FUTURE WARS AND AEROSPACE POWER

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Soon after the Iraqi Army moved into Kuwait in 1990, heralding the inevitability of Gulf War 1, and before Operation Desert Storm was unleashed, Saddam Hussein is reported to have said, "The United States depends on its air force, and everyone knows that no one ever won a war from the air." If this was intended to be a factual statement, it was correct. On the other hand, if it was suggestive of the ineffectiveness of air power, Saddam Hussein made a serious miscalculation. He was proved wrong twice, with grave and graver consequences. From World War II onwards, air power has had an increasingly significant role to play. Interestingly, no country has ever won the air war and then lost the war. On the contrary, there are many instances where winning the air war markedly eased the way to victory. As air power capability improved, more and more reliance was placed on it. In the 1999 Kosovo conflict, the war objectives were fully achieved with the employment of air power alone. Such an eventuality may not recur very often, but it is now generally accepted, even by the committed detractors of air power, that it has a decided, and sometimes decisive, role to play. Technological developments are rapidly increasing the potential of air power. It is opined that the role of air power, or more correctly, aerospace power, in the resolution of future conflicts, will only increase.

In the last decade or two, there have been tremendous improvements in information technology, communications, engineering, propulsion, exploitation of space and the electro-magnetic medium, etc. The changes have transformed our lives, impacted the geopolitical dimension, and the

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manner in which governmental machinery functions. Major changes have also come about in the way we do business. Little wonder, therefore, that the changes have impacted the military dimension with equal force. Substantial advances have been made in military equipment, weaponry and all round capability. The revolution in military affairs (RMA) has matured. What is of greater import is that transformations continue to occur. The pace of change is rapidly increasing, and such accelerated changes are bound to continue. At the same time, the nature of war is also changing. The spectrum of war is expanding and the concept of conflict is becoming more complex. Its resolution is also becoming more complex. In fact, developments in the nature of war and how to wage it are inextricably linked like never before. In times to come, the changes and developments will be faster and over a larger ambit. To deal with such situations, the military mind has to become more fluid and receptive to absorb the changes, be able to forecast the impact of likely changes, and adapt to the changing order of how to bring about optimum utilisation of military capabilities. This is easier said than done.

In analysing the role of aerospace power in wars of the future, it will be worthwhile to first discuss the expected nature of conflict and means to counter the threat. Thereafter, the impact of recent and expected developments on air operations is analysed.

NATURE OF FUTURE WARS

A full-fledged military war is highly unlikely. International opinion, economic interests, impact of globalisation, threat of sanctions, the unchallenged position of the United Stated as the sole hegemon, all militate against it. At the same time, conflict is an intrinsic part of human nature. It is doubtful if even sanctions, or threat of sanctions will be able to stop wars from continuing or breaking out. Conflicts will continue to occur, but their nature, purpose, and direction could be different and changing rapidly. Competition and greed are endemic to human nature. Plato was indeed right when he said, “Only the dead have seen the end of war.”

Military conflicts that do occur will probably be limited in terms of objectives, area, force utilisation and time; but the perpetrators and the responders will both use the military only as one part of a closely integrated multi-dimensional effort. This is an essential requirement for success. If it is also accepted that a multi-dimensional conflict is indeed a continuous process, even without the active participation of the military, the need for an integrated approach cannot be over-emphasised. This has enlarged the spectrum of conflict.

If war objectives are to be met by military means, adequate superiority is essential. Therefore, if there is no serious asymmetry in conventional war capability, a major war is unlikely. Similarly, if there is no major asymmetry in nuclear weapons capability, a nuclear exchange is unlikely.

The likelihood of a conventional war between two nuclear power states bears examination. Nuclear weapons have not only deterrent but also mutual deterrent value. It is difficult to define the limit of tolerance. Much will depend on relative strengths and perceived resolve. There can be doubt that a nuclear attack will invite not only an immediate nuclear response but also international condemnation. Such condemnation may not be short-lived. Again, the nation planning on the use of a nuclear weapon, must first consider the beneficial impact, if any, of a nuclear attack on the war aims and the post-war situation. Use of a nuclear weapon should never be considered in isolation. It is difficult to imagine a contingency where nuclear weapons could be advantageously used in war, unless it is erroneously believed that there will be no retribution in kind. As such, it appears that a fair degree of latitude is available in the prosecution of conventional war. In fact, it is much more likely that the level of military confrontation will be contained because of international pressure rather than the threat of use of nuclear weapons. As the horizontal proliferation of nuclear weapons takes place, as is considered inevitable by many informed sources, the chances of use of nuclear weapons are likely to decrease till effective missile defences create the asymmetry again.

In the present geopolitical scene, asymmetric warfare involving terrorism in its various manifestations, including sea piracy and export of terrorism, is likely to continue. This will be true as long as a concerted international effort is not made to combat it immaterial of other self-interests. In the real world, this utopian concept will remain utopian. Unfortunately, the international character of terrorism, the terrorist movement(s) supported wherever short-term or immediate interests so dictate, have made combating terrorism far more complicated. The interplay of the different dimensions, power centres, and conflicting interests, demand a fluid approach and an ever changing response. However, militarily, the situation is not markedly altered although some restraints may become necessary.

Intimidation and coercion have always been part of the lexicon of military conflict, and preemption is a valid military operation. It is suggested that such operations of war will continue.

The Iraq War in 2003 has thrown open the question of preemption and coercion. Intimidation and coercion have always been part of the lexicon of military conflict, and preemption is a valid military operation. It is suggested that such operations of war will continue; only the scale will depend on whether the operation is likely to be viewed as acceptable by international agencies. Alternatively, preemption in asymmetric warfare will be accepted as reasonable, and may not be even termed as preemption.

It will have to be a very powerful country that will be able to capture territory. “Occupation” is taken as a bad word and forcible “annexation” is taboo. The objectives of war have to be attained differently. This once again highlights the importance of the diplomatic, political and economic dimensions to both the prosecution and response to conflict. By the same token, attrition warfare has lost its meaning. It is too long drawn out a process, and attrition of military capability is unlikely to resolve the conflict.

Civil and military interaction is inescapable. Military capability, coupled with economic strength, and the convincingly stated resolve to use either or

both is a powerful deterrent. Different situations will warrant coercion in different manner, and such coercion should be a major weapon in the continuous nature of conflict that obtains. It is, however, emphasised that the resolve must be genuine, and perceived to be genuine. Psychological operations (PSYOPS) and effective, intelligent use of media are indelible ingredients of the coercion process. The issue requires no further elucidation.

To revert to military aspects again, use of precision weapons has come to be expected. The casualties have to be kept to the minimum to avoid international opprobrium. Availability of precision weapons; far greater reach that is now available both in terms of platform range and weapon stand-off range; and the lethality of weapons available automatically suggest that it is now possible, indeed advisable, to hit at centres of gravity of the adversary directly. With precision, there is less dependence on mass or numbers. Large forces needed so as to launch enough relatively inaccurate weapons for the same desired results, are no longer necessary. Hence, we should plan for, and expect, attacks in the hinterland, as part of the initial onslaught in a conventional battle, and also in asymmetric warfare. We should also plan for, and expect, 'attacks' intended to compromise the civilian and military 'data sphere.' This factor cannot be over-emphasised. The data sphere is always highly vulnerable and yet its importance is increasing rapidly. Hence, the need to protect it, or provide enough redundancies.

Countering the Threat

The term countering the threat refers to actions to support national interests. It is not necessarily defensive in character. Offensive action that furthers our cause, or pushes aside impediments to our objectives, is very much part of the term. In fact, an offensive proactive stance should more often than not be the preferred option.

Military combat is not an end unto itself but a means to an end. The principal requirement is to stipulate national objectives and establish why wars and conflicts have become inevitable. With this, if the desired end results are formulated, the means will suggest themselves. The twin intents

of conflict are to make it too costly for the adversary to continue along his chosen path; and, secondly, to do so in a manner that provides the best cost-benefit ratio. This is a gross over-simplification, but the principle is valid. The principle also implies a multi-dimensional approach so often referred to earlier. However, having made the point emphatically and often, the rest of the paper will be restricted to the use of armed forces, particularly air power, to effect conflict resolution.

Military combat is not an end unto itself but a means to an end. The principal requirement is to stipulate national objectives and establish why wars and conflicts have become inevitable.

Technological developments have made warfare more efficient, and weapon systems more effective. The advantages of speed, stealth, reach, precision, and lethality, all attributes of air power, have introduced a new paradigm in warfare. There is now no pressing requirement for a clear military victory to achieve national objectives. Earlier, more troops were required to produce the mass needed; more weapons to cater for inherent inaccuracies; and difficulties in rapid transit and perennial shortage of forces implied that the offensive could be launched only at selected places. The relatively slow tempo of war permitted regrouping and opposition by the adversary. The first purpose was to effect a breakthrough across a defended area or line. Alternatively, the objective was to deny such a breakthrough by the enemy. Attrition warfare was the norm. Further victories were needed over subsequent defended areas or defended lines. With military victory finally achieved over time, a favourable conflict resolution was facilitated as the adversary country found itself extremely vulnerable. In case of a military stalemate, nothing substantial was achieved.

The requirement of ground forces and their importance in the total war effort will always remain or even increase, but success in war is no longer an amalgam of many tactical successes. It is now possible to hit the enemy centres of gravity to start with. A sequential war is now not necessary.

Tactical victories along the battle front will remain important, but centres of gravity are unlikely to be found in the tactical battle area.

In the past, use of air power had similar problems due to lack of accuracy, reach and lethality. A form of sequential warfare had to be resorted to. As it happens, recent technological developments have impacted the effectiveness of air power to a far greater degree. RMA is, to a large extent, synonymous with enhanced air capability. If the purpose of war is to change the attitude of enemy leadership towards us, or create unacceptable paralysis in the enemy country, air power can now do so by attacking the enemy centres of gravity initially itself. More importantly, such centres can be attacked concurrently to create confusion, and force inability of the nation to recover in time to continue with the conflict effectively. The concept of parallel war is precisely this. The object is to attack a multitude of targets near simultaneously across the enemy country. The targets could include military assets; command and control networks; communications; rail and road movements; and national infrastructure, particularly water, electricity, sewage, as well as industry. Such attacks can be repeated over and over again till the enemy is not willing to absorb any more punishment and sues for peace. It will be noticed that it is possible to meet our objectives by the use of military forces, particularly air power, but without necessarily having to go through a string of military victories at the tactical level. Governments and national leadership are often brittle and will find it difficult to cope with damage or destruction of strategic assets on a large scale.

The scenario painted in the above paragraph relates to actions that can be taken by only a powerful country against limited opposition. However, once again, the principle and strategy are valid. If the adversaries are more evenly balanced, both sides will try and conduct parallel warfare. If the mutual threat is finite and likely to be effective, a deterrent is in place. Some superiority in terms of acquisitions for increased capability is needed. Thereafter, the air war must be won. Winning the air war was always important, but now it has become even more important given the tremendously

increased impact of air power. Therefore, both tactical and strategic air superiority is essential. Otherwise, once again, a stalemate could occur.

With the adversaries somewhat evenly matched, there will still be relative strengths and weaknesses that should be exploited. Operational plans are based on available resources but if available resources are inadequate, and our acquisition process is faulty and needs correction, what should be given due consideration is the high flexibility that air assets provide in terms of geography, type of target, location, etc in both offensive and defensive warfare. If we add to this the crucial time element during which the gains in war must be achieved, with the ability to respond to situations rapidly, the importance of air power becomes self-evident. Another factor that bears mention is that it is relatively easier to demonstrate air capability to deter the enemy. More importantly, the mere fact that air power can readily hit centres of gravity must have a sobering influence on a nation planning to impose its will. In conflict, demonstration of this capability over one or two target systems is bound to have a salutary effect. Such an impact can be created by air power alone. Thus, air power capability is cost effective, has inherent flexibility and deterrent value, is time sensitive and lethal, requires relatively very few people for similar desired effects, and ensures fewer casualties on both sides. It is bound to play a major role in conflicts. However, air power capability has to be created, and it follows that it should be so created.

Good intelligence is the key to air power effectiveness; air power is both ineffective and vulnerable without it. Intelligence is probably even more important in counter-terrorism operations. Air power assets are used regularly to garner intelligence and will continue to be so used, but they cannot provide all the intelligence required. Human intelligence will always be at a premium. However, the fact that a continuous, day and night surveillance and reconnaissance of designated areas is feasible should aid counter-terrorism operations considerably. Counter-terrorism as a subject needs to be studied in greater detail and our R&D tasked to improve

capability. Also, if counter-terrorism operations involve cross-border attacks, air power will once again be the indispensable if not the dominant force.

Air power characteristics and operations of war have remained near constant from the beginning; only the effectiveness and operational exploitation have altered with technological progress. Future developments will also alter or modify the utilisation of air assets. The impact of developments in the near term is next addressed.

IMPACT OF FUTURE DEVELOPMENTS

The core competencies of air power are winning the air war to achieve air superiority; precision and lethal attacks; rapid deployment of troops and equipment; and surveillance, reconnaissance and the exploitation of such information. No change in these core competencies is expected.

Domination of the air will remain a critical factor, and conduct of future wars will increasingly depend on the degree of air dominance. The developments in air defence systems which have made the probability of kills dangerously high will alter the concept of conduct of offensive air operations and vice versa. Similarly, more capable aircraft with extended flight envelopes and range will be produced. For economy, aircraft will be modified to perform two or more tasks. Armed forces will make increasing use of unmanned aerial vehicles (UAVs) and unmanned combat-aerial vehicles (UCAVs), and systems for safe, integrated use of fixed wing aircraft with UAVs and UCAVs will be in place. More effective surveillance systems will be fielded. Greater accuracy in weapon delivery will be made possible, not only by better systems, but also by ensuring accurate location information, relying on a networked system of geo-locating sensors based in space, in the air, and on the ground. Precision weapons will be the weapons of choice and non-lethal weapons will soon be operational. Improvements in these fields and more will continue bringing about changes in operational concepts. Operational utilisation of air power assets is outside the scope of this paper. However, two developments merit special consideration—the introduction of network-centric warfare (NCW), and exploitation of space.

Network-Centric Warfare

With war becoming more lethal, it has become necessary to speed up the pace of conflict to put the adversary at a disadvantage. This implies faster decision-making and faster implementation of decisions. NCW is intended to satisfy these requirements.

NCW is a product of the information technology (IT) revolution. Networking has always been beneficial. Whenever information can be pooled in a usable manner, the result is superior to the sum of different parts. Metcalfe's Law states that the power of the network increases with the square of the number of nodes connected to the network. The power of the network, therefore, increases significantly with every node that is added. The utility of networked information produced by integration of radars, communication systems, airborne warning and control system (AWACS), joint surveillance and target attack system (JSTARS), etc, is beyond dispute. NCW envisages the integration of information from *all* sensors and making it available as required, wherever required, to authorised recipients. The object is to provide a very high level of situational awareness that will, in its wake, lead to great efficiency in the prosecution of war. The availability of information is not intended to be a one way street, but field units can also demand information in real time, and vice versa. With an effective network, the geographic location of the controlling authority becomes irrelevant. It could occupy a permanent location immaterial of where the battle is being waged.

It will be obvious that with good situational awareness and communications, quick decisions can be arrived at, transmitted and implemented. This is a considerable advantage but NCW goes beyond that. NCW calls for a change in the war-fighting doctrine. The hypothesis is that with full situational awareness, and knowledge of the commander's plan, there is little need for further directions. The commander can always intervene if required but that should be as an exception. The field units can operate on their own, the planning is ongoing and continuous, and the time lines reduced considerably. For instance, 80 per cent of fighter aircraft that

took off from aircraft carriers in the Iraq War, 2003, were tasked after getting air-borne. If a similar system were to be extended to include all aircraft, and there were to be no tactical tasking agency, the sortie generation rate can be markedly increased safely and with great benefit. The system will take parallel war to its logical conclusion. Similarly, the concept of effects based operations (EBO) can be given full rein.

The question arises as to how NCW will operate if both sides are using a similar approach. For an answer, we must go back to the essentials of war-fighting.

With increased sortie generation rate, and near autonomous functioning, the observe, orient, decide, act (OODA) loop becomes irrelevant and so do areas of responsibility, linear battles and sequenced operations. NCW operates at the operational level, but impacts at the strategic level as well. Again, the higher efficiency implies the feasibility of reduced force levels. Also, the need for supervision decreases, and a flatter hierarchical structure is possible.

NCW will bring about greater capability. For instance, all types of aircraft could operate safely over a given area and in consonance. Once again, heightened efficiency will result. However, there are a few areas of concern. The most important concern is the vulnerability of the network. Networks are inherently vulnerable to both soft and hard kills, and adequate redundancy has to be built in. There are other problem areas like dealing with information overload, safety features to prevent compromising of the system, formulation of a clear, easy to understand doctrine and, above all, acceptance of the concept. All this will take time. The system is both exciting and promising. As it develops, many more advantages and operational concepts will be thrown up.

The question arises as to how NCW will operate if both sides are using a similar approach. For an answer, we must go back to the essentials of war-fighting. Before the advantages of NCW can be fully realised, the enemy network has to be attacked, and 'information superiority' gained and maintained. Again, in limited wars and counter-terrorism operations, what

would be the utility of NCW? The answer must be that much will depend on the situation. NCW will provide the necessary information and situational awareness, and thereafter, strategy and planning will dictate how the capability is to be used.

An interesting aspect is that once the battle for 'information superiority' has been won, or even if it is perceived by the adversary that the winning of it is a fair probability, the adversary's fear of the damage that could ensue in short order, could well be a deterrent for further prosecution of the conflict. Therefore, although NCW is a mere tool, the strategic decision to use it is the equivalent of creating another force for the adversary to reckon with.

Exploitation of Space

Recent wars are witness to the fact that space power has come of age, and use of space assets has a decided impact on the conduct and outcome of military conflicts. Spaces assets can support the military requirements of communications, surveillance, reconnaissance, navigation, and missile warning. These broad headings, by themselves, are inadequate to describe the full ambit of current space capabilities. Suffice it to say that space assets have already transformed warfare and there is considerable potential yet to be harnessed.

A few examples will highlight the importance of space assets. During Operation Enduring Freedom against the Taliban in Afghanistan, a unit of US special forces came upon a well defended Taliban position. Given the mountainous nature of terrain, the Northern Alliance Afghan guides accompanying the US troops opined that it would take weeks to plan, approach and defeat the Taliban in their well defended positions. In fact, using space assets, including communication satellites and other satellites to guide weapons, the enemy position was reduced to rubble in only 19 minutes. Space assets have indeed transformed warfare with very significant improvements in speed of action, accuracy of weapon delivery, and consequent lethality. The kill chain of "find, fix, track, target, engage and assess," has been markedly reduced. This was amply demonstrated when

on April 7, 2003, during the Iraq War, information was received that President Hussein was in a particular building on the outskirts of Baghdad. Within 45 minutes of the intelligence, and only 12 minutes after the air-borne B 1 bomber was tasked, the building was successfully attacked. The B 1 bomber went on to attack 17 more targets. Such operations owe much to the exploitation of space assets. Communication satellites are the key to distributing information between weapon systems and command posts, surmounting line of sight limitations. The use of cruise missiles is another worthy example. The entire operation involves gathering intelligence information, ascertaining target location, command and control of the weapon system, weather assessment, launch, en route navigation, precision attack, and damage assessment. Except for the actual launch of the missiles, all other ingredients of the operation are dependent on space assets.

It has been amply proved that space capabilities no longer only support military operations. Space systems have graduated from their role of being "force enhancers" to assets that are "force enablers". However, it must be emphasised that the heightened military capability is not a function of space assets alone. Developments in information and data processing, miniaturisation, and other technological advances play an equally important role, and the synergy of all these advances and inventions has brought military capability to levels that were unimaginable only a few years ago. This aspect cannot be over-emphasised although, in this article, the discussion is restricted to space assets only.

The Gulf War of 1991, Operation Desert Storm, has been christened the first space war. In comparison to the capabilities demonstrated in the Iraq War of 2003, Operation Iraqi Freedom, the use of space in Desert Storm was a mere beginning. The progress made in harnessing space capability in the intervening 12 years, encompassing the 1999 Kosovo conflict, Operation Noble Anvil, and the 2001 Afghanistan conflict, Operation Enduring Freedom as well, is briefly discussed in this paper. As the USA is leagues ahead of the others in exploiting space for military purposes, the analysis is restricted to US capabilities.

GULF WAR, 1991

As space assets had a role to play in nearly every aspect of the war, it has been called the first space war. The areas in which satellites supported the war effort were navigation, weather forecasting, communications, surveillance and provision of imagery, and for warning of missile attack.

The major aid to navigation and position location was the constellation of satellites that comprised the global positioning system (GPS). The GPS was functional but at reduced capability as only 18 of the 24 satellites were on station. This reduced the effectiveness and accuracy of the system but, the promise and potential of the system was readily apparent. The greatest advantages were its continued availability, reliability, accuracy, and the fact that it was a passive aid. Once the satellites were in orbit, there was no limitation on the number of users of the system. However, the system was still in its nascent stage and only partially exploitable when in August 1990, Iraq invaded Kuwait. In fact, at that time, the US Army had only 500 small, lightweight, demonstration GPS sets. The availability of the sets improved considerably and very rapidly, but the initial low availability indicates that the outbreak of conflict preceded the tried and tested fielding of the facility. Again, in the Gulf War, 1991, a mere 10 per cent or so of the weapons used were precision guided munitions (PGM), and none of the PGMs was GPS aided.

The Allies had only outdated maps of the area and more accurate maps were certainly needed given the near featureless terrain in most parts of the area of operation. The Defence Mapping Agency was tasked to provide more accurate updated maps. Imagery from SPOT and LANDSAT satellites was used and 4,500 different maps of the theatre were produced in very quick time. As many as 35 million updated maps were distributed to the Allied forces in the Gulf by the end of 1990. This is indeed a tribute to the technological capability of the USA, but space imagery had a major part to play. The upgraded maps helped to calculate more precise coordinates of targets and locations.

The desert terrain and the frequency of sandstorms meant that accurate weather forecasts were a great advantage. Such forecasts were needed at the lower tactical levels as well. Information from weather satellites supported the weather forecasting in substantial measure. Furthermore, the satellites comprising the Defence Support Programme (DSP) were used to provide information of Scud missile launches but, in spite of US claims to the contrary, the DSP satellites and Patriot missiles combination was inadequate.

Possibly the backbone of the space related military effort was the system of communication satellites. Even in the early years of the use of space for military purposes, the bandwidth available through defence satellites was a mere 30 per cent of requirement, and the remaining 70 per cent was taken from commercial satellites.

It will, therefore, be seen that satellites played a major role in the preparation and conduct of military operations, but the use of such capability was somewhat ad hoc. To underscore this point, to provide personnel support, soldiers from the Army Space Institute and the Army Space Programme office were deployed in the field as individuals, or as members of ad hoc task forces. The personnel had the benefit of little to no formalised training on what they were required to do.

KOSOVO CONFLICT, 1999

The rate of progress in exploiting space capabilities was rapid in the eight-year period between Desert Storm and the Kosovo conflict of 1999, codenamed Operation Noble Anvil. The Allies were also better prepared for the start of the conflict. To begin with, about 50 satellites supported the war effort. Further, adequate numbers of trained personnel were available. A US Space Command Joint Space Support Team was deployed in the theatre to provide support and guidance to the fighting forces in Europe on the use of available space assets. They also aided in the coordinated optimum use of space assets.

Much improved satellite communication systems were now available. Instantaneous satellite communication was possible between US and North

Atlantic Treaty Organisation (NATO) Command and Control HQ, intelligence agencies, operational centres, and deployed forces. The capability speeded up the control functions as well as ensured more effective dissemination of instructions, on the one hand; and status reports and requests, on the other. The business of warfare was made more efficient and guesswork reduced. The increased use of satellites can be gauged from the fact that although the Allies were operating in smaller numbers as compared to Desert Storm, and from NATO bases or aircraft carriers, the bandwidth requirement increased some two and a half times from 99 to 250 MBPS.

The operation was carried out by air forces alone. No ground troops were used. More interestingly, even the air assets were deployed and operated from some distance away from the theatre of operations. Therefore, the requirement for reconnaissance and target imagery became more pressing. Again, accurate and sustained electronic intelligence (ELINT) was needed. Space satellites proved invaluable. Satellites were controlled to ensure adequate number of passes at suitable times. Apart from other satellites, the US National Reconnaissance Office (NRO) operated two Lacrosse radar imaging satellites for 'seeing' through clouds and bad weather. Each of these satellites weighs 15 tonnes and operates 400 miles above the earth. Coordinated space-based imagery from different types of satellites was forwarded to mission planners and the Combined Joint Task Forces.

The weather over Kosovo was often unsuitable for air operations. Weather was a major determinant of the timing of air strikes and missions for damage assessments. The problem became more acute as to stay out of range of Serbian air defences, the Allied aircraft operated at height. This factor and the increased distances from operational bases to target areas, with mid-air refuelling often necessary, made correct weather forecasting, including local area forecasting, more necessary. Once again, weather satellites made a very valuable contribution. Apart from the Defence Meteorological Satellite Programme (DMSP), information from four National Oceanic and Atmospheric Administration (NOAA) satellites was used to provide the best possible weather forecast.

A notable difference during these operations was the far more effective use made of GPS. All 24 satellites were deployed, and GPS sets were part of the avionics suite on most aircraft. A first in the conflict was the use of GPS aided bombs, the joint direct attack munitions (JDAM). JDAM is a normal unguided bomb with a GPS kit attached, that makes it a very effective PGM with circular error of probability (CEP) better than that of laser guided bombs, and at a small fraction of the cost. JDAMs were used extensively; 30 per cent of the bombs dropped during this operation were PGMs, mostly JDAMs. GPS aided bombing became even more significant during these operations as, if the target coordinates were accurate, the JDAMs could be dropped from above cloud cover without visual contact with the target, and with more than a fair certainty of hitting the target.

It is definite that without space capability, the Allies would have found it almost impossible to subdue the Serbians with very limited losses (two aircraft lost), fairly rapidly, and with the use of air power alone. The realisation of the vital importance of space assets was almost automatically accompanied with the understanding of the need for ensuring or, if necessary, gaining ‘space superiority’.

AFGHANISTAN CONFLICT, 2001

The Afghanistan conflict of 2001, Operation Enduring Freedom, was launched on the heels, so to say, of the September 11, Al Qaeda attacks on the World Trade Centre and the Pentagon. The response had to be swift and only available assets could be used. Yet, in the two and a half years since the Kosovo conflict, the progress in the exploitation of space assets had been remarkable. The Allies were able to bring into use over 100 satellites. Of these, some two dozen were used for each of intelligence gathering, communications and the GPS system. As a coincidence, NRO had earlier planned and did launch a series of new and replacement satellites. Satellites were launched on August 17, September 9, October 5, and October 10, 2001, and paid good dividends.

Operation Enduring Freedom was the first conflict where coordinated use was made of space technology. In the year 2000, the US Air Force created the Air and Space Operations Centre. A Space Battlement Management Core System was fielded and used in Air Operational Centres and Space Operational Centres. A Space Warfare Centre was also established. Soon after the attacks on the US mainland, accelerated training of 400 uniformed personnel was undertaken to make them *au fait* with space assets, capabilities and control and coordinating systems. These personnel acted as advisers in the field.

The surveillance capability had improved and satellite-based communication systems were more advanced. Satellites supported weather forecasting, navigation, surveillance and ELINT, and precision weapon delivery more effectively. The low cost and reliable JDAMs were used with accuracy even through heavy cloud cover or by night. Satellites were able to locate vehicles and structures, and satellite information was used to support Special Operation Groups to search for terrorists. Also, information from satellite imagery was used to locate targets, plan and execute attacks, and in near real time determine the efficacy of the attacks. Thereafter, ingress into enemy territory by ground troops could be carried out in the sure knowledge that the enemy weapons or positions had been disabled. Space assets also facilitated real time tracking of own and enemy aircraft, helicopters, and ground troops. The allies were not always successful in this endeavour as evidenced from some 'blue on blue' kills, but the capability permitted far greater leeway than hithertofore. For instance, a soldier could use a GPS and laser rangefinder to fix the coordinates of a target. These could then be radioed, via satellite, to the command site that could be hundreds of miles away. The command centre would then task the available aircraft. The pilot would feed the coordinates into the GPS enabled bomb and carry out the attack. In fact, the maximum time taken was for the aircraft to reach the target. Under certain circumstances, the aircraft on air-borne alert could be directly tasked, thereby reducing the time to attack to near zero.

The space imagery available to the Allies was far better than what was commercially available. The US satellites have a resolution of 10 cm or so as against the four metre resolution available commercially. Yet to prevent the Taliban from using commercially available imageries to try and determine US positions, the US agreed to pay for exclusive rights of all commercially available imageries of Afghanistan. As an attendant 'advantage', the imageries were also not available to the media either and they had no independent means to assess the conduct of operations. In a sentence, the importance of space superiority was brought home most emphatically during the conflict.

IRAQ WAR, 2003

The Iraq War, Operation Iraqi Freedom, was launched after due preparation, with little urgency, after ensuring that the plans and assets were in place, and the troops trained and ready. As such, the full ambit of US conventional war capability, including space capability, was brought into use.

The war started with a satellite-based video teleconference comprising the president, secretary of defence, US Central Command commander, and the Combined Force Air Component Commander (CFACC). It was the most precise and integrated military operation ever conducted and has been dubbed the "first space enabled war." All command centres and major military units were linked through the network of communication satellites. The Defence Secure Communication System (DSCS) used four constellations of 18 or 19 satellites. Ultra-portable video phones were also available and often used by the media. The DSCS was supported by the MILSTAR constellation of satellites for super high frequency, secure, jam resistant communications. The system can transmit coded voice, data, teletype and fax messages to any place on earth.

Besides the all important and pervasive communication requirements, satellites were on station to provide intelligence and imagery, identify targets, provide early warning of sandstorms, and much more. It was a space satellite

that first discovered that oil wells in southern Iraq had been set ablaze. The information led to the Marines advancing their attack into Iraq. About 1,000 personnel of the US Air Force Space Command were assigned to Central Command, the US command responsible for the conduct of the operations. The personnel ensured the optimum use of satellites and in integration with other military activities as necessary.

Round the clock uninterrupted intelligence, surveillance and reconnaissance capability (ISR) was available. ISR is a fundamental requirement for effective use of air power, but takes on added importance in the case of fleeting targets and targets on the move. The capability was well honed and over 150 rapid response missions were carried out. With good ISR capability, near total air superiority, and good communications, command and control became more effective. It was possible for commanders to examine and assess proposed actions, and conduct operations that largely avoided collateral damage or excessive civilian casualties. With ISR capability, coupled with GPS and communication satellites, the Allies were able to carry out precision attacks and find tanks and other targets in spite of sandstorms. Radar imaging satellites were used to see through sandstorms and track troops on the move. ELINT satellites listened in on Iraqi communications. Control of UAVs became possible from long distances. The Global Hawk UAV was controlled from mainland USA with control instructions relayed through satellites. Ground troops were able to receive target imageries on portable devices. In fact, a two-way system obtained. The 'control' could pass instructions and other support requirements, and also call for information. Similarly, the field units could supply information as well as seek support or elucidation as needed. Real time tactical terrain data was available and readily updated using digitised data bases and models.

GPS sets were available in plenty. With regular uplinking of position information, it became possible to keep track of own forces and, to a large extent, maintain a fair idea of the position of own and enemy troops. There was a case of a ground unit that saw a sand swirl, characteristic of movement

of tanks in the desert, and thought that enemy action was imminent. The commanding officer (CO) immediately used his portable computer to elicit information on the position of own and ground troops, and was able to straight away confirm that the tanks were friendly. The query and the response were in real time and the value of such capability in war needs no emphasis.

The plentiful supply of GPS sets meant that they could be fitted on tanks, aircraft, and trucks. Positioning of GPS on trucks with uplinking facility, considerably improved the coordination of logistics operations. GPS was also used for precision attacks and some 70 per cent of the weapons used were PGMs. Twenty-eight GPS satellites were in use and freshly updated navigational information was fed to each satellite as it approached the theatre of operations. The fine tuning improved the accuracy of weapon delivery by over 30 per cent.

For weather forecasting, DMSP had been operational for over 20 years with two satellites in polar orbit at all times. The meteorological staff introduced a sophisticated system that integrated information from satellites, radar stations, observations and aircraft mission sortie reports. As a result, fairly accurate forecasts of sandstorms, rain, turbulence, cloud, etc could be forwarded to the planning centres and field units. In fact, tank commanders could also be given forecasts of soil moisture content.

The Iraq War was indeed the first war where space assets were used so extensively and effectively. Most importantly, space capability permitted command and control and networked capability that heightened the efficiency of waging war to very high levels. It is on the cards that this capability will continue to increase and far more rapidly in the years ahead.

In military terms, space is the “ultimate high ground.” The connotation extends to mere surveillance but encompasses the feasibility of offensive action.

Military use of space assets includes communications, surveillance, reconnaissance, navigation, as well as aids for accurate weapon delivery. Some assets serve both civilian and military users. Others have a purely

military purpose e.g. anti-ballistic missile defence. The utilisation of space assets is so linked to warfare on earth that 'space power' in now considered as an adjunct of air power.

It is on the cards that warfare will be dominated from space to an increasing extent. Surveillance of the battlefield will be continuous, possibly aided by space-based radars with ground moving target indicators. Better sensors will also be developed. Directed energy weapons and high energy lasers will soon be fielded on satellites. As space assets become more important for the prosecution of conflict, defence of such assets and the ability to deny the use of such assets to the enemy will become valid operations of war. As soon as the overwhelming superiority of the USA in the exploitation of space is reduced, the threat of space warfare will be live, treaties and agreements to the contrary notwithstanding. "Counter-space" and "space defence" operations will mirror the present concept of "counter-air" and "air defence" operations. As space is weaponised, aerospace power will be more flexible, and increasingly more responsive for attacks against targets in space, on the ground, or in the intervening atmosphere. Indeed, the entire ambit of offensive, defensive, or support missions that are part of air operations of war, will be extended into space.

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Militarisation of space is no longer a covert exercise. The US defence secretary has been quoted as saying "... we must guard against a Space Pearl Harbour." Official US papers and pronouncements categorically assert the need for control of space. The 2001 Quadrennial Defence Review states "... a key objective…is not only to ensure US ability to exploit space for military purposes, but also as required to deny an adversary's ability to do so." In a war game held in the US in 2001, the focus was on space as the primary centre of operations rather than use of space to support operations

on earth. As for China, the Autumn 2003 issue of the *Washington Quarterly* ascribes to the director of China's Aerospace Corporation's Science and Technology Committee as saying that it is a major aim of China's space programme to develop advanced weapons for space warfare. It will be appreciated that as in other forms of warfare, parity is not necessary to either threaten or to deter. Hence, it should be expected that all major powers will aim to develop adequacy in space warfare.

Qualitative developments are taking place in surveillance capability; possible use of EHF for satellite-based, secure worldwide communications; tracking and attack on missiles in the boost phase, post-boost or mid-course stages; better space-based systems for communication, navigation, identification, etc. At the same time, research and development agencies are working apace to produce systems to attack space assets and also for systems to defend against such attacks. Use of manned spacecraft possibly on a hypersonic vehicle is under active consideration.

Direct hard kills of satellites have an inbuilt danger of debris hitting other friendly satellites. The preferred option is to jam, degrade, blind or even wrest control of enemy satellites. Destruction of the satellite control station on earth is another option. More work is required but the US has already created a Space Operations Directorate and started a Space Warfare School. A Space Control Squadron, implying space warfare, and a Space Aggressor Squadron have been established to assess US vulnerabilities in space.

China plans to field a direct ascent anti-satellite system by 2005 to 2010. The system will be based on satellite tracking radars, and high energy lasers. Elsewhere, aircraft-based lasers are also under development. Research is continuing to produce a system that could ascertain whether difficulties experienced by a satellite are due to technical problems, natural phenomenon or a 'soft kill' attack.

To avoid hard kills, a concept is under study to use mini satellites as guardians. In fact, micro and nano satellites, with payloads as low as one kilogram, are being developed. Such satellites could be readily placed in

orbit by manned aircraft, or a small launch vehicle to provide varied types of defences for space assets. Alternatively, when sufficient miniaturisation becomes possible, the small satellites, relatively inexpensive and readily launched, could provide the needed redundancy for space assets.

It will be seen that exploitation of space and future wars are inextricably linked. The costs are going to be high but so will the resultant capability. In any case, all have to go the space militarisation route to avoid serious, disabling asymmetry. What is important is the formulation and implementation of a plan for exploitation of space, in terms of both equipment and doctrine. As stated in the USAF study titled "USAF 2025", "..by 2025, space will be to air, what air is to cavalry today."

CONCLUSION

As in the past, wars and conflicts will continue in the future as well, but at a pace that will make it appear that past wars were conducted at a leisurely pace. Military history teaches us that the side that uses the products of newer technology has a distinct advantage. No system even approaches perfection, but the debilitating disadvantages and limitations of the newer, more advanced systems become important only when the adversary has near similar capability. Therefore, modernisation is an essential prerequisite for maintaining adequate military capability. In recent decades, the progress in technology has been awesome, and has altered operational concepts quite dramatically. It can be surmised that technical advances on the anvil will be more important still.

Advances in technology that impact military capability, have affected mainly air power and its utilisation. Air power capability has been spectacularly enhanced. Use of air power for the attainment of military objectives has become even more urgent. The enhanced capability has affected the nature of war as well. The air power characteristics of speed, stealth, precision and lethality have combined powerfully, but major military gains can be fought for only once air superiority is achieved. With air superiority, rapid and significant victories become inevitable. Parallel war,

essentially air power driven, is the cost effective method to achieve national objectives speedily. War is a multi-dimensional effort where the different agencies operated concurrently and in unison. With this in mind, the start point for a good recipe for success would be to understand the political, economic, diplomatic, technical and military environment. Thereafter, political objectives should be established, and what will make the adversary accept our writ determined. After that, all that remains is selection of centres of gravity, and then to apply the principles of parallel war.

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Superior military capability has not only deterrent value, but it can, and should, be used for its coercive value. Military strength and superiority are national assets, and must be used for attainment of national objectives in every which way. By the same token, build-up of military capability should be based on national aspirations. For this, we need to invest money and resources towards development of concepts, capabilities and technologies. Preparation for war is an ongoing exercise, and demands near continuous attention on improving the utilisation of available assets. Above all, it must be emphasised that hesitation or worse in employment of military power reduces the perceived capability quite considerably.

Exploitation of the electromagnetic spectrum and space will probably alter irrevocably the science and art of war. It is essential that we give these aspects the priority attention they deserve.

Military hardware, and the associated infrastructure, is becoming increasingly more expensive. However, such expense is inescapable. What we can and should do is to favour capabilities rather than numbers. Few state-of-art assets, regularly acquired, is a more effective approach; rather than greater numbers of less capable equipment acquired less frequently.

This factor takes on added significance in the face of the type and nature of war we are likely to confront. ■

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