of the enemy, whether by radar or radio communications. ECM is also used to counter any of enemy's weapons that use electromagnetic, infra-red or laser systems for guidance and aiming. There are two main method of achieving this: by jamming and deception. Jamming is the use of transmissions to disrupt the enemy's communications channels or to saturate his radar to obscure its target.[12] The second method of ECM is deception, that measure the laser wavelength and pulse repetition frequency and then set up a similar but more powerful laser that can be used to illuminate the false decoy target, attracting any laser seeking projectile towards the latter.[13] Either chaff in the case of electromagnetic threats or flares against combat infra-red devices.[14] Many modern ECM employ both methods in an integrated system.

ELECTRONIC COUNTER-COUNTER MEASURES (ECCM)

ECCM is a method by which one endevour's to combat the ECM systems of the enemy by either making his equipment ECM-resistant or by using techniques to nullify his jamming and/or decoy systems.[15] The most basic ECCM tactic is emission control

(EMCON) that reduces the radiation of electromagnetic energy that is vulnerable to ESM or ECM. Radio or radar silence is its most intense application.

So, we can say that the next war may be a nuclear war or may be a chemical war, but it will certainly be an electronic war.

INTELLIGENCE BASED WARFARE

Perhaps the most visible part of information warfare as far as the military is concerned is the focus on intelligence-based warfare. The crucial component in the conduct of warfare is the availability of intelligence of data. Advances in satellite technology, reconnaissance and surveillance capabilities, and imagery has made possible to see the other side of the hill. Over the last few decades, information distribution systems have been developed and operationalised to allow the users to receive and transmit data in real time. This has made it possible to integrate sensors, emitters and processors into reconnaissance, surveillance, target acquisition (RSTA) and battle damage assessment (BDA) system.[16]

TRANSPARENCY

IBW is all about conducting warfare in a transparent battlefield environment, while increasing the transparency for oneself, and decreasing it for the enemy. Advances in surveillance and target acquisition technologies, satellites, unarmed air vehicles and various kinds of radars and sensors have made the battlefield transparent. Advanced technological and human intelligence are constantly expanding the commander's detection range, improving the quality of information and disseminate the data to required levels via near real-time digital transfer.[17] Therefore, the battlefield is becoming more transparent aiming to make it more obscure for the enemy.

The fact that technology has made it possible to achieve situational awareness on the battlefield has altered the way in which war will be conducted in the future. The purpose of IWB is to create an asymmetry in the level of transparency or situational awareness in relation to the enemy. Three basic elements go into situational awareness—knowledge of our own position, knowledge of the position of friendly forces, and knowledge of the enemy's position. Till recently, knowing your position and that of the friendly forces was in itself a huge task. Precision position locating technologies such as the navigation based on the Global Positioning System (GPS) has made those problems easier to a large extent. Knowing the position of the enemy has also been made possible to a certain extent through employment of reconnaissance and surveillance technologies.

Therefore, there will be two pillars of IBW: situational awareness and anti-situational awareness measures. Situational awareness measures would rely on reconnaissance, surveillance, and communication technologies. Situational awareness measures would rely on reconnaissance, surveillance, and communication technologies. The aim would be to clear the fog of war through de-fogging operations for one's forces. On the other hand, anti-situational measures would be aimed at the enemy's reconnaissance, surveillance, and communication technologies including actions taken to reduce the visibility of one's forces. Anti-situational measures would create a "relative fog". As technologies for de-fogging continue to improve, creation of a relative fog in which the enemy knows less about you than what you know about him is likely to become critical in future.[18]

PSYCHOLOGICAL WARFARE

A psychological warfare campaign is a war of the mind. Since the target of infowar is the mind, it is natural that psychological warfare is a key method of conducting infowar. Psychological warfare may be defined as the planned use of propaganda and other

actions designed to influence the emotions, opinions, attitudes and behavior of enemy, neutral, and friendly foreign groups in such a way as to support the accomplishment of national aims and objectives.[19] Psychological warfare is the attempt to wrap the opponent's view of reality, to project a false view of things, or to influence his will to engage in hostile activities. It is the use of information against the human mind. This warfare is used to kill the courage of the people of enemy country and changed their opinion through propaganda and rumors. Through this sort of warfare, a country captures the public of enemy country without using weapons. Sun Tzu first talked about this kind of warfare. Clauswitz gave the concept of ideal war to destroy the country through propaganda and rumors.

Psychological warfare can be waged against the military and/or society. Infowar through psychological warfare operations can be used with great effect against the society, especially in a democracy where the opinion of the masses can be shaped by exploitation of the media. When employed against the military, it could be in the form of anti-commander on anti-troop measures. The information media is used to create a sense of depression and hopelessness amongst the military forces when engage in battle or preparing for it. PSYOP can be disseminated by face-to-face communication, audiovisual means (television), audio media (radio or loudspeaker), visual media (leaflets, newspapers, books, magazines and/or posters).

PSYCHOLOGICAL OPERATIONS

Psychological operations may be defined broadly as the planned use of communications and planned operations in peace and war directed to enemy, friendly, and neutral audiences in order to influence their attitudes, behavior, emotions, motives, objective reasoning, behavior and ultimately the behavior of foreign government, organizations, groups, and individuals.

Psychological operations consist of three distinct types: Tactical PSYOP, Strategic PSYOP and Consolidation PSYOP. Tactical PSYOP is addressed to a specific enemy combat group, to induce them to perform a specific action that will affect the current or short-range combat situation. Aimed at a larger audience, Strategic PSYOP is put into effect by a carefully planned campaign against a larger target audience than that toward which Tactical PSYOP is directed. Consolidation PSYOP's mission is to assist the civil and military authorities in consolidating their gains, by establishing and maintaining law and order, and by re-establishing civil government in an occupied or liberated area.[20] All three types of psychological operations, Tactical, Strategic and Consolidation, can be employed to produce the following desired effects: Reduce moral and combat efficiency within the enemy's ranks. Promote mass dissension within and defections from enemy combat units and/or revolutionary cadre. Support our own and allied forces cover and deception operations. Promote cooperation, unity and morale within one's own and allied units, as well as within resistance forces behind enemy lines.

It is a weapon whose effectiveness is limited only by the skill of the commander using it. Psychological Operations (PSYOP) or Psychological Warfare (PSYWAR) is simply learning everything about your target enemy, their beliefs, likes, dislikes, strengths, weaknesses, and vulnerabilities. Once you know what motivates your target, you are ready to begin psychological operations.

THE MEDIA AS PSYCHO-WEAPON

The attempt to influence human mind in the conflict is not a new technique. The means for conducting psychological warfare and to achieve this end have been newspapers, radio and television broadcasts, and distribution of leaflets and more recently is the Internet. The information warfare, with live reports from the battlefield,

has transformed warfare. The live portrayal of conflicts has intensified hatred around the world to the death and destruction of war, which adversary state can exploit. A key to successful information warfare deterrence policy is a state must engage in media wars by transmitting its own messages, specifically early in a crisis.[21] Satellite television is a prominent technology for psychological war techniques. The emerging Direct-to-Home (DTH) television broadcasting is likely to alter the manner of conducting the information war. DTH will allow far greater number of channels permitting customization of news, both for the broadcaster and the viewer.[22] This is already available through the Internet where a user can request customized news to be delivered to his desktop computer. Customization of news has an important implication for practitioners of psychological warfare. Discussion groups on the Internet either through chat sessions, electronic conferences, e-mail exchanges have permitted specialized targeting of minds.

Infowar through psychological warfare operations can be used with great effect against the society, especially in a democracy where the opinion of the masses can be shaped by exploitation of the media. Democracies, by their very nature, are acutely sensitive to public opinion. American troops left Somalia after the loss of just nineteen American Rangers in a conflict with the forces of Somali leader Mohammed Aideed. That conflict reportedly cost Aideed about fifteen times that number, roughly a third of his forces. And yet it was the Americans who conceded defeat. Because of the photos of jeering Somalis dragging corpses of U.S. soldiers through the streets of Mogadishu transmitted by CNN. In result, the U.S. forces left Somalia, and Aideed, in essence, won the information war.[23]

INFO-ECONOMIC WARFARE

Information warfare is an integral element of the new economic and political world order. The possession of digital infrastructure is one of the key determinants of military power and economic strength today. Economic battles are being fought and will continue to be fought. In the " Death of Money", Joel Kurtzman says, " economic success in today's world, especially in the financial sector but increasingly in the other sectors as well, is dependent on assimilating large quantities of information very rapidly".[24] Info-economic warfare is one state's assault on another's economy through information or trade of information. This kind of information warfare consists of attacks on cooperate organisations, which can be waged by an individual, a group of hacker, or by one corporate organisation against another one.[25] This is a sophisticated form of industrial espionage carried out by electronic means. Manipulating the banks and stock markets to ruin a country's economy through organised hacking operations by another country would shift information warfare to a strategic level in the form of info-economic warfare. U.S. Senator David Boren during his speech delivering to national pres club on April 3, 1990, admitted that, " An increasing share of espionage directed against the United States come from spying by foreign governments against private American companies aimed at stealing commercial secrets to gain a national competitive advantage".[26]

Info-economic warfare could also be employed to create an information blockade as an instrument of state policy or denial and exploitation of the trade of information.[27] Nations would try to cripple the economies of other hostile nations by cutting off access to external data or exporting data service thus removing the benefits of information exchange. Information blockade would interrupt real-time interactions and restrict access to a large information flows. With the less opportunity for physical confrontation,

the probabilities of violence is less.[28] Info-economic warfare is about money. It is about the acquisition of wealth, and the denial of wealth of the competitors. Info-economic is about power. He who control power control wealth.[29]

CYBERWAR

Cyber warfare is based on "non-kinetic, offensive actions taken to achieve information superiority by affecting enemy information-based processes, information and computer –based networks." The methods used would include 'computer network attacks, transmitting computer viruses and other significant destructive hacking".[30] It essentially involves organized cracking of other people's systems, to spy, to deceive and alter, or to deny services. It means disrupting the enemy's information and communication systems while maintaining a relative balance of information of one's own side. It also involves diverse technologies that enhance command, Control, and Communication (C^3I) particularly regarding intelligence collection, processing and distribution.[31] It also enhances tactical communications, positioning, identification-friend-or-foe (IFF), and the delivery of smart weapon systems. It may also involve electronically jamming, blinding deceiving or overloading an enemy's information and communications systems.[32] It minimizes capital and labour expenditure. The notion of cyberwar has crucial implications for military organization and doctrine. It may require modifications in the structure of centralized hierarchies as well as institutional redesign in the case of many forces.[33] It would provide centrally located commanders an enhanced information of and from the theatre of operations. Cyberwar would also require the development of new military doctrines to manage the flow of information.

Cyber war may be divided into two categories: hard kill and soft kill.

HARD KILL

It would involve the physical destruction or tempering of enemy's information systems like mainframes, severs, up-linking stations, communication nodes etc

SOFT KILL

It may involve pest programs or unauthorized access known as hacking. It may be carried out against military forces that use computer networks or even stand-alone, non-networked computers.

PEST PROGRAMS

These software programs involve various techniques of inserting codes that have damaging effects. There are many types of pest programs:

VIRUSES

These are the computer programs, which have the ability to attach themselves to legitimate files and then propagate from computer to computer as file or floppies are exchanged. These may result in:

- File disappearance.
- Reduction of disk space or memory
- Disruption of the system.
- Slower program loading, running or disk access.
- Change in size of files.
- Malicious display, etc. [34]

WORMS

These are software program, but unlike virus these can be executed remotely. They usually spread in networked environments only. The worm can propagate itself at an exponential, thus slowing down internet sites and stop the communication.[35]

TROJAN HORSES

This program is design to do thing that the user did not intend. It remains inactive and tricks the user to activate it with a certain command. It could result in:

- Disabling of hardware.
- Capturing and steeling data.
- Corruption of operating software.
- Total destruction of the network or operating system. Trojans can replicate and spread across networks.[36]

LOGIC BOMBS

It is a program that embeds itself in an executable file to lie dormant until a specific event i.e., a date triggers it, upon which it becomes active. It can spread havoc if combined with a virus.[37]

UNAUTHORIZED ACCESS

Interconnected communication and computer systems are vulnerable to intrusion. Once a system has been hacked, the intruder may do any of the following, information gathering, alteration, mutilation, deletion, and subversion.

The processes involved in gaining unauthorized access could be:

- **Initial access.** The hackers scan the target system for open ports, which may be exploited. Open ports are programs within an operating system that allow exchange of files, e-mails etc., between computers or networks.

- **Login Options.** Then the look for certain user-defined or system-enabled login options.

- **Password Access.** Through the login or open port, they access password files and run password-cracking programs to obtain user login passwords.

- **Root Access.** If the hacker obtains root access i.e., access to the operating system, it gives them total control over the functioning of the system. So they may delete, modify, subvert, mutilate, steel information or use the system to hack into the other system, without leaving a sign of their identity.[38]

COMPUTER HACKING

Computer hacking or breaking into computer networks is a part of information warfare. It has evolved from a stage where hacking or breaking into computer networks was the pastime of computer hobbyists. Computer hacking refers to the employment of techniques (bad software), to destroy, degrade, exploit and compromised information

systems, both military and civilian. One of the prime weapons of the hacker war is the use of computer virus by insertion through a telephone line. All that is required to neutralize or degrade a sophisticated military computer network is another computer and a telephone line with sufficient knowledge and determination. The means to disrupt or destroy digital equipment are relatively inexpensive, easily smuggled from place to place, can be used from a distance. In short, hacking can be the perfect terrorist weapon. Hacker war could be conducted by intelligence agencies, some of which insert microbes into the computer systems of potential adversaries, which eat the electronic systems in order to degrade the computer system for a prolonged time period.[39] According to Pentagon experts that the military computers in the U.S. are probed 500 times a day of which only 25 are detected and 2-3 reported to security officials.[40] However, in hacking warfare, not all attacks are directed against the military's command and control system. Despite these alarming statistics, the real threat is in the civil field, where concepts of computer security are much lower. Databases stored on computer networks that are not directly related to command and control systems and a large number of computer networks that are involved in routine tasks of administration could easily be the target of hacking. Hacker war may be operating independently, without the sanction of the states. These computer hackers could act individually or on behalf of non-state actors, or even sponsored by a state.[41]

In April 2001, the Russian newspaper ***Moskovsky Komsomolets*** reported that the US embassy in Moscow had attempted to recruit a Russian hacker, known as 'Verse', to secretly collaborate in the interests of American intelligence services against the Russian federation. Verse was instructed to hack into the FSB central servers to create programs to conduct electronic surveillance, while also selecting hackers to help him in his task of finding and coping databases that would interest the USA and destroying others.[42]

During the Gulf War, according to Pentagon officials, a group of Dutch hackers offered to disrupt the U.S. military's deployment to the Middle East for $1 million. Saddam Hussein rejected the offer. According to Pentagon officials, the potential for disruption was great. Douglas Waller, a Pentagon official, "In the Gulf War the military made extensive use of the Internet for its communications, and it would have suffered if the Iraqis decided to take it out.[43] The fact that unlike conventional armed conflict, this form of warfare could be conducted at any time without physical proximity or destruction may even lead to a reassessment of the definition of war.

As Desert Strom demonstrated the futility of fighting with an old-fashion military against a cutting-edge one, future opponents are unlikely to repeat Iraqi mistake and they are likely to take refuge in a different kind of warfare. In pre-Internet times, the conduct of acts of hostility was difficult to plan, expensive to fund and the responsible party was difficult to trace. In this Information Age, anyone with a computer and Internet access, with little expense and knowledge, and little planning, could potentially wreak havoc, without leaving any trace. It is interesting to note that as the art of warfare has advanced technologically, the rules of warfare have also changed to include the technological advances.

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CHAPTER 3
THE ORIGINS OF THE RMA

History gives a sense of the trajectory of the war's evolution.[1] The reflection of past of anything, clear its picture of present and future. Without the help and support of past military capabilities and concepts- particularly the recent past no revolution can take a leap into the future. And without a realistic understanding of the past, no military organisation can make developments in creating successful RMAs. So, in order to fully understand the gradual transformation in the conduct of warfare and in the nature of military weaponry, caused by information-based revolutionary technologies, envisaged in the Gulf War, it is essential to trace the evolution of the RMA.

HISTORICAL OVERVIEW OF PAST MILITARY REVOLUTIONS

Through out history, nations have always pursued innovations to increase relative military effectiveness. Militaries that have lost a war or have perceived themselves to be in a position of weakness have been most open to creativity.[2] It is the acceleration of evolutionary technological change combined with operation and organizational transformation that altered the character of war over the last 200 years. Military historians have suggested that there was not one military revolution but a series that started from the Middle Ages to the present day. These revolutions may have begun as early as the 14th century and continued with increasing frequency till today.

In their book "War and Anti War" Heidi and Alvin Toffler divided human history into three distinct phases: "First Wave" based on agrarian society; "Second Wave" based on industrial society; and Third Wave" based on information-based high-tech society. This wave theory linked the way we make wealth to the way we make

war.[3] The wave theory is helpful tool for moving towards an understanding of future war.

AGRARIAN AGE

The First Wave of change in human history is launched by agriculture revolution that brought gradual changes leading to the formation of the earlier premodern societies. War was one of the most important among those social and political changes and innovations that emerged from agriculture revolution. During that phase, most technology was driven primarily by energy from the muscles and agriculture and economic surplus became the precondition for warfare among communities. During this period, the war form was feudal in nature and technological change had little impact on how wars were fought and for thousands of years, the basic mode of warfare involved face-to-face killing and pikes, swords, lances, axes, battering rams-dependent on human muscles power were the basic war-fighting tools for soldiers which were designed for close combat. Due to lack of resources, large standing armies were not feasible and there are variations in the size, capability, morale, training and the quality of leadership among military units. Based on primitive agrarian economy, communications were also outdated and orders were delivered mostly orally rather than in written form.

The 17th century laid the bases for the modern state and the nation-state became the predominant form of government in Europe. This nation-state revolution created military organizations that imposed the laws and these organizations were more effective on both the battlefield and in the conduct of civil affairs because they were responsive to the orders of the state bureaucracy.[4] This revolution also influenced the warfighting tools and European armies were equipped with firearms. However, firepower during this period (running generally from the late seventeenth to mid-nineteenth centuries) were quite primitive and suffered from short effective ranges, slow

rates of fire, unreliable ignition, and an inability to fire effective exploding projectiles.[5] This first wave agrarian age lasted for almost 8,000 years till the arrival of industrial age.

THE NAPOLEONIC REVOLUTION

The French Revolution has also deep bearing on military revolutions. The Napoleonic Revolution took place when the French were able to standardize and improve their artillery, greatly increase the size of their armies and greatly improve the organization and command of their military formations.[6] During the Napoleonic era, warfare was transformed by the harnessing of a number of technical, tactical and organizational innovations including mobile field artillery deployed in close support of the infantry; mixed system of skirmishers, march and attack columns and linear formation, to nationalist social forces through the *'levee en masse'*, after the foreign invasion.[7] The French Revolution mobilized the economic, scientific and popular resources. L*evee en masse*, placed citizens and their goods at the disposal of the state. The result was that the French tripled their army, though less effective, in less than a year. Though France finally lost the battle, but its revolutionary pattern was followed in American Civil War and later in the two World Wars.[8]

After the defeat of Napoleon in 1815, a revolutionary transformation occurred in the nature of warfare. This transformation was created and sustained by many forces like technological, political, economic, and social, in which technological one was the most profound and dramatic. The weaponry of this revolution was the product of machines, which themselves the creation of a revolution in mechanics and engineering. By the end of the Napoleon Wars, the combination of flintlock and bayonet, supported by smoothbore and muzzle-loading cannon, was the dominant weapon of battlefield.[9]

THE INDUSTRIAL AGE

Parallel with French Revolution, Industrial Revolution, was gradually taking place that brought with it a "Second Wave" of historical change. The second-wave warfare resulted from a combination of the Industrial Revolution and technologically matured firearms. The industrial age changed not only the nature of economy but also the whole approach to war.

RAILWAYS

In the middle of the nineteenth century, railways emerged as a new logistical weapon and armies quickly took its advantage for transporting men and equipments rapidly. It made generals able to transfer armies from one theater to another in weeks. Furthermore, at the beginning of the war, the railways, in conjunction with mass army, made mobilization a critical element in the efficiency of a military organisation.[10]

VOLUME OF FIRE AND EXTENSION OF RANGE

This machine age gave birth to mechanized warfare and to entirely a new firepower, which led to new kind of tactics. The most dramatic changes in war came from new standardized weaponry that was now produced by mass production methods. The introduction of rifling in the 19th century extended the range and accuracy of individual weapons and artillery guns. Now the artillery was able to fire shells upon enemies beyond ranges. The principle of progressive combustion of gunpowder was discovered in 1860. This discovery resulted in improvements in the ordinary black powder which continued to be the basic propellant for small arms throughout the remainder of the century.[11] It had an important consequence in the development of rifled artillery as it made it possible for the guns of any caliber to fire a heavier projectile than before. As a result, by lengthening the bore, muzzle velocity had increased to almost 3,000 feet per second as well as ranges also increased, by the end of the century.[12]

The introduction of rifle musket and cylindro-conoidal bullets in the decade between 1850-1860 was more revolutionary in nature which finally replaced the inaccurate, short-ranged smoothbore musket, which was much more difficult to load, by the highly accurate, much longer ranged rifle.[13] That rifle soon became the basic infantry weapon.

An American, Hiram Maxim in 1884, invented the first automatic gun with heavy volume of fire. The rate of fire was 600 bullets per minute. Gatling machine gun was invented by Richard Gatling. Two Gatling guns were enough to replace an entire infantry regiment, thus reducing overall cost.[14]

The introduction of percussion cap in 19th century was another important contribution to weaponry, which brought about significant changes in the infantry musket and eliminated most of the uncertainties of firing. It reduced the misfires to fewer than one in two hundred rounds.[15] Late in the 19th century, the new explosives TNT, tetryl, picric acid, PETN, and cyclonite were introduced. These explosives contributed a lot to increase the lethality of weapons. During the period of industrialization, the effective ranges of small arms had been tripled and their rates of fire had been increased by tenfold. These new weapons could now be built in great numbers and at a low cost This machine age gave birth to the machine gun. Machine gun wrecked havoc in World War I with its heavy volume. Massed artillery fires destroyed the enemy defense and assets. This trend to increase the firepower with improved effectiveness continued after World War II too. Improved effectiveness of munitions, heavier calibers of guns, and increased rates of fire changed the shape of battle and battlespace.

As the range of weapon extended and their lethality improved, individual and units became more dispersed, and increased lethality and dispersion had direct effects on

organization, tactics, doctrine equipment, and method of command and control.[16] In turn, these changes had effects on training, soldiers and leaders.

TELEGRAPH AND COMMUNICATION

Throughout the history, electronic devices have also been used for military purpose in order to increase the lethality of weapons. The earlier use of electronic devices was to send orders, information and firing data from one place to the other. The telegraph was probably the first electronic device, which brought into commercial use in 1830, simultaneously in America and Europe. Militarily, telegraph was first used in the Crimean war. Submarine cables came into use in 1851 and Trans-Atlantic cables were functioning by 1866.[17] Telegraph helped general staffs coordinate rapid mobilization and launch large military movements.

The first usable version of telephone was introduced in 1876 and radio was introduced in 1908. Radio and telephone were more efficient than telegraph in military performance. In contrast to telegraph and telephone, radio was developed largely for military use. It solved a need for open-sea communication. Radio could be used to transmit telegraphic, telephonic, or more complicated types of signals.

The industrial age changed not only the nature of economy but also the whole approach to war. The industrial age had a different and dominant method of conducting war and industrial age armies were fundamentally different from agrarian age military units. During this period, war became progressively industrialized and war itself accelerated the process of industrialization. One of the most important trends in military strategy between 18th and 20th centuries was the broadening of its focus. In the 18th century, a state needed only to destroy the enemy's field army or in some cases, seize control of key forts or territory. With the emergence of "total war" in the 20th century, an enemy's

entire society, infrastructure manufacturing base and raw materials became the target of military operations. Industrial age was the age of mass production, mass education, mass communication, mass consumption, mass entertainment, weapon of mass destruction and mass armies.[18] As an army could not achieve these expanded objectives in one decisive battle, a sequence of battles, engagements and major operations conducted over time. To conduct these kinds of campaigns, whether offensive or defensive, required large, dispersed armies. So the large and extended armies become the dominant feature of this age. As forces grew in size, armies groups emerged. The commanders of these armies needed different set of skills than their predecessors.

The industrial transformation of war not only influenced the technology and standardized the weaponry but also affected the military training, doctrine, organization and shape of armies. During this period, the military became a profession and specialization and staff system evolved. A military education system emerged in industrial nations in order to ensure conceptual, technical and organizational skills and temporary armies were replaced by standing armies, which were led by professional officers trained in war academies.

WORLD WAR I

Of all the military revolutions, World War I should be regarded as the most revolutionary in military terms. It involved combined arms, exploitation tactics, strategic bombing, unrestricted submarine warfare, carrier operations, and amphibious war.[19]

In addition to these improvements in weapons, there were three significant new weapons introduced in the World War I. These were aircraft, poison gas, and tank. Development of these weapons, tanks and infantry combat vehicles, provided the forces with mobility,

protection, survivability and increased firepower. They had the ability to move through a battlefield and changed the defenses as well as the face of war.

THE ORIGINS OF AIR COMBAT

Aerial attack and delivering troops or projectiles over the enemy had always been a dream of man since the invention of organized warfare. The first flight of hot air balloon took place in 1782. The hot air balloon was first militarily used in the French revolution war in 1794. These balloons were also used in American civil war though without much success.

In 1903, this invent took a better form and the first aircraft invented for the purpose of communication, observation and reconnaissance. By the World War 1, the airplane was developed into a weapon of combat. It turned into a fighter plane with machine gun that could be fired by pilot or gunners. The combined fighter-bomber developed in 1917 by the chief of the British Royal Flying Corps. This fighter plane could carry up to four light explosives (25 pound) for ground support purposes either by using it machine gun or by dropping its light bombs.[20]

Aircraft had a more significant effect on the conduct of World War 1 military operations. They had also become useful for artillery observation and for long-range bombardment. In this war, Aircraft played a decisive role in the land battle by providing close support to troops on the ground.

Rifles and machine guns including .30-caliber and .50-caliber machine guns were the first antiaircraft weapons against fighters used in the World War 1. However, these weapons did not proved much effective against the aircraft. Some light cannon with high explosive shells were also employed against aircraft. Again, these proved ineffective.

By the end of the World War I, there were three separate types of military aircraft: the observation plane, the fighter, and heavy bomber with multiengine. Most of the aircraft were biplanes and triplanes and there were also few monoplanes.[21]

NAVAL REVOLUTION

The industrial revolution left a deep impact on naval way of warfare too. During the last half of eighteenth century, the political and economic consequences of British naval supremacy, made the importance of sea power clear to all European nations. So they took great interest in developing naval technology in order to gain military advantages and maintain supremacy. By the end of the eighteenth century, as a result, battleship had been introduced and steam power had become critical component of navies. The first great impact of industrial revolution on the naval warfare was in the area of heavy naval ordnance rather than in the area of ship construction.[22] One of the most revolutionary innovation was the build-up gun with the combination of rifling. As these huge guns with great power could not be easily handled on land, wooden ships were changed into heavy armored vessels due to the advances in metallurgy and heavy machinery so that could carry huge guns. In less than a century, navies made a transition from propulsion by wind and sail, through propulsion by steam produced by coal, and steam produced by oil, to steam produced by nuclear fission.[23] During 20th century, naval technological revolutions brought more sweeping and remarkable changes in the conduct of naval warfare that were more profound than that of the changes, occurred in the three previous centuries.

SUBMARINES AND AIRCRAFT CARRIER

By the First World War, the submarine had been developed as the most important single type of naval warship and soon became a major component of sea power during the World War I (1914-18) as commerce destroyers by Germany. One of the most

important influence on the character of naval warfare and modern battle fleets was the development of airplane. It rendered large surface vessels obsolete. Nevertheless, naval strategists soon developed the ways to destroy the airplanes. Aircraft carrier developed by World War II, which sent aircraft roaming far ahead to attack enemy ships, and rendered ship-for-ship engagements of large ship formations obsolete.[24] Carrier-based aircraft were not only the supporters of surface naval forces, but they soon became the primary naval striking elements and carrier soon reduced the role of battleship as the capital ship of the fleet.

The changes in technology and organization, which had taken place by the end of World War I, set the stage for the Revolutions in Mechanization, Aviation and Information, which took place in the interwar period.

SECOND WORLD WAR

The Second World War was a period of sudden change in the military arts and sciences.[25] The revolutions of interwar period led to the great military innovations of World War II: Blitzkrieg by the German Army, carrier aviation by Japan and the United States, amphibious warfare by the United States, and strategic bombing by Great Britain and the United States. All of the elements of the later revolution -- motor vehicles and tanks, airplanes and radios -- were present in World War I. It was the combination of their technical advancement in the 1920s and 1930s, along with new doctrine and organizations that created revolutions.

RADARS

Radar, introduced in 1938-39, was a by-product of radio and also entirely a military requirement and development. It had no civilian application until after World War II. It transmitted high-frequency signals that were bounced off distant objects, then, using strongly directional antennas to pick up the signal as they returned.[26] In 1940, first

Magnetron-equipped higher frequency airborne radars were also developed, and radar was applied to offense as well defense. Radars were also used by the British army to help direct searchlights and antiaircraft guns.

NAVAL AIR POWER

World War II also saw a transformation of war at sea. With the advent of naval air power, fleets could now launch attacks at one another from distances of hundreds of miles. The effectiveness of bombers and torpedo aircraft against surface warships was so profound from the outset of the war that it soon became evident that air superiority also automatically included surface superiority. Carrier-based aircraft were not only the supporters of surface naval forces, but they soon became the primary naval striking elements and aircraft carrier developed by World War 11 quickly reduced the role of battleship as the capital ship of the fleet.[27] Naval radars and sonar were developed early in the Second World War and played a decisive role in the war at sea. Together with other electronic communication innovations, they contributed in a vast and delicate refinement in command and control.[28]

AIR COMBAT

The speed, range and load-carrying capacity of aircraft were remarkably improved between the First and Second World War, due to the Technological advances in propulsion and aircraft frames. During this period, there emerged prototypes of modern high-speed fighter planes and both short and long-range bombers and they proved to be highly effective weapons.

Britain and Germany developed low-wing, single-engine, monoplane fighter and Me-109 respectively. These planes were armed with six or eight wing-mounted machine guns and could be able to carry light bombs.[29] They could fly at speeds between 350 and 400 miles per hours.

The two-engine, low-wing bombers also appeared during this period. They had increased range, greater speed and large cargo capacity. They could deliver a significantly more lethal load at ranges up to 300 miles.

In 1935, the U.S. produced the first modern four-engine, long-range strategic bomber B-17. B-17 which played a major role in the defeat of Germany and Japan in the World War 11.

In 1939, the Britain improved and perfected the performance of fighter based on the revolutionary development of radar. Radar made possible highly efficient use of the fighter interceptor with improved radio communications and control centers.[30] Most of them were equipped with Very High Frequency (VHF) radios. These new systems increased effectiveness of the Royal Air Force (RAF) fighters and contributed a lot in the victory of Britain in the World War 11.

The subsonic pulse-jet German V-1 was first used in 1944, but it was not much accurate and easily detected and shot down by aircraft and antiaircraft weapons. The larger supersonic V-2 was the first ballistic missile used in the World War 11. It could carry a half-ton high explosive warhead to a range of up to 200 miles. Its weight was about eight tons at the time of take off. V-1 and V-2 both were driven by solid propellant.

The rockets were first used tactically in ground and naval warfare in World War 11. They were much smaller in size than V-1 and V-2 and they were also solid fueled.

Antiaircraft artillery was greatly improved between the two World Wars. By the outbreak of World War 11, significant developments were made in the field of electronics and sophisticating electronic devices were available that permitted accurate

tracking of aircrafts, predicting flight paths, and calculating range, altitude and time of flight.[31]

The lethality of antiaircraft artillery was greatly increased by the development of VT fuse and radar tracking devices and by improvements in electronic equipments including large target seeking rockets and electronically guided missiles.[32]

NUCLEAR WEAPONS

Finally, the introduction of nuclear weapons at the end of World War11 in 1945 along with ballistic missiles and intercontinental bombers changed everything. The first atomic bomb, with a yield of 14,000 tons of TNT, was exploded over Hiroshima in 1945. It was thousand times powerful than any other previous weapon.[33] Nuclear weapons and the evolution of the wireless into modern electronics together with aeronautics and nuclear submarines revolutionized the conduct of warfare and it was perhaps the most striking development in military history that marked the most profound revolution in military affairs to date.[34]

Industrial age reached its peak in the post world war 11 period. In the post World War 11 nuclear era warfare, command and control were highly decentralized as compare to the highly centralized command system in the early second wave. However, nuclear age warfighting methods alone were not enough to ensure unlimited victory, therefore, by the late 1970s and early 1980s, Third Wave technologies, forces, ideas and social forms began to challenge Second Wave mass society.

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CHAPTER 4

EMERGING TECHNOLOGIES

In 1970s, a variety of socio-military forces eventually changed the industrialized total war into knowledge-intensive warfare therefore, most of the core technologies associated with the contemporary RMA could be listed by the early 1970s which involves the increasing use of microelectronics, precision munitions, stealth technology, near real-time sensing capabilities and more advanced C^4I (command, control, communications, computer and intelligence.[1] All these changes generated huge and enormous improvements in 'visibility' (the ability to grasp the battlefield), 'lethality' (the ability to destroy or incapacitate the enemy on the battlefield), and 'agility' (the ability to respond to developments on the battlefield) of weapons systems in the battlefield.[2] Alvin and Heidi Toffler in their book " War and Anti-War" contend that " if nothing else, this fact alone justify the term revolution in military affairs that range, speed and lethality all reach their outer limits in the present half of the century".[3] Now weapons can be delivered with unprecedented precision. Surveillance and reconnaissance systems can provide remarkably detailed information about the structure of hostile force and locations. This information can be rapidly exploited by a combination of data analysis and distribution systems. This transformation in the nature of warfare and weapon technology has occurred gradually. We can say that technology has shifted the valuation of weapon system. In the past, the valuation was based on the ratio of cost to destructiveness. Now accuracy and increasingly decision making capability is equally important.

A NEW ERA OF WARFARE

After the World War 11, all the major powers (particularly Soviet Union and the United States) invested heavily in research and development in order to maintain a technological edge over their adversaries in the hot atmosphere of cold war. It is therefore, military technology grew faster during this period. In 1953, the United States acquired the technology of hydrogen bomb and in 1961, the USSR exploded a device with an estimated yield of 53 million tons of TNT, that was equivalent to over 4,000 Hiroshima type bombs.[4] These weapons are still very cheaper than conventional second and third-generation armies. Their use or even the threat of their use could render the employment of conventional armies very difficult if not impossible.[5]

LAND WARFARE

A number of exciting developments are taking place since 1980s, which have profoundly affected the conduct of major land warfare as well as connected with the operational and doctrinal developments. Vastly improved mobile ordnance, fast tanks i.e., (Tankita, the M1A3 tank, M-1a1 Abrams), tank destroyers, and other cross-country vehicles have increased the capability of mobile warfare.

ARTILLERY

LAND-BASED MULTIPLE LAUNCH ROCKET SYSTEMS (MLRS)

ATACM ROCKET

Weight: 55,420 lbs
Length of rocket: 13 feet
Range: 20-28 miles
Propulsion: Solid
M77 Rocket
Length: 155 inches
Weight: 675 lbs
Range: 32 km
Warhead: Bomblets

Anti-tank mines
Radar guided munitions

The MLRS is a tracked vehicle containing twelve missiles designed to deliver a large quantity of munitions into an area in a short time. The primary mission is the suppression of enemy air defenses and counter-fire against fixed targets. It fires an M77 rocket in a six- round pod. The rocket warhead contains 644 grenades for lightly armored systems and personnel.[6] One MLRS M77 rocket can dispense its grenades over four to five acres. If the launcher fires all of its 12 rockets, the target area coverage would be 30 acres. It can also fire the Army Tactical Missile System (ATACMS) that is used as a deep strike against soft, stationary and semi-fixed targets.

There are many other areas of land warfare like tanks, extended range artillery, lighter armoured vehicles, guided and unguided anti-tank weapons, small arms etc., where considerable improvements are being made.

M-16 RIFLE CALIBER

Size: 5.56mm
Weight: 7 lbs
Range: 450 yards
Type of Fire: Semi-automatic, three round bursts
Magazine Capacity: 30 rounds
Attachments: Bayonet (M7)
Grenade Launcher (M203)

The M-16A2 was developed for the use during the Vietnam War. It is now the primary combat rifle with the U.S. military and many of our allies around the world. It was extensively used during operation Desert Strom.[7]

ARMOUR

Tanks

M-1 Abrams
Length: 32 feet, 3 inches
Width: 12 feet
Height: 8 feet
Weight: 120,250 lbs (combat loaded)

Top Speed: 41 mph
Cross Country Speed: 30 mph
Range: 279 miles cruising
289 miles cruising (no NBC protection)
Operational Range: 127 miles (NBC protection on)
Crew: 4
Main Gun: M256 120 mm smooth bore cannon
Ammunition: M829/A1 Armor Piercing Fin Stabilized Sabot (SABOT)
M830 High Explosive Anti-Tank Multi-Purpose (HEAT)
Other Weapons: One (1) M2 .50 Cal machine-gun
Two (2) M240 7.62 mm machine-guns
Power: 1,500hp gas turbine
4 speed automatic transmission

Designed in the 1970's, the first M-1's were delivered in 1980. The more modern M1A1 includes a nuclear, biological, chemical (NBC) cooling system to allow the tank to operate in a chemical warfare situation. It is also equipped with night vision, automatic fire suppression systems and, in some cases, reactive armor to defeat armor-piercing weapons.[8] The M-1 mounts an M68E1 105 millimeter main gun. Two 7.62mm M240 machine guns are also mounted, one with the main gun, and one on top of the turret at the loader's station. A .50 caliber Browning M2 HB machine gun is mounted at the commander's station for anti-aircraft defense.

ARMOUR VEHICLES

BRADLEY FIGHTING VEHICLE

Weight: 50,00 lbs
60,00 lbs with add-on armor tiles
Length: 21 feet, 6 inches
Height: 9 feet, 9 inches
Width: 10 feet, 6 inches
Main Armament: M242 25mm Cannon
Other Weapons: TOW anti-tank missile
M240C 7.62 Coaxial machine-gun
Crew: M2: 9 man Infantry Squad (three are crew)
M3: 5 man Scout Section (three are crew)
Power: 500hp Diesel
Cruising Range: 300miles
Max Speed: 41 mph
Operational Speed: 30-35 mph

In 1981, the first Bradley came into service in U.S Army and the Army continues to procure this vehicle to supplement the M113 Armored Personnel Carrier. The Bradley disembarks troops by lowering a door in the rear and protects them with a wide variety of armaments.[9]

The M2 Bradley is called the Infantry Fighting Vehicle, carrying a nine-man squad (three are crew) and the M3 is the Cavalry Fighting Vehicle, carrying a five-man scout section (three are crew).

PRECISION GUIDED MUNITIONS

The increased accuracy obtained from new and refined guidance techniques, is perhaps among the most striking developments in military weapon technology. Though efforts to develop practical precision-guided weapons have been continued since the First World War, but such weapons did appear in the Second World War, in rudimentary but significant form. During the past three decades, an entire new class of weapons has emerged, and a potent new family of precision guided munitions (PGMs) has come to the fore. The term "precision guided munitions" is used to describe a growing class of bombs, missiles including long-range cruise missiles and artillery projectiles with single-shot kill probabilities from ten to a hundred times greater than unguided missiles.[10] This increase in accuracy is made possible by numerous guidance technologies that can reduce the circular error probability (CEP) of delivery vehicles to 20 miters or less. These weapons are based on computer imbedded-systems, conventional explosives, and real-time designation of targets replaced the gyroscopes, nuclear payloads, and self-contained guidance of ICBMs.[11] PGM is designed to destroy surface fixed targets as well as mobile and moving military targets, including armor, air defense, and shipping. These weapons can be aimed and directed against a single target, relying on external guidance or its own guidance system.[12]

The precision weapons can be launched from aircraft, ships, submarines, and land vehicles, or even by individual soldiers on the ground. Uniquely, PGM can be delivered by both small and medium fighters planes including Mirage 2000 and F-16. It is also compatible with smaller fighters such as the F5, Hawk, cruise missiles, and artillery. So we say that the PGM family is one of the most flexible, versatile and interchangeable smart weapons available today. PGM reduces the strike timeline and increases the effectiveness of weapons in terms of range, target discrimination, and lethality. Such systems could provide conventional forces the ability to rapidly destroy an opponent's critical military targets at minimal cost and with little collateral damage.

JOINT DIRECT ATTACK MUNITIONS (JDAMS)

Joint Direct Attack Munition (JDAM) is an Inertial Navigation System (INS)/GPS guidance tail kit that converts dumb bombs into accurate adverse-weather capable weapons. These new weapons are all autonomously guided and have adverse weather capability. JDAMs are designed to hit targets with pinpoint accuracy. During the operation Desert Strom, JDAMs, guided not by their platforms but by the Global Positioning System (GPS), during the air bombing campaign.[13]

LASER GUIDED BOMBS [LGBS]

INTRODUCTION

Guided bomb technology appeared in World War II, the Germans in particular made many advances in this area of research. They successfully deployed two different guided bomb systems, the Fritz-X and the Hs 293.[14] Laser guided bomb technology was developed during the Vietnam War and LGBs remain the most numerous precision guided munitions. LGB's demonstrated accuracies are estimated at between three and eight meters.

Laser Guided Bombs (LGB)
GBU-10 Paveway II 2000lb
GBU-12 Paveway II 500lb
GBU-16 Paveway II 1000lb
GBU-24 Paveway III 2000lb
GBU-27 HAVE VOID
GBU-28 "Bunker Buster" 'Deep Throat'

GBU-10 PAVEWAY II

The Paveway II series of Laser Guided Bombs (LGBs) are based on the MK-82 & MK-84 GP bombs. LGB is capable of operating in cloud ceilings down to 2,500 feet.[15] The GBU-10 weighs about 2,081 lbs. The Paveway II bombs can be carried by the F-16, F-15E, and F-111 fighter aircraft.

GBU-16

The Guided Bomb Unit-12 (GBU-16) utilizes a MK-83 1,000-pound general-purpose warhead. The operator illuminates a target with a laser designator and then the munition guides to a spot of laser energy reflected from the target.[16]

GBU-24 PAVEWAY III

The GBU-24 is a third generation laser guided bomb, called the Paveway III, and contains a penetrating warhead. The Paveway III, bomb is effective against high-value targets. It can be employed from various altitudes to include low, medium, and high altitude operations. The Paveway III is employed by the F-111, F-15E, and F-16. The GBU-24s performance was proved successfully during the Gulf War, and it remains in production. The Paveway III uses semi-active laser homing to guide to its target, and the entire bomb weighs about 2,350 pounds and is approximately 14 feet long.[17]

GBU-27

The GBU-27 was developed especially for the F-117 Stealth fighter's unique requirements. It is an adapted Paveway III (GBU-24) with additional guidance features necessary to meet the F-117 strict mission requirements. Like the GBU-24, it uses a

semiactive laser for terminal homing, and weighs 2,170 pounds and is approximately 13 feet in length.[18]

(GBU-28) 'BUNKER BUSTER' 'DEEP THROAT'

It was developed in minimal time under USAF's rapid response program. It is primarily used as a deep penetration weapon against buried and hardened command and control facilities. It is employed by F-111s and F-15E.[19]

WARFARE IN THE AIR

Nuclear age brought important developments in all areas of the air power, both missiles and manned and unmanned aircraft. At the same time, technological advances in optics have increased altitude for reconnaissance and range, speed and climb of aircraft have also increased.

Jet engines have improved considerably and becoming more efficient, powerful and reliable, over the past several decades. For example, between the development of F-15 and the F-22 aircrafts, engine technology improved so much that F-22 fighter has twice the power of F-15, in the period of roughly two decade. New aircraft materials include titanium and a number of composites, have reduced the aircraft's weight by about 25 percent.[20] There has been considerable progress in making the aircraft less observable, not only against radar but also against other types of sensors and stealth technology has improved impressively over the last three decades a prominent example in this regard is F-117A Stealth. Helicopters are becoming stealthier too. Developments in the realm of Unmanned Aerial Vehicles (UAVs) are also in progress. Other developments in this regard are: Joint Surveillance Target Attack Radar System (Joint STARS), E-3 AWACS Sentry, Airborne Aircraft Carriers, multi-role bomber, including Space Systems like Global Positioning System.

GUIDED MISSILES

Guided missiles are self-propelled, unmanned space or air vehicle, which carry an explosive warhead. Guided missiles are powered either by rocket engines or by jet propulsion and their path can be adjusted during flight, either by automatic self-contained controls or remote human control. The Germans, who in World War II employed V-1 and V-2 guided missiles against Great Britain and the allied Countries, first developed guided missiles in their military form. The V-1 was the first cruise missile. The V-2 was the world's first operational ballistic missile. They have become the key strategic weapon of modern warfare and a crucial, and much used, tactical weapon. Guided missiles are of various types and ranges; long-range missiles generally have nuclear warheads, while short-range missiles usually have high-explosive warheads.[21] There are many types of missiles:

Air-to-air missiles: these missiles are launched from an aircraft against an enemy aircraft or missile. These missiles are supplemented with antiaircraft guns and are often guided by self-contained controls that detect and target the missile toward heat or electronic sources.

Surface-to-air (SAM): surface-to-air and antiship missiles are also continually improving. These missiles are launched from ground against an enemy air target like missile or aircraft. French Exocet supersonic missile is a good example. Its range is some seventy kilometers. It operates on inertial guidance initially but home in on its target with active radar.

Air-to-surface missiles: These missiles are launched by aircraft against ground positions. These missiles are often radio-controlled.

Surface-to-surface: These missiles are launched from ground against ground targets. These missiles (including ship and submarine launched versions) include many different types. All long-range missiles are ballistic.

Intercontinental ballistic missile (ICBM): has a range over 3000 nautical miles. The Soviet Union completed the first operative ICBMs in 1958, and the United States in 1962.

Multiple Independently Targetable Reentry Vehicles (MIRVs): All currently deployed ballistic missiles can be equipped with Multiple Independently Targetable Reentry Vehicles. MIRV is a single missile or booster equipped with several nuclear warheads, each sends against separate target.[22]

CRUISE MISSILES

Guided cruise missiles are low flying continuously powered offensive missile. They are designed to evade defense systems. The German V-1 (1944) was the first simple cruise missile. The potential of cruise missile was realized during the 1970s, when the United States sought to develop a relatively inexpensive method for delivering weapons over long distances with pinpoint accuracy. Cruise missile flies at altitudes of about 50 ft (15 m), and has a range of up to 2,000 mi (3,200 km). It uses internally stored computerized maps of its route to follow the contour of the terrain and can deliver conventional or nuclear weapons.[23] In its various modifications, it can be launched from aircraft, ships, or ground installations against land or naval targets. There are many types of cruise missiles: Air-Launch Cruise Missile (ALCM), Sea-Launch Cruise Missile (SLCM), JASSM, Conventional Air-Launched Cruise Missile (CALCM), ACM, ATACMS, Tomahawk.

AGM-86C C-ALCM

The conventional air-launched cruise missile (C-ALCM) was developed from the nuclear-armed AGM-86B version during the 1980s. It has a range of 2,778km. It is the primary weapon of the B-52 fleet.

AGM-88 HARM

GENERAL CHARACTERISTICS

Primary Function: Air-to-surface anti-radiation missile
Contractor: Texas Instruments
Power Plant: Thiokol dual-thrust rocket motor
Thrust: Dual thrust
Length: 13 feet, 8 inches (4.14 meters)
Launch Weight: 800 pounds (360 kilograms)
Diameter: 10 inches (25.40 centimeters)
Wingspan: 3 feet, 8 inches (101.60 centimeters)
Range: 30 plus miles (48 plus kilometers)
Speed: Supersonic
Aircraft: Used aboard the F-16C
Guidance System: Proportional
Warheads: High explosive
Unit Cost: $200,000
Date Deployed: 1984 [24]

AGM-88 high-speed, anti-radiation missile (HARM) is an air-to-surface anti-radiation tactical missile of USAF, designed to seek and destroy enemy radar-equipped air defense systems. It has largely replaced the older Vietnam-era AGM-45 Shrike. The first HARMs were delivered in 1982 by the USAF.[25] Upgrade programmes are underway, to maintain HARM's lethality that includes fitting GPS navigation systems and a long-term project involves fitting a ram-jet power plant.[26]

JASSM

Joint Air-to-Surface Stand-off Missile (JASSM) is a next generation stealthy long-range standoff precision-guided munition with a limited hard target penetration capability. It is intended to replace the AGM-130, HAVE NAP and early model AGM-84 SLAM series of weapons on a wide range of combat aircraft, including the B-2.[27] The development of this next-generation weapon began in 1980s. All of these are now in development, or in the initial stages of production.

TOMAHAWK CRUISE MISSILE (SLCM)

Length: 20 feet, 6 inches
Diameter: 20 inches
Speed: High subsonic

Range: 500+ miles
Warhead: TLAM-C 1,00 lbs high explosive TLAM-D 166 BLU 97/B bomblets in 24 packages

Tomahawk Cruise missile was designed to deliver nuclear weapons into the Soviet Union from aircraft and ships off the shore. It is a highly accurate system relying on on-board computers to guide it to its target. An air-launched version of Tomahawk is also available and is used with the B-52. The missile moves at about 550 miles per hour, and can make twists and turns like a radar-evading fighter plane.[28]

STEALTH

Stealth is the weapon system involving a variety of techniques employed to reduced detectability and observability in order to enhance the system's ability to perform its mission. The idea of stealth is based on to reduce the range and probability of detection, as weapon systems cannot be made totally undetectable. The main contributions of low observability have been to strike and reconnaissance activities. Stealth design is radically different from current weapon system configuration and involves substantial technical and cost risks.[29] Stealth is claimed to be major contributor to an RMA along with other factors. Stealth may also be applicable to ships and cruise missiles.

F-117A NIGHTHAWK

This super-secret aircraft was born in 1978. The F-117A was designed to be virtually invisible to radar, and difficult to see with the naked eye as well. The F-117A is a single-seat, twin-engine aircraft. Its skin covering is composed of small, flat surfaces that reflect radar signals in every direction. Its almost entire external surface is coated with radar-absorbent material. It is highly maneuverable aircraft. The primary mission of the aircraft probably entails low-level precision attacks on high-priority targets with smart bombs or air-to-ground missiles.[30] The aircraft is fitted with an exceptionally

accurate weapons computer. It also has a FLIR sensor that produces TV-quality images of distant objects, even on hazy nights.[31]

RECONNAISSANCE AND SURVEILLANCE

As the Cold War developed, the speed, range and destructive power of modern weapons evolved a need for an airborne reconnaissance system that was effective over land or sea. This need led to the development of essential elements of modern reconnaissance systems.

E-3 AWACS Sentry

The Airborne Warning and Control System (AWACS) was designed to defend against a bomber threat. The AWACS is in use today as a mobile, survivable, surveillance station and command and control center and its role is to carry out airborne surveillance, and command, control and communications (C3) functions for both tactical and air defense forces.

The basic E-3 aircraft is a militarized version of the Boeing 707-320B commercial jet and now the Boeing 767. It has a large, rotating and externally mounted 30-foot-diameter-by-6-foot-high rotodome. Rotodome contains the main radar, identification friend or foe (IFF) and data-link fighter-control (TADIL-C) antennas.[32] Its radar is the distinguishing technical feature of AWACS, which detects and tracks large numbers of targets to extremely long ranges at all altitudes over land or sea simultaneously. AWACS operates at its normal station altitude of 29,000 feet. AWACS is capable of detecting, tracking, and identifying aircraft several hundred miles away and during all kinds of weather and above all kinds of terrain. Operating in maritime mode, AWACS can detect and track ships at anchor or underway.[33]

IFF (Identification, Friend or Foe) recognition of aircraft is a vital part of the AWACS task. In a tactical role, the E-3 can detect and track hostile aircraft operating at low altitudes over any terrain, and upon detecting enemy aircraft, the E-3s can vector friendly fighters to optimal attack position in the same airspace.[34] In the strategic defense role, the E-3 provides the means to detect, identify, track and intercept airborne threats.

Key to the effectiveness of the AWACS is its ability to monitor aircraft movements and situations in real time. This information can be supplemented through digital or voice communications links. A wide variety of both digital and voice signals can be received, transmitted, and relayed through onboard communications equipment, to and from ground and air stations. The E-3 AWACS is also used to guide bombers to their targets. It directs fighters toward enemy threats where fighters use onboard radar to shoot down enemy bogeys almost 100 miles away. An AWACS can carry Theater-Wide Air-to-Air Missiles (TWAAM). The AWACS has plenty of external space to mount dozens of missiles.[35] The large AWACS is slow to turn, therefore these missiles could be mounted on flat turrets beneath the aircraft so they can be aimed toward a target without turning the aircraft. This would allow an AWACS to fire upon approaching fighters while flying away from the threat.

It is no longer regarded as strictly a wartime aircraft, and is widely used around the world for treaty enforcement, peacetime reconnaissance, and surveillance.[36] NATO E-3s have also played a major role in the United Nations' enforcement of the no-fly zone over Bosnia and during the Kosovo crisis.

JOINT SURVEILLANCE AND TARGET ATTACK RADAR SYSTEM, (JOINT STARS)

An E-8C Joint Surveillance Target Attack Radar System (Joint STARS) is a Boeing 707 long-range, air-to-ground surveillance system with special multi-mode radar system to locate, classify and track ground targets, in all weather conditions. It has a range of more than 150 miles (250 km). Its typical mission lasts 10 hours and it can produce map images or photos of the precise locations of vehicles as well as buildings, bridges or other man-made obstacles to ground maneuver.[37]

Basically, Joint STARS allows a ground commander to know what lies ahead. It provides ground commanders a near-real time, bird's-eye view of the battlefield, by transmitting images and radar data to mobile ground stations. Joint STARS is capable of determining the direction, speed and patterns of military activity of ground vehicles and helicopters. While flying in friendly airspace, the joint Army-Air Force program can look deep behind hostile borders to detect and track ground movements in both forward and rear areas.[38] JSTARS provides a picture of the ground situation equivalent to that of the air situation provided by AWACS. Through advanced signal processing, Joint STARS can differentiate between wheeled and tracked vehicles. By focusing on smaller terrain areas, the radar image can be enhanced for increased resolution display.[39] This high resolution is used to define moving targets and provide combat units with accurate information for attack planning.

JSTARS was first deployed in Operation Desert Storm in 1991 when it was still in development, and has since been deployed to support peacekeeping operations in Bosnia-Herzegovina and during the Kosovo crisis.

HELICOPTERS

The importance and potential of the helicopters are already apparent from their use in recent wars. As the battlefield becomes more dangerous for expensive aircrafts, the supporting role of helicopters has been increased for carrying troops and supplies swiftly and independently crossing terrain obstacles.

AH-64 APACHE

The AH-64A Apache helicopter is specifically designed for the attack role. Known as "flying tank," the Apache was designed to destroy invading Soviet tank columns in Europe. It is fully equipped for night fighting. Its Hellfire anti-tank missiles have a range of more than 3.7 miles. It can penetrate the armor of any known main battle tank. The Apache may also be armed with 2.75-inch folding-fin aerial rockets that provide additional lift.[40] The aircraft is 48 feet long, 12 feet high and can weigh about 21,000 pounds maximum. Its top speed is 184 miles per hour, range is 300 miles and service ceiling is 21,000 feet.

COBRA

Weight: 14,750 lbs (loaded)
Length: 58 feet
Rotor Diameter: 48 feet
Cruise Speed: 140 knots
Maximum Range: 140 miles (combat radius)
Endurance: 2.5 hours
Crew: 2
Armament: 20 mm chain gun
Eight TOW anti-tank missiles
Two 70 mm rocket launchers

It is used as attack helicopter by U.S. Marine Corps. The Cobra is also used to escort transport helicopters in and out of hostile landing zones and provides air support to troops on the ground. The Cobra was extensively used in operations in Vietnam.[41]

CH-53E SUPER STALLION

Speed: 173 mph
Range: 257 miles
Weight: 36,400lbs maximum
Troop lift: 35
Armament: None
Lift: 16 tons

A large transport helicopter, the Stallion is used for a wide variety of missions from transport to special operations. Later versions are capable of air-to-air refueling and may be used for long-range commando raids or rescue missions. A Navy version is capable of minesweeping operations. Army versions are also used for transport of heavy equipment such as artillery and recovery of downed aircraft.[42]

UH-60 BLACKHAWK

Max Gross Weight: 20,250 lbs
Cruise Speed: 165 mph
Range: 373 miles
Crew: 2 pilots, 1 crew chief
Armament: Two 7.62 mm machine-guns
Payload: 2640 lbs (or 11 combat troops)

The UH-60 plays an important role in any mobile force with its ability to carry a full squad of eleven men, a 105 mm howitzer.[43]

BOMBER AIRCRAFT

B-52 STRATOFORTRESS

The development of Boeing's B-52 Stratofortress began in the late 1940s. The B-52 made its first flight in 1952 and entered service with the U.S. Air Force's Strategic Air Command (SAC) in 1954. The B-52H was designed for nuclear standoff, but it now has the conventional warfare mission role with the retirement of the B- 52G's. The B-52 can carry different kinds of external pylons under its wings.

Known as the Big Ugly Fat Fellow (BUFF), the B-52 can carry up to 60,000 pounds of bombs, or a mixture of bombs and air-launched cruise missiles (ALCM). A remote-

control tail turret is armed with either four .50 caliber machine guns or, a 20 millimeter multibarrel cannon for air defense.[44]

All B-52s are equipped with an electro-optical viewing system that uses platinum silicide forward-looking infrared and high resolution low-light-level television sensors to augment the targeting, battle assessment, flight safety and terrain-avoidance system, thus further improving its combat ability and low-level flight capability.[45]

Its advanced electronic systems and terrain-avoidance radar allow for low-level, long-range penetration missions under adverse weather conditions. It is highly effective when used for ocean surveillance, and can assist in anti-ship and mine-laying operations. Two B-52s, in two hours, can monitor 140,000 square miles (364,000 square kilometers) of ocean surface.

The variants presently in service are the B-52G and B-52-H. The B-52H has a wingspan of 185 feet, and is 161 feet long and 41 feet high. Maximum take-off weight is 488,000 pounds. The aircraft can attain a top speed of nearly 600 miles per hours; maximum range is 10,145 miles, and service ceiling is 55,000 feet.

DRONES (RPVS)

The Pioneer unmanned aerial vehicle (UAV) Drone was developed by the Israelis and produced in the U.S. UAVs have supported military operations since the late 1960s during the Vietnam War, and subsequently in the 1983 Israeli War, the 1991 Gulf War, and the most recently over Bosnia. RVP has a wingspan of 17 feet and is 14 feet long. It is powered by a 26 horsepower snowmobile engine and has a range of about 100 miles. It has flight duration of five hours. It can carry a large number of sensors including television and FLIR.The primary function of remotely-piloted vehicles (RPVs) is to take

highly detailed pictures. Non-lethal UAVs are intended to operate as a system of systems to provide comprehensive imagery collection for tactical and operational commanders in combination with other manned and satellite intelligence collection systems. UAVs have broad mission capabilities of reconnaissance; surveillance and target acquisition; targeting; deception; electronic warfare; and command and control (C2).[46] UAVs save not only pilot lives conducting various missions but it also cut the cost more than 50 percent, relative to manned aircraft carrying out the same mission. UAVs are notable not for breaking aerodynamic performance barriers, but it may be used to jam or attack enemy air defenses and even to conduct traditional bombing operations.[47] Each Pioneer carries a video camera that can take highly detailed pictures from 2,000 feet and transmit them 100 miles away.[48]

HAWK MISSILE SYSTEM

Length: 16 feet, 6 inches
Range: 3 miles

The *HAWK* is a medium-range air defense missile developed during the 1960's and improved several times in the last thirty years. HAWK missiles consist of acquisition radar, a command post, a tracking radar, an Identification Friend or Foe (IFF) system, and three to four launchers with three missiles each.[49] A proximity fuse is used to detonate its warhead.

PATRIOT AIR DEFENSE MISSILE

Length: 17 feet, 5 inches

Warhead: 221 lbs High Explosive

Range: 43 miles

Altitude: 78,00 feet

Speed: Mach 3.0

As an anti-aircraft weapon, the Mim-104 Patriot was originally designed against medium to high altitude high performance aircraft and it was modified in the mid-1980s to defend against ballistic missiles as well. It is carried in a container that also serves as a launcher. Its ground-based guidance system can track and guide eight missiles simultaneously to different targets. The system includes computer connected radar, command, and launcher. Each launcher contains four missiles with six to eight launchers per system. Completely computerized, the system is activated when a launch is detected and missiles are launched when the highest probability of a kill is obtained.[50]

Along with anti-ballistic missiles, guided missiles, Tomahawk missile, Ss-1 Scud, Video-Guided missiles were also come to the fore. All these weapons increased the lethality, agility and precision of modern battlefield.

NAVAL WARFARE

Nuclear power has left deep impact on navy like other spheres of military. It has not only brought radical changes in both weaponry and propulsion, but it necessitated the need for radical changes in ship construction also. Since the World War 11 1945, there have been many advances in naval tactic, weapons systems, and in command and control of naval operations.

In the post World War 11 period, aircraft and the submarines became the key naval weapons and there has been the continued domination of the world's major fleets by the great aircraft carriers. As the tactical aircraft had limited range, the aircraft carrier provided a floating airbase to bring the aircraft within the range of their targets and aircraft were used to attack opposing fleets.[51] During this period, missiles emerged as the pre-eminent ship-to-ship weapon and larger, and quieter nuclear-powered missile-armed submarines have been introduced. These nuclear-powered attack submarines (SSNs) are faster, better armed and capable of diving deeper. The nuclear-powered

submarine, armed with submarine-launched ballistic missiles (SLBMs) has extended sea power as never before. Even there are steady improvements in the character of conventional submarines in the post World War 11 era.

1980s and 1990s, are proved to be the most revolutionary in naval technology and during these years many breakthroughs occurred in the development of weapons which, brought radical changes in the nature of navies and revolutionized the whole conduct of naval warfare.

ANTI-SHIP MISSILES

ASMs became prominent in 1967 Arab-Israel War. The Exocet is subsonic like other ASMs. Surface-to-air missiles are another development in naval sphere. These missiles include SM-2 missiles used by U.S. Navy's Aegis that by far, is the most sophisticated air defense and British Seawolf, which is one of the most advanced anti missile systems. It is fully automatic.

SURFACE WARSHIPS

Surface warships are the symbol of naval might and they have undergone remarkable technological developments since 1945. Surface warships are becoming more sophisticated, expensive and complex in nature and the number of world's Surface fleets is gradually increasing.

SENSORS

The modern warship is totally dependent on its sensors, both active and passive. Sensors used by naval systems have certain advantages. They can be deployed prior to engagement. Standing offshore, they can pick up electronic intelligence and through acoustic sensors, can monitor port operations. They can oversee the flight operations of coastal cities, peer into the mountainous terrain and, from some locations, acquire radar signatures.[52]

AIRCRAFT CARRIERS

Aircraft carrier is one of the most impressive fighting machines of the world. It has a greater variety of lethal weapons with a greater power of destructivity, at longer range than any warship in history. In the post World War 11 era, destroyers, cruisers, amphibious Craft, battleships, seaplanes etc., have also come to the fore leaving deep and vital impact on the conduct of warfare.

FRIGATES

Oliver Hazard Perry Class--FFG

Displacement: 3,585 tons
Length: 445 feet
Beam: 49 feet
Speed: 29 knots
Power: Two gas turbines, one shafts
40,00 shaft horsepower.
Aircraft: Platform for SH-60 Seahawk Helicopter
Armament: One 76mm gun
Six torpedo tubes
One Phalanx anti-missile gun
Harpoon Anti-Ship missiles

The role of Frigates is escorting aircraft carriers along with protecting amphibious forces.[53]

DESTROYERS

SPRUANCE CLASS--DD

Displacement: 7,800tons
Length: 563 feet
Beam: 55 feet
Speed: 33 knots
Power: Four gas turbines, two shafts,
80,00 shaft horsepower.
Aircraft: Platform for SH-60 Seahawk Helicopter
Armament: Two 5 inch guns
Two Phalanx anti-missile guns
Tomahawk Cruise missiles
Harpoon Anti-Ship missiles.
Two triple torpedo tubes

FARRAGUT CLASS--DDG-38/DDG-46

Displacement: 6,00 tons
Length: 512 feet
Beam: 52 feet
Speed: 33 knots

Power: four boilers, two shafts,
85,00 shaft horsepower.
Aircraft: none
Armament: One 5 inch guns
Harpoon Anti-Ship missiles.
Two triple torpedo tubes [54]

CRUISERS

TICONDEROGA CLASS (CG47-60)

Displacement: 9,600tons
Length: 563 feet
Beam: 55 feet
Speed: 30+ knots
Power: Four gas turbines, two shafts,
80,00 shaft horsepower.
Aircraft: Helicopter platform
Armament: Two 5-inch guns
Two triple torpedo tubes
Two Phalanx anti-missile guns
Tomahawk Cruise missiles
Harpoon Anti-Ship missiles.
Crew: 358

The Ticonderoga Class cruiser contains the AEGIS radar and defense system that is rated one of the best in the world. In the Gulf, the cruisers used their AEGIS radar to oversee the skies in an escort role for the carriers. It also used to provide naval gunfire support to troops on the shore.[55]

AMPHIBIOUS CRAFT

TARAWA CLASS:

Displacement: 39,000 tons
Length: 820 feet
Beam: 106 feet
Speed: 24 knots
Power: Two boilers, two turbines, two shafts, 70,000 shaft horsepower.
Aircraft: CH-53, CH-46 Sea Knight and other helicopters along with AV-8A Harriers operate off the flight deck.
Crew: 950
Marines: 1,703

IWO JIMA CLASS:

Displacement: 18,000 tons
Length: 602 feet
Beam: 84 feet
Speed: 23 knots

Power: Two boilers, one turbines, one shaft, 22,000 shaft horsepower.
Aircraft: CH-53, CH-46 Sea Knight and other helicopters
Crew: 684
Marines: 1,703

The Amphibious Assault Ships are used to place Marines via air or sea.[56] Each ship can accommodate a number of smaller landing craft.

SPACE WARFARE

Space is another important characteristic of RMA. This category focuses on the activities facilitated or made possible by space vehicles: reconnaissance and intelligence gathering, missile defense, navigation, data transmission, communications.

The US military's increasing reliance on support from space-based systems for its everyday operations and especially during times of conflict has highlighted the importance of space operations. However, space assets could provide more than support for the terrestrial war fighter in the future. The space environment offers the possibility of conducting worldwide military operations in a greatly reduced time frame.

The space-based observation platform commonly called "remote sensing" systems have many commercial, civil and scientific applications. Space warfare is characterized by the used of weapons and manned or unmanned vehicles that transmit, or operates in, space to influence military operations conducted in space or on earth.[57] In additions to weapons and space platforms- intercontinental ballistic missiles (ICBMs), antiballistic missiles (ABM) weapons, launch rockets (boosters), satellites, antisatellites weapons (ASATs), manned spacecraft-an extensive network of surface-based radars and other space surveillance sensors, command and control centers, communications networks, and launch facilities support military operations in or through space. These space systems are among the most technology complex and expensive piece of military equipment ever built.

Space operations will also greatly differ from air operations. First, the "geography" of space is fundamentally different from that of the earth's atmosphere. Orbital mechanics require operating speeds (17,000 miles per hour).[58] Thus, if properly placed and employed, space assets could perform missions in much less time than state-of-the-art aircraft.

DEVELOPMENT OF SPACE WARFARE

The ability to see developments on the battlefield has always been an important determinant of victory in war and it has been an advantage for the commanders to be better able to observe friendly and enemy locations and activities. Space warfare began with the German development of the V-2 medium-range ballistic missiles (MRBM) (October 1942) in the world war 11. V-2 missile started a new era in warfare. However, during the World War 11, in spite of the unprecedented visibility-enhancing technologies such as aerial photography, radar and other detection devices were used, commanders were unable to get real-time information about friendly and enemy location, in order to manage the battle.

After world war 11 in 1957, the soviets had succeeded in making a missile, the SS-6, capable of taking a small satellite into lower-earth orbit, by exploiting German technology. The launch of the first artificial satellite, *Sputnik* 1 on 4 October 1957, marked a beginning of space age while opening a new arena for military competition. Booster development by both of the superpowers further enhanced the space activities. Liquid-fuel ballistic missiles such as the SS-6, SS-4, Atlas, and Titan continued to serve as the basis for space launch programs.[59] These missile coupled with subsequently developed systems SL-16 booster and US space shuttle have created room necessary to deploy and sustain the large variety of manned and unmanned space systems used in their military operations.

The revolution in visibility or the ability to grasp the battlefield began in 1970s. This revolution in military affairs also has brought with it a revolution in weaponry and sensor and intelligence-gathering technology. Contemporary information-gathering systems enable commanders to have continuous wide area surveillance and target acquisition and real-time battlefield information. This visibility also plays central role in the improvement of accuracy of long-range precision strikes that has become an integral part of the RMA.

CURRENT SPACE OPERATIONS

Military space activities primarily support the conduct of terrestrial military operations by enhancing communications, weather forecasting, navigation, surveillance, mapping, charting, and geodesy.

SURVEILLANCE AND EARLY WARNING

The advent of ICBMs in the late 1950s, with their intercontinental flight times of less than 30 minutes, significantly increased the need for surveillance and early warning. The U.S. Defense Support Program (DSP) is third generation satellites deigned to provide early warning of Soviet intercontinental missiles.

Early warning satellites detect the launch of a ballistic missile by using infrared sensors that detect the hot plume of plasma emitted by the rocket motor.[60] They plot the source of infra-red emission over several scan by their sensors to see if it moving or stationary, and then relay the information to ground sites where it is combine with the data from ground-based radars to development an assessment of the size of the attack and its targets. These satellites are critical in facilitating the launch of bombers and tankers in the event of an ICBM or a submarine-launched ballistic missile (SLBM) attack.

Space-based surveillance is also had a significant effect on tactical operations i.e., radar-ocean reconnaissance and electronic-intelligence ocean reconnaissance satellites. The former satellites detect and track naval surface units and later satellites collect electronic intelligence on enemy fleet dispositions. The White Cloud ocean surveillance satellites are also U.S. spaced-based early warning systems.

COMMUNICATION SATELLITES

The world wide military operations of developed countries have been greatly facilitated by the development and proliferation of communication satellites. These satellites are vital for the near-instantaneous transmission of commands to units all over the world.[61] The first active communication satellite the U.S. Army's *Courier* was launched in October 1960. These satellites are used for the transmission of photoreconnaissance data.

NAVIGATION AND POSITIONING SATELLITES

Space systems have also increased the accuracy of weapons delivery by navigation and providing data for, mapping, charting, and geodesic information. These data are specially important in programming the guidance systems ICBMs, submarine-launched ballistic missiles, cruise missiles and other advanced weapon systems, which require precise information on gravitational, magnetic, and terrain variations in their fight path.[62]

WEATHER SATELLITES

Because of their altitudes, space systems have an inherent capability to detect weather patterns over the earth surface. The U.S. Defense Meteorological Satellite Program (DMSP) use a variety of sensors to provide data on cloud cover, temperature, water vapor contents, atmospheric density and ionospheric conditions.[63] In order to efficiently

plan reconnaissance satellite missions, these satellites provide data about cloud cover. A mobile receiving station can provide real-time weather photograph. Such information is useful for any military mission in peace and war, particularly valuable in planning air operations.[64]

GEODETIC SATELLITES

Geodetic satellites are used to produce maps of the earth using photographic and radars techniques. They also provide data about the earth gravitational and magnetic fields. This information is essential for the guidance systems of cruise missiles and enables the trajectories of ballistic missiles to be predicted accurately.[65]

INFLUENCE OF SPACE OPERATIONS ON TERRESTRIAL COMBAT

The development and application of these military space systems since 1957 have had far-reaching effects on the conduct of terrestrial military operations. Though early warning, communications, navigation and weather satellites were basically evolved to conduct or defend against strategic missile operations, now they are being used for the execution of conventional military operations as well. The increasing reliance on support activities in space has simultaneously stimulated efforts to deny those activities to an enemy and protect friendly space systems.

ANTISATELLITE WEAPONS

An effective antisatellite (ASAT) capability could lead to the ability to achieve aerospace control or superiority in order to deny the opponent's ability to operate in or from space.

Though space programs of both the superpowers the U.S. and the former Soviet Union have not yet resulted in deployment of offensive and defensive weapons in the space. However, it would include space-to-atmosphere, space-to-ground and space-to-space capabilities.

Two concepts have been developed thus far: an antisatellite (ASAT) system based on earth, and one carried by satellite in orbit. In the earth-based ASAT system, a missile carries an explosive warhead that can be aimed at a satellite, either from the ground or from space. In the satellite-based ASAT system, the satellite itself carries either conventional explosives or beam weapons. The satellite approaches another satellite in the orbit, identifies it, and then destroys or disables the target.

ASAT weapons can be divided into three basic categories: kinetic-energy weapons (KEWs); space-based explosives; and directed-energy weapons (DEWs).

KINETIC-ENERGY WEAPONS (KEWS)

Kinetic-energy weapons are propelled by either chemical rockets or electromagnetic forces. Although, some of these weapons may carry chemical explosive, they destroy their targets by impact rather than a by means of explosions. As most of these devices do not contain explosives, they are commonly referred as "rocks". "Smart rocks" are those equipped with some sort of tracking or homing devices, simple "rocks" not so equipped, are solid projectiles.[66] The speed of kinetic-energy guided projectiles can be accelerated by chemically propelled boosters. As they derived their destructive energy from their momentum, this would increase their effectiveness. KEWs are effective at any stage of a missile trajectory, from boost to re-entry, and can be fired from the ground or from space.[67]

SPACE-BASED EXPLOSIVES

These explosives provide comparatively low-technology alternatives to KEWs and DEWs. Space mines, orbited within the lethal range of target satellites, would be commanded from the ground to explode and destroy the targets.

DIRECTED-ENERGY WEAPONS (DEWS)

Directed-energy weapons can deliver destructive energy at or near the speed of light. They deposit on a target an energy impact that creates serious secondary thermomechanical damage in the target material that leads to the malfunctioning or destruction of the object.[68]

For a soft target, such as a satellite, a smaller amount of energy is required to cause disabling damage. DEWs are basically of three types: high-energy laser weapons, particle-beam weapons, and high-power radio-frequency weapons.

HIGH-ENERGY LASER WEAPONS (HELWS)

A laser beam is a ray of light that is coherent and highly focused and concentrated. Since energy moves at the speed of light, such a beam can almost instantaneously deliver to the target. The properties of laser weapons make them particularly suitable against aircraft, cruise or guided missiles or ballistic re-entry vehicles.[69] The essential elements of a laser weapon are the high-energy laser-producing system and the beam control system. The beam control system aims the laser beam at the target and focuses the laser on it. The frequency of its electromagnetic radiation is the key to successful laser weapon. The higher the frequency, the more power the beam.

PARTICLE-BEAM WEAPONS (PBWS)

A particle beam is stream of atoms or subatomic particles that are accelerated to nearly the speed of light and rely on the technology of particle accelerators. PBWs can disable a missile without actually destroying it.[70] Instead of burning a hole in the body of the missile, like a laser beam, the particle beam easily passes through the body of a space vehicle and disrupts the electronic devices on board.[71]

When particle beam struck by an object, the object emits gamma rays and neutrons. PBWs can discriminate between the lightweight decoys and heavier re-entry vehicles by these emissions. Particle beam technology is as destructive as laser technology.

HIGH-POWER RADIO-FREQUENCY WEAPONS (HPRF)

HPRF weapons, which include high-power microwave weapons, are capable of producing intense beams radio-frequency radiation that can damage a target satellite or missile by either jamming or physically destroying it electronic equipment. Another way of damaging the object is to heat the target, such as a satellite, to a sufficiently high temperature to cause it to cease functioning.[72]

Another type of HPRF weapon is the high-power microwave beam. A microwave beam, like a high-energy laser beam, has a number of applications. An important one in electronic warfare is the jamming of enemy radio transmission.

The capability of military satellites is increasing and terrestrial military forces are becoming more dependent upon them. So a dramatic expansion of military space activity may expected in future conflicts

GLOBAL POSITIONING SYSTEM (GPS)

The first Global Positioning System (GPS) satellite was launched in 1978. It is a worldwide satellite radio-navigation system formed from a constellation of 24 satellites and their ground stations. GPS is the only system today, which is able to show the exact position of something or someone on the Earth anytime, in any weather, anywhere. With its advanced technology, it can make measurements of every squire meter of the earth rather a centimeter. GPS satellites orbit at 11,000 nautical miles above the Earth.[73] Ground stations located worldwide continuously monitor GPS satellites. The satellites

transmit signals that can be detected by anyone with a GPS receiver. Armies, by using the GPS receiver, can determine their and their enemy's location with great precision.

RECEIVERS

GPS receivers have been miniaturized to just a few integrated circuits and so are becoming very economical that is made the technology accessible to virtually everyone. GPS receivers can be hand carried or installed on aircraft, ships, tanks, submarines, cars, and trucks. These receivers detect, decode, and process GPS satellite signals. More than 100 different receiver models are already in use. The typical hand-held receiver is about the size of a cellular telephone, and the newer models are even smaller. The hand-held units distributed to U.S. armed forces personnel during the Persian Gulf war weighed only 28 ounces.[74]

These days GPS is finding its way into cars, boats, planes, construction equipment, movie making gear, farm machinery, and even laptop computers.[75] GPS has many uses in both military and civilian life.

GPS provides two levels of service: Standard Positioning Service and the Precise Positioning Service.

The Standard Positioning Service (SPS) provides a predictable positioning accuracy of 100 meters (95 percent) horizontally and 156 meters (95 percent) vertically and time transfer accuracy to UTC within 340 nanoseconds (95 percent).[76]

The Precise Positioning Service (PPS) is a highly accurate military positioning, velocity and timing service provides a predictable positioning accuracy of at least 22 meters (95 percent) horizontally and 27.7 meters vertically and time transfer accuracy to UTC within 200 nanoseconds (95 percent).[77] It will be denied to unauthorized users by the use of cryptography.

GPS is one of history's most exciting and revolutionary developments, and it has become important for nearly all military operations and weapons systems. Therefore, new uses for it are constantly being discovered. In addition, it is used on satellites to obtain highly accurate orbit data and to control spacecraft orientation.[78]

These are the glimpses of the developments in the high-tech weapon that have triggered an info-RMA and ultimately demonstrated their power in the Gulf War 1991.

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CHAPTER 5

THE IMPACT OF THE GULF WAR

This chapter deals with the revolutionary character of above mentioned weapon systems that turned the tables on Iraq in the Persian Gulf War. Though many techniques and tools used in Operation Desert Strom were based on the second wave industrial age technologies and ideas, most of these were evolutionary and new. These weapon systems added a new and decisive chapter in the history of military revolutions.

PRECISION MUNITIONS IN THE GULF WAR

The most obvious capability of Operation Desert Strom was precision strike. These munitions have left deep impact on logistics and operations too. The ability to destroy certain targets using one or two precision-guided munitions dramatically cut the logistic lines instead of large-scale bombing. Between 80 and 90 per cent of the precision-guided munitions (PGMs) hit their targets compared with about 25 per cent of dumb bombs. Above all, precision-guided munitions enabled the Coalition forces to minimize collateral damage.

The Gulf War showed how radically precision attack had transformed the traditional notion of a military campaign and, especially, an air campaign. Precision attacks against the Iraqi air force destroyed it in its hangars, and caused a mass exodus of Iraqi aircraft to Iran. Key precision weapon attacks against bridges severed the movement of Iraqi forces and create fatal blockage for them. Overall, postwar analysis indicated that Iraq's ability to move supplies from Baghdad to the Kuwaiti theatre of operations had dropped from a total potential capacity of 216,000 metric tons per day by six main routes (including a rail line) to only 20,000 metric tons per day by only two routes, a nearly 91 per cent reduction in capacity; as all others route (including the railroad) had been

destroyed.[1] This destruction had taken place in an astonishingly short time. Previously, non-precision military campaigns often took hundreds of sorties to destroy a bridge, whereas in the Gulf War, precision weapons in approximately four weeks destroyed 41 of 54 key Iraqi bridges, as well as 31 pontoon bridges hastily constructed by the Iraqis in response to the anti-bridge strikes.

The advent of routine around-the-clock laser bombing of fielded enemy forces in the Gulf War represents a new phase in the history of air warfare. The vast majority was these laser guided bombs were made in the 39 days prior to the ground operation. 4.3 per cent precision munitions expended on Iraqi forces by American airmen consisted of laser-guided bombs, which caused approximately 75 per cent of the serious damage to Iraqi strategic and operational targets.[2] The remaining precision munitions consisted of specialized air-to-surface missiles such as the Maverick and the Hellfire, as well as cruise missiles, anti-radiation missiles, and various other small numbers of special weapons. The combination of laser-guided bombs from F-111Fs, F-15Es, British Tornadoes and Buccaneers, and AS-30L laser-guided missiles fired from French Air Force Jaguars together with Maverick missiles using imaging infrared thermal sensors fired by A-10s and F-16s were devastating.3 Particularly the F-111F night 'tank plinking' strikes proved deadly by using 500 pound GBU-12 laser-guided bombs. On 9 February for example, in one night of concentrated air attacks, 40 F-111Fs destroyed over 100 armoured vehicles. Overall, 1,500 of Iraqi tanks and other mechanized vehicles were destroyed by the small 66-plane F-111F force and averaged over 30 artillery pieces or armoured vehicles were destroyed per night by the air strikes of F-15Es and Marine A-6Es in the easternmost section of the theatre.

In the air campaign plan for the Gulf War, coalition political and military leaders were very comfortable with using precision weapons in attacks deep in the midst of major

cities as PGM minimized the collateral damage. On 'opening night' of the Gulf War, the coalition forces attacked Baghdad by two kinds of precision weapons: air-launched laser-guided bombs and ship-launched cruise missiles. Other prominent feature of this operation was the use of stealth aircraft. The combination of the systems such as stealth aircraft, laser-guided bombs and cruise missiles enabled certain attacks to take place against highly defended targets virtually without warning.

It was overall, the laser- guided bombs that dominated both the battlefield, the counter-air campaign against Iraqi airfields, against its command and control and leadership targets, and the anti-bridge and rail campaign.

JOINT DIRECT ATTACK MUNITIONS (JDAMS)

During the operation Desert Strom, JDAMs, guided not by their platforms but by the Global Positioning System (GPS), during the air bombing campaign.[4]

LASER GUIDED BOMBS [LGBS]

GBU-10 PAVEWAY II

In Operation Desert Storm, GBU-10s were used extensively by F-15Es and F-111Fs mainly against bridges, Scuds, C3I (command, control, communications, intelligence) nodes, and bunkers. Of the 2,637 expended, over one-third were dropped by F-111Fs, and the rest by F-117s, F-15Es, and Navy and Marine Corps aircraft.[5]

Desert Storm F-111F pilots used GBU-15 glide bombs to seal flaming oil pipeline sabotaged by Saddam Hussein's troops. According to the US Air Force, during Operation Desert Storm, Paveway II series, hit 78 percent of its targets.[6]

GBU-12

The munition was used during Operation Desert Storm, and, according to the Air Force, hit 88 percent of its targets. During Desert Storm the GBU-12 was dropped by F-111Fs, F-15Es, and A-6s, mostly against fixed armor. It was the F-111F tank-busting weapon of choice.7 Of the 4,493 GBU-12s employed, over half were dropped by the F-111Fs.

GBU-16

During Desert Storm virtually all 219 GBU-16s were dropped by Navy A-6Es, which had the capability to chase the target themselves (self-designation).[8]

GBU-24 PAVEWAY III

The GBU-24s performance was proved successfully during the Gulf War, and it remains in production. In the Gulf War all of the 1,181 GBU-24s were released by F-lllFs.[9]

GBU-27

The GBU-27 also proved successful during Desert Storm, with its accurate precision. According to the Air Force, the GBU-27 hit 70 percent of its targets during the operation.[10]

(GBU-28) 'BUNKER BUSTER' 'DEEP THROAT'

In Operation Desert Storm, the GBU-28 was the famous bunker buster. It was developed in minimal time under USAF's rapid response program. GBU-28s were dropped in Desert Storm by F-111s. The U.S.Air Force produced a limited quantity of the GBU-28 during Operation Desert Storm to attack multi-layered, hardened underground targets.[11]

In the Gulf War, a single strike aircraft with one or two crewmen, dropping two laser-guided bombs, could achieve the desired results with essentially a 100 per cent expectation of hitting the target.

War	Number of Bombs	Number of Aircraft	CEP (in feet)
World War II	9,070	3,024	3,300
Korea	1,100	550	1,000
Vietnam	176	44	400
Gulf War 11	112,000	2,600	4-5 meters

Source: www.fas.org/man/dod-101/sys/smart/docs/paper53.htm

AIR POWER IN THE GULF WAR

The second Gulf War was won by the air superiority of the coalition forces. Air strikes proved effective beyond the expectations of the military commanders. Round the clock air strikes caused the sudden and complete collapse of Iraqi ground forces.

GUIDED CRUISE MISSILES

AGM-86C C-ALCM

It has a range of 2,778km. It is the primary weapon of the B-52 fleet and has used against Iraq in 1991 on the opening day of Operation Desert Storm. AGM-86Cs also used against Iraq in 1996 and again during Operation Desert Fox 90 missiles were fired against Iraq.

SLCM TOMAHAWK CRUISE MISSILE (U.S.)

Some of the first allied hits on Baghdad were the Tomahawk cruise missiles launched from the U.S.S. Wisconsin in the Persian Gulf. The Tomahawk were primarily used from ships in the Gulf against hard, non-moving Iraqi targets in the Gulf such as command and control centers and military industry. Initial reports of Desert Storm indicate a success rate of Tomahawk almost 90%. By the end of the war, the Navy had launched over 282 of 288 Tomahawks by 16 surface ships and two submarines, with a

high success rate. Of these, 64% were launched in the first 48 hours. In the war, Tomahawks were used to destroy surface-to-air missile sites, command and control centers, and electrical power facilities along with the destruction of Iraq's presidential palace.[12]

STEALTH

F-117A NIGHTHAWK

U.S. stealth F-117A *Nighthawk* were among the first aircraft to strike Baghdad in the opening minutes of the air war F-117A infiltrated the airspace above Iraq without being detected by its early-warning radar network. During Desert Strom, the F-117 achieved a remarkable strategic success in it specialized role of accurately planned attacks, by night and in clear weather conditions, against heavily guarded fixed and high-value targets.[13]

The F-117 was apparently undetected by Iraqi defenses and destroyed numerous key facilities. It was able to fly safely at lower altitudes than conventional aircrafts. About 2,00 lbs laser guided bombs fired from F-117's direct hit on Iraqi strategic targets and mobile missile launchers with pinpoint accuracy. While the F-117 represented only 3% of the Coalition's tactical air power, they hit 31 percent of the targets hit in the first day of the war and destroyed over 43% of the total strategic targets and remained the centerpiece of the strategic air campaign for the entire war.[14]

U.S. Forces used three platforms during the Gulf War that were in the stealth/low-observability category: the F-117 stealth fighter and two long-range cruise missiles, the Tomahawk Land Attack Missile (TLAM) and the Conventional Air-Launched Cruise Missile (CALCM). Low observability made possible direct strikes at the heart of the Iraqi air defense system at the very outset of the war. In the Gulf War, the Coalition could strike Iraqi air defenses immediately, and they never recovered from these initial, stunning blows. The F-117 operated at night and the TLAMs during the day.[15]

RECONNAISSANCE AND SURVEILLANCE

Airborne reconnaissance and surveillance played a key role in Operations Desert Shield and Desert Storm. The Coalition's ability to monitor and control the battle area confirmed the Iraqi's defeat. Land, air and space-based sophisticated surveillance, reconnaissance, and intelligence gathering systems played equally important role in the Persian Gulf War. These systems included the E-3 Sentry airborne warning and control system (AWACS), Joint Surveillance Target Attack Radar System (JSTARS), as well as a wide variety of photo-reconnaissance aircraft.

E-3 AWACS SENTRY

E-3 Sentry aircraft were among the first to deploy during Operation Desert Shield where they immediately established an around-the-clock radar screen to defend against Iraqi aggression. During Operation Desert Storm, some 845 AWACS sorties were flown. The E-3 was also used to guide bombers to their targets. AWACS's computer, communication equipment, radar and sensors scanned the skies for enemy aircraft, missiles and sent targeting data to interceptor aircraft ground units.[16] In Operation Desert Storm, the AWACS planes created an interlocking network of command posts that was able to manage the hundreds of warplanes that might be conducting attack sorties and combat air patrols at any given moment.[17] They provided radar surveillance and control to more than 120,000 coalition sorties. During the conflict, it provided senior leadership with time-critical information about the actions of enemy forces. For the first time in the history of aerial warfare, an entire air war has been recorded. This was due to the data collection capability of the E-3 radar and computer subsystems.[18]

JOINT SURVEILLANCE AND TARGET ATTACK RADAR SYSTEM, (JOINT STARS)

JSTARS was first deployed in Operation Desert Storm in 1991 when it was still in development, and has since been deployed to support peacekeeping operations in Bosnia-Herzegovina and during the Kosovo crisis.

The Air Force-Army joint Surveillance and Target Attack Radar System (JSTARS) proved its worth beyond the shadow of a doubt during Operation Desert Storm, despite the fact that the system was still in development. JSTARS the counterpart of AWACS, scanned the ground to help, detect, disrupt and destroy the fellow-on of the enemy.[19] Two aircraft deployed in 1991 to participate in Desert Storm. Joint STARS was praised for tracking mobile Iraqi forces, including tanks and Scud missiles. Joint STARS provided real-time information of the retreat to the air operations center. This information allowed commanders to use tactical airpower to block and destroy the slow-moving Iraqi mechanized troops as they used the roads out of Kuwait City.[20]

The airborne JSTARS provided coalition combat commanders with near real-time information on various targets, including moving targets, in all weather conditions during Operation Desert Strom. The Air Force used it for target acquisition, chiefly of moving targets. Coalition forces considered JSTARS their most reliable and valuable platform. JSTARS and other moving target indicator (MTI) platforms, such as the Army's OV-1D Mohawk, tracked the movement of Iraqi logistics/supply units and other mobile tactical targets throughout the war. This information was passed, sometimes in near real-time, to strike aircraft for targeting and destroying these Iraqi forces.[21]

For the Army, JSTARS, during the ground offensive, provided the information that allowed Commander-in-Chief, Central Command (CINCCENT) to make key

operational decisions at crucial moments. JSTARS showed that the Iraqi forces arrayed on the front lines and about to attack [22]

JSTARS found significant target groups, such as convoys as well as detected the Republican Guard movement and massive retreats from Kuwait City during the ground offensive, which gave CINCCENT the opportunity to attack and destroy the Iraqi forces while they were moving.

Along with AWACS and JSTARS, there were more weapons systems that played decisive part in surveillance, reconnaissance, and intelligence gathering including: the RC-135 Rivet Joint electronic intelligence-gathering aircraft and a wide variety of photo-reconnaissance aircraft.

AIRSHIPS

Desert Strom also provided the first example of large-scale heliborne operations, covering the whole spectrum, reconnaissance, vertical assaults, fire support, transport and antiarmour combat.

AH-64 APACHE

Ah-64 Apache was the primary attack helicopter in the Army during the Gulf War II. The Apache helicopter was a ground-attack aircraft; tanks and fighting vehicles were its principal targets. In Operation Desert Storm, the Apache performed its primary mission of tank-killing with tremendous success. In some of the first attacks of the air war, Apaches attacked Iraqi command and control centers for air defenses on the border. Using the laser-guided Hellfire missile, Apaches destroyed a number of tank and armor units prior to the ground invasion.[23]

When the ground war commenced, Apaches destroyed a considerable number of Iraqi tanks and provided close air support to advancing allied forces. 274 AH-64's were

deployed to the KTO. This represented 45% of the Army's AH-64 fleet at the time. AH-64's flew over 18,700 hours with a readiness rate of over 90 percent.[24] In the Gulf War, the U.S. Army AH-64A Apache helicopter gunships destroyed of nearly 950 tanks, personnel carriers, and miscellaneous vehicles.[25]

B-52 STRATOFORTRESS

The old B-52s was among the first aircraft that attack Baghdad during the Persian Gulf by launching cruise missiles hundreds of miles from Iraqi territory. During Desert Storm, the B-52 was used for massive bombing operations against Republican Guard and other front line targets. 68 B-52Gs were deployed during the war. They delivered more than 54 million pounds of bombs without a combat loss. In Operation Desert Storm, B-52s were used to conduct round-the-clock carpet bombing attacks against Iraqi troop concentrations and defenses. In addition to high-explosive bombs, the B-52s saturated Iraqi positions with anti-personnel and anti-armor bombs launched from bases in Diego Garcia, England and Saudi Arabia. In addition, several B-52s from Louisiana were used to launch cruise missiles prior to the start of the air war. Later in the conflict, the B-52s became a key weapon to hit Iraqi forces in Kuwait, and delivered 40% of all air munitions during that conflict.[26]

DRONES (RPVS)

The unmanned aerial vehicles (UAVs) were used extensively in Desert Shield and Desert Storm, not only by the United States but also by coalition forces. The US Navy, Marine Corps, and Army used basically two types of RPVs in the war, the Pointer and the more sophisticated Pioneer.

RPVs were so good during their performance. These systems were employed for battlefield damage assessment (BDA), targeting, reconnaissance and surveillance missions particularly in high-threat airspace, searched for mines in the Gulf, watched for

Iraqi patrol boats, and carried out other tasks. They tracked Iraqi mobile missile launchers, marked Silkworm missile sites and determined whether they were active or inactive. The information they collected by their cameras or sensors were sent to ground stations then to coalition aircraft to strike the Iraqi formations. RPVs provided substantial imagery support to Marine, Army and Navy units during Operation Desert Storm. UAVs acted as aerial spies. Northrop Grumman drones were used both deception and EW missions during the 1991 Gulf War.

In its use as long distance eyes for battleship guns, the RPVs position sent information to the shipboard computer. Based on that information, the shipboard artillery aimed at whatever the RPV 'sees'. Marines also used the RPVs's for aerial patrols along the Saudi-Kuwait border. The infrared capacity of camera picked up troops and vehicles on the ground hidden behind camouflage. It picked out targets for bombing. When bombing raids were over, it circled over the area and sent back live TV coverage of the damage done. RPVs were also used to collect mapping information to guide Tomahawk cruise missiles to their targets.[28]

PATRIOT AIR DEFENSE MISSILE

During Operation Desert Storm the Patriot received more attention than other weapons. The PATRIOT system surrounded many of the coalition air bases and troop locations in the Gulf region to protect them from incoming Iraqi missiles and aircraft. Although there have been some questions about its effectiveness, initial reports demonstrate that the PATRIOT missile is successful in destroying incoming Iraqi SCUDs moving towards Israel and Saudi Arabia. Patriots used an elaborate early warning system that gave controllers about six minutes warning prior to interception of the incoming missile. Iraq had no comparable weapon.

President Bush, Israel, and the families of the servicemen in the Gulf had great respect for this anti-missile defense system which intercepted and, maybe destroyed dozens of incoming SCUD missiles. This system, also served other purposes, including international diplomacy in helping to keep the Israelis at bay and domestic political concerns in calming the fears of many families of servicemen in the Gulf.[29]

Overall, the coalition air campaign accumulated a total of 109,876 sorties over the 43-day war, an average of 2,555 sorties per day. Of these, over 27,000 targeted Iraqi Scuds missiles, airfields, air defenses, electrical power, biological and chemical weapons, headquarters, intelligence assets, communications, the Iraqi army, and oil refining.[30]

We can get some perspective on the scope of the Gulf air war by comparing it to some predecessors. The following table presents U.S. Army Air Forces, and U. S. Air Force bomb tonnage statistics extracted from various wars, compared with Air Force tonnage dropped in the Gulf War:

War	Tonnage	Length	Tonnage/Month
WW II	**2,150,000**	**47,777.78**	**45 months**
Korea	**454,000**	**12,270.27**	**37 months**
Vietnam/SEA	**6,162,000**	**44,014.29**	**140 months**
Gulf War	**60,624**	**40,416.00**	**1.5 months**

Source: www.fas.org/man/dod-101/ops/desert_storm.htm

NAVY IN THE GULF WAR

Desert Strom demonstrated that sustained war efforts must be supported by sea in order to greatly enhance the available air capability.

FRIGATES

Despite the Iraqi Navy and Air Force's inability to fight, frigates were called on to escort larger ships and defend them from attack. Several frigates, including the U.S.S. Curts and the U.S.S. Nicholas undertook offensive operations, attacking Iraqi oil platforms and ships and capturing a number of enemy prisoners of war. Frigates also played a large role in the interception of merchant vessels.[31]

DESTROYERS

U.S. destroyers played an important role in the interception and interrogation of enemy and unfriendly shipping in the Gulf region. With the elimination of the Iraqi Navy's smaller patrol boats, the U.S. destroyers were able to operate without much fear of any anti-ship missile. Coalition navy used it as a platform for Tomahawk missiles.

CRUISERS

Cruisers in the Gulf were successful in their primary role of protecting the fleet from air attack. The AEGIS cruisers coordinated all incoming intelligence from its own radar and other surface ships, made sure that no U.S. ships were lost to enemy attack from the air, despite the threat of Iraqi Exocet and Silkworm missiles. Cruisers also played a major role in the blockade of Iraqi shipping and stopping hundreds of suspect vessels.[32] Iraq had no comparable vessel.

AMPHIBIOUS CRAFT

TARAWA CLASS:

Amphibious Assault vessels played a large role in deceiving Iraqi forces. These vessels gave the impression to Iraqi forces that an amphibious operation was imminent. These ships loaded and launched a number of landing craft and helicopters giving the

impression that the Marines would be coming ashore on the Kuwaiti coast. In the end, the invasion did not come, but these ships were essential resupply bases for Marines and other inland units. In addition, AV-8 Harrier Jump Jets used these ships as a platform for carrying out close-air support attacks on Iraqi forces.[33]

AIRCRAFT CARRIER

NIMITZ CLASS: CVN-71 THEODORE ROOSEVELT

Aircraft carriers are the ultimate power projection weapons. The carrier can place 90 aircraft. In the Persian Gulf, they used as platforms to launch attacks on Iraqi forces and provide air support to the fleet in the Gulf.

Around 20% of the sorties launched by U.S. air power came from the carriers in the Gulf and the Red Sea. The six carriers on station were used to launch a variety of raids against strategic and tactical targets, along with support and command operations for Navy and Marine aircraft in the theater. Despite fears of anti-ship missile attack, the six carriers emerged from the battle unscratched. Iraq has no comparable vessel. It is likely that some carrier presence will be maintained in the Gulf region for several years to come.[34]

LAND SYSTEMS IN THE GULF

M-1 ABRAMS

The M-1 mounts an M68E1 105 millimeter main gun. Two 7.62mm M240 machine guns are also mounted. It was the principal U.S. heavy tank used in the Gulf War. The heavy U.S.-based divisions arriving in the Gulf during the fall of 1990 were equipped with the earlier M1. The U.S. Army in Saudi Arabia probably had about 1,900 M1A1 tanks.[35] Because of its stabilized gun mount its has the ability to fire when moving at speed over rough ground. This capability made it valuable in the Gulf. The Abrams tank also has FLIR, an infrared vision device that proved effective not only at night, but also

in the dust and smoke of Kuwaiti daytime. On average, an Abrams outranged an Iraqi tank by about 1,000 meters.

SPACE WARFARE

Desert Strom was an information war and probably the first space war. It was the first war where combat forces were deployed, sustained, commanded and controlled by satellite communications. Satellites, space-based sensors, cameras, radars and communication repeaters, surveillance and earth observation navigation systems provided allied forces a decisive edge in the Gulf War. These included sensors that tracked tanks, artillery, and scuds, the intelligence centers that correlated and fused these data, and the command centers that adjusted war plans based on this near real-time information.[36] A full range of military space systems was directly used in this war including 60 Western military satellites. These satellites enabled an effective and secured tactical communication network that supported a 400,000 army to be established in theater in a few weeks.[37] At each stage, satellites provided not only intelligence but also told individual units where they were, what forces they face and what their commanders thought they should do.[38] They provided detailed images of Iraqi forces and their damage caused by allied air attacks. Space-based navigation system gave a perfect accuracy, which enhanced the performance of soldiers, missiles, tanks, aircraft and ships. Commercial satellites and observation systems were also used during the Gulf War.

SPACE SYSTEMS

The war with Iraq was the first conflict in history in which the coalition forces had a comprehensive support of space systems. Space systems communications played a central role in the effective use of advanced weapon systems. All of the following space

systems helped the Coalition's air, ground, and naval forces in winning the Gulf War against Iraq: The DMSP (Defense Meteorological Satellite Program) weather satellites; US LandSAT multi-spectral imagery satellites; the global positioning system (GPS); DSP (Defense Support Program) early warning satellites; the tactical receiver, equipment and related applications satellite broadcast; the Tactical Information Broadcast Service; as well as communications satellites.

DSP was the primary Scud launch detection system during Operation Desert Storm. The DSP constellation and associated ground station processing provided crucial warning data of Scud launches. This data was disseminated by a variety of means. The national military command center used DSP data to provide military and civilian warning to Israel and the Gulf states.

GLOBAL POSITIONING SYSTEM (GPS)

NAVSTAR GPS has many applications in all functional war-fighting areas and played a key role in Operation Desert Strom. The Gulf War was the first combat use of the GPS, and it was hugely successful. The GPS satellite constellation has proved to be a most valuable aid to U.S. military forces during Operation Desert Strom. Land navigation proved the biggest beneficiary, giving Coalition forces a major advantage over the Iraqis.[39] With its featureless wide area of sand the Iraqi and Kuwaiti terrain looks much the same for miles. It made the big night maneuvers possible. With GPS, the soldiers were able to go to different places and maneuver in sandstorms or at night when even the troops who lived there couldn't. Without a reliable navigation system, coalition forces could not be able to perform the maneuvers of Operation Desert Storm. GPS made it possible for the attackers to shift their attack plans back and forth virtually up to the moment of attack.

GPS was a blessing for ground troops traversing the desert, especially in the frequent sandstorm. Tanks crews and drivers of all sorts of vehicles depend on the system. Meal trucks were equipped with GPS receivers to enable drivers to find and feed soldiers of frontline units widely dispersed in the theater of war. Initially, more than 1,000 portable commercial receivers were purchased for their use.[40] However, the demand was so great that more than 12,000 commercial receivers were in use in the Gulf region before the end of the conflict. They were carried by foot soldiers and attached to vehicles, helicopters, and aircraft instrument panels.[41] GPS receivers were used in several aircraft, including F-16 fighters, KC-135 aerial refuelers, and B-2 bombers. The marines received fresh intelligence of Iraqi positions, and Iraqis movement of forces. Navy ships used them for meeting, minesweeping, and aircraft operations.

GULF WAR SATELLITE COMMUNICATIONS SYSTEMS

Space-based sensors, cameras, radars and communications repeaters were the elements that gave the coalition forces a decisive edge. During the Gulf War, satellites carried out the task of delivering military trunk traffic (secure speech, FAX, telegraph, data) into and out of the theater.[42] They provided total communications to ships, to moving troops and to military aircraft. The forces could make telephone call allover the world.

Iraq had no military satellite except an access to civil international networks, Intelsat, Inmarsat and Arabsat, which destroyed in an early bombing campaign.

DEFENSE SATELLITE COMMUNICATIONS SYSTEM (DSCS)

Before the Gulf War, the US super-high frequency (SHF) Defense Satellite Communications System (DSCS) provided the telecommunications by its Eastern Atlantic (EA) and Indian Ocean (IO) satellites.[43] The total military traffic over these two satellites was about 4.5 Mb/s equivalent to around 70 commercial voice circuits. But during the Gulf War, 48 tactical terminals had been deployed in the theater and the

traffic had increased to 38 Mb/s (600 vice channels).[44] By the mid September, DSCS increased its Gulf traffic capacity by realigning its multibeam antennas. After few months, when 200,000 more U.S troops were deployed to the Gulf, DSCS traffic had risen to 68 M/s (1,100voice circuits) and the number of earth stations was increased to 110.[45]

Before the Gulf War, the British Army had only six aging and small transportable terminals of a single 2.4 Kb/s channel of multiplexed voice and telegraph. And six months later at the outset of Gulf War, British forces were operating 26 land mobile/transportable terminal in the theater with a combined traffic of more than 23 Mb/s (300 voice channels).[46] Naval ships supporting the Operation Desert Strom also enjoyed communications via satellite, which allowed direct links with other allied vessels and with local and national headquarters. The U.S. Navy used ultra-high frequency (UHF) satellites, which had limited capacity and faced with interference. While Royal Navy of the U.K. uses SHF satellite communications. But during the Gulf War, Royal Navy had also fitted additional terminals to communicate with other user systems in the Gulf. In order to communicate with US Navy fleet in the area, UHF terminals were installed and commercial Inmarsat terminals were fitted to provide contacts with merchant ship in order to enforce the United Nations embargo.

CIVIL COMMUNICATIONS

Along with the immense use of military satellite communications resources, international commercial satellites networks, Intelsat and Inmarsat were also extensively used in support of Operation Desert Strom. Inmarsat and Intelsat reported a 50 percent growth in Gulf traffic between January and March 1991. The full-time television channel usage increased from 2 to 22 channels according to Intelsat as well as 65

temporary TV and telecommunications earth stations were licensed to operate in the area.[47]

NAVIGATION

At the outset of Desert Strom, there were 13 navigation satellites in the space providing two-dimensional positioning service in the Gulf area for up to 22 hours per day and with three dimensional positioning service for around 16 hours per day.[48]

During the Gulf War, coalition forces used around 12,000 personal GPS receivers. Using hand-held GPS receivers, a ground soldier could locate his position and able to obtain the range and bearing of the target. In this way, with the help of their GPS receiver, the coalition army was able to attack with surprise and lethal precision. Magellan GPS receivers were fixed in Cobra and Huey helicopters, in F-111s and B-52s, in British Tornados and French Jaguars as a part of survival kit of the air crew. These receivers could also be fixes on ships and landing aircraft, on tanks and armored vehicles and in forward observation posts directing air and ground artillery strikes.[49]

SURVEILLANCE

Civil and commercial earth observation and weather satellites provided key surveillance support to Gulf forces. More than 30 Western commercial and military surveillance satellites provided intelligence to coalition forces during the operation.

EARLY WARNING

The U.S. Defense Support Program (DSP) is third generation satellites deigned to provide early warning of Soviet intercontinental missiles. These satellites monitor missile launches from its 35,000 km geostationary with the help of scanning infrared (IR) telescope, capable of 3km resolution.[50] The White Cloud ocean surveillance satellites are also U.S. spaced-based early warning systems.

DSP satellites played an important role in providing early warning of Scud launches to Patriot crew during the Gulf War. During Operation Desert Strom, the U.S. had as many as 4-5 DPS satellites in orbit.

COMMERCIAL EARTH OBSERVATION

Civil remote sensing satellites played a key role in the Operation Desert Strom in providing up-to-date, wide area information in the theater. Pentagon spent up to $ 6 million on Landsat and SPOT commercial earth observation satellites during the Gulf War for tasks including quick response map-making, flight planning and images showing the location and description of a large infrastructure.[51] These satellites provide 185 km square images. The SPOT satellite carry optical sensor that provide multispectral images at 20 meter resolution. The two imagers that SPOT 1 and 2 carry can capable of recording a combined instantaneous Earth picture.

Iraq, in contrast, had no military space assets. Iraqis did have access to civil international network, Intelsat, Inmarsat and a share in Arabsat that operates two regional telecommunications satellite covering the area. However, Arabsat earth station in Baghdad was an early victim of coalition forces's air strikes.

DESERT STORMS COMMUNICATIONS

The factor that best contributed (among other factors) to the victory of allied forces in the Persian Gulf War was information systems based on computers and communications that synchronized every aspect of war. The latest advances in computer communications technology were put to their first wartime test in Operation Desert Strom. The Army Central Forces Command and Control Information Systems (AC2IS) provided staff officers with a secure means to quickly passed electronic messages and transfer data files long distances.[52] The communication network that supported

Operation Desert Strom was the largest joint theater system ever established. In order to connect users, the system combined special computer networking equipment with existing automation and communication equipment. AC2IS was a more accurate system and could transfer the file to any other center to any other station on the network, including stations in the United States or Germany in less time than a secure FAX machine could take to make a connection. During the operation, this system supported 700,000 telephone calls and 152.000 messages per day and more than 30,000 radio frequencies were managed to provide necessary connectivity and to ensure minimum interferences.[53] This network relied on circuit and message switches that had been developed under the joint TRI-TAC program. By the end of Desert Strom, there were more than 3,000 computers in the war zone linked to other numerous computers in the United States.[54]

ELECTRONIC WARFARE IN THE GULF WAR

The Coalition used extensive ESM during operation Desert Strom that yielded a comprehensive intelligence picture of battlefield as well as of Iraqi forces. The Coalition forces had specialized ESM aircraft including U.S.Air Force RC –135s; British RAF Nimrod R.2s; and French DC-8 Sarigue, an EC-160 Gabriel, and two modified SA 330 Puma helicopters. These aircraft were used to collect COMINT and some could relay intercept data in real time through a wideband satellite link.[55] EW combat aircraft such as the U.S. Navy's EA-6B, Air Force's F-4G, EF-111A, TR-1As and RF-4Cs were also used for COMINT collection and radar surveillance.[56] These combat aircraft were supplemented by U.S. Army ESM aircraft including RC-12s and RV-ID Quick Looks and helicopters including EH-60 A Quick Fix IIBs that provided intelligence vital to the rapid movements of the ground campaign.

At sea, eight U.S. submarines conducted surveillance and reconnaissance operations using ESM, and also provided indications and warning for carrier battle groups. French electronic research ship *Berry* was also used against Iraq. Along with ESM capabilities, the Navy used " bolt-on" ELINT (electronic intelligence) and COMINT systems.[57]

In space, two U.S. geostationary ELINT satellite Magnum and Vortex were stationed over the western Indian Ocean to provide information on Iraq. As continuous advancements in satellite technologies had accelerated the intelligence flow considerably, the ELINT satellites provided information to field commanders promptly. Ground-based strategic ELINT sites for the intelligence efforts against Iraq were installed in Saudi Arabia, the United Arab Emirates, Oman, Cyprus and in Djibouti.

Electronic counter measures were extensively used in the Gulf War. Almost every fixed-wing tactical aircraft had internal or podded jammer and many helicopters had self-protection ECM gear.[58] The most formidable ECM aircraft were the U.S. Air Force's EF-111A and the Navy-Marine Corps EA-6B. Both the aircraft had powerful ALQ-99 jamming system and were used through the war to escort air strikes, providing jamming support that enabled tactical aircraft to penetrate to their targets. EA-6B support prevented the strike aircraft from Iraqi SAMs.

U.S. Air Force EC-130H Compass Call aircraft had the mission of air communications jamming. These aircraft along with surface-based jammers and accurate air strikes severed the control links from Saddam's centralized national command authority to his troops. The coalition wisely used ESM and hard-kill weapons in order to defeat Iraqi C^3I and air defense. Hard-kill systems included U.S. Air Force F-4G, "Wild Weasels" as well as F-117 s and F-16s, U.S. Navy-Marine Corps EA-6Bs and F/A-18s using anti-radiation missiles (ARMs). Attacks on the key nodes of the Iraqi C^3

systems with hard-kill weapons supplemented Paveway laser-guided bombs, in the first hours of the war were so destructive that Iraq never recovered.

It some times became difficult to maintain effective electronic control in the Coalition force particularly the Saudi did not have such control. Iraq made extensive use of EMCON. When war started, Iraq activated its radars. However, Coalition forces soon destroyed Iraqi radars. By January 23rd, almost 95 percent of Iraqi radars were destroyed. The Iraqis were also quite good in using tactical EMCON and they effectively controlled radar emissions from their missile sites until the last moment. The Iraqi had first and second generation secure radios with ECCM capability however, they used them less effectively.

ECCM proved vital in the success of secure and reliable Coalition communications. The United States had a wide array of electronic and electronically enhanced systems deployed throughout the Middle East.

INTELLIGENCE WAR IN THE GULF

The manifestation of IWB was witnessed in the Gulf War 11 in 1991, in which JSTARS aircraft were employed to give real time data for conducting precision strikes. Desert Strom proved to be a decisive military operation also because of the systems that collect, analyze, fuse and disseminate intelligence. When Desert Strom began, many intelligence systems were come onto center stage. Air Force intelligence personnel at Central Command Air Force (CENTEF) in Saudi Arabia were force to bring together a number of different systems into an integrated architecture to provide the operators with timely intelligence.

Successful operations depend on the knowledge of enemy force capabilities, dispositions, intentions and operations well as the battlefield environment. In the Gulf War, technology had achieved the level of a high degree of information (or in its refined

form—intelligence) and this war was a crucible for systems that collect, analyze, fuse and disseminate intelligence. When operation desert Storm started, many intelligence systems, in various states of development, were come to the fore to provide the operators with timely and fused information. In order to do this, a variety of collection assets employed from the national to theater level. Once the information was collected, some of it was processed and analyzed at intelligence centers at United States, and some of it was done in-theater at joint intelligence centers and component command intelligence organisation.[59]

The coalition was able to monitor and intercept Iraqi communications throughout the war by deploying a vast array of intelligence-gathering systems.

In space these assets consisted of:

1. One Vortex SIGINT/COMINT and two Magnum telementry satellites in geostationary orbit feeding information to ground stations at Pine Gap (Australia), Bad Aibling (Germany) and Menwith Hill (UK).

2. The geostationary Defense Support Program (DSP) satellites capable of infrared detection of missile launches feeding information to ground stations at Nurrungar (Australia) and at Kapaun (Germany).

3. Between five and seven Keyhole photo-reconnaissance satellites in 500 km orbit able to transmit images via the US Satellite Data System (SDS), NASA Tracking And Data Relay and commercial satellites

4. One Lacrosse radar all weather satellite in 500 km orbit.

5. The US Navy deployed the Project White Cloud ELINT satellite clusters, based on a mother satellite and three sub-satellites for ocean surveillance.

In the air, the allies deployed the U-2 and TR-1 high altitude surveillance aircraft and the RC-135 "Rivet Joint" aircraft for strategic intelligence and the E-3A, AWACS, EF111, RF-4C, Navy E-2C "Hawkeye", P-3C Orion, Army RC-12D "Guard Rail", RU-21 H "Ute", OU-ID "Mohawk" and Marine Corps C-130 "Senior Warrior" aircraft for tactical intelligence. The US also deployed two Joint Surveillance Target Attack Radar

System (Joint STARS) for tactical intelligence on ground movements. This tactical air-borne intelligence was supplemented by UAVs

In the ground the allies deployed a vast array of intelligence-gathering systems in the regions including 17 SIGINT in Turkey, 18 in Saudi Arabia, 12 in UAE and several in Oman.[60]

In the Operation Desert Strom, contrarily, Iraqi forces were devoid of space-based sensors and other information-gathering devices. In contrast of Iraq, commanders of coalition forces were receiving a level of intelligence support more than any commanders in the previous conflict. During the Gulf War, deception, due to the absence of Iraqi space-based sensors, false radio signals and strict operational security by coalition forces had tricked Iraqi forces into believing that the U.S. XIIIth and VIIth Corps were still stationed along the Saudi border with Kuwait.

In the information war scenario, availability of knowledge will be crucial and IBW provides the platform for this purpose.

PSYOP DURING THE GULF WAR

The Gulf War brought a whole new meaning to the use of multimedia in psychological operations including radio and TV broadcasts, leaflets, and loudspeakers. During the Gulf War, America won world opinion against Iraq through televised campaign of CNN. It was the first war to be televised live. The U.S. in the Gulf War of 1990-91 won psychological warfare too by successfully using media. The coalition media reports made the Iraqis believed that the air war was to be a short-term strike, followed by an immediate ground war, in which they felt themselves to have the advantage of numbers and territorial dominance. The Iraqi forces were also kept busy along the Kuwaiti coasts, by means of disinformation of an imminent American coastal offensive. Iraq believed that the United States would try to recapture Kuwait from the sea.[61] Likewise, In the

Gulf War, Coalition forces convinced many Iraqis that if they abandoned their vulnerable vehicles they would live longer. One of the most effective tactics involved the dropping of leaflets on a particular unit, informing it that it would be bombed within twenty-four hours and had to surrender to avoid destruction. Over a seven-week period, 29 million leaflets in at least 14 varieties were dropped behind Iraqi lines.[62]

The 4th PSYOP Group of coalition forces began broadcasting the "VOICE OF THE GULF" radio network on 19 January 1991. It operated continuously through 1 April 1991 with more than 210 hours of live broadcasting and 330 hours of prerecorded programs. A total of 2072 news items were aired along with 189 PSYOP messages.[63]

One of the best examples of the successful use of loudspeakers occurred during the Gulf War. on Faylaka Island, rather then a direct assault, a tactical PSYOP team from the 9th PSYOP Battalion, flew aerial loudspeaker missions around the island. The message told the adversary below to surrender the next day in formation at the radio tower. The next day 1,405 Iraqis, including a general officer, waited in formation at the radio tower to surrender to the Marine forces without firing a single shot.

The coalition forces developed a videotape, called *"Nations of the World Take a Stand"*, that showcases the coalition's military might. The video was circulated throughout the Middle East, and more than 200 copies were smuggled into Baghdad.

The International Red Cross reported that nearly 87,000 Iraqi soldiers surrendered themselves to coalition forces, most of them holding the leaflets or hiding them in their clothing. These proved the PSYOP mission's worth and saved countless enemy and coalition lives.[64]

In the aftermath of the Gulf War II and the lessons learnt by this war convinced the advanced nations by setting in motion a conception that the nature of war is undergoing

radical changes due to increasing use of information technology such as computers and satellites in actual conduct of warfare. Gulf War II is an important landmark as it brought sea change in a way war has been waged. Desert Strom indeed suggests that a new RMA is emerging. It may have provided a glimpse of major transition to a different type of warfare heavily based on information processing stealthy long-range precision strikes. It gave rise to a new framework and new war terms such as 'post modern war', 'information warfare', and 'knowledge-intensive warfare'. The Gulf War has also convincingly demonstrated that information-based armies can quickly and decisively defeat the industrial armies.

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CONCLUSION

Mao Ze Dong once said, "A revolution is not the same as inviting people to dinner, or writing an essay or painting a picture. It is nothing so refined". Same is the case with revolution in military affairs. It is equally unrefined. Because it is really challenging to blend on-going revolutionary changes in information technologies to warfare on land, at sea and in the air.

This description of the revolution in military affairs is neither definitive nor conclusive. This discussion is intended primarily to stimulate thinking in a more meaningful ways about how future warfare may be different than it is today and, how information revolution will alter the modes of waging war.

Information warfare does represent a new paradigm in military thinking. The idea of information warfare stresses digitization of the battlefield and improvements to smart weapons and intelligence devices. The increased speed and precision of modern weaponry make information the heart of RMA and an essential dimension of warfare. Information-based technologies have made the traditional methods of war fighting obsolete to the larger extend and created a space-based battlefield by blending the land, sea and air power. This kind of battlefield would be dominated by real time information, instant communications, on-line command and control, and lethal long-range precision strikes.

There is no doubt that the United States introduced the same new form of information-based warfare in the Persian Gulf in 1991. By using and exploiting knowledge, it destroyed the fourth largest army of the world and the overall Iraqi military formation. Technologically-dense weapons and superbly trained and skilled military commanders and their personnel played key role to US success in Gulf War. This war has changed the standards of war fighting. The factor that best contributed

(among other factors) to the victory of allied forces in the Persian Gulf War was information systems based on computers and communications that synchronized the air campaign. Without those systems, combat forces could never have been applied so skillfully and effectively and the outcome of war might have been different. The military use of information technology was at its peak during the Gulf War. New technologies enhanced the ability of Coalition forces to exchange and use information, and denied the adversary's ability to communicate with his forces.

Basically, the RMA is about a process of transformation and Desert Strom represented at least the beginnings of a transformation of the means and methods of war. It is a clear evidence that there is a revolution in military affairs in progress and a major change in the nature of high intensity warfare is occurring. A network equipped with advanced sensor systems such as communications satellites and high-speed information processing system will dramatically improve the battle-space awareness capability. Satellites and other sensors such as the Global Positioning System, space-based communications, AWACS and JSTARS aircraft and battlefield computers will provide commanders a "God eye's" view of the battlefield and a new generation of long-range precision weapons guided by signals from these satellites will strikes accurately regardless of weather or the time of day. All these instruments will largely dispel the fog of war that has been a persistent feature of the battlefields throughout history. As the fog of war will become thin, each and every fighting unit will have instant access to precise battlefield information. Consequently, the new information-based battlefield will become a very lethal battlefield because essentially anything that can move can be detected and hit from a distance.

The extensive use of electronic, intelligence and psychological war forms, military commanders of future warfare will receive a far greater level of electronic, communication and intelligence support.

Precision strike will hold an enemy at a distance and blind and immobilize him by destroying operationally and strategically crucial targets. While Dominating maneuver will deploy the right forces at the right time and place to cause the enemy's psychological collapse and complete defeat. Space warfare will enable the countries to project force at dramatically increased speeds while denying the enemy the ability to do the same. This is the overall concept of RMA.

Of course, these conclusions are based on the experiences of the Gulf War 1991. The possibility cannot be excluded that future developments in weapons technology, doctrines and organisations might change the dynamics of battle. Because a central element of this notion of the RMA is computer technology that is now highly market-driven, it is unlikely that the pace of change in this area is going to slow. Countries that can exploit emerging technologies and combine the same with innovative operational doctrines and organizational adaptation could doubtless achieve military effectiveness.

So, after observing the present military scenario, we can say that a revolution in military affairs has indeed begun but it will be shaped by the integration of different elements with technology. We expect that the true revolutionary impact of future changes in the conduct of warfare will come from the combination of information warfare, precision strike, dominating maneuver, and space warfare. And these changes are driven by innovations in information technology and complementary adjustments to military doctrine and organisation.

APPENDIX

COMPONENTS OF ADMIRAL OWENS'

SYSTEM OF SYSTEMS

AIR-HAWK---An air-to-ground version of the Tomahawk Land Attack Missile. See TLAM(BLK III) below. Range more than 350 nm.

AGM-130---An Air-to-Ground missile guided by television or infrared from the launching aircraft. Range more than 15 nm.

ATACMS/BAT---Army Tactical Missile System with Brilliant Anti-Tank sub-munition. ATACMS is an all-weather tactical missile. BAT is a self-guided submunition with acoustic and infrared sensors that autonomously locates and attacks tanks or other armored vehicles. Range more than 15 nm.

ATARS---Advanced Tactical Airborne Reconnaissance System. An airborne reconnaissance pod with a data downlink capability to be carried by tactical aircraft.

AWACS---Airborne Warning and Control System. A long-range moving aircraft detector radar carried by a Boeing 707-type airframe.

CALCM---Conventional Air-Launched Cruise Missile. A converted Air-Launched Cruise Missile guided by an inertial navigation system and the Global Positioning System. Range more than 350 nm.

CGCS---Global Command and Control System. A group of military systems to provide high-level military and civilian leaders information processing and dissemination capabilities to conduct command and control activities.

C4IFTW---Command and Control, Communications, Computers, and Intelligence For The Warrior. A conceptual framework for providing a battlefield commander the information he wants, when, where and how he wants it, anywhere in the world.

DISN---Defense Information System Network. A digital information system designed to meet all Department of Defense requirements for voice, video, and data communications.

DMS---Defense Message System. A digital system designed to replace two earlier systems for transmitting messages on the Department of Defense Internet.

FDS---Fixed Distribution System. A supplemental detection capability to be added to the SOSUS (SOund SUrveillance System) undersea submarine detection system at choke points.

HASA--High Altitude Signals Intelligence Architecture. A system for structuring the acquisition of signals intelligence from high altitude platforms.

HARM---High Speed Anti-Radiation Missile. An airborne missile designed to attack radar transmitters. Range more than 15 nm.

HAVE NAP---AGM-142 An air-to-ground medium-range precision guided missile carried by B-52 aircraft. Range more than 15 nm.

HELLFIRE II---A short-range laser-guided missile usually carried by Army and Marine Corps helicopters.

ISAR---Inverse Synthetic Aperture Radar. A type of radar especially suited for generating high-resolution images of moving targets. Carried on some Navy aircraft for surface search activities.

JAVELIN---A man portable fire-and-forget anti-tank missile.

JSIPS---Joint Service Imagery Processing System. A ground station common to all services for receiving, processing, and disseminating satellite transmissions.

JSTARS---Joint Surveillance Target Attack Radar. Similar to AWACS above, but devoted to the detection of moving and certain fixed ground targets. Based upon a Boeing 707-type airframe.

JWICS---Joint Worldwide Intelligence Communications System. A secure high speed, multi-media communications network for the defense intelligence community. Transmits voice, text, imagery, and data.

LINK-16---The NATO version of TADIL-J. See below.

MIIDS---Military Intelligence Integrated Database System. A general military data base containing information on order-of- battle and installations.

MTI---Moving Target Indicator Radar. The capability of a radar to automatically identify moving objects.

REMBAS---Remotely Monitored Battlefield Sensor System. A remote ground system capable of identifying vehicles through acoustic and seismic sensors and reporting over a data link.

RIVET JOINT---An airborne signals intelligence gathering aircraft based upon a Boeing 707-type aircraft.

SABER---Surface Analysis Branch Exploitation and Reporting. A Navy Intelligence Analysis Unit located in Suitland, Md.

SADARM---Sense and Destroy Armor. A submunition capable of detecting and destroying lightly armored vehicles. Can be launched in 155mm artillery rounds or by the multiple launch rocket system.

SBIR---Space-Based InfraRed. A satellite capability to provide improved infrared detection, location and tracking of hot infrared events such as missile launches.

SFW---Sensor Fused Weapon. An anti-tank cluster bomb capable of destroying heavy tanks by attacking their top armor. The SFW dispenser carries 10 submunitions each of which in turn carries four Skeet anti-armor warheads.

SLAM---Stand-Off Land Attack Missile. An air-to-ground missile guided by a video data link, GPS and a terminal imaging infrared seeker.

SONET---Synchronous Optical Network. A high-speed, high-capacity digital optical path for data or voice transmission.

TACSAT---Tactical Communications Satellite. The group of satellites supporting tactical ground forces.

TADIL-J---Tactical Data Information Link-J. A secure anti-jammer transceiver that provides real-time data between sensors, weapons and command and control systems.

TARPS---Tactical Air Reconnaissance Pod System. An airborne photo reconnaissance system without data downlink capability. See ATARS.

THAAD---Theater High Altitude Area Defense. A theater missile defense system designed to intercept short and intermediate- range missiles.

TIER 2+---A high-altitude, long endurance unmanned aerial vehicle for targeting or intelligence. Endurance of more than 30 hours at 12 mile altitudes.

TIER 3---A low observable (stealth) unmanned aerial vehicle. Lesser capabilities compared with Tier 2+ because of stealth tradeoffs.

TLAM(BLK III)---Tomahawk Land Attack Missile.(Block III). A long range, very accurate cruise missile with upgraded navigation and targeting capabilities. Range more than 350 nm.

TRAP---Tactical Receiver Equipment and Related Applications. A system which broadcasts time-sensitive intelligence in pre- formatted messages.

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