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CONTENTS

Vol. 4, No. 3, Monsoon 2009 (July-September)

the poor record, mostly as a result of lack of consensus among the P-5. In order to improve the efficiency and effectiveness of peacekeeping, greater cooperation and support by the powerful and rich nations, especially the members of the UN Security Council, need no underscoring. Meanwhile, the challenges ahead for the peacekeepers are getting more complex.

EDITOR'S NOTE

The recent induction of the first Airborne Warning and Control System (AWACS) into the Indian Air Force (IAF) symbolises a great landmark not only in the capability in air warfare but also in the conceptual approach to air operations compared to two decades ago when a large segment of the leadership believed in the efficacy of low level radars and, hence, proposed greater importance for them in comparison to airborne early warning systems. So much so that two years after initiating an indigenous project to design and develop our own airborne early system by the Defence Research and Development Organisation (DRDO) (which remained under-funded and without any effort to establish collaboration with a foreign entity), the Ministry of Defence is believed to have told the visiting US Defence Secretary in late 1986 that India would have no problem if the US supplied such systems to Pakistan even under the questionable assumption that they were needed by Pakistan to intercept air violations by Afghan/Soviet aircraft targeting Afghan Mujahideen fighting the Kabul government on behalf of the US, with Pakistan as the frontline state!

The induction of AWACS symbolises not only the transformation of the Air Force in technological terms but also points to the necessity to ensure the transformation of the mind of air warriors. In a way, AWACS has symbolised the high end of technology on one side and the fundamental changes in the

nature of air warfare on the other. But we must remember that even as one of the major force multipliers of today and tomorrow, this cannot replace force. Many old and existing systems have to remain in place to ensure a total integrated capability if full advantage of the AWACS' special attributes are to be fully exploited. Unfortunately, there has been a school of thought in the Air Force, which may still be lingering in some quarters, that with force multipliers available, we could do with a smaller force. But we need to consider that both of our neighbours and likely adversaries have already acquired such capabilities. Force multipliers would no doubt enhance the effectiveness and capabilities of an Air Force; but the degree of advantage it offers would also depend upon whether the adversary also has similar even if not symmetrical capabilities. Hence, we must go back to the core lesson of military history: that technology and mass (size) do provide definitive advantages, but it is force employment that finally decides victory or defeat. Hence, the induction of AWACS in China, Pakistan and India must be seen from that perspective and the conceptual basis for ensuring advantage in force employment given high priority.

With this issue, we complete five years of publication since the journal was started in 2004. Our list of contributors has grown steadily and we are happy to see greater participation by younger authors. We are grateful to our publishing team for maintaining the excellent quality of workmanship and bringing the journal out on schedule with great regularity. Above all, we are grateful to our readership for the continued interest and support for the journal.

NORTH KOREA'S NUCLEAR TESTS

JAYADEVA RANADE

The second nuclear test by North Korea, officially called the Democratic People's Republic of Korea (DPRK), on May 25, 2009, has far-reaching implications. With this test, North Korea brazenly challenged the US-led Six-Party Talks begun in 2003 and introduced a new dimension into the talks. While the DPRK's first test, conducted on October 9, 2006, had stunned the world, this latest test has changed the geo-political structure in Northeast Asia. By the end of June and once North Korea tests its long range Taepodong-II missile, it would have enlarged the arc of countries directly threatened by its capabilities to include parts of the USA. The two nuclear tests have together additionally graphically highlighted the dangers of the uncontrolled spread of nuclear weapons technology and programmes to unstable regimes and exposed the vulnerabilities of the nuclear non-proliferation regime ushered in by the USA in 1968.

North Korea has kept the world on tenterhooks for many years now, using its nuclear weapons technology and programme as a bargaining chip. Its reputation as an unpredictable regime with a dubious track record has ensured that it would receive world attention. North Korea's main objectives included getting formal recognition of the US and benefits

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Once North Korea tests its long range Taepodong-II missile, US concerns will mount as portions of the US too will be vulnerable to a DPRK missile strike.

from the consequential inflows of investment and aid. The framework of the Six-Party Talks comprising all the concerned parties, namely, the USA, Russia, Japan, South Korea, China and, of course, the DPRK, was set up in 2003 to negotiate a mutually acceptable formula and one which would get the DPRK to dismantle its nuclear weapons programme. The talks, which lurched over five years, were complicated from the start by the competing interests of each of the six participants. The main objectives of each of the participants are briefly enumerated in the succeeding paragraphs.

For the US, the Six-Party Talks were begun to make North Korea's nuclear programme and weapons capability a multinational problem instead of only a bilateral issue between the US and North Korea. The USA's primary concern is North Korea's nuclear weapons programme and to prevent the possible sale of nuclear materials and technology to hostile states and terrorist groups. It is insistent that the DPRK accepts International Atomic Energy Agency (IAEA) monitors as part of any agreement. An additional concern is the safety of the approximately 25,000 US military personnel stationed in South Korea and who would be in the direct line of fire. Once North Korea tests its long range Taepodong-II missile by the end of June, US concerns will mount as portions of the US too will be vulnerable to a DPRK missile strike. An unstated beneficial spin-off of the successful conclusion of talks would be the extension of US influence right across the Korean Peninsula, bringing the US up to the doorstep of China and Russia.

North Korea, or the DPRK, is the key player in the talks. It is economically the worst off and has a regime which is dependent on one individual. It has the least to lose in the event of failure of the talks or a clash with South Korea. It is these fears that Pyongyang is playing upon. Pyongyang's demands are for normalised and formal relations with the USA and a pledge of non-aggression from the US, which has over 25,000 troops stationed in South Korea.

In addition, it wants to be dropped from the USA's "sponsors of terrorism" list and wants unfettered aid from all the participant countries in the talks. It also hopes for completion of the two light water reactors promised under the Agreed Framework to meet its energy requirements. The scope of its demands would have changed now after the second nuclear test.

Japan has serious concerns about North Korea's growing nuclear weapons and missile capability. The testing of increasingly longer range missiles by North Korea has alarmed Japan as its mass population centres are within missile strike range.

South Korea or the Republic of Korea (ROK) has a different set of objectives. It prefers a cautious and 'softer' approach which takes into account the discomforting reality of physical proximity. Seoul also wants to avoid straining people-to-people relations. This approach is dictated by the emotional feeling among South Koreans, who view the North Koreans as their poorer cousins. Seoul has carefully studied the economic fallout of the collapse of the Berlin Wall and wants to stave off any possibility of a huge economic burden occasioned by either a sudden regime change in the North or emergency influx of refugees from the North. Taking into account these considerations, ROK President Kim Dae Jung in 1998 articulated and adopted the "Sunshine Policy," intended to effect a gradual warming of relations between the two halves and usher in a "state of peaceful coexistence." His successor, Roh Moo Hyun carried on this policy, which has now been cast aside by the current ROK President.

Japan has serious concerns about North Korea's growing nuclear weapons and missile capability. The testing of increasingly longer range missiles by North Korea, pointedly aimed into the Sea of Japan, has alarmed Japan as its mass population centres are within missile strike range as are the US troops deployed there. The North Korean missile tests have triggered occasional debate about whether Japan should acquire deterrent capability. Tokyo feels it can also use the platform afforded by the Six-Party Talks to get North Korea to admit its guilt in the abduction of Japanese citizens by North Korean 'spies'

China is in a unique position to facilitate the talks and is using them to demonstrate that it is a responsible international power and supports nuclear non-proliferation.

in the 1970s and 1980s. The relationship between the Japanese and Koreans is steeped in deep dislike, which is a complication and has prompted Pyongyang to, at times, demand the exclusion of Japan from the talks.

Russia is a country which is now directly affected by North Korea's nuclear weapons and missile programme as parts of Russia's population centres are within North Korea's strike range. Russia also faces the prospect of refugee inflows in the event of a sudden regime change in North Korea or a food and energy famine. In the beginning, though, Russia's objective was mainly to try and regain some of its lost influence in North Korea. Russia has anticipatedly opposed tough sanctions against North Korea.

China's role and objectives in the Six-Party Talks are multiple. It is in a unique position to facilitate the talks and is using them to demonstrate that it is a responsible international power and supports nuclear non-proliferation. At the same time, the talks are a useful diplomatic tool for Beijing to improve relations with the USA and highlight that it would be a useful partner in the Asia-Pacific region. Among the entities participating in the Six-Party Talks, China has the maximum influence on North Korea. In addition to the fraternal ties which both sides used to, till some years ago, officially describe "as close as lips to teeth," China has maintained Party-to-Party and leadership ties with North Korea and its leaders. Beijing has hosted Kim Jong Il and impressed upon him the benefits of economic reform and special economic zones. It is North Korea's main supplier of food grain and coal and was responsible for bringing North Korea into the Six-Party Talks. But China has also been slow to move forward in the talks and has had to be often nudged by Washington. It remains opposed to stringent sanctions against North Korea and while there are real fears of a refugee influx in case of a famine or collapse of the regime, these would appear to be exaggerated. An important consideration for Beijing is the strategic need to retain influence over North Korea and prevent the

entire Korean Peninsula from coming under US influence, which would be the case if the US and DPRK reach an agreement. Beijing will delay this eventuality as long as it can, especially as it views the Korean Peninsula as within its sphere of influence, and a buffer with the US.

South Korean and US military commanders both, however, are apprehensive that in case the DPRK launches a sudden swift attack, the South will not have more than a few minutes to organise its defence.

Some digression is necessary here to illustrate the threat to the South from North Korea's million-strong armed forces. North Korea additionally has reserve units of 7 million. Almost 70 percent of the DPRK's armed forces, most of which are ground forces, are deployed at the Demilitarised Zone (DMZ) or within ninety miles of the DMZ. North Korea's military doctrine relies mainly on the use of its infantry and artillery. North Korea's deployment in this sector consists of 700,000 troops, 8,000 artillery systems and 2,000 tanks. These are protected by over 4,000 underground facilities. These troops are stiffened by the Special Operations Forces, of which there are 25 regiments. It is these forces that are expected to be the mainstay of any battle and penetrate into the southern half to wreak havoc in the ROK's cities, including Seoul. North Korea relies a lot on stealth and has constructed more than 11,000 underground facilities across the country to protect its armed forces and equipment from surveillance. In addition, North Korea has built, and continues to build, underground tunnels to destinations in the South. Each year, a number of these tunnels are discovered exiting well inside the South. There has been emphasis on communications and frequency hopping radios allow soldiers to communicate in secure mode. Fibre optics have been installed between fixed facilities and deployments. These indicate a preparedness for sudden quick operations. North Korea's defence budget is, however, estimated at a paltry US$ 5 billion in contrast to South Korea's defence budget of US$ 29.5 billion. In addition, South Korea has US troops and equipment for its defence. South Korean and US military commanders both, however, are apprehensive that in case the DPRK launches a sudden swift attack, the South will not have more than a few minutes to

The DPRK has set a high benchmark for delivery by the Six-Party negotiators and that dismantling of its nuclear weapons programme will, in all probability, henceforth not be on the agenda for discussion.

organise its defence. In case the North decides to launch an offensive with missiles, then the response time will be less and defence of the population centres, including Seoul, would be at high risk.

The recent test is evidence that the DPRK has set a high benchmark for delivery by the Six-Party negotiators and that dismantling of its nuclear weapons programme will, in all probability, henceforth not be on the agenda for discussion. The timing of the test coincides with the increased strain on North Korea's internal power structure. Food shortages have been acute for the past some years, necessitating widespread rationing. A few years ago, the situation was so acute that the North Korean leadership had to drastically reduce rations distributed to civilians in order to ensure adequate supplies for personnel of the Korean People's Army (KPA). Energy, especially for heating, has similarly been in very short supply and this has enhanced Pyongyang's dependence on Beijing. China is North Korea's main source of food and coal and almost 70 percent of its coal supplies come from China. But North Korea's populace has weathered very difficult conditions earlier too, including almost near-famine conditions a couple of years ago. Kim Jong-Il's regime has been helped in maintaining social order by the consistently vice-like iron grip it has retained over the country's propaganda apparatus, security and armed forces.

The succession issue, however, looms larger over North Korea and would have been a major consideration for the conduct of the tests at this time. Reports circulating over the past many months claimed that "Dear Leader" Kim Jong-Il had suffered a stroke, was hospitalised and was unable to discharge his official functions. Months later, to dispel doubts that he was incapacitated, the official print and TV media showed visuals of Kim Jong-Il attending official public functions. While this was designed to project that Kim Jong-Il was fit and in charge, the visual images, however, showed an obviously infirm Kim

Jong-Il. These indirectly confirmed that he was unwell. The images signalled that a succession could be likely. There have been no signs of dissension in the KPA, where factions are known to exist, and neither any overt indications of concern at the impending succession in the Korean Workers Party (KWP). Nevertheless, reports emanating from South Korea and elsewhere strongly suggest that the succession process has begun and Kim Jong-Il's younger son, 25-year-old Kim Jong-un, is the likely successor. South Korean intelligence reports that personnel in North Korean Embassies took an oath of allegiance to Kim Jong-un on May 25, 2009.

Kim Jong-un, who attended school incognito in Switzerland, is said to resemble his father, is short and is fond of basketball. There are, however, other relatives in the wings who could, at some stage, complicate matters although that is assessed as very unlikely. They are Kim Jong-Il's eldest son, 37-year-old Kim Jong-nam, and the second son, Kim Jong-chol. Of them, the eldest son, Kim Jong-nam is reputed to haunt the gambling tables at Macau and once earned the ire of his father for trying to visit Disneyland in Japan on a forged passport. The second son, Kim Jong-chol has been described, by Kim Jong-Il's Japanese cook, Fujimoto, who escaped and fled back to Japan, as "effeminate" because of the side effects of a drug he took to bulk up for sports. Despite the absence of signs of factionalism or infighting, there can be little doubt that the situation inside North Korea is quite fragile.

Conscious of the potential for trouble, Kim Jong-Il has taken precautionary steps. Among some recent appointments of his loyalists to key positions is the elevation of his brother-in-law Jang Sung-taek. The appointment has been made to ensure support for Kim Jong-un. Jang Sung-taek has won Kim Jong-Il's trust and has been steadily promoted after his rehabilitation in 2006. Reports, though unconfirmed, indicated that when Kim Jong-Il was incapacitated due to a stroke in August 2008, his brother-in-law Jang Sung-taek officiated. Subsequently, in November 2008, he was promoted and appointed Director of the powerful Organisation and Guidance Department of the Korean Workers Party (KWP) Central Committee (CC) and he now controls the country's and Party's security and administrative apparatus.

The data seems to corroborate the DPRK's claim that the underground nuclear test was "part of measures to bolster up its nuclear deterrent" and "on a higher level in terms of its explosive power and technology of its control."

The DPRK's latest nuclear test occurred in this backdrop. It was marginally more powerful than the first and, according to a Russian Defence Ministry spokesman, the force of the blast is estimated at 10-20 kilotons or 0.8 kilotons more than the blast in 2006. The magnitude of the earth tremor on this occasion was measured in the US, Japan and South Korea at between 4.5 to 5.3. The first test caused a 3.6 magnitude tremor. The data seems to corroborate the DPRK's claim that the underground nuclear test was "part of measures to bolster up its nuclear deterrent" and "on a higher level in terms of its explosive power and technology of its control." Experts are still evaluating whether the test was a success. The tests have anticipatedly triggered critical responses from around the world, with unprecedented tough responses from China and Russia. The United Nations Security Council (UNSC) on May 29, 2009, circulated a draft resolution calling upon member-nations to implement the sanctions approved earlier. South Korea, which had thus far resisted signing the Proliferation Security Initiative, tipped over and joined the initiative. Both these elicited a belligerent response from Pyongyang, which particularly warned that any attempt to stop or search its ships would result in war.

There were indications that the DPRK was preparing to augment its capability and conduct another nuclear test, flouting international opinion. Pyongyang had a year ago blown up the cooling tower at its main nuclear weapons plant and had launched a long-range rocket in April 2009. This prompted the UN Security Council to urge stricter sanctions against North Korea. Earlier, in 1998, North Korea had test-fired a multi-stage rocket over Japan, leaving no doubt that it had the capability to strike Japan. This time again, barely hours after the nuclear test, North Korea test-fired a series of three missiles toward the sea between North Korea and Japan. The missiles had a range of 130 km or 80 miles, sufficient to strike targets in South Korea,

Japan and parts of Russia and China. In the following days, North Korea unleashed another three short-range missiles from a base on the central-eastern coast into the sea opposite Japan. The firing of the missiles was unmistakably intended to demonstrate that North Korea has acquired a nuclear weapon delivery capability.

Doubts exist as to the number of nuclear weapons in North Korea's arsenal. Estimates in 2003 were that North Korea had one or two nuclear weapons, but after it expelled the inspectors, it is believed to have harvested fuel for six or eight nuclear weapons. Whether these latest tests have depleted North Korea's nuclear stockpile is unclear. Pyongyang has announced though, simultaneous with its missile launches, that it plans to resume extracting weapons-grade plutonium at its Yongbyon complex.

The consequences of North Korea acquiring a nuclear weapons capability are alarming and dangerous. The countries affected immediately and directly will be South Korea and Japan. There is long-standing enmity between North Korea and Japan and the present government in Seoul has reversed the earlier "Sunshine Policy" designed to improve relations with the North. Additionally, both countries are allies of the US. Consequent to the DPRK's nuclear tests, there are presently in Northeast Asia no other nuclear powers. China and Russia are the only two nuclear weapon states bordering the DPRK. There is bound to be concern in Seoul and Tokyo and a debate is likely to recommence regarding the desirability of acquiring deterrence capability, especially in Tokyo. Japan is already sufficiently technologically advanced to cross the threshold and become a nuclear weapon state, except for the popular revulsion towards nuclear weapons.

The rest of the world could be affected too. Parts of Russia and China are within the DPRK's strike range. Once North Korea tests its long range Taepodong-II missile, portions of the US will be within its strike range, a prospect that has long worried US military and strategic planners. North Korea's is a fragile regime, dependent on a single individual and without a proven mechanism for stable succession, though on the last occasion, it was peaceful. The regime's track record is not at all encouraging and confirms that

More disturbing is the nexus among the DPRK, China and Pakistan and the manner in which they have ignored missile proliferation concerns. A prime example is the illegal and clandestine collaboration with Pakistan in a Chinese-brokered missiles-for-nuclear technology deal.

it is a renegade regime which has engaged in actions not acceptable in international relations, including planning assassinations of foreign political leaders. In 1983, the DPRK planned the assassination of South Korean President Chun Doo Hwan in Rangoon, Burma, but he escaped as he was delayed in a traffic accident, while 17 South Korean officials were killed in the bomb explosion. In 1987, Pyongyang organised the bombing of Korean Airlines flight 858. The South Korean government suspects that North Korea was responsible for the assassination of its diplomat in Vladivostok in 1996.

More disturbing is the nexus among the DPRK, China and Pakistan and the manner in which they have ignored missile proliferation concerns. A prime example is the illegal and clandestine collaboration with Pakistan in a Chinese-brokered missiles-for-nuclear technology deal. By this arrangement, North Korea shipped ready-to-be-assembled Nodong-I and Nodong-II missiles to Pakistan, which renamed them as the Hatf series of missiles. The DPRK received, in return, technology for building its nuclear weapons programme. Actually, the DPRK-Pakistan military cooperation relationship can be traced back to 1971, when Pakistan assisted the DPRK with secret deliveries of Scud-C missiles to Iran. Direct DPRK-Pakistan military cooperation, however, commenced in the late 1980s. A few years ago, a North Korean freighter carrying voluminous detailed drawings, missiles (M-9) in ready-to-be-assembled condition and spares for the missiles, was intercepted off Kandla port in Gujarat, India. Interestingly, both Pakistan and North Korea have followed a similar approach with regard to acquiring a nuclear weapons capability. They have ensured that the delivery system is ready simultaneous with the nuclear weapon.

North Korea's recent test also resurrects memories of the role played by China and Pakistan in helping the DPRK acquire nuclear weapons capability.

All three nations would, by definition, be nuclear weapon proliferators. China, keen to overtly demonstrate to the US its willingness to abide by the Missile Technology Control Regime (MTCR), ceased directly selling missiles to Pakistan in 1991 after being sanctioned by the USA. China's missile sales were, incidentally, the key to Pakistan's Ghauri series of missiles. While China did not sell missiles directly to Pakistan thereafter and assured the US that it would abide by the MTCR, it did ensure though that Pakistan's missile programme did not stall. It mediated an arrangement between it and the DPRK. North Korean missiles, which are modelled on Chinese missiles, began being transported by air to Pakistan, overflying China. Pakistan expanded its military cooperation with the DPRK during Benazir Bhutto's two terms as Prime Minister (1988-90 and 1993-96) and sent its nuclear scientists to North Korean nuclear facilities for training. North Korean scientists and engineers, in turn, visited Pakistan's uranium enrichment plant at Kahuta. A.Q. Khan was among those who travelled to Pyongyang with designs and parts for the centrifuge. A.Q. Khan travelled to North Korea 13 times during this period. Benazir Bhutto, as Prime Minister, also visited North Korea and has been reported as personally carrying centrifuge designs in a CD to Pyongyang. In indirect confirmation of the Pakistan Army's complicity in the arrangement, Pakistan Army Chief Gen Karamat visited Pyongyang in 1997. Suspicions persist as to whether these old links have actually withered away. With such a track record, there is a high possibility that if North Korea feels isolated or its fiscal situation becomes precarious, it could either sell its nuclear weapons technology or the nuclear weapons. Revenues from its arms sales presently are estimated at between US$ 200 million to US$ 1 billion. There would be incentive to increase these earnings and willing buyers would be the terrorist outfits or other countries aspiring to be nuclear weapon states.

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There are also at least 22 nuclear facilities at 18 sites across North Korea. Most of them are in the west.

The US Administration is preoccupied with the developments in Afghanistan and Pakistan and Pyongyang has certainly taken advantage of this, as well as the advent of a new US Administration, in timing its nuclear test. The US' options currently appear limited, unless it plans a quick surgical strike to take out North Korea's nuclear weapons related sites. After the nuclear test by North Korea in 2006, this option was actively explored. US spy planes have regularly probed North Korean defences and radar and identified the vulnerabilities. US spy ships regularly trawl off North Korean waters, at times intruding close to the shore. Intelligence relevant to a military strike would, therefore, be available. The hermetically sealed nature of North Korea's actual power structure and decision-making process, however, would inhibit realistic planning of the repercussions of a strike on North Korea's nuclear facilities. Any such action would need to strike multiple targets, be very stealthy, swift and extremely accurate. Military planners would have to ensure that they eliminate or disable the missile launch bases and storage sites, the nuclear facilities and nuclear weapon storage sites in North Korea. The construction over the years by North Korea of a number of underground missile launch sites and bases complicates planning and execution of a sudden strike. A majority of these sites are located on the east coast and target Japan and US military facilities there. A new intercontinental ballistic missile (ICBM) base called Tongchang-ri was detected earlier in 2009 and found to be near completion. It is about 50 miles from the Chinese border. Another new secret site is located on the west coast. There are also at least 22 nuclear facilities at 18 sites across North Korea. Most of them are in the west and concentrated in Pungang-chigu, Yongbyon-kun and North Pyongan Province. Additionally, simultaneous action would be required, with the attendant risk of collateral damage, to frustrate a ground attack by the North Korean Army and North Korean Special Forces. There would be no second chance. The window for such action is rapidly shrinking, however, and it will in all likelihood be

opposed by China and Russia. The US could well acquiesce to Beijing's pressure because it currently seeks China's assistance in Afghanistan and Pakistan.

It is likely that, wanting to avoid entanglement in yet another theatre, US President Obama would opt for tightening the sanctions against North Korea. Demands from military and strategic analysts in the US for tough military action against North Korea are, however, increasing. Tokyo and Seoul would remain averse to escalating tension in the region, especially with a regime as unpredictable and fragile as North Korea's is today. At the same time, the US will increase pressure for sanctions and resumption of talks. The talks, once they start, are likely to be protracted and prospects for their success do not appear to be promising unless the US and other parties are willing to yield bigger concessions on tangibles to the DPRK. With these tests, Pyongyang has signalled that it continues to be willing to negotiate, but that its nuclear weapons programme will not be dismantled. It might be willing, though, to accept some form of safeguards.

It is useful to recall China's statements issued at various stages of the Indo-US civilian nuclear agreement. These comments could presage efforts by China to support the case of its clients viz. Pakistan and the DPRK.

China's sincerity in issuing the latest warning and how far it is willing to go along with the US to punish North Korea is questionable. Though China has been assisting the US and other powers to resolve the nuclear issue on the Korean Peninsula and received kudos from the US for its efforts, Beijing remains reluctant to see a real warming of US-DPRK relations. It does not want to see normalisation of US-DPRK relations and, consequently, have a Korean Peninsula dominated by the US adjacent to it. At the same time, it has been unable to prevent North Korea going nuclear, a development it views as unfavourable. Beijing will, nonetheless, try to ensure that its relationship with North Korea is not damaged and that it continues to exercise some influence over the North Korean regime.

A South Korean academic recently hinted at China's likely stance when he suggested that Pyongyang could be following India's example and will strive to get a similar nuclear deal. In the context of this remark and surrounding circumstances, it is useful to recall China's statements issued at various stages of the Indo-US civilian nuclear agreement. These comments could presage efforts by China to support the case of its clients viz. Pakistan and the DPRK, and secure for them a deal similar to the Indo-US civilian nuclear agreement.

China has opposed the Indo-US civilian nuclear agreement from the time it was proposed. Beijing's opposition to the agreement was enunciated in the official media, including the daily newspaper of the Chinese Communist Party, the *People's Daily* and by military journalists. Chinese arguments were along predictable lines, but they all reflected Beijing's unease at the marked improvement in India's ties with the US that the agreement signalled. The Chinese also realised, as the agreement progressed towards conclusion, that India had been able to effectively leverage its strengths and was driving a hard bargain with the US. A *People's Daily* commentary on August 14, 2007, declared that "the US has made big concessions and met almost all India's requests." It assessed that "a substantial change has taken place in the nature of India-US relations despite possible twists and turns in the future." The commentary accused the US of double standards and sought to buttress the arguments of India's 'Left' by claiming that the US was trying to use "India as a tool" to achieve its strategic aims. This was followed by another *People's Daily* commentary on August 30, 2007, which advanced similar arguments. On September 1, 2008, the *People's Daily* carried another commentary written by Fan Jishe, a member of China's prestigious Chinese Academy of Social Sciences. This commentary was blunt and declared that "whether motivated by geopolitical considerations or commercial interests, the Indo-US agreement has constituted a major blow to the international non-proliferation regime." Fan Jishe asserted that India would "enjoy the benefits of being a party to the Nuclear Non-Proliferation Treaty without being bound to accept the corresponding restraints." He accused the US of "double standards" and urging the Nuclear Suppliers Group (NSG) to open a "back door" for India.

On October 26, 2008, Xin Bejian, a military journalist and member of a Chinese military educational facility, said the US had styled itself as a "guard" of non-proliferation, but had this time itself sought to make an "exception." He said this would lead to "a series of negative consequences" and call into question its status as a "guard." The article asked how the US could now hope to win the support of the international community in its efforts to get Iran and North Korea to dismantle their nuclear programmes. Even more significantly, Xin Bejian reiterated a warning issued earlier by China. He stated that "now that the US buys another country in with nuclear technologies in defiance of the international treaty, other nuclear suppliers also have their own partners of interest as well as good reasons to copy what the US did." He added the warning that the US action would have a domino effect and lead to global proliferation and competition. Xin Bejian's meaning was clear. The reference was to Pakistan and North Korea, both best described in this context as China's clients. Beijing was already pushing Pakistan's case with Washington and urging the Bush Administration to extend to Pakistan the same arrangement as it intended to India. While it did not formally take up North Korea's case, the slow pace at which the North Korean nuclear issue was proceeding was making it apparent that a stage would soon be reached where North Korea would decline to dismantle its nuclear programme. This has now happened.

Now that the US buys another country in with nuclear technologies in defiance of the international treaty, other nuclear suppliers also have their own partners of interest as well as good reasons to copy what the US did.

China could well receive indirect support from an unexpected quarter. Both the so-called "ayatollahs" of non-proliferation viz. Robert 'Bob' Einhorn and Michael Krepon are more influential with the advent of the Obama Administration in the US. Bob Einhorn has, in fact, been appointed an envoy in the US State Department. In his testimony before the US Senate Foreign Relations Committee in April 2006, Einhorn asked, "How can the US seek exceptions to the rules for India without opening the door to exceptions in less

worthy cases—indeed, without weakening the overall fabric of rules the US worked so hard to create?" Asking how other countries would view the US action of "giving India the opportunity to have its cake and eat it too", Einhorn added that it would be difficult for the US not to "convey the impression to countries contemplating the nuclear option that, if they opted for the nuclear weapons, the world would eventually accept them into the nuclear club." Now that the Indo-US civilian nuclear agreement has been signed by both parties, there are limits to what Bob Einhorn and others could do. But they and the groups representing their viewpoint could be expected to push for amendments to the India-US civilian nuclear agreement.

The next steps in the resolution of the nuclear issue in the Korean Peninsula are expected to be subject to protracted negotiation. Indications are that US President Obama will push for tougher sanctions and, if the US seeks to closely monitor North Korea's fiscal transactions, then Chinese banks, which are the ones North Korea generally uses, will be under scrutiny. This might compel China to lean harder on Pyongyang. It is likely, however, that China will advocate Pakistan's and North Korea's case with Washington, albeit behind closed doors. The US would then have to decide whether additional exceptions should be made, which would irreparably weaken the international non-proliferation regime and implicitly convey a green signal to other aspirants to nuclear weapon status like Iran, etc.

SIX DECADES OF PEACEKEEPING

E.R. RAJAPPAN

A principle of the United Nations which is absolutely binding upon all is the maintenance of peace, in order to protect human life.

— Dag Hammarskjold, UN Secretary-General

Though the concept of peacekeeping was evolved immediately after the United Nations (UN) was founded, peacekeeping as a means to resolve conflicts began only with the deployment of the United Nations Truce Supervision Organisation (UNTSO) into the Middle East in 1948 to monitor the Arab-Israeli ceasefire. Since then, the UN has established a total of 63 peace missions, of which 50 were in the post-Cold War era. Presently, more than 1,23,000 (92,000 uniformed personnel and 21,000 civilians) from 117 countries are serving in the 18 UN peacekeeping missions across the world. In the last six decades, the UN has spent $ 61 billion for peacekeeping. The peacekeeping budget has increased significantly in the 21st century and now stands at $ 7.1 billion for the accounting year 2008-09.[1] Peacekeeping, during the Cold War period traditionally involved employment of unarmed or lightly armed military

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1. United Nations Peacekeeping Operations – Fact Sheet, available at http://www.un.org/depts/dpko/dpko/bnote.htm

Though there were more than 100 major conflicts and 20 million deaths around the world during the period of the Cold War, the UN intervention for conflict resolution was limited to just 18.

personnel to observe a ceasefire or withdrawal of the forces after the ceasefire has been signed by the conflicting nations. The only exception to this traditional peacekeeping role was in Congo in the early 1960s, when the UN hesitatingly undertook robust actions, including use of offensive air power to suppress the rebel forces and to restore the territorial integrity of the country.

Though there were more than 100 major conflicts and 20 million deaths around the world during the period of the Cold War, the UN intervention for conflict resolution was limited to just 18.[2] The UN was unable to respond to the remaining crises, mainly due to the lack of resolve among the members of Security Council, especially the USA and Soviet Union which were engaged in proxy war and cultivating client states, and lack of consent by the affected nations for fear of prolonged presence of UN forces in their countries. Even when the UN responded, consensus could not be reached among the five permanent members (P-5) for any robust action and the intervention was limited to observing ceasefire, withdrawal of troops, supervision of political transition and holding of election in the newly decolonised countries. The end of the Cold War also brought an end to the "veto culture," of the superpowers, thus, paving the way for greater cooperation among the members of the Security Council to resolve many long standing conflicts. The 1990s witnessed an unprecedented surge in peacekeeping activities: a total of 38 peacekeeping missions were established in one decade alone as compared to 18 until the end of the 1980s. The peace operations in the post-Cold War era also threw up many challenges to the peacekeepers, thus, necessitating many a peace-enforcement operations. Whenever Chapter VI operation did not bring in peaceful settlement to the crises, the Security Council, without much reluctance, authorised more robust actions under Chapter VII, especially to deal with humanitarian crises. In the

2. Boutros Boutros Ghali, "Agenda for Peace - Preventive Diplomacy, Peace-making and Peacekeeping," 1992, available at http://www.globalpolicy.org/reform/initatives/ghali/1992/0617peace.htm

post-Cold War era, the most difficult and arduous challenges to peacekeepers were presented by civil wars in "failed states," where governmental functions were suspended, police and judiciary had collapsed, infrastructure destroyed and the population uprooted. The nature of conflicts, steadily shifted from inter-state to intra-state as the millennium came to a close. In the growing intra-state conflicts, innocent civilians, particularly women and children, have become victims as hundreds of thousands of these defenceless people were massacred by the marauding forces, rebels and militias, as was witnessed in Cambodia, East Timor, Rwanda and Democratic Republic (DR) of Congo, etc. The contemporary intra-state conflicts present multi-dimensional roles for the peacekeepers, who, unlike in the past, also have to deal with post-conflict peace and nation-building activities, besides carrying out peacekeeping roles: Disarmament, Demobilisation and Reintegration (DDR).

Ever since the deployment of the UN Protection Force in 1992 for the settlement of the Yugoslav crisis, the dependence on air power for peacekeeping has become marked.

Ever since the deployment of the UN Protection Force in 1992 for the settlement of the Yugoslav crisis, the dependence on air power for peacekeeping has become marked. As in the case of conventional conflicts, the application of air power for peacekeeping operations gained operational acceptability among the members of the Security Council for prosecuting peace-enforcement and post-conflict peace-building operations. In order to enhance the success of intrusive peace-enforcement, all facets of military capability such as intelligence gathering, integrated C3 (Command, Control and Communication), aerospace power, maritime power/sea control, forcible entry, strategic mobility, global logistic support, land combat power, nation-building, etc had to be employed. Of all these capabilities, air power stands out distinctly because of the speed and effect it can lend to peace operations, both pacific and enforcement.[3] Air power resources for troop movement, logistic

3. Steven Metz, "The Air Force Role in UN Peacekeeping," available at http://www.airpower.maxwell.af.mil/airchronicles/apj/apj93/win93/metzz.htm

support, intelligence gathering, airborne early warning, interdiction, counter-air missions, close air support, communication, casualty evacuation, etc became more prominent since the Yugoslavian crisis. The changing dimensions of 21st century peace operations would require the use of advance capabilities of air power in the realms of Intelligence, Surveillance and Communication (ISR) enabled through space-based platforms.[4]

In order to understand why and how the UN peacekeeping has changed over the years and what shape it will take in future, it is pertinent to understand the procedure for establishing UN peacekeeping missions, peacekeeping roles envisioned in the UN Charter, elements of peacekeeping force and force structure, conduct of peace operations, principles and guidelines of peacekeeping as set out in UN Charter and later evolved through precedence, legal tenets and international laws concerning peacekeeping, and the reforms undertaken by the UN to make the peacekeeping operation ensure international peace and security in the evolving geo-political security scenario.

PEACEKEEPING IN THE UN CHARTER

Though *peacekeeping* is one of the main activities of the UN, the UN Charter makes no explicit mention of it. In order to ensure prompt and effective action by the UN, to maintain international peace and security, the members of the UN confer on the Security Council the power and responsibility to take collective action. The international community expects that the Security Council, while discharging its peacekeeping duties, will act in accordance with the *purpose and principles* of the UN. The specific powers granted to the Security Council for maintenance of international peace and security shall be in accordance with Chapters VI, VII, and VIII. Generally, the peace operations are established and implemented by the UN itself, with troops serving under UN command. In some cases, where direct UN involvement is not considered appropriate or feasible, the Security Council may authorise regional agencies such as the North Atlantic Treaty Organisation (NATO), Economic Community of West African States (ECOWAS), Organisation of African Union (OAU) or

a coalition of willing states to implement both peacekeeping and peace-enforcement functions on behalf of the UN, in accordance with provisions contained in Chapter VIII of the UN Charter. [4]

Chapter VI lays down the guidelines for pacific settlement of conflicts and forms the basis of consensual peacekeeping. It implies that peacekeeping would be voluntary and non-enforceable.

Chapter VI – Pacific Settlement of Disputes

Under Article 33(1), the UN Security Council (UNSC) may call upon the parties to any dispute which may endanger the maintenance of international peace and security, to resolve the dispute by means of negotiation, inquiry, third party mediation, conciliation arbitration, judicial settlement or any other means of the disputant's choice.

Article 34 empowers the UNSC to "investigate any dispute, or any situation which might lead to international friction or give rise to dispute in order to determine whether the continuance of the dispute or situation is likely to endanger the maintenance of international security."

Under Article 37, if the Security Council deems that the continuance of the dispute is likely to endanger the maintenance of international peace and security, it shall initiate actions considered appropriate, for the pacific settlement of the dispute[5].

Chapter VI lays down the guidelines for pacific settlement of conflicts and forms the basis of consensual peacekeeping. It implies that peacekeeping would be voluntary and non-enforceable. All peacekeeping operations, with the exception of Congo, launched by the UN until the end of the Cold War were Chapter VI operations. The fundamental feature of Chapter VI operations is the consent of the parties to the deployment of peacekeepers to resolve conflicts.

4. Bruce Jones, "Evolving Models of Peacekeeping – Policy Implications and Responses," available at http://www.smallwarjournal.com/documents/pkomodels
5. UN Charter VI, available at http://yale.edu/lawweb/avalon/un/unchart.htm

Force beyond self-defence also may be used by the peacekeepers when forced to withdraw from their position, disarm, and prevented from fulfilling the mission mandate.

Chapter VII – Action With Respect to Peace, Breaches of Peace and Acts of Aggression

Under Article 39, the UN Security Council "shall determine the existence of any threat to peace, breach of peace, or act of aggression and shall make recommendations or decide what measures shall be taken."

Article 41 allows the use of measures not involving use of armed forces; these are economic and diplomatic sanctions (complete or partial interruption of economic relations and of rail, sea, air, postal, radio and other means of communication and severance of diplomatic relations). Article 42 states that should the Security Council consider that measures provided for in Article 41 are inadequate or have proved to be inadequate, it may take such action by air, sea or land forces as may be necessary to maintain or restore international peace and security. Such action may include demonstrations, blockades and other operations by air, sea or land forces of the members of the UN.

Article 43 calls upon all member states to make provisions to make available to the Security Council, "armed forces, assistance and facilities including the rights of passage of the troops."

Article 44 stipulates that whenever the Security Council decides to use force, it shall, before calling upon a member not represented on it, provide armed forces in fulfilment of the obligations assumed under Article 43, invite that member to participate in the decisions of the Security Council concerning the employment of contingents of that member's armed forces.[6]

Chapter VII provides the guidelines for "action with respect to peace, breaches of peace and acts of aggression" comprising enforcement actions (use of military, sanctions and severance of diplomatic ties). Generally, Chapter VII operations are authorised by the Security Council only in grave situations such as to prevent acts of aggression, to deal with armed conflict, to

6. UN Charter VII, available at http://yale.edu/lawweb/avalon/un/unchart.htm

facilitate humanitarian operations and to protect life and property of the UN in the mission area.

Force beyond self-defence also may be used by the peacekeepers when forced to withdraw from their position, disarm, and prevented from fulfilling the mission mandate.[7] Though the UN will try and seek consent from the parties before undertaking peace-enforcement operations, it may not possible or may not be done where the operations are necessitated on account of human catastrophe or where the legitimacy of the government is questionable.

Chapter VIII – Regional Arrangements (Hybrid Operations)

Article 52 authorises regional arrangements or agencies for dealing with matters relating to the maintenance of international peace and security, provided that such arrangements or agencies and their activities are consistent with the purposes and principles of the UN. Members of the UN, when entering into such arrangements or constituting such agencies, shall make every effort to achieve pacific settlement of disputes.

Article 53 empowers the Security Council to allow regional arrangements or agencies to undertake peace-enforcement action. But no enforcement action shall be taken by regional arrangements or by regional agencies without the authorisation of the Security Council, with the exception of measures against any enemy state to prevent further aggression.[8]

Budgetary constraints, time delay involved in mustering the troops and lack of troop support from major military powers since the mid-1990s have forced the UN to follow a flexible approach and tailor its peacekeeping response based on resources available in a particular situation, while structuring the peace operation.

Compulsions of the emerging attitude of major military powers in committing their military troops for peace operations under the aegis of the UN, has prompted it to resort to joint or hybrid operations to avail of the advantage of legitimacy and force, two distinct requirements of peacekeeping

7. Boris Kondoch, *International Peacekeeping* (Hampshire: Ashgate Publishing Ltd, 2007 Edition), p. 190.
8. UN Charter VIII, available at http://yale.edu/lawweb/avalon/un/unchart.htm

operations. In many cases, this flexible approach of the UN has resulted in coopting a bilateral force, a multinational force under a lead country or regional or sub-regional organisations. These non-UN organisations can supplement or fill up troop deficiency. The UN has been conducting hybrid operations with regional arrangements like NATO, European Union (EU), ECOWAS and OAU. Four types of hybrid operations have evolved over the years: integrated operation (UN and regional agencies operate with a single joined command: Haiti – UN/EU/OSCE); coordinated operation (UN and regional organisations operate side-by-side under separate command structure but in a coordinated fashion: Kosovo – UN/NATO); parallel operation (UN and regional organistations operate alongside forces of other countries: Rwanda – UN and France led forces); and sequential operations (UN precedes multinational/regional/bilateral forces: Sierra Leone).[9]

Chapter VI versus Chapter VII Operations

While peacekeeping under Chapter VI still remains the most preferred option, the proliferation of violent intra-state conflicts in the recent past has compelled the UN to authorise peace-enforcement operations under Chapter VII. Expectedly and significantly, the emphasis on UN Chapter VII mandated that peace operations would have a strong impulse in the future years. And this point needs to be taken into account.[10] Considering the highly fragile political atmosphere and internal security in many nations in various parts of the world, UN intervention under Chapter VII peace-enforcement is highly probable.

Peacekeeping Defined

In simple terms, peacekeeping is primarily a diplomatic tool used to stimulate the peaceful resolution of conflict and is not an end in itself. Dag Hammarskjöld, the second UN Secretary-General, referred to it as belonging to "Chapter Six and a Half" of the Charter, placing it between traditional methods of resolving disputes peacefully, such as negotiation and mediation

9. Jones, n.4.
10. AVM Kapil Kak (Retd), "IAF and Peacekeeping Operations," *Air Power Journal,* vol.2, no.3, Monsoon 2005 (July-September).

under Chapter VI, and more forceful action as authorised under Chapter VII.

Peacekeeping as defined by UN is *"a way to help countries torn by conflict and create conditions for sustainable peace."*[11] A more comprehensive and apt definition is the one offered by the International Peace Academy: *"Peacekeeping is an international technique used in conjunction with diplomacy for the purpose of conflict management. Peacekeeping operations employ voluntary military and diplomatic personnel from one or more countries, either to create the conditions for conflict resolution or to prevent further hostilities through the supervision of an interim or final settlement of conflict. Peacekeeping forces are impartial and exist only with the consent of the host countries of all disputing parties; therefore, peacekeeping forces do not interfere with the internal affairs of the host countries or use coercion to enforce agreements – the use of force is limited to self defence."* This definition embodies three principles or foundations that set peacekeeping apart from other international methods of conflict control or resolution: consent, impartiality and use of force limited to self-defence.

This definition embodies three principles or foundations that set peacekeeping apart from other international methods of conflict control or resolution: consent, impartiality and use of force limited to self-defence.

UN Bodies Responsible for Peacekeeping

When the United Nations was established, it was composed of six principal organs: General Assembly, Security Council, Economic and Social Council (ECOSOC), Trusteeship Council, Secretariat, and International Court of Justice. Since then, the UN family has grown over the years and now has 15 agencies, several bodies and programmes. Of these six principal organs, the Trusteeship Council suspended its operations from November 1, 1994, as the last such territory under it, Palau, became a formal member of the UN. Four of the UN organs are located at the main United Nations Headquarters located in the international territory in

11. "UN Peacekeeping – FAQ – Meeting New Challenges," available at www.un.org/Depts/dpko/faq

New York City and the fifth, the International Court of Justice, is located in the Hague.[12] The principal organs of the UN are briefly explained below:

- **UN General Assembly**. It is the main deliberative organ and is composed of representatives of all member states, each of which has one vote. Decisions on all important matters such as peace and security, admission of new members and budgetary matters, etc require two-thirds majority, but other issues require only simple majority. Though the General Assembly is the main deliberative organ of the UN, in practice it does not have any executive powers with regard to maintenance of peace. As per Article 11 of the UN Charter, the General Assembly may discuss, make recommendations and call the attention of the Security Council regarding issues related to maintenance of international peace and security. Under the "*Uniting for Peace*" resolution adopted by the General Assembly in November 1950, the Assembly may take action if the Security Council, in the event of lack of unanimity of its permanent members, fails to act where there appears to be a threat to international peace, breach of peace or act of aggression. The Assembly is empowered to consider the matter immediately and with a view to making recommendations to the members for collective measures, including the use of armed forces when necessary to maintain or restore international peace and security.[13]
- **UN Security Council.** As per Article 24 of the UN Charter, the General Assembly confers on the Security Council the primary responsibility for the maintenance of international peace and security and agrees that in carrying out its duties, it shall act in accordance with the purpose and the principles of the UN. The Council consists of fifteen members of the UN, of which the US, UK, France, China and Russia (five members) are permanent and the other ten are non-permanent members elected for two years, on the basis of equitable geographical distribution. Each member has one vote and decisions on procedural matters are made by an affirmative vote of at least 9 of the 15 members, and on substantive matters, require

12. "UN Organisation," available at http://www.un.org/depts/depts
13. *The UN Today* (UN Department Information, 2007 edition), p. 7.

nine votes and the absence of a negative vote by any one of the P-5. If a permanent member does not fully agree with a proposed resolution, but does not wish to cast its vote, it may choose to abstain, thus, allowing the resolution to be adopted if it obtains the required number of nine votes in favour. Under Article 25 of the UN Charter, all members of the UN agree to accept and carry out the decisions of the Security Council. While other organs of the UN make recommendations to member states, the Council alone has the power to take decisions, which member states are obligated under the Charter to implement. The Security Council is the primary decision-making body with regard to establishment or closure of peacekeeping/peace-enforcing missions[14].

- **Secretariat.** The Secretariat is headed by the Secretary-General, who is assisted by a staff of international civil servants worldwide. The Secretariat services the other principal organs of the UN and administers the programmes and policies laid down by them. It provides studies, information, and facilities needed by United Nations bodies for their meetings. Some key offices such as the Office of Legal Affairs (OLA), Department of Political Affairs (DPA), Department of Peacekeeping Operations (DPKO), Department of Field Support (DFS), Department of Economic and Social Affairs (DESA) and Department of Public Information (DPI) are part of the Secretariat.
- **Department of Peacekeeping Operations (DPKO).** Established in 1992, the department is responsible for assisting member states and the Secretary General in their efforts to maintain, achieve and sustain international peace and security. DPKO is responsible to plan, prepare, manage and direct UN peacekeeping operations, so that they can effectively fulfill their mandates under the overall authority of the Security Council and General Assembly and under the command vested in the Secretary-General. DPKO provides political and executive direction to UN peacekeeping operations. It also maintains contact with the Security Council, troop and financial contributors, and parties to the conflict in the implementation of Security

14. Ibid., p. 8.

Council mandates.[15] The Department works to integrate the efforts of UN, governmental and non-governmental entities in the context of peacekeeping operations. It also provides guidance and support on military, police, mine clearing activities, and other relevant issues to other UN political and peace building missions. DPKO is headed by an Under Secretary General, who is assisted by a military advisor and policy and analysis unit. DPKO has two main branches: Operations, and Planning and Support. The Operation Branch is responsible for controlling the ongoing missions and is divided into Africa, Asia, Middle East, Latin America and Europe divisions. The Planning and Support Branch undertakes the planning of new missions and provides field support to ongoing missions. The functions of this branch are shared between Field Administration and Logistics (FALD) and Planning. FALD is responsible to plan logistic support for new missions, administer ongoing missions and provide staff for the logistic functions in the peacekeeping missions.[16]

- **Department of Field Support (DFS).** DFS was established on June 29, 2007, as part of the reforms undertaken in the face of growing demands for UN peacekeeping and aims to strengthen the capacity of the organisation to manage and sustain the peace operations, which are spread around the world. Under the new arrangement, DPKO is responsible for strategic oversight and operational political guidance, while DFS is charged with planning, deployment and maintenance. In order to help ensure unity of command, the Under Secretary General for Field Support reports to, and receives directions from, the Under Secretary General for Peacekeeping Operations.[17]

AGENDA FOR PEACE

With the end of the Cold War, there came a new enthusiasm among the P-5 of the UN Security Council for contributing more constructively towards maintenance of international peace and security. In order to resolve many

15. Ibid., p. 28.
16. Ibid., p. 28.
17. Ibid., p. 30.

long lasting conflicts, the UN had to revamp its doctrine and expand its activities beyond conventional peacekeeping. The UN's response to the emerging peacekeeping operations was unveiled by UN Secretary General Boutros Boutros Ghali in 1992 in a policy document titled *Agenda for Peace, Preventive Diplomacy, Peacemaking and Peacekeeping*. The new peace agenda *proposed* the expansion and enlargement of UN peacekeeping. He argued that the UN should be involved in peacemaking, peacekeeping and peace-building activities. The *Agenda for Peace* envisages peace operations encompassing the earliest stages of conflict prevention to the stage of post-conflict peace-building. The significant aspects of the *Agenda for Peace* are:[18]

- **Preventive Diplomacy.** Preventive diplomacy envisages actions to prevent disputes developing between parties; if a dispute occurs, prevent it from escalating into a conflict, and limit its expansion. Though primarily a diplomatic activity, some situations may demand application of force to coerce the parties to avoid confrontation; in that way, preventive diplomacy includes both military and non-military activities. Military activities include confidence-building measures, early warning based on intelligence, preventive deployment of force, and maintaining forces ready for deployment. These days, preventive diplomacy is being increasingly used as a tool to demonstrate the will and commitment of nations to a pacific resolution of disputes.
- **Peacemaking.** Peacemaking involves both political and diplomatic efforts to bring the hostile parties to a negotiated settlement of the dispute, especially through pacific means such as negotiation, inquiry, mediation and conciliation as outlined in Chapter VI. A peacemaking operation is conducted after the conflict has arisen, to secure a ceasefire or a peaceful settlement. In this type of operation, all military interventions, either actual or threat of use, are preceded by diplomatic efforts. It is the belief that an apparent high state of readiness for military deployment would help in making peace.
- **Peacekeeping.** Peacekeeping involves the presence of a peace force in

18. "An Agenda for Peace," available at www.globalpolicy.org/reform/initiatives/ghali/1992

the field to implement or monitor the arrangements relating to control of conflict. The facilitating arrangements may vary from ceasefire, separation of forces, monitoring of borders, and delivery of humanitarian aid. Peacekeeping is undertaken normally after the ceasefire has been achieved and there is consent from the parties to the conflict to make peace and there is low threat of disruption. Force is used only as a last resort, and when used, it is only for defence. Military tasks during peacekeeping would primarily consist of observation and monitoring of truces and ceasefires through a system of reporting and monitoring. Other tasks that could be entrusted to a peacekeeping force are: supervision of ceasefire lines, borders and demilitarised zones, refugee and displaced persons camps, DDR (Disarmament, Demobilisation, and Reintegration) of combatants, census, referendums, plebiscites and elections. Sometimes, a peacekeeping force could be entrusted with negotiation, mediation, liaison with parties to the conflict/other agencies and investigation of complaints/violations also.

- **Peace-building.** Peace-building entails actions to identify and support indigenous structures which will promote peace and build trust and interaction between the parties to the conflict. Peace-building includes but is not limited to reintegrating former combatants into the civilian society, strengthening the rule of law by training and restructuring of government institutions such as the military, police and judicial systems; monitoring of human rights and providing technical assistance for democratic development and promoting national reconciliation techniques.

PRINCIPLES OF INTERNATIONAL PEACEKEEPING

The legal doctrine of consensual peacekeeping operations under Chapter VI of the UN Charter is based on three principles. Firstly, the presence of a peacekeeping force requires the consent of the state; secondly, the force should be impartial; and, thirdly, the use of force is permitted only in the case of self-defence. These key legal principles have been derived from the establishment and operation of the United Nations Emergency Force (UNEF I) in 1956, which became the precedent for consensual peacekeeping operations.

- **Consent of Parties.** Consent of parties to the conflict is the primary principle of all UN peacekeeping operations, except for peace-enforcement operations under Chapter VII. The parties to the conflict must agree for the truce, the participation of the multinational force for peacekeeping from the soil of the nation(s) concerned, the terms and mandates of the UN force and its composition. As a general rule, the continued consent of the concerned government(s)/parties is essential in inter-state conflicts. In civil war situations, although only the consent of the government is required from a legal point of view, in practice, the UN tries to obtain factual consent from other parties to the conflict as well. An exception to the rule of consent of the parties is applied when the UN is unable to obtain consent due to the collapse of internal authority or when resorting to "*peace-enforcement*" under Chapter VII. The UN interventions in former Yugoslavia and Liberia were undertaken without recourse to the consent of the parties, due to the total collapse of governmental functions and the governmental authority lacking credibility.[19]

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- **Impartiality.** Another important principle is impartiality, which implies that the peacekeepers should not be party to advancing the interest of one party over the other. Without impartiality, there is hardly any prospect of preserving the confidence or cooperation of the parties to the conflict. A peacekeeping force can perform successfully only when it is trusted by all parties to the conflict. Wider international support is seen as a major contributor to overall impartiality of a mission. Impartiality must not be confused with neutrality or inaction as this will restrict both flexibility and the potential to execute an initiative. The conduct of a peacekeeping force should be impartial to the parties but can never be neutral to the execution of the mission.

19. n. 7, p. 213.

- **Use of Force.** One of the cornerstones of peacekeeping is the defensive use of force. If not otherwise mandated under Chapter VII, peacekeepers can use force only in self-defence. However, over the years, the concept of self-defence has evolved and the UN on many occasions got involved in operations that went beyond self-defence and included robust actions. Peacekeepers would be entitled to use force beyond self-defence, when forced to withdraw from their position, infiltrate and envelop such positions as deemed necessary by their commanders for them to hold, thus, jeopardising their safety; attempts by force to disarm peacekeepers; attempts by force to prevent peacekeepers from carrying out their responsibilities as ordered by their commanders; violation by force on UN premises; attempts to arrest or abduct UN personnel (military/civil); and attempts to use force to make them withdraw from positions which they occupy under orders from the force commander. Force should be used only when negotiations and other pacific means have failed. When force is used, it should be precise, appropriate, proportional and timely, with due regard for civilian casualties and collateral damage.[20] Use of force also can be authorised by the Security Council to ensure safety of civilians and delivery of humanitarian assistance as was done in Somalia (UNSOM II), Kosovo (UNPROFOR), Croatia (UNCRO) and Rwanda (UNAMIR), etc.
- **International Support.** UN peacekeeping operations are to be mandated by the Security Council. A peacekeeping mission can be formed only with a positive vote of a minimum nine members, including all permanent members, of the 15-member Security Council. There must a wide support from the General Assembly and the international community for undertaking peacekeeping operations under the aegis of the UN.

LEGAL ASPECTS OF PEACEKEEPING

UN peace operations are essentially international in composition and character. Every peacekeeping mission derives its legitimacy from statutory laws, conventions and other legal instruments. The legal status of the members

20. Ibid., p. 176.

of the peacekeeping force is secured by the mandate of the mission, the Status of Force Agreement (SOFA) or Status of Mission Agreement (SOMA) and the Rules of Engagement (RoE).[21] Therefore, it is incumbent on the peacekeepers to regulate their conduct and operations entirely in pursuance of these legal instruments. Mission Standard Operating Procedures (SOPs) and the Force Commander's operational orders are drawn up in consonance with the spirit of these overarching instruments, to guide the conduct of peacekeepers. The broad legal aspects of peace operations are discussed below:

- **Mandate.** A mandate emerges from the Security Council Resolution and it lays down the broad objective and time-lines for the operation. A mandate is a basic necessity for the conduct of peace operations. It is the overarching UN document which provides the outline, composition and functions of the military and civil components of a peace mission. It also lays down the procedures for humanitarian intervention and election monitoring, if planned to be held in the host country.
- **Status of Force Agreement (SOFA)/Status of Mission Agreement (SOMA).** SOFA/SOMA essentially is a legal agreement between the UN and the host country to describe the legal position of the Peace Force in the host country and also to define the relationship of the Peace Force and its members with the government and citizens of the host country. This agreement provides the Peace Force a legal international status, privileges and immunities of the UN and arrangements for the criminal jurisdiction of the force, freedom of movement to the members of the force, and authorisation to bring in arms and ammunition, carry and employ them as per conditions set out in the Rules of Engagement.
- **Rules of Engagement (RoE).** Though "use of force" is resorted to as the last option for peacekeeping, the contemporary peace operations invariably use force well beyond self-defence, either because of the volatile nature of the conflict or to fulfill the mandate of the mission. Therefore, peacekeepers must be aware of the tenets of the application of force and the RoE.

21. Ibid.

Rules of Engagement may be modified or changed during a peacekeeping operation depending upon the ground situation and progress of the peace operation, with the consent of UN HQ.

The Force Commander or the Head of the Mission is responsible for drawing up the RoE, based on the mandate, resources available to the force, and terms of the agreement between the parties to the conflict. RoE are directions that delineate the circumstances and limitations for use of force. In addition to providing the legal authority, RoE also reflect the legal, political and diplomatic constraints of use of force. Nothing in the RoE prohibits a commander from taking appropriate actions to protect his force. Rules of Engagement may be modified or changed during a peacekeeping operation depending upon the ground situation and progress of the peace operation, with the consent of the UN HQ. While RoE are essential for preventing excesses by the peacekeeping forces, many times these very rules have served as great impediments to the successful conduct of peace operations, as evidenced in former Yugoslavia, Rwanda, Haiti, DR Congo, Liberia and Cote d'lvoire.

INTERNATIONAL LAWS AND PEACEKEEPING

In general, the legal status of personnel serving in peacekeeping operations refers to their rights and duties under the applicable law, and the terms of civil, service and criminal jurisdiction which are applicable. The legal status of peacekeepers is derived from four different bodies of law: the national law of the host country, the law of the intergovernmental organisation (if the peacekeeping operation is not established by a group of states), the law of the sending or participating state and the rules of general international laws (humanitarian law, human rights law and criminal law).[22]

22. Ibid., p. 230.

- **International Humanitarian Law**. One of the legal disputes concerning peacekeeping operations is whether international humanitarian law is applicable and to what extent. The application of humanitarian law becomes all the more important when peacekeepers become involved in combat situations or when they are taken as hostages. The UN, being an international organisation, is not in a position to become a party to the Geneva Convention or Additional Protocols. Also, since it is not a state, it lacks the legal and other structures for dealing with violations of humanitarian law. However, this does not mean that the conduct of peace operations by UN forces will be free from humanitarian constraints or that humanitarian law considerations do not apply. For a long time, the UN argued that peacekeepers were under no legal obligations arising from international humanitarian law and they were only bound by its principles and spirit, as peacekeepers act on behalf of the international community and, therefore, cannot be considered a "party" to the conflict, nor a "power" within the meaning of the Geneva Convention.[23] In response to the long standing plea of the International Committee of the Red Cross (ICRC), the UN promulgated "*Observance by United Nations Forces of International Humanitarian Law*" in 1999 and, for the first time, it declared itself to be bound by the fundamental principles and rules of international humanitarian law.
- **International Human Rights.** Peacekeepers should be aware of human rights standards. Until the 1990s, peacekeepers had no specific mandate related to human rights. The common understanding that "human rights violations are often the cause of conflicts and addressing them is a pre-condition for peace," led to the assignment of various human rights functions to second generation peacekeeping and other types of human rights operations. Human rights have played an important role in the performance of UN peace operations since the Kosovo and East Timor missions. Even if human rights are incorporated in the mandate or in UN regulations, peacekeepers serving in consensual peacekeeping

23. Ibid., p. 326.

operations are bound by human rights rules, which form part of customary international law.[24] In the case of peace operations established under Chapter VII, legal obligations flow at least from those rights that are legally enforceable. The UN established security zones and safe corridors for the protection of civilians in Rwanda and in Bosnia-Herzegovina are classic examples of importance attached to human rights protection during peace operations.

- **Protection of Peacekeeping Force.** In the recent years, increasing numbers of peacekeepers are becoming victims of crimes such as killing, kidnapping, hostage taking, armed robbery, etc, and protection to peacekeepers, has now become an important agenda of the UN. The safeguards and protection available to the peacekeepers under the Convention on the Safety of UN and Associated Personnel of 1994 (Safety Convention 1994), which was adopted following assaults on peacekeepers in Somalia, Rwanda and former Yugoslavia, are limited to murder, kidnapping or other attacks against personnel. As per the Safety Convention 1994, the safety of a Peace Force engaged in peace-enforcement operations undertaken under Chapter VII is outside the purview of the Safety Convention and is to be dealt with under the provisions of the Law of International Armed Conflict (IAC).[25] With most of the 1990s peace operations falling under Chapter VII, there was a need to bring Peace Forces engaged in peace-enforcement also under the cover of the Safety Convention. Triggered by the massacre of nine UN peacekeepers in February 2005 in DR Congo, the "Operational Protocol" to the "Convention on the Safety of the UN and Associated Personnel", was signed in December 2005. As per this new operational protocol, UN peacekeepers would be granted legal protection when they are engaged in providing emergency humanitarian assistance, peace-building activities and delivery of humanitarian, political and development assistance.

24. Ibid., p.312.
25. Ibid., p.410.

PEACEKEEPING AND CHANGING ROLES

- **First Generation Peacekeeping.** The "First Generation" peacekeeping, referred to as "classic" or "traditional" peacekeeping, started in 1948 and continued until the end of the Cold War. The first full-fledged peacekeeping operation to be undertaken by the UN was the United Nations Emergency Force (UNEF I) in 1956, with contributions from ten nations, to supervise the withdrawal of foreign troops (Israeli, UK and France) from the Suez Canal area. The basic principles and guidelines for peacekeeping operations were evolved during this mission and these tenets continue to regulate the peacekeeping missions established thereafter. Peacekeeping was conceived as a useful means for the UN to resolve inter-state conflicts. Normally, a ceasefire had to be in place between the parties to the conflict, before the deployment of UN peacekeepers. The presence of peacekeepers was intended to provide the time and opportunity for initiating a diplomatic process to address the root cause of the conflict. The peacekeepers were not intended to fight fire with fire, but were to observe the ceasefire from the ground and report impartially on the adherence to it. The role of peacekeepers until the end of the 1980s, with the exception of Congo, was mostly to function as a neutral party to monitor the ceasefire, create and control buffer zones after the agreement had been signed, and withdrawal of forces from the ceasefire line. Out of the 13 missions established during the Cold War period, five are still operating as they have not yet fulfilled their mandates. The details of the first generation peace missions are given in Table 1.

UN peacekeepers would be granted legal protection when they are engaged in providing emergency humanitarian assistance, peace-building activities and delivery of humanitarian, political and development assistance.

Table 1. First Generation Peacekeeping Missions

Start	End	Name	Acronym	Purpose	Comment
1948	On-going	UN Truce Supervision Organisation	UNTSO	Monitor Arab-Israeli ceasefire.	Authorised in June 1948. The first UN peacekeeping mission.
1949	On-going	UN Military Observer Group in India and Pakistan	UNMOGIP	Monitor India-Pakistan ceasefire in Kashmir.	The mission still continues due to Pak claims of violation of LoC/ ceasefire line.
1956	1967	UN Emergency Force 1	UNEF I	Supervise withdrawal of troops from the Suez crisis.	First armed peacekeepers. Ended in June 1967.
1958	1958	UN Observation Group in Lebanon	UNOGIL	Prevent troops and weapons entering Lebanon during crisis.	Ended in December 1958.
1960	1964	UN Operation in the Congo	ONUC	Prevent foreign intervention in and preserve territory of the Congo	Ended in June 1964.
1962	1963	UN Security Force in West New Guinea (West Irian)	UNSF	Monitor ceasefire during transition of West Irian from Dutch rule to Indonesia.	Ended in April 1963.
1963	1964	UN Yemen Observation Mission	UNYOM	Supervise disengagement of Saudi Arabia and Egypt from Yemen's civil war.	Ended in September 1964.
1964	On-going	UN Force in Cyprus	UNFICYP	Prevent conflict between Greek and Turkish Cypriots.	

1965	1966	Mission of the Representative of the Secretary-General in the Dominican Republic	DOMREP	Monitor situation caused by rival governments in Dominican Republic. Ended in October 1966.	
1965	1966	UN India-Pakistan Observation Mission	UNIPOM	Supervise India-Pakistan ceasefire outside of Kashmir.	Ended in March 1966.
1973	1979	UN Emergency Force II	UNEF II	Supervise withdrawal of forces from Sinai after Egypt, Syria and Israel battle.	Ended in July 1979.
1974	On-going	UN Disengagement Observer Force	UNDOF	Maintain ceasefire between Syria and Israel on the Golan Heights	
1978	On-going	UN Interim Force in Lebanon	UNIFIL	Supervise Israeli withdrawal from Lebanon. Keep the international peace and security, and help the Lebanese government restore its effective authority in the area.	
1988	1990	UN Good Offices Mission in Afghanistan and Pakistan	UNGOMAP	Enforce Afghanistan and Pakistan from mutual non-interference.	Ended in March 1990.
1988	1991	UN Iran-Iraq Military Observer Gp	UNIIMOG	Supervise Iran-Iraq ceasefire.	Ended in February 1991.

Source **: h**ttp://en.wikipedia.org/wiki/Time_ofUnited_Nations_peacekeeping_missions

- **Second Generation Peacekeeping.** "Second-Generation" peacekeeping was evolved in the late 1980s. The collapse of the Soviet Union, following the social revolution brought about by the 1988 *Glasnost* and *Perestroika,* marked a new beginning in the history of the UN functioning. The new Russian Federation under Gorbachov was more willing to contribute towards building a new world order and peace. A new spirit of cooperation began to emerge among the P-5 members, which facilitated the UN to take a central role in the international security system. The immediate result of the increased cooperation among the Security Council members was evident from the brokering of the tripartite agreement among Angola, Cuba and South Africa in December 1988 and deployment of UN Transition Assistance Group (UNTA) to oversee free and fair election in the new republic of Namibia. In one of its most complex and successful interventions, the United Nations became directly involved in peacekeeping and peacemaking efforts in Central America in 1989, when the Governments of Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua requested its assistance in the implementation of their collective agreement to establish lasting peace in Central America. The role of peacekeepers exceeded beyond the traditional neutral party to cover combat functions to include demobilisation of armed Nicaraguan rebels. The second generation peacekeeping mainly focussed on ensuring smooth political transitions of newly forme republics, peacekeeping and peacemaking as demonstrated in Central America, which had been besieged by civil war, and to ensure mutual non-interference between Pakistan and Afghanistan. The UN peacekeepers, for their contribution to establish smooth political transitions in Central America and in recognition of their efforts for "reducing tensions" and making a decisive contribution towards peace negotiations, were awarded the 1988 Nobel Prize for Peace. The details of "Second Generation" peacekeeping mission are given in Table 2.[26]

26. http://en.wikipedia.org/wiki/Time_ofUnited_Nations_peacekeeping_missions

Table 2. Second Generation Peacekeeping Missions

Start	End	Name	Acronym	Purpose	Comment
1988	1990	UN Good Offices Mission in Afghanistan and Pakistan	UNGOMAP	Enforce Afghanistan and Pakistan from mutual non-interference.	Ended in March 1990.
1988	1991	UN Iran-Iraq Military Observer Group	UNIIMOG	Supervise Iran-Iraq ceasefire.	Ended in February 1991.
1989	1991	UN Angola Verification Mission I	UNAVEM I	Supervise withdrawal of Cuban troops from Angola.	Ended in June 1991.
1989	1990	UN Transition Group	UNTAG	Supervise Namibia's elections and transition to independence.	Ended in March 1990.
1989	1992	UN Observer Group in Central America	ONUCA	Monitor ceasefire In Nicaragua	Ended in January 1992.
1991	2003	UN Iraq-Kuwait Observation Mission	UNIKOM	Enforce Kuwait-Iraq border after Gulf War.	Ended in 2003.
1991	1995	UN Angola Vérification Mission II	UNAVEM II	Enforce ceasefire in Angolan civil war.	Ended in February 1995.
1991	On-going	UN Mission for the Referendum in Western Sahara	MINURSO	Implement ceasefire and help promote referendum on area's future.	
1991	1992	UN Advance Mission in Cambodia	UNAMIC	Prepare the way for UN Transitional Authority in Cambodia.	Ended in March 1992.

- **Third Generation Peacekeeping.** `Third Generation' peacekeeping evolved in the 1990s in response to domestic conflicts with complex

internal dynamics and fallouts emanating from ethnic, religious, political and linguistic conflicts. The intra-state strifes in Somalia, former Yugoslavia and Rwanda are typical of intra-state conflicts which resulted in genocide and internal displacement of millions of people. The magnitude of human tragedy caused by these conflicts, shocked and horrified the international community, forcing the UN to intervene on humanitarian grounds even without the consent of the nation and parties to the conflict. The traditional principles of consent and use of force only for self-defence became contested. With the increase in the number of conflicts in Africa, Balkans and Central America, the Security Council has found itself under pressure to respond, and approved over 37 new peace operations since 1990. Half of all current peacekeeping operations have been authorised since the dawn of the 21st century. This expansion in UN peacekeeping could be justified by pointing out the international consequence of the conflict, such as refugees or preventing widespread conflict and instability. Third generation peacekeeping definitely a dramatic shift from earlier doctrines and guidelines on peacekeeping. Liberal use of military forces, policing functions, human rights interventions, reconstruction, election facilitation and monitoring and post-conflict reconstruction became the hallmarks of third generation peacekeeping. The details of peacekeeping missions established by the UN since 1991 are given Table 3.[27]

Table 3. Details of Third Generation Peacekeeping Missions

Start	End	Name	Acronym	Purpose	Comment
1991	On-going	UN Mission for the Referendum in Western Sahara	MINURSO	Implement ceasefire and help promote referendum on area's future	

27. http://en.wikipedia.org/wiki/Time_ofUnited_Nations_peacekeeping_missions

1991	1992	UN Advance Mission in Cambodia	UNAMIC	Prepare the way for UN Transitional Authority in Cambodia.	Ended in March 1992.
1992	1995	UN Protection Force	UNPROFOR and UNPRODEP	Protect area of Croatia, Bosnia and Herzegovina, and Republic of Macedonia.	Restructured in December 1995.
1992	1993	UN Transitional Authority in Cambodia	UNTAC	Assist reorganisation of Cambodia.	Ended in September 1993.
1992	1993	UN Operation in Somalia I	UNOSOM II	Enforce ceasefire, reorganised as Unified Task Force (UNITAF).	Replaced March 1993 by UNOSOM II.
1992	1993	UN Observer Mission to Verify the Referendum in Eritrea	UNOVER	Monitor referendum for independence of Eritrea from Ethiopia.	Ended April 1993.
1992	1994	UN Operation in Mozambique	ONUMOZ	Monitor ceasefire in Mozambique's civil war.	Ended in December 1994.
1993	1995	UN Operation in Somalia II	UNOSOM I	Stabilise Somalia and assist humanitarian efforts.	Ended in March 1995.
1993	1994	UN Observer Mission Uganda -Rwanda	UNOMUR	Enforce ceasefire between Rwanda and rebel group based in Uganda	Ended in September 1994.
1993	On-going	UN Observer Mission in Georgia	UNOMIG	Enforce ceasefire between Georgia and Abkhaz separatists.	

1993	1996	UN Observer Mission in Liberia	UNOMIL	Monitor ceasefire and elections in Liberia.	Ended in September 1997.
1993	1996	UN Mission in Haiti	UNMIH	Stabilise Haiti after coup overturned.	Ended June 1996.
1993	1996	UN Assistance Mission for Rwanda	UNAMIR	Monitor ceasefire, and after Rwanda genocide, to promote relief efforts.	Ended in March 1996.
1994	1994	UN Aouzou Strip Observer Group	UNASOG	Monitor Libya's withdrawal from disputed territory given by International Court of Justice to Chad.	Ended in June 1994.
1994	2002	UN Mission of Observers in Tajikistan	UNMOT	Monitor ceasefire in Tajikistan civil war.	Ended in May 2000.
1995	1997	UN Angola Vérification Mission III	UNAVEM III	Monitor ceasefire and disarmament.	Ended in June 1997, but followed up with another mission, MONUA.
1995	1996	UN Confidence Restoration Operation in Croatia	UNCRO	Attempts to implement ceasefire.	Ended in January 1996.
1995	1999	UN Preventive Deployment Force	UNPREDEP	Replaced UNPROFOR in former Yugoslav Republic of Macedonia and monitored border with Albania.	Ended in February 1999.
1995	2002	UN Mission in Bosnia and Herzegovina	UNMIBH	Monitor human rights, de-mining, relief.	Ended in December 2002.

1996	1998	UN Transitional Administration for Eastern Slavonia, Baranja, and Western Sirmium	UNTAES	Supervise integration of region into Croatia.	Ended in January 1998.
1996	2002	UN Mission of Observers in Prevlaka	UNMOP	Monitor demilitarisation of the Prevlaka Peninsula, Croatia.	Ended in December 2002.
1996	1997	UN Support Mission in Haiti	UNSMIH	Modernise police and army of Haiti.	Ended July 1997.
1997	1997	UN Verification Mission in Guatemala	MINUGUA	Monitor ceasefire in Guatemala's civil war.	Ended in May 1997.
1997	1999	UN Observer Mission in Angola	MONUA	Monitor ceasefire and disarmament	Ended in February 1999.
1997	1997	UN Transition Mission in Haiti	UNTMIH	Help stabilise Haiti.	Ended in November 1997.
1997	2000	UN Civilian Police Mission in Haiti	MIPONUH	Modernise Haiti's police forces.	Ended in March 2000.
1998	1998	UN Civilian Police Support Group	UNPSG	Monitor Croatian police.	Ended in October 1998.
1998	2000	UN Mission in the Central African Republic	MINURCA	Maintain security and stability in Central African Republic.	Ended in February 2000.
1998	1999	UN Observer Mission in Sierra Leone	UNOMSIL	Monitor disarmament and demobilisation in Sierra Leone.	Ended in October 1999.
1999	On-going	UN Interim Administration Mission in Kosovo	UNMIK	Exercise administrative authority, including administration of justice in Kosovo	

1999	2005	UN Mission in Sierra Leone	UNAMSIL	Help stabilise and disarm Sierra Leone.	Ended in December 2005.
1999	1999	UN Mission in East Timor	UNAMET	To oversee popular consultation on political relation to Indonesia.	Ended in 1999, but followed with UNTAET.
1999	2002	UN Transitional Administration in East Timor	UNTAET	Transition of East Timor to independence	Ended in May 2002, but followed with UNMISET.
1999	On-going	UN Peace-building Support Office in Guinea-Bissau	UNOGBIS	Facilitate elections in Guinea-Bissau and implementation of the Abuja Agreement	
1999	On-going	UN Org Mission in DR Congo	MONUC	Monitor ceasefire in DR Congo	
2000	2008	UN Mission in Ethiopia and Eritrea	UNMEE	Enforce ceasefire between Ethiopia and Eritrea	Ended in July 2008.
2002	2005	United Nations Mission of Support in East Timor	UNMISET	Ensure security and stabilise the nascent state during the post-independence period.	Ended in May 2005.
2003	On-going	United Nations Mission in Liberia	UNMIL	Oversee ceasefire and train national police.	
2004	On-going	United Nations Operation in Côte d'Ivoire	UNOCI	Facilitate implementation of peace process.	
2004	On-going	United Nations Stabilisation Mission in Haiti	MINUSTAH	Return stability to Haiti	

2004	2006	United Nations Operation in Burundi	ONUB	Help implement the Arusha accords	Ended in December 2006, replaced by BINUB.
2005	On-going	United Nations Mission in the Sudan	UNMIS	Support implementation of the Comprehensive Peace Agreement, perform certain functions relating to humanitarian assistance, and protection and promotion of human rights.	
2006	On-going	United Nations Integrated Mission in Timor-Leste	UNMIT	Support the government in consolidating stability, enhancing a culture of democratic governance, and facilitating political dialogue among Timorese stakeholders, in their efforts to bring about a process of national reconciliation and to foster social cohesion.	
2007	On-going	United Nations African Union Mission in Darfur	UNAMID	Monitor arms trade and shipping, to cause and keep the ceasefire.	
2007	On-going	UN Mission in the CAR & Chad	MINURCAT		

Source : http://en.wikipedia.org/wiki/Time_ofUnited_Nations_peacekeeping_missions

TREND LINES

The nature of conflicts in the 21st century has forced a greater degree of consensus in the UN Security Council and acceptance of "Peace Enforcement" to hasten the resolution to conflicts. There is an enlarging area of legitimate tasks as part of contemporary peace operations. As part of the conflict resolution, peace-building and humanitarian assistance operations have become integral to the contemporary peace operations. A contemporary peace operation mandate encompasses a variety of roles such as end civil wars, establish/reestablish democratic government, promote development of civil society and provide impetus to economic reconstruction and growth. With post-conflict nation- building taking centre-stage of peacekeeping operations,

The Security Council, for budgetary and tactical reasons, is increasingly acquiescing to delegate its part of the peacekeeping responsibilities to international and regional arrangements.

the peacekeepers, in addition to undertaking traditional functions like Disarmament, Demobilisation and Reintegration (DDR), need to perform peace-building functions such as humanitarian relief, assistance in post-conflict reconstruction, facilitation of elections, peace-building through training and development of the state's indigenous institutions such as the military, police, judiciary, etc. Many of the operations conducted since the 1990s were also aimed at establishing or reestablishing democratic government, promotion of civil society, facilitating economic reconstruction and growth of conflict affected nations.

Current trends indicate that the Security Council, for budgetary and tactical reasons, is increasingly acquiescing to delegate its part of the peacekeeping responsibilities to international and regional arrangements and organisations such the OSCE (Organisation for Security and Cooperation in Europe), NATO (North Atlantic Treaty Organisation) , OAU (Organisation of African Unity) and ECOWAS (Economic Community of West African States), etc which are willing to take up peace operations in a more vigorous and forceful manner.[28] Traditional troop contributing nations such as the US, France, UK, Canada, Sweden and Norway, etc have significantly decreased their troop contribution to the UN and have become more involved with regional arrangements, which are founded on the commonality of their interests. These regional arrangements provide them more flexibility and enable them to act promptly without much criticism of interference. What needs to be ensured is that peace operations by these regional agencies should not become a means to further the vested interests of these agencies at the expense of the UN. If the rich military powers continue to abstain from committing troops, it will certainly limit the capability and the scope of peacekeeping operations and

28. Maria Kiani, "Changing Dimensions of Peacekeeping," available at http://www.issi.org/pk/journal/2004_files/no_1/article/8a.htm

marginalise the UN in the international security system. Peacekeepers' role in the 21st century will be mainly to protect civilians in the conflict zone, create stability, and facilitate democratic transformation and economic recovery of conflict affected states.

India has remained one of the most consistent supporters of UN peacekeeping since 1952 and has contributed troops to 43 missions since then.

INDIA'S ROLE IN INTERNATIONAL PEACEKEEPING

Of all the developing nations, India has remained one of the most consistent supporters of UN peacekeeping since 1952 and has contributed troops to 43 missions since then. Today, there are about 10,000 Indian troops engaged in seven out of 18 ongoing UN peace missions. Indian participation in international peacekeeping started in 1952. During the Korean War, 60 Para Field Ambulance of the Indian Army treated more than 1,800 battle casualties and some 9,000 sick and injured. Lt Gen K.S. Thimayya, as the Chairman of the Neutral National Repatriation Commission, and Maj Gen S.P.P. Thorat as the Force Commander ably facilitated the protection of 22,000 Prisoners of War (POWs) and their eventual transfer to North Korea. In Congo, the Indian Air Force (IAF) Canberras and Indian Army's Independent Brigade were in support of the UN mission and enabled suppression of the secessionists and unification of Congo, thus, playing a vital role to the success of the UN mission in Congo in the early 1960s. The Indian infantry battalion group in Gaza monitored the buffer zone between Egypt and the Anglo-French forces since 1956 and remained there until 1967, when the war broke out between Israel and Egypt. Even today, an infantry battalion group is performing the delicate task of maintaining peace in Southern Lebanon as part of the UNIFIL. Indian contribution to UNTAC (UN Mission in Cambodia) was considerable. The Indian Army provided an infantry battalion, ambulance company, mine training team, staff personnel and military observers to UNTAC. Indian Military Observers participated in the UN Mission in Yemen (1964), Iran-Iraq (1988-91), Namibia (1989-91), Angola (1989-91), Central America (1988-92),

El Salvador (1991-95), Liberia (1993-97), Democratic Republic of Congo (1999 onwards) and Ethiopia Eritrea (2000 onwards).

After Congo, Indian military contingents have participated in UN peacekeeping missions in Cambodia (1992-93), Mozambique (1992-94), Somalia (1993-94), Rwanda (1993-96), Haiti (1994-2000), Angola (1995-99), Somalia (93-94) and Sierra Leone (1999-2000) Kosovo (1999) East Timor (1999) Liberia (2003) DR Congo (2000) and Sudan (2005). Currently, Indian troops and air power elements form a major part of UN peace missions in DR Congo and Sudan.

CONCLUSION

In spite of some degradation in its capabilities and flawed responses, the UN still remains the one global institution that can ensure peace and security. UN peacekeeping has come a long way since the mission in the Suez Crisis 1956. In response to the changing international security environment, the peacekeeping has evolved and become multifunctional, from the limited mandate during the Cold War period. In the 21st century, the UN has become central to the response of the international community to a host of complex security issues. The peacekeepers' responsibilities have enlarged and taken on unfamiliar roles in preventive action (UNPREDEP in Macedonia), intervention and peacemaking in active war zones (UNOMIL in Liberia, UNPROFOR in Bosnia, UNOSOM in Somalia), peacekeeping and post-conflict peace-building (ONUSAL in El Salvador, UNTAC in Cambodia, ONUMOZ in Mozambique) and conflict control and democratic process (MONUC in DR Congo).

In order to reinvigorate the UN to undertake peace operations in the emerging security environment, there is an urgent need for the members of the UN, particularly the developed nations, to commit more troops and finance. In addition to strengthening the peacekeeping force, there is also a need to empower peacekeeping by developing new approaches and skills to deal with the conceptual and practical problems at the strategic, operational and tactical levels. The past failures of peacekeeping are results of deliberate inaction or lack of consensus among the P-5. This should not be allowed to happen in

future. In order to improve the efficiency and effectiveness of peacekeeping, greater cooperation and support by the powerful and rich nations, especially the permanent members of the UN Security, needs no underscoring. The challenges before the peacekeepers in the new millennium are unique and unprecedented. Helping to salvage nations from the woes of civil war, provision of humanitarian relief, monitoring of elections, building/strengthening of state institutions in "failed states" and nations affected by civil war, and nation-building, etc would be the main functions of future peacekeeping missions. In order to increase the effectiveness of peacekeeping, the UN authorised a comprehensive restructuring programme in 2007. This new initiative has facilitated reorganisation of DPKO and the establishment of a separate Department of Field Support, augmentation of resources and capabilities.

Past failures of peacekeeping are results of deliberate inaction or lack of consensus among the P-5. This should not be allowed to happen in the future.

The "Blue Helmets" are a symbol of the UN's efforts to fulfil its commitments to ensure peace and stability in the world. In the strength and effectiveness of this august force, lies the guarantee for a peaceful and prosperous world. It is high time that the rich and influential members of the UN, particularly the P-5, took greater interest in strengthening the UN, so that peacekeeping and peace-building can be done more effectively and expeditiously. In order to establish global peace and stability, there is no other credible and internationally acknowledged instrument other than peacekeeping; therefore, it is important for the members of the UN to strengthen it. The need is greater than ever before, because of the unprecedented security and divisive challenges the world faces today.

LOWERING THE HIGH GROUND FOR EFFECT-BASED OPERATIONS

KAZA LALITENDRA

Every revolutionary idea seems to evoke three stages of reaction. They may be summed up by the phrases: one, it's completely impossible; two, it's possible, but it's not worth doing; and, three, I said it was a good idea all along.

— Sir Arthur C. Clarke

The dawn of the space age set in motion the wheels of militarisation of space by the superpowers. They were soon joined by other nations that could afford the technology either through collaboration or indigenisation. While space has been utilised as a force enabler since the decade of the 1960s, it was only during the 1991 Gulf War that the true potential of space as a force multiplier for military operations was realised. Since then, nation-states have marshalled their resources to ensure better battlefield awareness than their adversary to retain the cutting edge. The US, considered the undisputed leader in pioneering the militarisation of space, found that all its space power could not deliver persistent situational awareness and communication to its war-fighters during the 2003 Iraq War[1]. On some occasions, the war-fighters were bereft of critical information at the

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1. Maj Andrew.J.Knoedler, "Lowering the High Ground: Using Near Space Vehicles for Persistence C3ISR", Centre for Strategy and Technology, Air War College, Maxwell, USA, at http://www.stormingmedia.us/46/4653/A465364.html

tactical level which led to a delay in successful execution of a time critical mission.

Since then, the US has been considering with renewed vigour two concepts that will help it ensure battlespace awareness on a 24x7 basis. These are Operationally Responsive Space (ORS) and the use of near space. While ORS focusses on employing satellites launched at short notice for specific missions, near space focusses on effect-based operations by employing sensors on platforms like balloons, airships or high altitude long endurance Unmanned Aerial Vehicles (UAVs) that are persistent, cost-effective, survivable and responsive. Considering that active employment of airships for military use has been discontinued since 1962[2], this renewed interest in Near Space Vehicles (NSVs) or High Altitude Airships (HAA) is noteworthy.

The interest has been rekindled due to many factors. First is the overwhelming domination of US air power in military conflicts. Second, the US military's demand for persistent surveillance, a function for which the aerostats and airships are well suited. Network-centric warfare approaches, increased emphasis on internal security and growing force protection demands in urban environments all call for "dominant battlespace awareness." Third, growing budget pressures in the US have encouraged the study of potential solutions to military problems that may reduce procurements, operations and maintenance spending[3]. Last, but not the least, are the technological advances in terms of propulsion technologies and breakthroughs in solar cell technology which have combined to make the allure of the NSVs a reality in the near future. According to a Congress Research Service (CRS) report for the US Congress in 2005,[4] more than 32 countries are actively involved in airship development.

India too joined the bandwagon at the beginning of the 21st century with work commencing on airship development and design in the Indian Institute of Technology (IIT), Mumbai. Though it is at a nascent stage, the final concept

2. The US Navy was the last to discontinue the use of airships for military employment in 1962. Over the last four decades, airships have been used only for commercial activities, barring the USAF use of tethered aerostats over the last decade.
3. Christopher Bolkcom, " Potential Military Use of Airships and Aerostats," *CRS Report for Congress,* May 9, 2005, at http://www.fas.org/sgp/crs/weapons/RS21886.pdf
4. n.2.

envisages the development of a stratospheric/ high altitude airship. It is expected that in future wars, NSVs will play a seminal role in the successful outcome of conflicts at all levels by providing a Common Operating Picture (COP) down to the tactical commander.

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CONCEPT OF NEAR SPACE

The realm of near space considered as the region between controlled commercial air space and Low Earth Orbit (LEO) has been a cultural blind spot for many years but is not a new phenomenon. It has been used for weather forecasting by hoisting free floating hydrogen balloons (up to 27 km), scientific balloons (up to 42 km)[5], by adventure balloonists who jumped from near space, and by the strategic reconnaissance platforms like the MiG-25, SR-71, U-2 and more recently the unmanned Predator and Global Hawk flying at the lower envelope of near space at 65,000-70,000 ft. However, of late, it is being seen as another medium which would offer new capabilities not accessible to orbiting satellites or manoeuvring aircraft, capabilities that are critical to emerging national defence needs.

Definition of Near Space

There are contrasting claims of the altitude band for near space. According to the International Aeronautical Federation, the near space region lies between the 75,000 ft (~23km) and 3,25,000 ft[6] (~100km). The US Space Command considers near space to be between 20 km and 300 km. However, in most nations, the controlled air space is considered up to, and including, 60,000 ft above mean sea level (Class A air space). To provide a buffer between commercial traffic operating at 60,000 ft and any NSV, this paper considers the start of near space as 65,000 ft or about 20 km. Ideally then,

5. "Near Space: The Shore of Our New Ocean," available at http:// www.hobbyspace.com/ NearSpace/
6. n. 2.

near space must extend up to the lowest altitude that a vehicle can maintain low earth orbit; defined as 490,000 ft or about 150 km. However, with the present technological advancements, the focus is on developing vehicles operating in the realm of 65,000 ft (20km) to 120,000 ft (36.6 km). We call it near space as it provides effects similar to what satellites have traditionally given us without having to go into orbit. It is a medium that we need to exploit to get space effects.

Thus, the near space concept involves floating payloads into a region of the stratosphere where winds are light and weather virtually non-existent. From that extremely high vantage point, the payloads have Line of Sight (LOS) for hundreds of kilometres to the horizon, becoming long-range communications relays or providing intelligence over theatre-sized areas.

This paper will examine near space and its environment, various NSVs on the anvil, advantages and disadvantages of operating in near space vis-à-vis aircraft and orbital assets, development of NSVs, and bring out the effects that NSVs can bring in towards persistent battlefield awareness.

THE NEAR SPACE ENVIRONMENT

The environment of near space differs considerably from the atmosphere and space in terms of temperature, winds, pressure and ozone effects while being free of ionospheric effects that are a cause of concern for spacecraft. While a complete discussion of the near space environment is beyond the scope of this paper, it is important to understand a few of the basic conditions that near space platforms will encounter. Contrasting them with air and space will give an understanding of the relative advantages and disadvantages of operating in each of the media.

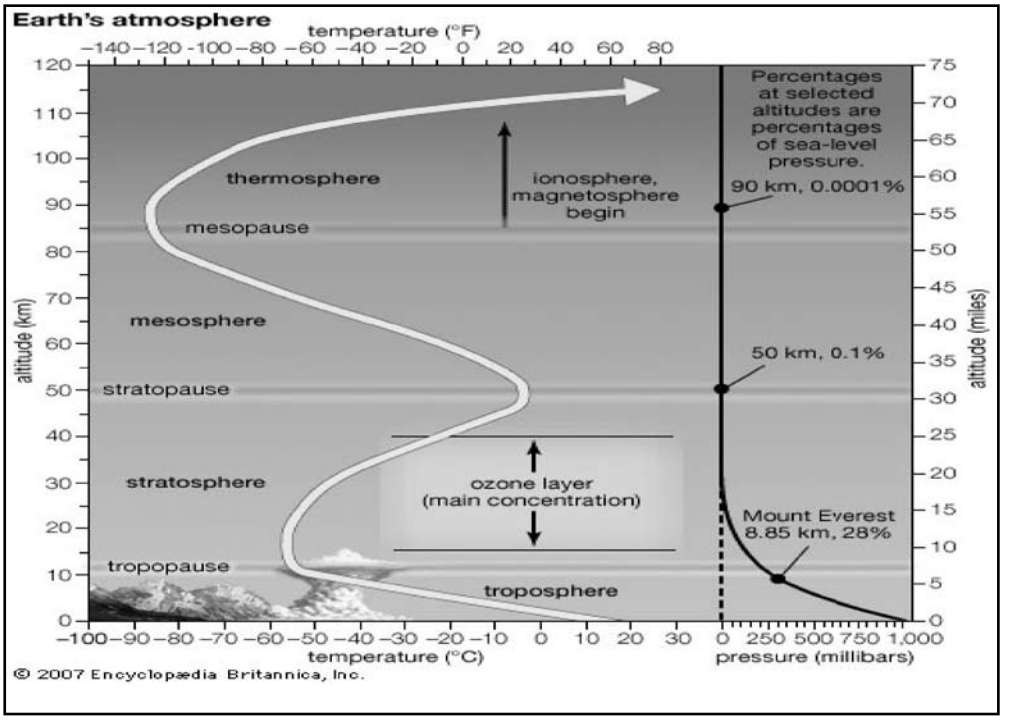
Temperature. In atmosphere, the temperature decreases at a lapse rate of -2^0C for every 1,000 ft rise in altitude up to 36,000 ft and thereafter remains constant at -59^0C up to 65,000 ft, i.e the start of near space. The temperature thereafter starts increasing up to -27^0C at 120,000, ft[7] as depicted in Fig. 1.

7. 2007 Encyclopedia Britannica, inc at http://media-2.web.britannica.com/eb-media/56/97256-003-96282CF1.gif

This is in contrast to space where surfaces facing the sun would be hot whilst others facing away or in the shadow would be extremely cold.

Hence, for operational use in near space, the designs of vehicles, airships and payloads need to cater for moderately cold temperatures as opposed to having to deal with a hysteresis of extreme temperatures in atmosphere and space.

Fig.1: Temperature and Pressure Variation in Atmosphere and Near Space



Wind. Wind patterns are also different in near space as opposed to space. Compilations of surveys of the general wind condition in near space had shown that for equatorial regions such as India, wind speeds average at 15 knots, with speeds gusting up to 40 knots 95 percent of the time. However, as the density of the atmosphere in near space ranges between 7 percent of sea level down to 0.5 percent of sea level at 120,000 ft, gusts and transient changes in wind speed will have minimal effects as there are very few air

Recent advances in technology have enabled countries like the US to foray into developing UAVs and airships that can operate in near space.

molecules to transfer momentum. Only sustained winds will cause an object to slowly accelerate to the ambient wind velocity, so all-in-all, the environment can be characterised by 15 to 30 knots of ambient wind speed[8]. By designing the correct types of propulsion, it would technically be feasible to design a vehicle to overcome such speeds, as has been demonstrated by the National Aeronautical Space Agency's (NASA's) Helios solar powered UAV which has achieved up to 150 knots at 96,500 ft.[9]

Another difference between space and near space is **pressure**. In space, pressure is essentially negligible[10]. In near space, pressure is a significant factor, especially for structures based on gas-filled volumes. All else being equal, when external pressure decreases, there must be a corresponding increase in volume. Thus, when the atmospheric pressure decreases by half, the volume of a closed balloon must increase by a factor of two. Between about 65,000 ft and 120,000 ft, the pressure halves with every change of approximately 15,000 ft, implying that such an ascent would approximately double the volume of a balloon[11]. These large changes in volume can be a severe design constraint for near space platforms using helium lift.

The corrosive and harsh solar radiation environment that the near space region presents differs from that of space and the atmosphere below 65,000 ft. In the atmospheric region, ozone is the primary absorber of ultraviolet (UV) radiation. However, at higher altitudes, the ozone concentration reduces significantly, and very little UV radiation is absorbed. As such, designers would have to design vehicles to accommodate UV damage. To escape UV damage, one could fly in the lower portion of near space. However, the

8. Matthew K. Heun, "Maneuverable Platform Wind Environment," Global Aerospace Corp (June 2000).
9. Maj Joeh Leo, "Tech Edge: Near Space, Near Future," *Pointer Journals*, vol. 33. no.1,2007.
10. See Fig. 1.
11. Lt Col Edward B. Tomme, "The Paradigm Shift to Effects-Based Space: Near Space as a Combat Space Effects Enabler," Research Paper 2005-01, Air Power Research Institute, USA.

density of ozone increases up to thirty times as much as that at 120,000 ft which makes the vehicle then susceptible to the corrosive effects of ozone[12]. Hence, although not impossible to accommodate, designing the near space vehicle would have to trade-off between ozone corrosion and UV protection, depending on its intended operating altitude.

NEAR SPACE ENABLED BY TECHNOLOGY

Recent advances in technology have enabled countries like the US to foray into developing UAVs and airships that can operate in near space. The success of near space technology will help countries derive the advantages of satellites without sending the vehicles into orbit while improving upon the endurance of their air breathing brethren. Some technologies contributing to this revolution in capability are[13]:

- Power supplies, including thin, lightweight solar cells, small, efficient fuel cells, and high-energy-density batteries.
- Extreme miniaturisation of electronics and exponential increase in computing power, enabling extremely capable, semi-intelligent sensors in very small, lightweight packages.
- Very lightweight, strong, flexible material that can resist degradation under strong UV illumination and is relatively impermeable to low-atomic-mass gases.

These technologies, when synergised, culminate into a force multiplier called the NSV which allows a revolutionary, transformational increase in capability. These NSVs, with their compact payloads powered by long-lasting and efficiently renewable power supplies, operating at extremely high altitudes, can perform many of the missions currently performed by satellites, in many cases just as effectively and in a more timely manner than their more traditional brethren. In effect, one needs to treat near space more as an effects enabler than a medium like space.

12. n.7.
13. Heun, n.8.

By virtue of being placed high up in the air, NSVs provide large area coverage for either communications or surveillance functions.

ADVANTAGES OF NEAR SPACE VEHICLES

Use of NSVs is limited only by the ingenuity of the payloads that can be put on them. The advantages of near space platforms as force enablers are discussed below.

Wide Area Coverage

By virtue of being placed high up in the air, NSVs provide large area coverage for either communications or surveillance functions. The lack of obstacles between earth and near space enables the maximum communication range, assuming that the power output of the radio is high enough to propagate through this distance. Or that the lens used is wide enough to capture the full area of operations for surveillance type functions. At 30 km, the minimum expected LOS range would be 720 km as calculated by the LOS equation,[14] while a radio atop the tethered aerostat balloon hoisted at a height of 5 km provides an LOS range of 300 km. Tests carried out by the US Air Force (USAF) Space Battle Lab under the Combat Sky Sat balloon programme[15] revealed that the range of the PRC-148 radio increased from 16 km on the ground to 650 km when used from an altitude of 20 km.

High Resolution, Better Sensitivity

Near space platforms operating at 30 km are at least 15 to 20 times closer to earth than their orbital counterparts. Considering that similar optical infrared (IR), Multi-Spectral Imaging (MSI), or Synthetic Aperture Radar (SAR) sensors onboard the satellites are employed as payloads on NSVs, they would be expected to provide 10-20 times better resolution. Distance is critical to resolving features in images and receiving low power signals. The power received by a passive antenna decreases as the square of the free space distance to the transmitter, while that of an active transmitter/antenna system decreases as the fourth power of

14. The LOS range is calaculated using the formula $R_{Nm} = 1.23(\sqrt{H1}+\sqrt{H2})$ where H1 and H2 are the height of the antenna on ground and height of the balloon in thousands of feet, at http://www.tscm.com/rdr-hori.pdf

15. Hampsten Stephens, "Near Space," *Air Force Magazine,* July 2005.

the transmitter/target distance[16]. A passive antenna on a satellite that received one watt of power from a transmitter in its footprint would receive between 100 and 400 watts on a near space platform, implying that it could detect much weaker signals (10 to 13 dB weaker). The signal strength improvement for active systems such as Radio Detection and Ranging (RADAR) or Light Detection and Ranging (LIDAR) would be factors of 10,000 to 160,000 (40 to 52 dB) for near space platforms. These examples at nadir are *best* cases for the satellites, too. Any off-nadir angle only increases the distance differential, increasing the near space signal strength and resolution advantages markedly.[17]

Near space platforms are inherently survivable. When compared to their air breathing counterparts, they are immune to enemy ground fire, Man Portable Air Defence Systems (MANPADS) and the vagaries of weather.

Another advantage of NSVs over satellites as discussed in the near space environment, is that they are free from the ionospheric effects like long range HF and VHF fades which is a common occurrence with satellite communication due to solar flare activity.

Survivability

Near space platforms are inherently survivable. When compared to their air breathing counterparts, they are immune to enemy ground fire, Man-Portable Air Defence Systems (MANPADS) and the vagaries of weather. Again, in comparison with orbital platforms, they are immune to attacks from space-borne weapons or accidental collision with debris or other orbiting satellites. With increasing range of air launched weapons, there is a belief that large balloons and airships can be targeted by air-to-air missiles/guns. However, if such an attempt by the US and Canada in the late 1990s is any indication, it would be a futile attempt, more so because of the low price and redundancy of these NSVs. In August 1998, Canadian scientists lost control of a 100-m diameter weather balloon. Fighter jets from three nations were scrambled to shoot it down as it first flew across

16. Tomme, n.11.
17. Ibid.

If the platform is survivable, then targeting the payload is another option to render the platform useless.

Canada, then the North Atlantic, Norway, Russia, and into the Arctic Ocean. Canadian F-18 fighters fired an estimated 20-mm cannon shells into the balloon, which obstinately continued flying for another six days[18]. Unlike the older generation balloons which used the highly flammable hydrogen gas, the modern ones use highly inert helium gas that does not burn.

If the platform is survivable, then targeting the payload is another option to render the platform useless. However, the slow speed of the platform with respect to modern fighter aircraft ensures that the platform remains in the doppler slot of the Airborne Interception (AI) radars and, hence, goes undetected. Even if the movement is discernible, the relatively low radar and thermal cross-section of the payload (radar/communication) make it difficult to acquire and track and, thus, target them by Anti-Radiation Missiles (ARMs). Estimates of their radar cross-sections are on the order of hundredths of a square metre[19], about the same as a small bird. The threats to near space platforms, specially in the lower fringes of near space (65,000-1,00,000 ft) emerge from the 5/6th generation aircraft capable of much higher operating altitude and equipped with better air-to-air missiles or from high altitude UAVs like the Predator if equipped with air-to-air missiles. Aircraft equipped with laser pods capable of targeting incoming air-to-air missiles may also pose a threat to these payloads. Alternately, present day ground-based Directed Energy Weapons (DEWs) like Anti-Satellites (ASATs) can also pose a threat to radar and communication payloads in near space. These threats can, however, be overcome by using Laser Radars (LADARs) which are designed to be passively stealthy using Low Probability of Intercept (LPI) techniques. The biggest challenge would lie in acquiring and tracking the near space platforms at those altitudes, and once tracked, targeting the payload and scoring a direct hit is another challenge.

18. "America's Rogue Balloon Lost at Sea," *BBC News Online,* August 31, 1998 at http://news.bbc.co.uk/1/hi/world/americas/162084.stm.

19 ."Vulnerability to Jamming Underscores Need for Navigation Back-up," *Air Safety Week*, September 7, 1998, at http://findarticles.com/p/articles/mi_m0UBT/is_/ai_50342689.

Responsive Persistence

Satellites are non-responsive to launch, taking an estimated eight days in the case of the Evolved Expendable Launch Vehicle (EELV) of the US to 27 days in the case of China. Once in orbit, satellites cannot be steered at will. Even a small change in orbital inclination requires expending the onboard fuel which shortens the lifespan of that satellite. Hence, changes in orbital altitude or inclination are generally undertaken only in the case of a physical threat to the satellite from orbital debris and /or other satellites.

Once on station, their persistence can be measured in terms of months and they also pose a less operational risk due to the single launch and recovery cycle.

Air breathing vehicles (aircraft and UAVs) are extremely responsive and can be launched in minutes to hours. They can be brought to bear on the area of interest in time and space for real-time information unlike the satellites which are limited by their orbital periods.

When compared with their orbital counterparts, NSVs are far more responsive, and are as responsive as their air breathing counterparts. Their launch preparation is a matter of a few hours and once launched, their ascent to their operating altitude (say 120,000 ft) would take about two hours considering an ascent rate of 1,000 ft/min. Once on station, their persistence can be measured in terms of months and they also pose a less operational risk due to the single launch and recovery cycle.

Once a near space vehicle is launched, it is expected to be on station for weeks to months at a time. In addition, near space avoids the traffic and vulnerability found in commercial air space, thus, avoiding frequent shifts in position due to conflicting traffic. This allows the payload to provide persistence surveillance / communication services to battlefield commanders at specified locations round the clock, with no gaps in coverage, unmatched by those of the satellites or even the most advanced UAVs like the Global Hawk (maximum of 30 hours).

Cost

Near space vehicles offer tremendous cost advantages over satellites or aircraft.

The surveillance cost per hour would also be the cheapest in the case of NSVs when compared to other assets.

When compared to the cost of acquiring one Heron UAV, at a cost of US$4 million from Israel, a SU-30 MKI at a cost of US $ 47 million from Russia or an Airborne Warning and Control System (AWACS) at a cost of US $350 million from Israel/Russia, the cost of a free floating balloon would be less than US $ 1,000. Even at the high end of the spectrum, the US $ 50 million cost of a strategic high altitude airship with payload would be less than that of an AWACS, even if more than a UAV, and comparable to that of the SU-30 MKI. Comparing the cost of an NSV to that of a satellite, we find that satellites are much more costly. The surveillance cost per hour would also be the cheapest in the case of NSVs when compared to other assets due to the saving in expenses in terms of refuelling, maintenance, major upgrades, payload reconfiguration, launch infrastructure and manpower for operation as it will be designed to stay on station for months at a time. Thus, we can say that when it comes to cost taken over the life cycle of an NSV, it has no peer.

Payload

As regards payload (sensor/communications), there is a limitation of the amount one can place on a satellite considering the cost/kg of launch and the fact that the payload can neither be retrieved nor upgraded. Similarly, in the case of aircraft and UAVs, the sensor payload is one of the many factors that need to be factored in during the design stage. Unlike the case of satellites, payload onboard aircraft and UAVs can be upgraded but at a considerable cost which involves reengineering of the platform to fit the payload. Even if the payload is a kind of plug and play and carried outside the platform, it would affect the range and endurance of the platform. The more advanced Global Hawk[20] UAV of the US is capable of carrying a total payload of 850 kg to 65,000 ft and provides persistence of about 42 hours. When compared with these assets, NSVs are being designed to carry more than 1,000 kg to above 100,000 ft

20. "RQ-4A/B Global Hawk High-Altitude, Long-Endurance, Unmanned Reconnaissance Aircraft, USA," at http://www.airforce-technology.com/projects/global/

and provide persistence for months together without any major maintenance. The payload can be changed by retrieval of the NSV or a new NSV can be launched. In essence, the type of payload is independent of the platform, and volume is not a major design constraint. Further, not being exposed to the high levels of radiation common to the space environment, payloads flown in near space do not require the costly space hardening required for orbital assets. Near space payloads also are not exposed to high gravitational forces during launch, as are satellites. Operating in near space obviously eliminates a great deal of expense involved in space sensor construction.

LIMITATIONS OF NEAR SPACE VEHICLES

The two most prominent limitations are launch constraints and legal constraints. Balloons and airships require large open areas/hangars for inflating them before launch. The launch preparation times can be of the order of a few hours during which their susceptibility to low-altitude wind needs to be factored into the design constraints of such near space vehicles. The same would be the case during their ascent and descent through the troposphere; recovery; and deflation. However, these problems are surmountable as has been seen in the case of very large balloons that have been routinely launched for years with similar constraints, and lightweight, inflatable hangars suitable for deployment are already available in the commercial market[21]. Such considerations are required to ensure seamless coverage of the area of responsibility. Additionally, construction of hangars for near space platforms is a relatively minor project when compared with construction of the launch infrastructure for other types of platforms such as satellites and aircraft. However, from the military perspective, these large open areas/hangers present lucrative offensive counter-air (OCA) targets for the adversary just like aircraft hangers and runways and, hence, would need the requisite terminal defence systems for launch site protection.

Freedom of overflight is another limitation for NSVs. Historically, the Karman Line at 100 km altitude has been considered as the boundary separating air and space

21. Tomme, n.11.

Historically, the Karman Line at 100 km altitude has been considered as the boundary separating air and space and, thus, the application of air law and space law.

and, thus, the application of air law and space law. This implied that below 100 km was the sovereign air space of a nation, and above it, the satellites had overflight rights. With the advent of NSVs having the ability to operate above 20 km and being relatively invulnerable to enemy air defences, there is considerable disagreement among legal analysts over whether overflight rights exist for NSVs similar to satellites. A recent memo from the USAF General Counsel addressing the matter stated, "Although we have not defined the boundary between air and space, it will be higher than near space."[22] In other words, the USAF position is that near space over a country will be treated as sovereign territory and air law will prevail. If the US as the leader in near space regime were to change its legal position, then such rights may open up the near space environment over one country to reciprocal overflights by foreign powers. Considering the low cost nature of developing and launching near space vehicles, many aspiring space-faring nations would join the more affordable near space race. In such a scenario, it would be difficult for countries to guard against an adversary's NSV operating in one's sovereign air space. The legal quandary surrounding overflight is not a fatal flaw for the near space concept. The simple reason being that, during hostilities, just as aircraft operate in an adversary's air space with their attendant vulnerabilities, near space platforms can also be expected to operate in a similar fashion. However, during peace-time operations, they can be positioned over own air space or over international waters to provide up to 400 km coverage of the adversary's air space.

While legal constraints can be overcome or violated subject to the interests of the country operating the near space vehicles, and launch constraints will possibly be surpassed with the passage of time, the advantages of near space for military use can be gleaned only with the change in mindset of the armed forces from medium/platform-centric operations to effect-based operations. Military planners historically tend to go with what they know, and often, it takes a great deal of push from a vocal minority within their

22. Ibid.

ranks to get them to adopt new ways of doing business. If the mindset is conditioned to adapt to effects delivered from near space, there appear to be no scientific or engineering obstacles that cannot be overcome in short order, provided that sources of funding can be found.

The advantages and limitations of NSVs when compared with air breathing platforms and satellites are tabulated below (Table 1).

Table1:Relative Strengths of Satellites, NSVs and Air Breathing Assets

S. No.	Attribute	Satellites	NSVs	Aerial Platforms
1	Cost		✓	
2	Sensor Payload		✓	
3	Persistence		✓	
4	Coverage	✓	✓	
5	Responsiveness		✓	✓
6	Resolution		✓	✓
7	Overflight	✓		
8	Survivability		✓	

PLATFORMS FOR NEAR SPACE

Lighter Than Air (LTA) balloons, the precursors to present day near space vehicles/airships have been used for military operations since the invention of the hot air balloon by the Montgolfier brothers in 1780[23]. However, the golden age of airships began with the German built rigid airships called the Zeppelins at the beginning of the 20th century[24]. Their use continued at a reduced scale during World War II due to the advent of aircraft. However, the Hindenburg disaster[25] and the United States' ban on export of helium gas sounded the death knell for the military use of airships by other countries,

23. K.V. Gopalakrishnan, *Impact of Science and Technology on Warfare* (New Delhi: National Book Trust, India 2003), pp.72-73 and "How is an Airship Made?", at http://www.answers.com/topic/airship. Between 1783 and 1900, airships and hot air balloons were used in the French-Austrian War, the Franco-Prussian War and the American Civil War.

24. The successful use of Zeppelins for reconnaissance missions by Germany during World War I spurred other countries' development of airships and by the end of the war, the UK, Italy, France, USSR and USA had operated rigid/non-rigid airships for the scouting and tactical bombing role.

25. The Hindenburg, an 804-ft-long rigid hydrogen filled balloon, returning from a transatlantic flight to New Jersey on May 6, 1937, burst into flames at the Lakehurst Naval Air Station while attempting a landing in inclement weather, killing 36 people, http://americanhistory.about.com/od/hindenburg/Hindenburg_Disaster.htm

US success in the use of tethered aerostats up to 10,000 to 15,000 ft in providing redundancy to existing ground and airborne platforms over theatre sized areas when deployed in an overlapping arc, has rekindled interest in their use from higher altitudes.

and their use was limited to adventure sports and sight-seeing activities, except in the US[26]. Between 1934 and 1961, crewed balloon flights, however, were used to conduct research in the stratosphere with pressurised capsules allowing crews to go as high as 100,000 ft (30 km). In 1961, the advent of space flight made many of these experiments obsolete[27] .Thus, the advent of aircraft and satellites foreclosed options for their gainful military use.

Over the last two decades, US success in the use of tethered aerostats up to 10,000 to 15,000 ft in providing redundancy to existing ground and airborne platforms over theatre sized areas when deployed in an overlapping arc,[28] has rekindled interest in their use from higher altitudes, along with other reasons discussed earlier. Unlike their tethered counterparts, the LTAs in near space come in a variety of forms. While some simply drift with the wind, others are able to manoeuvre and station-keep, providing persistent surveillance and communications and various other defence related tasks over the area of interest.

Not constrained by the orbital mechanics of satellite platforms or the high fuel consumption rates of airborne platforms, many envisioned near space systems are being designed to stay on station above a specified site almost indefinitely, providing persistent coverage in all three dimensions. The various types of platforms and their developments are discussed below.

Free Floaters

The most mature near space technology available today is the free floating balloon platform which has been used for high altitude weather monitoring

26 n.7.

27. "How is a Hot Air Balloon Made?," at http://www.answers.com/topic/hot-air-balloon-vehicle

28. n. 2.

over the last century. They are very straightforward to construct and launch, and very inexpensive (a Sky Site balloon costs US $100[29]). Once launched, they are at the mercy of the existing winds. Limited steering is possible by variable ballasting, causing the balloon to float at different altitudes to take advantage of different wind directions and speeds. Free floaters can travel as high as 49 km (160,000 ft), carry up to 4,000 kg, and stay afloat for as long as 700 days[30]. No single platform, however, has achieved all of these parameters in one mission till date. Free floater systems have already demonstrated commercial viability as communications platforms. The International Telecommunication Union (ITU) has allotted two frequency bands, 28GHz and 47/48 Ghz, for use by near space vehicles where, at present, the spare spectrum is plenty[31].

The two drawbacks with this platform are the requirement for continuous replenishment and loss of payload once the balloon bursts in near space. While their inexpensive nature allows for periodic replenishment, technological advances have helped overcome the loss of payload by employing a parachute/glider-borne payload attached to the balloon. The parachute/glider facilitates detachment of the payload from the balloon after the end of the mission or at a predetermined time, and allows retrieval of the payload for reuse. A variety of such hybrid glider/balloon systems is available off the shelf today[32], ranging from extremely inexpensive plastic gliders with limited payload capability (tens of kilograms) to much more complex and capable composite gliders such as those designed to land payloads on Mars. Efforts are on in the US[33] to design Global Positioning System (GPS) guided, extremely manoeuvrable high speed gliders which are capable of delivering the payload to the predetermined location and, thus, ensure their safety in times of operations

29. Mary Ann Stewart, Lt Col Kevin Frisbie, Gary Trinkle, "High Altitude Surveillance," *Geo Intelligence*, July 1, 2004, at http://www.gaerospace.com/press-releases/pdfs/HighAltitudeSurveillance.pdf
30. Ibid.
31. Sandeep Relekar and Rajkumar S. Pant, "Airships as a Low Cost Alternative to Communication Satellites," at http://www.aero.iitb.ac.in/~airships/WEBPAGES/PDFs/npaper05.pdf
32. Leo, n.9.
33. Bill Sweetman, "Taking a Dive," *Aviation Week*, November 12, 2007, at http://www.aviationweek.com/

Steered Free-Floaters

The steered free floater platforms generally drift with the wind but they can be controlled with a small degree of precision by a steering mechanism. Thus, although steered free floaters are capable of station keeping, their accuracy is insufficient for effective persistence, thereby requiring deployment in large numbers. The steered free floaters rely on the wind differential in two altitude bands. While the balloon floats at an altitude of about 115,000 ft, the steering mechanism is tethered 15 km below and takes advantage of the denser air at altitudes of 65,000 ft to provide trajectory control to steer the balloon. The StratoSat[34] (using super pressure ultra long duration balloons built by NASA) developed by Global Aerospace Corporation of Altadena, California, is one such example.

No integrated steered free floater has yet been flown, although most of the component parts have been tested individually. Having the capability for steered flight, payloads could be more complex than those flown on basic free floaters as they could be navigated to a depot, recovered, repaired, and reflown.

Manoeuvring Vehicles

Even more sophisticated persistent and responsive high altitude long loiter (HALL) options involve near space platforms like airships, aerodynamic balloon bodies, UAVs and hybrid systems that are able to manoeuvre and, thus, fly to, and station keep over, the specified points. Such platforms are the functional cross between satellites and airborne platforms, providing the large footprint and long mission durations commonly associated with satellites and the responsiveness of tactically controlled UAV. Manoeuvring vehicles are designed to have low mass, are highly aerodynamic, and are designed to fly in low air density conditions that do not support traditional flight. At the lower end of near space, the air is thick enough for high-efficiency propellers to provide effective propulsion for these large vehicles. Higher up, propeller requirements increase significantly in the thinner air, and other propulsion methods begin to become more efficient.

34. Relekar and Pant, n.31.

Some vehicles vary their buoyancy, ascending and descending within an altitude band during operations[35].

DEMONSTRATED/ DEVELOPMENTAL NEAR SPACE PLATFORMS

Many countries are developing near space platforms and accessories or researching on their exploitation for communication and surveillance purposes. The US is spearheading the race with parallel research and development by various organisations like NASA, Defence Advanced Research Project Agency (DARPA), USAF Space Battle Lab, while Japan and South Korea have tested small scale models of their proposed stratospheric airships. The various airship programmes that are under development are discussed below.

Space Data Corporation's Free Floaters

USAF Space Battle Lab's quest for finding and quickly demonstrating innovative solutions to top war-fighter needs led it to employ the Space Data Corporation's free floating balloons[36] to test the effectiveness of its tactical communication radio system, the hand-held PRC-148 used by US troops in Iraq and Afghanistan. The normal LOS range of the radio is 15 km. However, in 12 tests carried out in March 2005, the radio communications range increased from 15 km to more than 650 km. A balloon floating over the battlefield between 65,000 and 95,000 ft relayed LOS broadcasts from radios on the ground and in the air. The March demonstrations employed members of a tactical air control party on the ground and an F-16, A-10, and E-8 Joint Strategic Target Attack Radar System (JSTARS) aircraft in the sky to

35. Helios is an example of this kind of HALL system. Developed by AeroVironment of Monrovia, California, in cooperation with NASA's Environmental Research Aircraft and Sensor Technology Programme, Helios is a large solar-electric, flexible–wing stratospheric satellite that has 12 small engines across its wingspan. The wing flexes in the wind like that of a bird. Helios has been tested to 96,500 ft, carrying payloads of 1,100 kg for almost two days, achieving speeds of 150 knots.

36. On the commercial front, the free floaters have been in use by oil and gas companies in Texas and Oklahoma to monitor data from wells spread across thousands of square miles across sparsely populated areas. Two to three balloons are launched every day to provide persistent communications. The balloons with digital communication sets called Sky Sats provided uninterrupted communications in post-disaster management operations in the aftermath of Hurricanes Katrina and Rita in the US.

explore how such extended-range communications could improve Battlefield Air Support (BAS) missions. With the repeater on board the balloon, ground controllers were able to communicate with the strike aircraft over hundreds of kilometres to enable 'talk onto the target' which also allowed dynamic retasking. The success of the tests resulted in a US $ 49 million investment over a period of five years by the USAF Space and Missile Centre's Development and Test Wing for supply of Space Data Corporation's balloons and more improvised communication sets[37].

Since the free floater balloons cannot be recovered, the payload is retrieved by use of a parachute which deploys once the balloon bursts. However, the vulnerability of military communication payloads falling into enemy hands during their parachute descent to the ground has led the USAF Space Command's Space Innovation Development Centre to conceptualise the "Talon Topper" project under its Tactical Exploitation of National Capabilities Operations (TENCAP). The Talon Topper is a glider constructed from very high-tech polymers to return payloads to designated locations by using a plug and play cargo bay that can carry a variety of payloads and then return safely using GPS guidance[38]. The programme, estimated at US $ 9 million, is into its third phase of development, that of demonstrating delivering/retrieving even the balloon to the desired location[39].

Hi-Sentinel

Aerostar International of Sulfur Springs, Texas, USA, is developing a flaccid launch airship called the Hi-Sentinel for the US Army Space and Missile Defence Command. The project is focussed on developing small near space airships for inexpensive tactical communications and Intelligence, Surveillance and Reconnaissance (ISR) applications[40]. Hi-Sentinel is a conventional, 140m

37. "Near Space System Improves Battlefield Communications," August 31, 2006, at http://www.gizmag.com/go/6081/.
38. Knoedler, n.1.
39. Sean Meade, "Space Bound Balloon," at http://aviationweek.typepad.com/ares/final_frontier/
    The airship has been developed in coordination with the Southwest Research Institute, Raven Industries and US Air Force Research Lab.
40. "Stratospheric Airship Reaches Near-Space Altitude During Demonstration Flight," at http://

long, non-rigid airship designed to fly above 60,000 ft for at least a week. Its innovations include very low structural weight and an internal, steerable solar array. The first flight in 2005 carried a 60 lb payload and telemetry pod to 74,000 ft and achieved powered flight for 1.5 hours during a five-hour flight. The historic flight saw the largest stratospheric airship ever to achieve powered flight in the stratosphere and only the second stratospheric airship to do so[41]. The second flight planned for 2009 is attempting to extend the endurance demonstrated during the first flight.

Lockheed Martin's High Altitude Airship (HAA)

The most ambitious of the HAA military programmes is being undertaken by Lockheed Martin. Under contract to develop a HAA platform for the US Missile Defence Agency (MDA) since 2003 as part of an advanced concept technology demonstrator, Lockheed Martin was to execute the programme's third phase to build, flight test, and demonstrate the prototype HAA vehicle. The prototype under development is planned to have a mission life of one month, operating above 60,000 ft (18.3 km), while providing 10 KW of power for 227 kg/500 lb (operational version would carry 1,813 kg/4,000 lb) payload[42]. The HAA vehicle would be 152 m (500 ft) long and 46 m (150 ft) wide. Photovoltaic cells and fuel cells would power the HAA. Electric-powered propeller technology would be used to propel the HAA and help it to maintain geostationary location[43]. The HAA would be retaskable in flight and can be recovered and reconfigured as required for specific mission requirements. The operational vehicle is expected to provide mission times in excess of one year for a wide variety of applications like ballistic and cruise missile defence, theatre surveillance, environmental / weather monitoring and post-national disaster support, maritime domain awareness and

www.gizmag.com/go/4901/

41. Erik Schechter, "Airships on the Rise- Blimps to Challenge UAVs as ISR Craft," September 1, 2008 http://www.c4isrjournal.com/story.php?F=3633681
42. "High Altitude Airship," at http://www.globalsecurity.org/intell/systems/haa.htm
43. Lewis Jamison, Geffory S. Sommer, Issac R. PorcheIII, "High Altitude Airships for the Future Force Army," Technical Report prepared for the US Army, RAND 2005.

broadband communications connectivity[44]. The US MDA has transferred the operational management of the project to the US Army Space and Missile Defence Command (USASAMDC) in April 2008[45]. Budgetary constraints have shelved the project for the time being. However, it can be revived at a short notice.

Another subscale prototype airship system, the High Altitude Long Endurance-Demonstrator (HALE-D) is also under development. The performance goals for this prototype HAA include sustained operations for at least two weeks at 60,000 ft altitude, while providing 500 watts of power to a user-defined 50 lb payload suite. Driven by two electric propulsion motors, the HALE-D is powered by thin-film solar cells and rechargeable lithium ion polymer batteries. The HALE-D will demonstrate long-endurance station keeping and flight control capabilities during its planned demonstration in the summer of 2009.[46]

Sanswire's Stratellite

Sanswire Networks, a subsidiary of the US-based GlobeTel Communications Corporation, has been researching on HAAs for quite some time and has proposed several variants on such airships though with rigid frames rather than the overpressure, non-rigid design favoured by Lockheed Martin. Each Stratellite was to be approximately 70 m in length, have a payload capacity of "thousands of pounds", and be powered by a series of solar powered hybrid electric motors and other regenerative fuel cell technologies. The payload was more oriented towards communications to commercial users, with cell, phone services and data relay in place of terrestrial cables. Work ended when Sanswire's parent company experienced financial difficulties. Both Sanswire's and Lockheed Martin's programmes may return in some form[47].

44. "High Altitude Airship," at http://www.lockheedmartin.com/products/HighAltitudeAirship/index.html
45. USASMDC is the army specified proponent for space, high altitude, ground-based mid-course defence and serves as the army operational integrator for global missile defence; and conducts mission-related research and development. USASMDC conducts space and missile defence operations and provides planning, integration, control and coordination of army forces and capabilities in support of the US Strategic Command.
46. "HALE-D," at http://www.lockheedmartin.com/products/HighAltitudeAirship/index.html
47. Edward Herlik, "Unmanned Aerial Systems Becoming More Like Satellites," March 20, 2008, at

Disposable Spy Ships

The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, USA, is researching on disposable unpiloted spy ships. The High Altitude Reconnaissance Vehicle (HARV) would operate in near space, staying in one spot for roughly two weeks to 30 days. It would provide persistence surveillance of select areas on earth to the armed forces. The HARV would be ejected from either a cruise missile or possibly a reusable rocket. A second booster would propel the vehicle to about 300,000 ft above sea level, and then the HARV would inflate and descend to hover over a target area at about 100,000 ft.

The High Altitude Reconnaissance Vehicle (HARV) would operate in near space, staying in one spot for roughly two weeks to 30 days.

HARV could carry out radar and imaging missions, protect and track friendly forces, appraise battle damage and carry communications nodes. After about two weeks to a month, the vehicle would either disintegrate or be destroyed. However, problems like the ability to recharge the air vehicle's power source and anchoring the HARV in the right location need to be overcome over a period of time[48].

StratoSat

Sponsored by the NASA Institute of Advanced Concepts, Global Aerospace Corporation of Altadena, California, developed StratoSat, a steered free floater. StratoSats use super pressure Ultra Long Duration Balloons (ULDBs), developed by NASA and manufactured by Raven Industries that float at 115,000 ft. On a 15-km tether beneath the balloon is an aerobody-like device, known as the Strato-Sail that takes advantage of denser air at lower altitudes of 65,000 ft to provide trajectory control to steer the balloon[49]. The Strato-Sail can also contain sensors for imaging, positioning, and communications.

http://www.homelandsecurityresearch.net/2008/03/20/unmanned-aerial-systems-becoming-more-like-satellites/

48. Leonard David "Sky Trek To The 'Near Space' Neighborhood," November 9, 2005, http://www.space.com/businesstechnology/051109_airships.html
49. Stewart, et al., n.29.

Defence Advanced Research Project Agency's (DARPA's) Vulture Programme.
DARPA has announced work on a fixed wing, heavier-than-air Unmanned Air Ship (UAS) called Vulture. The programme envisages an unmanned air vehicle capable of being on station for five years with a 450 kg/1,000 lb payload, 5 KW of onboard power, and sufficient loiter speed to stay on station for 99 percent of the time against winds encountered at 60,000-90,000 ft. Reports indicate DARPA plans to complete risk reduction during 2012 and decide on prototype development then. Three firms have been given the contract to develop a system meeting DARPA's requirement over a period of five years.

Odysseus
Of the three firms short-listed by DARPA for its Vulture programme, Aurora Flight Science's winning design is called "Odysseus". The solar-powered concept aircraft is as radical as the mission it is designed to accomplish, combining three self-sufficient "constituent aircraft" in a unique Z wing configuration that spans almost 500 ft (150 m). The modular design provides several advantages. The shape of the aircraft can be adjusted to maximise the solar collection properties during the day and spread flat for aerodynamic efficiency at night-time, when energy stored in onboard batteries is used to drive the aircraft's electric motors. Because each of the constituent vehicles is capable of autonomously docking at altitude, the design also facilitates the replacement of one section of the plane whilst it is still aloft, meaning continuous flight can be maintained even if something goes awry[50]

Each autonomous section of the plane has three high efficiency electric brushless motors giving the aircraft the ability to cruise at 63 m/s during day-time and 45 m/s during night-time and carry a payload of 500 kg. The onboard batteries are designed to be recharged each day via double-sided cells optimised for energy collection efficiency at high latitudes, and adding to the redundancy built into the plane's architecture, Odysseus' electronics are adapted from spacecraft designs which have already proven their reliability in missions lasting several years.

50. "Odysseus: Aurora's Radical, Unlimited Endurance, Solar Powered Aircraft," from Aero Gizmo, at http://www.gizmag.com/auroras-radical-odysseus-solar-powered-aircraft-unveiled/9261/

Zephyr

Zephyr is an ultra-lightweight carbon-fibre aircraft with a wingspan of up to 18 m/ 59 ft, but weighing just 30 kg/ 66 lb. Launched by hand, by day, it flies on solar power generated by amorphous silicon arrays on the wings that are no thicker than sheets of paper. By night, it is powered by rechargeable lithium-sulphur batteries that are recharged during the day using solar power. On July 28, 2008, the Zephyr flew for 82 hours 37 minutes[51], The system provides autonomous navigation and orientation control together with command and data communications links to ensure timely and robust operation. Passive electro-optical systems capable of submetre resolution and communications relay packages have been built and tested. Many of its design approaches and technologies will be leveraged for the Vulture as QinetiQ, a British firm, is a major partner of Boeing which is one of the three contractors for the Vulture programme.

Helios

Helios is the most ambitious of NASA's solar UAV projects to date. With a 247-foot wingspan (greater than a 747 Jumbo Jet), 62,120 bi-facial solar cells and a projected maximum flying altitude of 100,000 ft, Helios is the peak of two and a half decades of solar aviation research[52]. Built by AeroVironment, Helios has been used on the Environmental Research Aircraft and Sensor Technology (ERAST) programme of NASA. Helios applies hybrid technology[53] – solar energy using photovoltaic cells by day and fuel cells by night. Helios was designed to be the forerunner of high-altitude unmanned aerial vehicles that

51. "QinetiQ's Zephyr UAV Flies for Three and a Half Days to set Unofficial World Record for Longest Duration Unmanned Flight." QuinetiQ Press release dated August 21, 2008, at http://www.qinetiq.com/home/newsroom/news_releases_homepage/2008/3rd_quarter/qinetiq_s_zephyr_uav.html It exceeded the current official world record for unmanned flight which stands at 30 hours 24 minutes set by the Global Hawk in 2001 and the Zephyr's previous longest flight of 54 hours achieved last year.
52. NASA evinced interest in solar powered HALE UAVs in the late 90s. It revived the high altitude long endurance solar (HALSOL) drone project of AeroVironment and went on to produce solar UAVs like Path Finder, Path Finder Plus and Centurion which was redesigned and modified to become the Helios.
53. Iddo Genuth "Solar UAV to Set a New World Record," *The Future of Things*, March 9, 2007, at http://thefutureofthings.com/articles/51/solar-uav-to-set-a-new-world-record.html

could fly ultra-long duration environmental science or telecommunications relay missions lasting for weeks or months without using consumable fuels or emitting airborne pollutants. On August 13, 2001, Helios demonstrated its capability when it reached an unofficial altitude record for non-rocket-powered aircraft of 96,863 ft. Unfortunately, on June 26, 2003, during a test flight over the Pacific Ocean near Kauai, Hawaii, the Helios[54] prototype was lost due to a structural failure caused by control problems.

Japanese Sky Net HAA

Sky Net is a major HAA project funded by the Japanese government, and aims to provide TV and communication services with an inter-connected network of about 10 airships covering Japan[55]. The aeronautical aspects are coordinated by the Japan Aerospace Exploration Agency (JAXA) and the applications areas (telecommunications), are coordinated by the National Institute of Information and Communications Technology (NICT). Conceptualised in 1998, the project has matured to the second phase with very successful results, especially in areas of launch and recovery, development of airship materials and its construction, station keeping and power management. Tests in this regard were carried out (during Phase one) with the help of a 47 m airship in August 2003 and with a 67 m long airship in November 2004 at an altitude of 4 km. The programme is envisaged to be achieved in three phases. The second phase is slated to be completed in four years from commencement with the development of a full size stratospheric airship (approximately 200 m long). Phase three envisages full commercialisation by Japanese industry[56]. The specific end applications are disaster relief/ event servicing, both 3G and broadband, broadcast HDTV, broadband fixed access to users and broadband mobile access to long distance trains and other vehicles.

54. Ibid.

55. Tim Tozer, David Grace, Jon Thompson, Peter Baynham, "UAVs and HAPs-Potential Convergence for Military Communications," at http://www.elec.york.ac.uk/comms/pdfs/20030506170424.pdf

56 Patrick Hendick, Laurence Hallet and Dries Verstraete, "Comparision of Propulsive Technologies for a HALE Airship," 7th AIAA Aviation Technology, Integration and Operations Conference (ATIO), September 18-20, 2007.

NICT, in close coordination with JAXA has examined tracking and control techniques for stratospheric flight, and developed a range of hardware for use with experiments. These include a number of telecommunications trials using NASA's Pathfinder Plus solar powered aircraft in Hawaii, USA, at approximately 20 km altitude. Overall, this Japanese national project has received funding of more than Euro 100 million to date. JAXA is currently lobbying the Japanese government for funding for the second phase, where it is anticipated that the total financial package will be a mix of public and industry funding.

The South Korean National Project

Close on the heels of Japan, in 2000, South Korea launched a 10-year programme, which consists of three phases, to develop an unmanned stratospheric airship. The purpose of the project is to develop a stratospheric airship platform and a ground system for basic operation and control of the airship. The airship could carry onboard payloads consuming l0 KW power and weighing up to l,000 kg. Station keeping within a limited boundary above 20 km altitude is planned to be achieved by autopilot. The project is supported by the Ministry of Commerce, Industry and Energy (MOCIE) of the Korean government[57]. The project consists of three consecutive phases to reduce developmental risks and actively cope with technical challenges. The Korea Aerospace Research Institute (KARI) was approved as a prime contractor for the first phase development. The first phase (which included the development and test of a 50 m unmanned airship, capable of flying to an altitude of 3 km and carrying a 100 kg payload, as well as a wide range of engineering trials and achievements) was finished in 2004 and the second phase has started. The target of the second phase is to develop a Stratospheric Prototype Airship (SPA), which will demonstrate the practical possibility of developing the stratospheric airship system[58]. It will demonstrate station keeping ability around 20 km altitude and also some possible missions such as communication relay and ground observation, etc. Through the second

57. Yung-Gyo Lee, Dong-Min Kim, Chan-Hong Yeom, "Development of Korean High Altitude Platform Systems," *International Journal of Wireless Information Networks*, vol.13, January 2006.
58. Dr Rajkumar S. Pant, "Global Developments and Critical Technology Review of Stratospheric Airships," Presentation at ADRDE, Agra, on Stratospheric Airships in 2005.

The Korean government clearly anticipates that HAAS will be a significant future technology that it can use to further strengthen its technical and manufacturing base.

phase development, the mission of the Korean stratospheric airship will be specified. A full scale commercialised airship system will be developed through the third phase.

The Korean government clearly anticipates that HAAS will be a significant future technology that it can use to further strengthen its technical and manufacturing base. They also see significant Asian and worldwide export potential for both the platforms and electronics.

SUB-ORBITAL ROCKETS AS NEAR SPACE SENSORS AND WEAPON PLATFORMS

The advent of commercially viable sub-orbital vehicles operating above 30 km may hold the prospects of military exploitation. Vehicles like Burt Rutan's Space Ship One or some of the DC-X type vehicles that are being worked on by companies like TGV Rockets of Norman, Oklahoma, may be used for ISR purposes[59], as these sub-orbital rockets will be able to carry significant sized sensors and they can be launched at short notice; like aircraft, they will be able land back with their imaging data preserved onboard or, if necessary, transmitted to a ground station as with a UAV or satellite.

Sub-orbital rocket vehicles have also been proposed as launch systems for testing target warheads and decoys for missile defence. If they are able to fulfil their low-cost promise, they could make it much easier to carry out large-scale missile defence simulation exercises without having to fire off expensive target rockets. The same mechanisms that a sub-orbital rocket would use to launch warhead targets could also be used to launch real weapons[60]. This raises the possibility of *combat in near space* between rival rocket planes. This may sound like science fiction but any craft used to carry out military information gathering is a legitimate target and may legitimately defend itself. From there,

59. Taylor Dinerman, "Near Space: A New Area of Operations or a New Pentagon Buzzword?" *Space Review*, September 20, 2004, at http://www.thespacereview.com/article/230/1

60. Ibid.

it is a short step toward being able to fire weapons at targets on the ground.

There is a host of other programmes which are focussed mainly at providing high speed broadband communication services to commercial users. These aim at overcoming the infrastructural constraints of erecting and operating cell phone networks to cater to the ever increasing demands from consumers. Just like satellites, these platforms can be of dual use. The European countries have carried out many experiments since 2000 in this regard through various programmes like the Eur*o*pean VI framework programme called the Communications From Aerial Platform Networks Delivering Broadband Communications for All (CAPANINA)[61] and HELIPLAT, a high altitude very-long endurance solar powered platform for border patrol and forest fire detection and high speed broadband communication[62]. The use of NSVs will also overcome the last mile connectivity problem associated with such networks.

Sub-orbital rocket vehicles have also been proposed as launch systems for testing target warheads and decoys for missile defence.

NEED FOR NEAR SPACE VEHICLES FOR THE INDIAN ARMED FORCES. The discussion to justify near space vehicles in the Indian military context, if projected at this stage, would seem to be too premature to be of any use, with apparently no proven system in operation on date, as seen from the above discussion. However, one needs to envision the integration of near space vehicles into the overall military Concept of Operations (CONOPS) for employment by the next two decades to meet the increasing demands of surveillance and communication to fight the future wars.

The lessons learnt from the recent high-tech wars/campaigns conducted by the US and its allies and the regional level conflicts like Kargil in India and

61. The CAPANINA project will develop broadband capability from aerial platforms to deliver cost-effective solutions providing a viable alternative to cable and satellite, at http://www.capanina.org/

62. G. Romeo, G. Frulla and E. Cestino, "HELIPLAT®: A High Altitude Very-Long Endurance Solar Powered Platform for Border Patrol and Forest Fire Detection," at http://library.witpress.com/pages/PaperInfo.asp?PaperID=15157 and http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.43.6955

the Second Lebanon War by Israel, bring out the imperatives of persistent, organic ISR and 24/7 over-the-horizon communications. The Kargil conflict of 1999 was a wake-up call for India as regards the inadequacy of effective and persistent surveillance and reconnaissance assets for national defence. In the light of the Kargil Committee report, India launched the experimental Test Satellite (TES) satellite, with one metre resolution. The CartoSat II A satellite launched on April 28, 2008, also provides a good measure of military grade surveillance. However, India depends on foreign satellites to get better imagery which may not be forthcoming in times of war at the frequency at which India needs it.

As regards communication, the armed forces communication networks are largely terrestrial, based on Tropo, ASCON, AREN supplemented by the DOT and HF network. Because of India's vast geographical size and nature of terrain and the changing nature of warfare towards net-centric operations, there is an increasing demand for bandwidth which India seeks to address through fibre optic links and satellite communication. A fixed fibre optic network in a dynamic war-fighting environment may not fulfil the needs at the operational and tactical levels. On the other hand, satellite-based communications are very expensive to field and generally have limited bandwidth. The availability gets further reduced due to heavy demand and fierce competition for transponders for civil uses.

From the foregoing, it can be analysed that the future requirement of a constant, staring presence on a time-scale of days, weeks, or months over a selected target or area of interest or to provide persistent communications is a difficult proposition. Even an increase in the number of satellites will not give us a persistent surveillance capability due to the constraints of revisit times of satellites. For example, most LEO satellites have a specific target in view for less than 15 minutes at a time and revisit the same sites only infrequently. Additionally, satellites can carry only limited amounts of manoeuvring fuel so their orbits and times overhead are very easily predicted, making them lucrative targets for ASAT weapons by the adversaries.

Evaluating the airborne platforms as another means of providing persistent

ISR efforts, we find that they are bound by an upper operating limit (of approximately 18.5 km) due to their engine limitations and the inability to achieve better aerodynamic effects. Though much more responsive than orbital assets and capable of providing much higher resolution imagery, the limited number of airborne assets still cannot always provide the persistent look needed by battlefield commanders. On the aerial reconnaissance front, India had phased out its strategic reconnaissance platform, the MiG-25 in 2006. Presently, none of India's air assets is capable of replicating the roles of the MiG-25. The tactical reconnaissance payload like the LORAP on board the Jaguar has become outdated technology. The fighter aircraft-borne reconnaissance assets are the VICON payload on the Jaguar and MiG-27. While the advent of Fuel Refuelling Aircraft (FRA) increased the endurance times of manned aircraft, they are limited by crew fatigue and availability of number of aircraft. On the naval front, the Indian Navy has the Kamov helicopters for performing Airborne Early Warning and Control (AEW&C) roles and the TU-142 Dornier for Long Range Maritime Patrol (LRMP) roles. However, considering our strategic interests stretching from the Strait of Hormuz to the Strait of Malacca, these assets will be inadequate to meet the demands of the Indian Navy. The increased instances of Indian commercial ships being hijacked as far as Somalia have further reinforced the need for an efficient surveillance system for the Indian Navy.

The future requirement of a constant, staring presence on a time-scale of days, weeks, or months over a selected target or area of interest or to provide persistent communications is a difficult proposition.

The use of more than 100 UAVs by all the three Services addresses India's tactical reconnaissance needs at present. However, both manned and unmanned airborne platforms are also exposed to the risk of enemy engagement while carrying out across the border activities.

India seeks to address its gaps in ISR by acquisition of AWACS, AEW&C platforms, tethered aerostats and ground surveillance radars. Three AWACS have been contracted for with Israel of which one may see operationalisation

India seeks to address its gaps in ISR by acquisition of AWACS, AEW&C platforms, tethered aerostats and ground surveillance radars.

by 2009, with the other two joining service by 2011. In April 2008, India signed for an additional three AWACS from Israel[63]. In addition, the Defence Research Development Organisation (DRDO) has contracted for three Embraer ERJ 145 platforms from Brazil to be fitted with an indigenous AEW &C system. India purchased two tethered aerostat systems from Israel in 2004, with four more on the anvil at the cost of US $ 300 million to beef up its ageing Air Defence Ground Environment System (ADGES) surveillance capabilities[64]. The Green Pine radars for Ballistic Missile Defence (BMD) architecture will also strengthen the overall network. On the orbital front, India plans to launch a network of five satellites for surveillance by 2012. Additional communication satellites with dedicated transponders for the armed forces are also on the anvil.

Thus, it would seem that by 2015, India would have an impressive array of ISR assets. But the fact of the matter is that all these assets have advantages and disadvantages in terms of responsive intelligence gathering and dissemination to the tactical level. In short, as a result of being tied to expensive, limited quantity platforms operating in the traditional media of space and air that do not have the capability to stay on station for extended periods of time, and the limited range and mobility of the ground radars, a battlefield commander has only a limited chance of being provided with all the information or communications capability he needs, where and when he needs it. Further, the physical limitations due to orbital mechanics and fuel consumption prevent long-term persistence for both orbital and airborne platforms. Thus, all the assets discussed herein are manpower and infrastructure intensive, incurring recurring expenditure in terms of maintenance and upgrades and

63. "Indian AWACS Moving Forward on 2 Fronts," *Defence Industry Daily*, September 18, 2008, http://www.defenseindustrydaily.com/Indian-AWACS-Moving-Forward-on-2-Fronts-04855/

64. "Did Flying LTTE Tigers Help Spur India's Aerostat Radar Buy from Israel," *Defence Industry Daily*, May 18, 2007, at http://www.defenseindustrydaily.com/flying-ltte-tigers-help-spur-indias-aerostat-radar-buy-from-israel-03309/

force protection, especially in the case of AWACS platforms.

India, thus, has two handicaps. The first is in terms of capability, where the need for the effects of persistent communications and ISR goes unfilled. The second is in terms of the altitudes covered by military assets. These two handicaps can be simultaneously filled through the use of near space platforms. Near space platforms operating in the altitude gap can provide the missing persistent communications and ISR effects desired by the armed forces as well as for internal security situations and disaster mitigation.

Considering India's increased strategic interests and the growing role it will be expected to play at the international level, these assets would just not be sufficient for India to provide the kind of persistent surveillance and communication needs of its armed forces. Near space vehicles as a functional cross between satellites and aircraft can bridge the capability and altitude gap of airborne and orbital assets. These vehicles can perform a multitude of roles for the armed forces enabling effect-based operations from the strategic to the tactical level.

DEVELOPMENT OF NSVs IN INDIA

The programme for development of airships in India was initiated at the behest of the Technology, Information, Forecasting and Assessment Council (TIFAC) an autonomous body under the Ministry of Science and Technology, in the year 2001. The programme was to assess airships as a means of transportation in the hilly regions of Uttaranchal soon after it got its statehood[65]. IIT, Mumbai was chosen as the premier agency for conceptual studies modelling and simulation of an airship.

Accordingly, a national Reseach and Development (R&D) project called Programme on Airship Design and Development (PADD) was launched at IIT, Mumbai, in 2001, with team members drawn from various national aerospace organisations, the central government and faculty members from IIT, Mumbai [66]. The first phase of the project was completed in 2003. As

65. P. V. Indiresan "A Tale of Two Attitudes," *The Hindu*, January 1, 2001, http://www.hinduonnet.com/2001/01/01/stories/05012524.htm

66. "Program on Airship Design & Development (PADD) LTA India," http://spot.colorado.edu/~dziadeck/airship/india.htm

Near space vehicles as a functional cross between satellites and aircraft can bridge the capability and altitude gap of airborne and orbital assets.

part of this study, two remotely controlled airships, the PADD Micro (with a payload capacity of 1.0 kg) and PADD Mini (with a payload capacity of 3.5 kg) were designed and developed. Successful demonstrations were carried out at the 90th Indian National Science Congress at Bangalore in 2003, as well as at other locations in the country[67].

The project, in part, was also aided by the Aeronautics Development Agency (ADA) at Bangalore. The scope of the project has increased over the years and a number of players have joined in. More notable amongst them are the Aerial Delivery R&D Establishment (ADRDE), Agra, for envelope and system engineering, National Aeronautics Limited (NAL), Bangalore, for propeller and propulsion system, Defence Research and Development Laboratory (DRDL), Hyderabad, for guidance, control, navigation and payload requirement, Indian Space Research Organisation (ISRO), Bangalore, for onboard power generation, storage system and payloads, and Tata Institute of Fundamental Research (TIFR), Hyderabad, for launch and recovery experiments. The initial aim was to develop a 70-m long aerostat which would be able to fly at 15,000 ft and carry up to two tons of weight. However, the programme seems to have been delayed as the prototype flight is still awaited[68]. Conceptual studies have also bee112n carried out by PADD for employability of HAA for pseudo satellite navigation in 2005. Possibly, with the development of an indigenous HAA, India may field such a system to reduce its dependency on the GPS and its own GAGAN.

Of late, there have been reports that the Indian government has constituted a high level committee to focus on the stratospheric airship development project in India under the aegis of NAL, Bangalore, headed by Mr M. L. Sidana

67. "A Flying Ship for India's Hilly Terrain," http://timesofindia.indiatimes.com/articleshow/1655548806.cms

68 This was evident from the paper presented by the research team of PADD at 26th International Congress of the Aeronautical Sciences in September 2008. Amol C. Gawale, Amool A. Raina, Rajkumar S. Pant, Yogendra P. Jahagirdar, "Design, Fabrication and Operation of Remotely Controlled Airships in India," at http://www.aero.iitb.ac.in/~airships/WEBPAGES/PDFs/jahagirdar.pdf

(ex-director of ADRDE, Agra).[69]

MILITARY UTILITY OF NEAR SPACE

From the foregoing, it is apparent that near space holds immense potential for military operations and is limited only by the ingenuity of the user and the payload on the platform. Some of the potential military applications of near space platforms are discussed below.

It is apparent that near space holds immense potential for military operations and is limited only by the ingenuity of the user and the payload on the platform.

- Signals Intelligence (SIGINT) payloads on near space platforms would enable persistent gathering of information and data collection of the enemy's electronic order of battle without giving him the option of switching off his sensors as is the case at present whenever an adversary carries out the task with manned/unmanned platforms.
- A network of NSVs with surveillance and communication payloads deployed over the international waters will enable seamless coverage of our area of interest (from the Strait of Hormuz to the Strait of Malacca) without violating the sovereign air space of any nation. This will enable persistent real-time actionable intelligence to the Indian Navy. It will enable the Navy to carry out a multitude of operations and effectively thwart any air attack on coastal regions/hinterland using the sea route.
- During hostilities, air space sovereignty over enemy territory is no longer a consideration; near space assets can operate above the same locations that aircraft can, subject to similar enemy threats. This will enhance line of sight communications to forward troops and overcome the effects of having to move with their communication networks, thus, enabling a lean and mean force to fight the war. Further, with the right kind of equipment and interface, the troops at the tactical level will be able to access the imagery being streamed by an NSV much like that of a UAV rather than wait for satellite

69 Interactive Correspondence and Exchange Reviews with Dr. Raj Kumar S. Pant, Director PADD, Mumbai, on October 11, 2008.

updates from the hinterland.

- Communication and surveillance payloads on NSVs will avoid fratricide in the Tactical Battle Area (TBA) by providing early identification of adversary aircraft and assist own aircraft to carry out Battlefield Air Support/Battlefield Air Interdiction BAS/BAI missions with more dwell time on target.
- NSVs, with their payloads, enable faster rates of data downlink and uplink which will enhance network-centricity of operations.
- NSVs could be controlled by the theatre/tactical commanders just like UAVs and aircraft, while providing space effects as against the control of orbital assets at the strategic level where it is time consuming and difficult for a theatre commander to get a responsive tactical picture of the operations area.
- Near space platforms have immense potential to increase space situational awareness. Being above the atmosphere for 99 percent of the time, large telescopes with membranous, holographically corrected and/or adaptive optically corrected mirrors could provide much better resolution of space assets than their earth-bound brethren that are limited by looking through significant distortion of the atmosphere.[70]
- The availability of near space platforms can act as a deterrent for the adversary to attack and destroy our orbital assets as NSVs will provide redundancy of operations, and adversaries' objectives will be defeated.
- Deployment of NSVs for pseudo satellite navigation in the theatre specific environment will provide redundancy against GPS jamming by the adversary.
- Armed forces are routinely tasked for post-disaster management operations. The availability of NSVs with their payloads will help them in search and rescue operations in the high seas or inhospitable terrains.
- NSVs' use in missile defence architecture is immense. It is in near space that both boost phase and terminal phase intercepts will take place. NSVs,

70. Lt Col Edward B. Tomme, "The Pardigm Shift to Effects-Based Space: Near Space as a Combat Space Effects Enabler," Air Power Research Institute, Research Paper, 2005-01, College of Aerospace Doctrine, Research and Education, USA.

with their ability to provide the surveillance in both the lower and upper reaches of the atmosphere and space, will enable sufficient early warning of the missiles during their ingress and egress through near space.

- Use of sub-orbital rockets is envisaged for adventure activities in the near future. However, once they are tested for their reliability, the same can be used for ISR collection or to simulate as decoys for ballistic missiles providing a relatively inexpensive way for testing and training our BMD architecture.
- With more than one stratospheric airship radar, and/or with naval or surface forces, or with other airborne systems, there is a very significant opportunity for bi-static radar operations. These might include quickly adding new radar antennas and other electronic equipment to the airship as a 'truck' concept, with internal room for various radar antennas, making the stratospheric airship an ideal vehicle to exploit the bi-multi-static system.
- Surveillance and tracking payloads on NSVs will also enable cruise missile defence over a wide area of coverage, enabling their successful interception. Presently, the US employs the Joint Land Attack Cruise Missile Defence Elevated Netted Sensor (JLENS)[71].
- As near space systems mature, there may be a possibility of launching kinetic energy interceptors for anti-ballistic missile defence, since the systems will be able to carry greater payloads and stay on station for longer periods.

Thus, near space vehicles will form another layer of our defence in-depth architecture, enabling effect-based operations to be carried out from the strategic to the tactical level, combining the benefits of both satellites and aircraft.

71. The JLENS consists of an aerostat with radars to provide over-the-horizon surveillance for defence against cruise missiles. JLENS is primarily intended to tackle the growing threat of cruise missiles to US forces deployed abroad. The system enhances cruise missile detection and engagement ranges with current air defence weapons such as the PATRIOT, Navy SM-2 missile, the advanced medium range air-to-air missile, and ultimately the medium extended air defense system and the corps surface-to-air missile system. http://www.fas.org/spp/starwars/program/jlens.htm

Most importantly, this technology gives a cheaper and quicker access to space-like conditions as compared to getting a launch to orbit.

CONCLUSION

Over the last century, militaries all over the world had become overly obsessed with the effects generated by rocket, aircraft and satellite technologies towards winning the conventional wars, hardly realising that they were overlooking a cheaper and more effective substitute to these technologies in the form of near space technologies. The beginning of the 21st century seems to have at last changed the mindset, considering the renewed interest in near space vehicles

Most importantly, this technology gives a cheaper and quicker access to space-like conditions as compared to getting a launch to orbit. The cameras at that high altitude can see for several hundred kilometres farther than with aerial photography, and access to a given area is more flexible than with the infrequent overflights by remote sensing satellites. Enhanced communications systems, network relays, and intelligence-surveillance-reconnaissance capabilities could all use the near space realm to quickly meet battlefield needs. Lighter-than-air vehicles operating in near space could quickly and inexpensively provide the capabilities that troops and commanders demand.

However, the technological breakthroughs which permitted the envisioning of NSVs are still at a nascent stage and the complete technological challenges are unknown. Even though these systems are likely to remain in a no-weather area, they will have to withstand significant ultraviolet radiations and other tough environmental conditions like handling high levels of corrosive ozone. Other problems like weight vs volume, endurance and regenerative power sources need to be overcome.

More importantly, we need to find the right synergistic mix of air, space, and near-space capabilities to produce the battlefield effects our combat commanders need. Near space is, thus, the *obvious and correct solution* to the armed forces surveillance and communication needs, forming an additional layer of effects delivery medium between satellites and air-breathers and enhancing the survivability and redundancy of such battlespace awareness systems.

AWACS AND AEROSTATS: ROLES AND MISSIONS

A.B.S CHAUDHRY

Modernisation and development are the processes of evolution. While scientists across the globe have made our lives comfortable by providing more efficient gadgetry and machinery, the innovations in the field of weaponry and their delivery systems have left the Air Defence (AD) planners working overtime to find suitable solutions to counter this development. Advancements have led to development of aircraft flying at high speeds and ultra low levels. Modern precision navigational systems help these aircraft navigate through hills to reach their designated targets and deliver their weapon loads with pinpoint accuracy.

The oldest adage from the dawn of air combat is, *"He, who spots first, has the advantage"*. The premise holds good to this day, even while technology continues to advance at a rapid pace. Air defence by definition is reactive and is directly dependent upon the availability of early warning to the air defence forces. All efforts are, therefore, on to increase the extent of early warning to the troops and decision matrix. While the reaction time is being curtailed by using computerised networks with modern generation data handling systems, the early warning is planned to be enhanced by induction of aerostats or Airborne Warning and Control System (AWACS).

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RADARS

Early writers of air power had emphatically prophesied the invulnerability and destructive capability of the manned bomber. It is true that in the absence of any early warning, by the time an enemy aircraft was detected either audibly or the visually, it was too late for the fighter aircraft on the ground to get airborne and hope to carry out a successful intercept. What they had, perhaps, not anticipated was the invention of the radar.

The initial developments in radar technology started way back in 1887 when the German physicist Heinrich Hertz began experimenting with radio waves in his laboratory. He found that radio waves could be transmitted through different types of materials, and were reflected by others, such as conductors and dielectrics. The existence of electromagnetic waves was predicted earlier by the Scottish physicist James Clerk Maxwell, but it was Hertz who first succeeded in generating and detecting radio waves.

The history of radar began in the 1900s when engineers invented simple uni-directional ranging devices. The technique developed through the 1920s and 1930s, led to the introduction of the first early warning radar networks just before the start of World War II. At the start of World War II, both the United Kingdom and Germany knew of each other's ongoing efforts in their "battle of the beams". Both nations were intensely interested in the other's developments in the field. By the time of the Battle of Britain, both sides were deploying radar units and control stations as part of integrated air defence capability. Progress during the war was rapid; by the end, the United States widely deployed radars that fit in a single semi-trailer.[1] It would be interesting to study the work done by some countries in the development of the radar.

Dutch Early Radars. Dutch scientists Weiler and Gratema were inspired by queries about "death rays" from their military, to start developing radar. They were well advanced by May 1940, and had built four working prototypes of centimetric gunlaying[2] radar operating at a wavelength of 50 cm and a

1. From www.en.wikipedia.org/wiki/history of radar accessed on January 15, 2009
2. "Gun laying is the process of aiming an artillery piece. The term is also applied to describe the process of aiming smaller calibre weapons by radar or computer control. The gun is typically traversed - rotated in a horizontal plane in order to gain a line of sight to the target; and elevated - moved in the vertical plane, to range it to the target", reference: http://en.wikipedia.org/wiki/Gun_laying

practical range of 20 km.[3]

UK. Shortly before the outbreak of World War II, several radar stations known as Chain Home (CH) were constructed along the south and east coasts of Britain. These radars operated at a frequency of 20 to 30 MHz (15 to 10 m) wavelength) and peak power of 350 kilowatts (KW). CH proved highly effective during the Battle of Britain, and is often credited with allowing the Royal Air Force (RAF) to defeat the much larger Luftwaffe forces. Whereas the Luftwaffe had to hunt all over to find the RAF fighters, the RAF knew exactly where the Luftwaffe bombers were, and could converge all their available fighters on them. In modern terminology, CH was a force multiplier, allowing the RAF fighters to operate more effectively as if they were a much larger force operating at the same effectiveness as the Germans. In order to avoid the CH system, the Luftwaffe adopted other tactics. One was to approach Britain at very low levels, below the sight line of the radar stations. This was countered to some degree with a series of shorter range stations built right on the coast, known as Chain Home Low (CHL).

Similar systems were later adapted with a new display to produce the Ground Controlled Intercept (GCI) stations in January 1941. In these systems, the antenna was rotated mechanically, followed by the display on the operator's console. That is, instead of a single line across the bottom of the display from left to right, the line was rotated around the screen at the same speed as the antenna was turning. The result was a 2-D display of the air around the station, with the operator in the middle, with all the aircraft appearing as dots in the proper location in space. These so-called Plan Position Indicators (PPI) dramatically simplified the amount of work needed to track a target on the operator's part. Such a system with a rotating, or sweeping line is what most people continue to associate with a radar display.

Germany. German developments mirrored those in the United Kingdom, but it appears radar received a much lower priority until later in the war. The Freya radar was, in fact, much more sophisticated than its CH counterpart

3. From http://reference.findtarget.com/search/History percent20of percent20radar accessed on February 6, 2009.

and by operating in the 1.2 metre wavelength (as opposed to ten times that for the CH) around 250 MHz, the Freya was much smaller and yet offered better resolution. As regards the PPI systems, it was quite some time before the Luftwaffe had a command and control system nearly as sophisticated as the British one.

US. After early work on radar by the US, conducted in the Twenties at the Naval Research Laboratories, Robert Page[4] successfully demonstrated a pulsed radar experiment in 1934. When the British and US began technology exchanges in 1940, the British were surprised to learn they were not unique in their possession of practical pulse radar technology. The US Navy's pulse radar system, the CXAM radar, was found to be very similar in capability to their Chain Home technology.[5] On entry to World War II, the army and navy had first generation working radar units in frontline units. The army's type SCR-270 radar detected the Japanese planes attacking Pearl Harbour at a range of 132 miles. Although the US had developed pulsed radar systems independent of the British, as had the Germans, there were serious weaknesses in their efforts — the greatest of which was the lack of integration of radar into a unified air defence system.

Japan. Well prior to World War II, Japan had knowledgeable researchers in the technologies necessary for radar but due to lack of appreciation of radar's potential, and rivalry between army, navy and civilian research groups, Japanese technology was three to five years behind that of the US during the war. Although progress was rapid after the value of radar was better appreciated, research continued to be impeded by inter-Service rivalry, and new units, though capable, were too late to influence the outcome of the war. Radar was used by the army for gun laying and aircraft detection, and by the navy for detection of air and sea threats on all major capital ships,

4. Dr. Robert M. Page (1903-1992), Eden Prairie, Minnesota. Retired as Director of Research, US Naval Research Laboratory 1966.

5. "The CXAM is listed (in 'U.S. Radar, Operational Characteristics of Radar Classified by Tactical Application') as being able to detect a single aircraft at 50 miles and to detect large ships at 14 miles. Other sources list CXAM detection range on aircraft out to 100 miles. *Lexington*'s CXAM-1 detected the incoming Japanese carrier aircraft strike at a range of 68 miles during the battle of the Coral Sea", from http://en.wikipedia.org/wiki/CXAM_radar, accessed on March 3, 2009.

including use of centimetric units in 1944.

Canada. Little radar research was done in Canada prior to the start of World War II. However, in 1939, the National Research Council of Canada was tasked with developing a Canadian designed radar system, which was eventually deployed on Royal Canadian Navy ships, thereby putting Canada in the forefront of naval radar deployment.[6]

> *Radar was probably the biggest force multiplier of World War II and the raison* d'être *for the British success in the Battle of Britain.*
>
> — Gp Capt Atul Kr Singh[7]

The place of radar in the larger story of science and technology is argued differently by different authors. Radar, far more than the atomic bomb, contributed to Allied victory in World War II.[8] The development of radar during the 1930s transferred aerial warfare from an imprecise adventure into science. At a stroke, the accurate detection of a hostile formation in bad weather and at night became a practical reality. Radar technology has come of age and specific role-oriented radars have replaced the general purpose detection radars. The Indian Air Force (IAF) has a healthy mix of radars which include radars with three-dimensional and two-dimensional coverage capabilities, static and mobile versions as well as long range and limited range systems. The various radars in the IAF can broadly be classified into high/medium level radars and low level radars.

High/Medium Level Radars. The high/medium level radars have long range detection capability ranging from 300 to 450 km; they may be either static or transportable. These radars have an array of systems and Electronic Counter-Counter-Measures (ECCM) techniques. The data handling is either automatic or semi-automatic, so as to have real/near real-time information.

6. ASDIC, Radar and IFF Systems Aboard HMCS HAIDA - Part 8 of 10, accessed through Wikipedia.
7. Group Captain Atul Kumar Singh, *Transformation of Air Defence in Asia*, (New Delhi: Knowledge World, 2008), ch. 2.
8. D.K. van Keuren, "Science Goes to War: The Radiation Laboratory, Radar, and Their Technological Consequences," *Reviews in American History,* 25: 1977, pp. 643--647.

These radars require very high power for their operation. The various high/medium altitude radars available with the IAF are the THD 1955, PSM 33 and TRS 2215, etc.

Low Looking (LL) Radars. The present day low level attacks and tactics by enemy fighters/armed helicopters have given the need for low looking radars. These radars have the capability to detect aircraft/armed helicopters/surface-to-surface missiles at ranges of 90 to 150 km. These are mobile or highly transportable radars with minimum site requirements, which can operate in various places at short notice. The data handling system could be automatic or semi-automatic. The various low lookup radars of the IAF are the ST-68U/UM, Indra I/Indra II, etc.

History has shown us that the ground-based radars have several inherent weaknesses, which are listed below:

- Essentially radar propagation is along Line of Sight (LoS) though radar horizon is more distant than the optical horizon. However, ground-based radar systems still cannot look very far.
- Some of the mobile radars are bulky and require a lot of time to deploy. A few of these mobile versions are unsuitable for all kinds of terrain and all weather operations.
- The targets coming at low level are picked up at very short ranges of 30-40 km, resulting in less reaction time to the AD system.
- Besides low flying, the capabilities of radars can further be degraded by employment of Electronic Warfare (EW) measures. These, in fact, are reaching high levels of sophistication. Ground-based radars are generally static, semi-mobile or mobile and can be located through electronic intelligence and Electronic Support Measures (ESM). The use of Remotely Piloted Vehicles (RPVs) has proved singularly effective in this role, especially since it reduces the risk to manned aircraft during this critical phase of operations. Once the radars are located, they can be neutralised by a hard kill or a soft kill.
- The problem of identification is the most difficult one to solve. Identification of Friend or Foe (IFF) equipment has a large number of shortcomings and

problems.

- Most of them are susceptible to enemy jamming and deception measures.
- Ground-based non-Moving Target Indicator (MTI) radars are restricted due to their siting in the use of some frequencies, for which they receive permanent echoes from terrain features.
- The radar sites are known features and thus prime targets of the enemy.
- There are still some gaps in the LL radar cover along the borders with our neighbours.

Of these, the first two limitations i.e. detection limited to LoS and mobile versions not being fit for all terrain and areas are the major factors that limit the deployment. This results in gaps in the low level detection, especially in hilly terrain.

AEROSTATS

It is said that Napoleon had expressed a need to be able to "look over the hills" and this could be taken as one of the early instances of the requirement for early warning. The French revolutionary armies used balloons as observation posts for their artillery in 1794. In the following century, the Union armies used them in the American Civil War.[9] In fact, balloons can be considered to be the forefathers of modern aerostats. The first balloon flight was demonstrated by the Montgolfier brothers on June 5, 1783. Later that year, they sent up the first balloon crew — a sheep, a rooster, and a duck[10]. Jean-François became the first human to ascend in a balloon on November 21, 1783. The need to preempt the enemy led to the utilisation of balloons for reconnaissance and these were used extensively during the American Civil War.

The persistent demand for low cost surveillance led to radars being fitted to tethered balloons. These were called "aerostats". The term has its origins

9. Air Vice Marshal R.A. Mason, *Air Power: An Overview of Roles* (New Delhi: Ritana Books, 1987), chapter 2.
10. http://en.wikipedia.org/wiki/Montgolfier_brothers

Special fabric surface minimises the snow and ice loading on the aerostats during winter seasons and the ability to withstand bullet holes and cuts in their fabrics proves that aerostats are not as fragile as they appear.

from the Greek words *aēr* meaning air and *statos* meaning standing[11]. The first modern aerostat is the Tethered Aerostat Radar System which was deployed by the United States in 1980. It is used for low level air surveillance to prevent air space violation and to intercept drug trafficking. This aerostat carries the Lockheed Martin L-88 surveillance radar as its primary payload. Among the later aerostats is the Marine Airborne Re-Transmission System (MARTS) which is equipped with transponders for Enhanced Position Locating and Reporting radios. It provides a 24-hour relay within a radius of 125 km for up to 15 days from 3,000 ft. The first MARTS system was deployed in Iraq in early 2005[12].

Capabilities

Modern aerostats have a low level detection range of about 350 km when hoisted to 15,000 ft. These platforms have a deployment period of approximately 30 days at a time. The on station time of aerostats is limited primarily due to loss of helium pressure and maintenance activities. Special fabric surface minimises the snow and ice loading on the aerostats during winter seasons and the ability to withstand bullet holes and cuts in their fabrics proves that aerostats are not as fragile as they appear. Aerostats are capable of withstanding several hundred bullet hits before deflating gradually and undergoing a controlled degradation. Similarly, missiles designed to fuse on a hard surface would pass directly through the balloon structure. Aerostat systems support a wide variety of electronic payload, including Airborne Early Warning (AEW) radar with integrated IFF, Signal Intelligence (SIGINT) and electro-optical payloads, besides operating as radio relays. The payload weight varies from 225 kg (500 lb) for small size aerostats to 2,300 kg (5,000 lb)

11. http://en.wikipedia.org/wiki/Aerostat
12. From *Directory of US Military Rockets and Missiles*, accessed through the link http://www.designation-systems.net/dusrm/app4/aerostats.html, on November 12, 2008.

for the TARS system[13].

Although the original aerostat radars were developed for aircraft targets, presently technology has developed to a state where boats and even cars and trucks can be detected. Generally, mission application of aerostats platforms is regarded as the border surveillance type, however, its role as AEW for navy surface ships cannot be over-emphasised. Taking into consideration the perceived threats from the northwest, ship-based aerostats in the northwestern seas would give us immense benefit in early warning. These ship-based aerostats could also be used in conjunction with other surveillance platforms for our maritime reconnaissance requirements and surveillance of our Sea Lines of Communication (SLOCs).

Since the aerostat's primary mission is normally to detect low altitude low speed targets, most of its energy is focussed below the horizontal.

Advantages

Aerostats offer the advantage of enhanced LoS due to their altitude. The added advantage of aerostat-mounted radars is their increased vertical coverage due to multipath reflections from the surface. Since the aerostat's primary mission is normally to detect low altitude low speed targets, most of its energy is focussed below the horizontal. Hence, multipath reflections from the surface can significantly increase the vertical coverage of the radar and targets well above the main beam are frequently detected due to surface reflections. An inherent limitation in ground-based low-looking radars is the restricted radar coverage due to shadowing by mountains and hills. Higher operating altitudes of the aerostats reduce the amount of shadowing. Generally, the aerostat can accommodate large parabolic antennae within the windscreen without serious loss of aerodynamic performance, again contributing to enhanced radar coverage.

Aerostats present a cost-effective option for long endurance Intelligence, Surveillance, Reconnaissance (ISR) and early warning capabilities as compared

13. Ibid.

It costs about $26,500/ hour to operate a Global Hawk Unmanned Aerial Vehicle (UAV), $18,000/ hour to operate a Hawkeye AEW and just $610/hour to operate an aerostat.

to other aerial platforms. The life-cycle cost of aerostat operation is approximately one-third that of fixed wing early warning aircraft. Smaller mobile aerostats like the American Rapidly Elevated Aerostat Platform, can be launched within five minutes. Larger aerostat systems require about 45 minutes for deployment. Launch and recovery operations for large aerostats require only a few ground handlers. Modern helium filled aerostats can stay aloft for extended periods of time and they have demonstrated mission availability of 95 percent and higher when weather and scheduled maintenance times are excluded. And, now, coming to one main consideration – the operating cost. It costs about $26,500/hour to operate a Global Hawk Unmanned Aerial Vehicle (UAV), $18,000/hour to operate a Hawkeye AEW and just $610/hour to operate an aerostat.[14]

Limitations

Aerostat operations would require the development of extensive infrastructure to accommodate launch and tether facilities, ground segment, and storage facilities for helium. Large size aerostats also pose ground handling problems. Although aerostats can operate in winds up to 80 knots in a deployed state, they are adversely affected by winds of more than 50 knots during the launch and recovery phase. In the event of inclement weather, winching down an aerostat system could take up to two hours for large size aerostats. Besides, the payload of an aerostat can be affected by lightning strikes.

The ground installations, particularly the mooring system, are vulnerable to air-to-surface weapons. Additionally, safeguards have to be provided against Special Forces operations. Aerostats are, therefore, deployed at a

14. Dr Vijay Sakhuja, "Airships are Back", Guest Column of *Salute* magazine, dated February 21, 2009.

distance of 100 to 150 km from the borders to achieve a balance between the required radar cover and depth against hostile threats.

ANALYSES OF AWACS ROLES

> *Radar had the effect of forcing air operations down to lower levels to stay below the radar horizon and thus evade detection… an airborne platform thereby nullifying the benefits of a low-level approach has been perhaps, the single, greatest force-multiplier in air operations.*[15]

The invention of the radar provided the much needed early warning to defending forces. However, its limitations spurred the way for the development of the 'airborne' radar or the radar held aloft in an aerial platform, viz the aerostats and other AEW platforms. These platforms subsequently led to the modern day AWACS, which sought to overcome the few drawbacks of radars and aerostats. AWACS has been touted as a great force multiplier and it has proved its capability on many an occasion. What, therefore, are the roles for AWACS? Where does the operational role finish and strategic importance begin to take over? Are there areas of overlap and do both roles overshadow each other to some extent? AWACS can be utilised for a variety of roles in many different situations which are covered in the following paragraphs.

Operational Roles

- **Radar Cover and Tactical Control of Offensive Missions.** Radar cover of ground-based radars is restricted by line of sight and consequently the ability to pick-up low-level targets flying at 100 metres (300 feet) is restricted to 45-50 km, whereas a single AWACS provides a seamless low and medium level cover up to 400 km or more. Flying at 30,000 feet, and approximately 100-150 km inside own territory, AWACS can provide 250 km of early warning and control capability in enemy territory for six to eight hours. The extent of radar cover from low to medium and high

15. Squadron Leader Ajay Singh, "The Air War with AWACS Symmetry", *The Indian Defence Review*, © 1995 by Lancer Publishers & Distributors, downloaded www.bharat-rakshak.com/LANCER/index.html

altitudes would facilitate effective employment of fighter sweeps and free escorts for conduct of air dominance operations in enemy territory.

- **Strike Control.** One of the biggest advantages of the airborne radar platform is the ability to warn and control own strike missions in the adversary's territory, which hitherto was not possible owing to line of sight constraints of ground-based radars. Under positive radar cover, friendly strike missions can fly at medium levels, thus, avoiding three-tier low-level radar cover of Mobile Pulse Doppler Radars (MPDRs) which are restricted to 4.5 km (15,000 feet) in elevation coverage. This would also render en-route Short Range Air Defence Systems (SHORADS) deployed in the Tactical Battle Area (TBA) ineffective because most of these weapon systems have a slant range of 2.5 to 3 km (8,000 to 10,000 feet). Medium level ingress would afford prompt threat warning, larger radius of action, more freedom to manoeuvre, better endurance for strike aircraft and reduced exposure to enemy ground-based air defences.

  It can also warn the friendly strike of enemy Surface-to-Air Missile (SAM) threats by sensing their emitters. Also, the strike aircraft can be assisted in its navigation to the target through safe corridors, avoiding the enemy radar pick-up zone. The AWACS can assist in the RV of the refueller aircraft with the strike aircraft during air-to-air refuelling.
- **Low/Medium Level Ingress.** The sole purpose of low-level flight profiles is to avoid and delay the detection by air defence radars and give minimal reaction time to anti-aircraft weapons, where the fighter aircraft flies at 50 to 100 metres (150 to 300 feet) above ground level (AGL). The gap free low level radar cover extending 250 km or more in the adversary's territory would afford instant detection, greater reaction time and swift offensive action by fighter sweep, free escorts or tied escorts, thereby rendering the low-level ingress tactics redundant. Pakistan's lack of geographical depth would place all its main and satellite airfields within the detection ranges of AWACS.
- **Defence in Depth.** AWACS would assist in early detection and interception, maintain continuity in application of firepower and afford

opportunity for multiple interceptions, thus, imposing greater attrition and providing the classical defence in depth. Enhanced early warning and gap free radar cover would facilitate the area defence concept which affords optimal exploitation of speed, mobility, flexibility and firepower of fighter aircraft and greater freedom of action for terminal weapons deployed at vital areas/vital points (VA/VPs). As an offshoot of greater early warning during AWACS operations, aircraft on ORP and terminal defence weapons would be able to maintain a more realistic state of readiness and avoid prolonged State of Readiness I / II.

- **Air Battle Management and Target Designation.** AWACS executes the air battle management in real-time in coordination with ground-based/ship-borne air defence systems, Multi-Role Air Superiority Fighters (MRASFs), a combination of electronic warfare and strike aircraft and other combat air support operations like aerial refuelling. This provides it the capability to do real-time allocation and reallocation of weapon systems against enemy assets.[16] This capability can be gainfully exploited for real-time target allocation, and shrinking the sensor-to-shooter loop, to achieve the objectives with minimal force and time.
- **Air Space Management over Tactical Battle Area.** The problem of air space management emanates from the delayed /no detection and identification of tracks, very little reaction time and unreliable chain of communication. AWACS with onboard long range HF/V/UHF RT and large detection ranges could perform the function of battlefield management. Detection ranges beyond horizon, early radio contact, medium level approach and timely communication give options of exercising positive control over AD weapons in the TBA, maximise their freedom of action and reduce the chances of fratricide. Higher and larger vertical slabs would be available for helicopter operations of the IAF and Army, transport

16 "In April 1996, rebel Chechen President Dudayev was assassinated with the help of a Russian A-50 AWACS operating over Chechnya. Capable of monitoring communication frequencies, an A-50 located the President's cellular phone frequency and the target data was relayed to a Su-25 ground attack aircraft armed with laser and TV guided bombs, which attacked the precise location to complete the mission," Timothy L. Thomas in "Air Operations in Low Intensity Conflict: A Case of Chechnya," *Airpower Journal*, Winter 1997, p.54.

Permanent solutions for integrated radar network, composite air picture and fibre optics communication links would streamline the battlefield air space management.

support operations, Special Heliborne Operations (SHBO) and Combat Search and Rescue (CSAR). The permanent solutions for integrated radar network, composite air picture and fibre optics communication links would streamline the battlefield air space management. Even then, the air space management might continue to pose the challenges experienced by the technologically superior Coalition forces. In the Iraq War of 2003, a US A-10 attacked and killed nine US Marines on March 23 and a US F-16 CJ fired on a Patriot missile battery on March 24, 2003.[17] Since the invasion in 2003, there have been at least five collisions between UAVs and manned aircraft. After decades of experience in joint operations, the fundamental differences on methods of air space control continue to exist between the US Army and US Air Force (USAF).[18] Magnification of this problem is on the cards if proliferation of UAVs in the forms of mini and micro UAVs is permitted without proper monitoring and/or establishing the requisite Standard Operating Procedures (SOPs).

- **Silent/Passive Intercept.** AWACS can provide a silent intercept to the modern day fighter aircraft like the Su-30 class, through the Operational Data Link (ODL). AWACS picks up the target and this target information is passed on to the fighter, through text or radar picture. The fighter would not need to switch on its own airborne radar till a weapon solution is achieved, thereby concealing its approach till the last stage.
- **Rescue and Recovery.** With state-of-the-art mapping and navigation system onboard, AWACS can pinpoint locations accurately. Thus, it can help to locate and recover any friendly aircraft to its parent base or to the nearest airfield. Helicopters on SAR missions may be directed to their destinations. In CSAR missions, the AWACS aircraft is the hub of all

17. Anthony H. Cordesman, *The Iraq War: Strategy, Tactics and Military Lessons,* (Natraj Publishers Dehradun, 2006), pp. 239-240.
18. Gayle S. Putrich, *Unmanned and Dangerous*, available on www.defensenews.com, dated June 11, 2007.

activities. The airborne mission commander can be on board an AWACS aircraft and can control the whole mission. The aircraft can relay information between the Joint Air Defence Centre (JADC), on-scene commander and rescue forces. Further, AWACS can simultaneously coordinate a number of search missions.

- **Electronic Intelligence.** The SIGINT system on board AWACS can receive, analyse and locate radar and communication frequencies at ranges much greater than the radar range of 400 km. This would supplement the existing intelligence infrastructure. AWACS could transfer SIGINT data either directly or through the Ground Exploitation System (GES) to command and control centres for real-time analysis and decision-making. The enemy's electronic Order of Battle (ORBAT) can be updated for planning of air operations and the real-time radar picture can be correlated with electronic ORBAT.
- **Air Intelligence.** Monitoring and analysing of the adversary's air activity is an ongoing process during peace and during operations. Information on the adversary's capabilities and analysis of such information [known as General Hostile Area (GHA) analysis in the parlance of the Indian Control and Reporting (C & R) organisation] during flying training and known periods of air exercises would give a very good insight into the enemy's tactics and capabilities. AWACS can monitor air activity up to 350 km or more during peace-time (because they can fly closer to the international border) and 250 km or more during war-time (for safety reasons, these platforms would operate at least 100-150 km inside own territory). The air activity, when correlated with radar and radio activity monitored by SIGINT systems, would form definite patterns of tactics and manoeuvres practised by adversary.

Strategic Roles

As a tool of power projection, the US has used AWACS for coercive politics on many occasions. "…the US has made increasing use of AWACS for political purposes, leading in fact to some people coining the term **'AWACS diplomacy'**

to describe the phenomenon."[19] The USAF has employed AWACS in different roles and for different purposes extending from purely defensive operations to coercive diplomacy and implementation of international sanctions, some of the examples are quoted below:

- Deployment of AWACS to maintain North American air sovereignty in Alaska and as part of NORAD.
- Deployment of E-3A Sentry in Saudi Arabia in March 1979 in the context of the conflict in Yemen.
- Deployment of AWACS in Saudi Arabia, Turkey, Bosnia for enforcing international sanctions.
- Deployment in Egypt in October 1981 (in the immediate aftermath of the assassination of President Anwar Sadat) and again in February 1983 (to forestall through coercive politics the allegedly impending Libyan backed coup attempt in Sudan).
- Deployment of E-3C Sentry in Operation Desert Storm (1991) for weapon control, battlefield management and surveillance and ESM and in Operation Iraqi Freedom in 2003 in similar roles.

- **Air Dominance Operations.** AWACS could be used to achieve air dominance over the adversary's air space and in a joint battle with the army and navy to attain time critical military objectives. Initiative, surprise, concentration of firepower, shock effect and attaining operational advantage over adversaries would remain the guiding principles for utilisation of AWACS. Therefore, it will be prudent to identify the specific areas of strategic value for AWACS utilisation in operational plans and in joint planning by the three Services.[20] The command and control of the air

19. Air Commodore Jasjit Singh, *AWACS: The New Destabiliser* (New Delhi: Lancer Press, 1987), p. 33

20 "… All these sensors and combat assets, both ground-based and airborne will be networked and this will give us the requisite capability to dominate the airspace", Air Chief Marshal F.H. Major in an interview in *Force*, vol 6, no. 6, February 2009, p.21.

battle management function would be carried out by AWACS over land or over sea in coordination with ground-based/shipborne air defence systems.

- **Command and Control Centre.** In peace-time as well as war-time, AWACS remains an instrument of power projection and force application. As an airborne command and control centre, AWACS, along with MRASF could be utilised for coercive diplomacy or sending vital politico-military signals or to actually open a new front of war and take the adversary by surprise. For example, a high intensity air battle may be in progress in a given theatre, and to dilute the adversary's resources and attention, integrated force projection of AWACS, Air-to-Air Refuelling (AAR) MRASF is brought to bear on our adversary by carrying out a heavyweight air attack in a different sector, thereby taking the enemy by surprise and seizing the initiative.
- **Disaster Management.** AWACS has played a vital role in surveillance, aircraft control and regulating the air effort in mitigation of natural calamities like earthquake, hurricanes, tsunamis, etc, to fill the void created by the inability of ground-based systems to move in quickly and operate from difficult terrain and poor infrastructure post natural disasters. In such circumstances, AWACS operating over a given area can coordinate and regulate air traffic to ensure safety and efficient flow of humanitarian assistance. After the devastating earthquake in Pakistan on October 8, 2005, as an element of the North Atlantic Treaty Organisation (NATO) Response Force, AWACS missions performed air assistance for humanitarian efforts and similar relief was provided to victims of Hurricane Katrina in New Orleans, Louisiana, in 2005.[21]
- **Air Battle Management.** The strategic importance of AWACS emanates from its ability to extend multiple functions like early warning, surveillance, ESM, command and control, SIGINT and battle management from one airborne platform. It affords the capability to single-handedly conduct air operations over geographically dispersed locations and diversified terrain. Defending India's land frontier that measures more than 15,000

21. "AWACS: NATO's Eye in the Sky", from http://www.nato.int/docu/awacs/awacs-e.pdf

km, which it shares with seven countries, including a small segment with Afghanistan (106 km) in northern Jammu and Kashmir[22], and a coastline of 7,516 km with a total of 1,197 island territories in the Bay of Bengal and the Arabian Sea,[23] by ground-based radars is neither practical nor cost-effective. AWACS would overcome the limitations of ground-based radars and function with relatively improved efficiency from the plains of Punjab, Rajasthan, coastal areas and over the Indian Ocean. This capability affords significant strategic advantage of conducting air operations over any area of national interest.

- **Prioritisation of Operations.** A large number of AWACS would be required to cover such a vast expanse of land, coastline and island territories. AWACS cannot be apportioned in a particular role; in a given theatre, it can support a variety of operations over a single mission. The demand to availability ratio for AWACS will always remain critical, considering the vast geographical expanse and distances between possible theatres of operations in India. Considering the limited numbers, AWACS will remain a strategic asset directly under the control of Air Headquarters (Air HQ) and the operational demands of Command HQ would have to be prioritised considering the overall military objectives and time critical operations.
- **AWACS in Nuclear Strategy.** Strategically, another very important and critical role for AWACS could be envisaged in unconventional warfare. Considering India's "no first use" policy, Indian nuclear strategists have to reconcile to absorbing the first strike and launching a punitive retaliatory strike within a reasonable time-frame. In this case, the first imperative would be to safeguard our weapons and delivery systems. The aerial delivery of nuclear weapons is the most viable option to create a desired impact at a given time and place. Although it is understood that after absorbing the first strike, the balance of air dominance will shift in favour of the adversary and own strike capabilities may face tough resistance,

22. Brig Gurmeet Kanwal, "India's Borders", accessed through http://www.indiandefencereview.com/?p=379
23. http://india.gov.in/sectors/defence/indian_navy.php, accessed in January 2009.

that is where the integration and networking of force multipliers is to be exploited. Such contingencies must be considered in our counter-strike strategies. AWACS, integrated with other force multiplying platforms, could play a strategically vital role in guiding and positioning our delivery vehicles over selected target areas, and also ensuring that such strikes go through unhindered.

- **AWACS for Continental Air Force.** The Indian Air Force is being shaped to expand from a subcontinental to a continental air force, which would be capable of safeguarding national interests and economic assets over a larger area of national interest in the Indian Ocean, Central Asian and Southeast Asian regions. In this process of evolution, the importance of an air expeditionary force needs no emphasis. For an expeditionary air force, AWACS would perform the role of an airborne command and control centre, for handling the contingencies beyond own territory/territorial waters, similar to the landing at Male airfield (Maldives in 1988), amidst the uncertainty about the status of the airfield, or protection of aircraft and ships evacuating the Indian population during the Gulf War (1991).

COMPARISON OF AWACS WITH GROUND-BASED RADARS AND AEROSTATS

Having understood the origin and the characteristics and advantages of AWACS and aerostats, it is indeed very clear that ground-based radars have a limited capability. The ground-based radars are also affected in the coverage by the curvature of the earth, thus, providing the critical gap below the radar horizon. Radar detects low-level targets at very limited range, thus, reducing the reaction time to activate the AD systems to neutralise the high-speed aircraft threat. At the same time, in the past decade or so, advances in electronic warfare have seriously threatened the efficacy of such radars. During peace-time, very little of the opponent's air activity can be monitored by ground-based radars. During war, the existence of the radar gap at low altitudes has traditionally brought the air warfare zone to lower heights. Since World War II, AD systems in all countries have been essentially orientated

towards a low level altitude air warfare environment.

On the other hand, airborne surveillance and tracking radars significantly increase the capability to track low flying aircraft, as well as negate most of the hostile electronic warfare capability. AWACS detects the threat at large distances, thus, increasing reaction time to neutralise the threat far away from the target. Not only is the target detected but the real-time data is transferred to ground-based AD systems which are integrated with AWACS.

A ground-based radar cannot detect an aircraft approximately 100 metres high until it approaches a range of 45 km, due to LoS limitation. On the other hand, the same aircraft can be detected at ranges of 400 km by the AWACS, flying at 9 km altitude. The targets at higher altitude can be detected at even greater ranges with improved clutter reduction facility. AWACS has the capability to control the air battle in the entire air envelope. In 1982, during the air battles over Lebanon's Bekaa Valley, the Hawkeye (E-2C) and Israeli Air Force gained distinction for synergistic control and coordination of air operations. One needs to note that the shooting down of 86 fighters with the loss of only one aircraft was due to surveillance and control through the E-2C stationed over the Mediterranean Sea.[24]

Aerostats can also perform continuous surveillance with minimum control capability. The aim is to increase the reaction time by increasing the early warning in order to neutralise or divert the incoming enemy threat. They are capable of detecting targets at a range of 150 to 200 nautical miles (nm), which is a significant increase in range compared to existing land-based radar equipment.

India has a vast air space to provide surveillance to our own aircraft as well as to guard the sky against any possible intrusion and violation of the air space. This demands a large inventory of radar and communication equipment and an extensive network of the Air Defence Ground Environment System (ADGES). The western front alone demands simultaneous operation of a large number of medium and high looking radars to provide surveillance to friendly air movements as well as to provide air defence watch from dawn to dusk.

24. Edwin Leigh Armistead, *AWACS and HAWKEYES* (St. Paul, USA: MBI Publishing Company).

In the case of any adverse political or military signal from across the border, they resort to round the clock watch. This demands extensive utilisation of the existing AD resources and high state of maintenance and serviceability. Their job can be made easy and be augmented by employing AWACS. For economy of effort, AWACS can be selectively used in conjunction with aerostat radars and the already existing ground-based radars to supplement each other. A similar arrangement could be worked out for the surveillance of the northeastern frontier and the peninsular area.

While operating at 30,000 ft and 100-150 km inside the international border (IB), the AWACS radar can cover upto 250 km inside the enemy territory. During the course of its normal surveillance, it can help us to monitor and analyse the enemy tactics and capabilities. Further, AWACS can intercept and detect almost all types of enemy radar and radio transmissions. Online data link with the ground stations can provide real-time study and intelligence from these radiations. However, dedicated Electronic Intelligence (ELINT) missions may be undertaken if the situation so demands. Thus, AWACS can supplement the existing ELINT and recce aircraft squadrons. Specific ESM equipment may be fitted on board the aerostat to search, detect and intercept enemy electro-magnetic (EM) radiation. Thus, a judicious use of AWACS can highly augment our intelligence capability.

During war-time, AWACS will act as the single largest airborne operations room, controlling and coordinating all the air activity in its area of pick-up. When linked up with ground-based ADGES through voice and datalink, it would act as an extended but superior platform of AD operations. Because of its height of operations, the inherent increase in radar pick-up range and radio/telephony (R/T) communications will curtail all the limitations of the ground-based system. The basic functions of active air defence, namely detection, identification and interception will not be restricted to the terminal phases of the enemy air strike. The basic drawback of air defence, namely a reactive operation, will shed much of its drawbacks, as the reaction time would be increased. The enemy threat can be neutralised well ahead of the VA/VPs. Further, AWACS can control the free escorts and the fighter sweeps,

thereby taking the battle into the enemy territory. With all these attributes provided by the AWACS/AEW&C platforms, air defence does not remain purely 'reactionary'. As a matter of fact, we now need to accept that the air defence component of air power has an offensive content, and the more properly we exercise this option, the more AD will contribute to counter-air (aircraft) operations.

Despite numerous advantages, the AWACS also has some limitations, which are:

- **Height Errors.** Due to the antenna thickness, the beam is not very sharp. This results in errors in elevation, which at times could be very large. This limitation would be overcome in an Integrated Air Command and Control System (IACCS) environment where a number of sensors would be linked through the ODL. The inputs from various sensors can be co-related to get the correct height of the target.
- **Limitation as an Independent Command and Control Hub.** If the AWACS operates as an independent Command and Control (C2) centre, in an IACCS environment, then the limited number of workstations on board the aircraft poses a constraint.
- **AWACS in Mountains.** Effectiveness of radar, airborne or ground-based, in mountainous terrain is restricted by terrain masking. All radars, including AWACS, work on the line of sight principle and are prone to radar shadows owing to terrain masking. Although as compared to ground-based radars, AWACS overcome the constraints of line of sight and provide higher detection probability at farther ranges, the performance of AWACS would also be restricted. While it is true that in mountainous terrain, aircraft would invariably take advantage of terrain masking and follow the valleys to avoid radar detection and give as little early warning as possible, it is also true that such an approach is predictable. Smaller sensors like mobile observation posts and UAVs could be deployed to cover the approaches to these valleys. AWACS could be used more advantageously in conjunction with smaller ground-based radars like Low Level Light Weight Radars (LLLWR), ST-68 and

other GCI units integrated on a network to provide a composite air picture.

- **Protection of AWACS.** AWACS, being a strategic asset, would be the prime target for any adversary and would need to be protected adequately at all times – be it in the air or on the ground. It is a considered opinion that a large number of fighter aircraft would be tied down for protection of this high value asset, thus, negating the advantages of AWACS. The effort diverted to protect AWACS and its associated infrastructure would also offset/negate the force multiplier effect which could be accrued.

AWACS, being a strategic asset, would be the prime target for any adversary and would need to be protected adequately at all times – be it in the air or on the ground.

  AWACS can easily be detected by enemy radars due to its height of operation but the onboard systems would give it adequate warning to take defensive action. The increasing number of long range SAMs has bolstered the case for engagement of AWACS. Although these are very live issues, they do not seem to be a cause for undue alarm because these missile systems have not been proven so far.
- **Data Transmission.** AWACS would operate over a large geographical expanse and data would need to flow seamlessly. The large amount of data transfer between the AWACS and other AD elements requires a very robust ground communications network. The operationalisation of IACCS on AFNET will overcome this limitation.
- **Aircrew Limitations.** Due to the large loiter time, which can be further enhanced with air-to-air refuelling, pilot fatigue is a consideration. Aero-medical indoctrination of the crew to operate in confined spaces for prolonged durations, could address this problem.
- **Unserviceability in the Air.** In case of any unserviceability of the system in the air, the downtime will be higher as compared to ground-based radars wherein the radar can be rectified faster. A radar transmitter failure would result in aborting the AWACS mission as it would not be possible

to replace this on-board.

- **Blind Zone.** There is a cone of blind zone above and below the platform, which can be exploited by the adversary. AWACS is a dynamic platform and would be operating inside our air space; hence, this blind zone might not seem to be of great importance. Additionally, this blind zone would keep shifting with the movement of AWACS, thereby, not giving a chance to the adversary to factor exploitation of this zone at the planning stage. The blind zone would be a limitation only in case the threat develops below the aircraft or passes underneath the AWACS platform. In such a scenario, the pick-up from other sensors like ground-based radars or aerostats would be taken on the IACCS network to complete the intercept.
- **Loss of Surprise.** The pattern followed by AWACS, observed by the adversary over a period of time, would be a dead giveaway. Thereafter, they could resort to taking protective measures, be it in terms of ECM, ECCM, ESM or Communication Support Measures (CSM) as soon as an AWACS is identified as being airborne. This would result in loss of force multiplication effect of the AWACS. This limitation can be overcome by carrying out minimum R/T takeoffs and frequently changing the pattern flown by the AWACS.
- **IFF.** The problem of identification is the most difficult one to solve. IFF equipment has a large number of shortcomings and problems. The IFF Mark-10, fitted on almost all our aircraft and compatible with AD sensors, is outdated. The newer generation IFF Mark-12 might be the answer to this problem but there are issues on its procurement, installation on all types of aircraft and integration with the AD sensors in the C&R chain. For a long time to come, the only reliable identification method will continue to be based on track history. This requires an extensive overlapping radar coverage without gaps. While such coverage is feasible with regard to medium and high altitude air activity, at low level, the limited range of radars would necessitate a very large number of such radars. A comparative study has revealed that about 50 low-level radars would be required to cover an area equivalent to the area covered by one AWACS.

CONCLUSION

Success in any air defence engagement depends on the ability to detect a raid as soon as possible. The extent of early warning available is the prime objective around which the defender force builds its defensive strategy. The order of the day is "real-time" information. Sufficient early warning is required to neutralise surprise attack. As the efficiency of radars and AD systems increased, attacking aircraft were progressively forced to lower and lower altitudes for penetration and attack so as to evade detection till as late as possible, thereby reducing reaction time available for the defences.

The limitations of the ground-based radars and the introduction of early warning have generated pressures for other tactical solutions against penetration of high speed, hostile strike aircraft. AWACS is used for surveillance and to provide aerial target information of high speed aircraft flying at low / medium altitudes. The evolution of AWACS and other AEW assets has forced a reevaluation of the core concept of 'reactionary' air defence and blurred the line between defensive and offensive operations. AWACS is a formidable component of the air defence system, and doctrines have to be suitably modified to offensive defence. There is a need to shift focus from air space denial to air space control as a means of achieving tactical objectives.

Airborne early warning systems provide better track histories by virtue of improved coverage against low flying aircraft, and, thus, provide a more reliable identification of tracks. The real answer to the tactical problems of air operations being executed at low levels lies in an integrated command and control system of which AEW systems constitute the key element. AWACS alone cannot win wars—it is has to be integrated with other interoperable war fighting components and employed aggressively for optimal exploitation. AEW systems cannot replace the ground-based radar network due to their inherent limitations. They must, therefore, form a complementary, though increasingly, important and indispensable element in the control, reporting and response system vital for conducting air operations in the modern environment.

THE EVOLUTION OF CRUISE MISSILE TECHNOLOGY

SITAKANTA MISHRA

The evolution of weaponry is directly "linked to the history of violence, peace and conflict." The history of violence, peace and conflict is also a history "of a series of ever-more-efficient devices to enable humans to kill and dominate their fellow human beings."[1] In the process, any such device or system that is effective is always copied and upgraded, thereby perpetuated. The infinitely ingenious human mind has always looked for creating and using new technology commensurate with necessity and the difficulties arising out of it. But this process of adoption and adaptation is sometimes slow. With this background, if we look at the evolution of cruise missile technology, it seems it is a sober success by gradually coming up to this stage.

However, to get an empirical notion on the evolution of a particular weapon system, one needs to establish an understanding of the "physical factors" required for effective weapons and the "psychological enabling factors" required to effectively employ these weapons.[2] Then only "an overall survey of weapons evolution becomes possible." Physical factors like the need for force, mobility, distance and protection are important physical limitations that stimulate innovations. On the other hand, the psychological enabling factors such as

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1. Dave Grossman, "Evolution of Weaponry" (Academic Press, 2000) available at: http://www.killology.com
2. Ibid.

To get an empirical notion on the evolution of a particular weapon system, one needs to establish an understanding of the "physical factors" required for effective weapons and the "psychological enabling factors" required to effectively employing these weapons.

resistance to killing, posturing, leadership or decision-making and conditioning are important aspects that instigate the surmounting of physical limitations.[3] Since both physical and psychological factors are ubiquitous, parallel evolution is widely evident. For example, when the Americans and British started thinking of radio-controlled "flying bombs" a few years before World War I, the Germans showed better technology during World War II.

Here an endeavour is made to track the evolution of cruise missile technology empirically. Though there are studies on the chronology of cruise missile development, the factors that steered the system towards maturity have been only scantily investigated so far. Whether it was the sheer technological curiosity or the necessity of war-fighting or any other factor that propelled the process of its onward journey, is the topic of discussion in this paper. Moreover, which technological problems cropped up in what phase and what solutions were applied thereto which kept the evolution cycle rolling is enquired into but with an empirical approach.

PHASE – I: THE GENESIS: EARLY YEARS TO 1941

The first reference on the genesis of modern cruise missile technology can be traced back to the pre-World War I period when the search for using radio communication to control aircraft was started. Among many, Elmer Ambrose Sperry, an American who invented the gyrocompass, succeeded in arousing the US Navy's interest. In 1911, when Sperry applied radio control to airplanes, he realised that for radio control to be effective, automatic stabilisation was essential. So he decided to adapt his naval gyrostabilisers[4] for this. In 1916,

3. Ibid., pp.1-5.
4. Bion J. Arnold to Secretary of War, "Secret Report on Automatic Carriers, Flying Bombs (FB), Aerial Torpedos (AT)," January 31, 1919, quoted in Kenneth P. Warrell, *The Evolution of Cruise Missiles* (Alabama: Air University Press, 1998).

Sperry and his son Lawrence joined Peter Hewitt, an electrical engineer, to develop an explosive-laden pilotless airplane, the "aerial torpedo". Together, they tested an automatic control system on a Curtiss flying boat and a twin-engine aircraft.[5] The American experiment to develop cruise missile technology is discussed in detail subsequently.

Early British Efforts

Almost during the same time, the Europeans, especially the British, also worked on the "flying bombs."[6] In fact, the possibility of automatic flight control was suggested in 1891 by British scientist Sir Hiram Maxim, who proposed "to secure longitudinal stability by the automatic actuation of elevators in response to disturbances detected by a gyroscope."[7] The pioneering attempts to achieve automatic flight were stimulated by the prospect of using uninhabited aeroplanes as missiles. Prof. A.M. Low and his team worked on this problem during World War I at Brooklands and Feltham.[8] Shortly after the War started, the British War Office asked Prof. Low to work on a rangefinder for coast artillery. But the project was subsequently changed to a radio-controlled "flying bomb" to intercept zeppelins and attack grounds targets. During the first demonstration, the vehicle crashed, and the second one, though it flew satisfactorily for a while, subsequently lost control and flew towards the assembled spectators before crashing.[9] Later, H.P. Folland, designer of the famous SE-5 pursuit plane, designed another missile. But that also did not succeed, failing to get airborne on all three attempts in July 1917. With these successive failures the British ended the radio controlled cruise missile project, at least for a while.[10]

5. Gordon Bruce, "Aerial Torpedo is Guided 100 Miles by Gyroscope," *New York Tribune* (October 20, 1915) cited in Warrell, Ibid., p. 7.
6. "The 'Aerial Target' and 'Aerial Torpedo' in Britain," http://www.ctie.monash.edu.au/hargrave/rpav_britain.html
7. "Automatic Flight," The Forty-Sixth Wilbur Wright Memorial Lecture, *Flight*, May 16, 1958, p. 658.
8. Ibid., "Professor A.M. Low and the 'Aerial Target'", http://naarcee.bizland.com/feedback.htm
9. Rhodi Williams, "The First Guided Missile", *Royal Air Force Flying Review*, May 1998, pp. 26-27.
10. G.W.H Gardner, "Automatic Flight: The British Story", *Journal of the Royal Aeronautical Society*, vol. 62, July 1958, p. 478.

The British, however, did have a successful inter-War missile development programme – the target missile.[11] The Royal Air Force (RAF) began this programme by converting three Fairley IIIF float biplanes. The initial two launches crashed and the third, launched on September 14, 1932, flew for just nine minutes.[12] In January 1933, the converted aircraft *Fairley Queen* survived two hours of the Royal Navy's anti-aircraft bombardment. In February, the Air Ministry contracted for a cheaper target missile, a version of the Tiger Moth trainer, called the Queen Bee. It first flew under radio control in 1934. In all, the Fairley Corporation built 420 such devices between 1934 and 1943.[13]

Parallel attempts were made in other European countries. In September 1914, an American attaché reported about an Italian aerial torpedo, while a successful French pilotless aircraft test of 36 miles was reported in 1917.[14] Also, the French did get a pilotless aircraft airborne for 51 minutes on September14,1918.[15] However, the fate and process of development of all these early experiments could not reach the intended destination except with the Americans who continued their efforts.

Early American Efforts

Sperry's "flying bomb" project got official attention and funds in the post-War period. Secretary of the Navy Josephus Daniels, formed a five-member committee to investigate the idea and approved $2000,000 for the flying bomb in May 1917.[16] Initially, successful manned experiments began in June at Amityville, Long Island, but failure dominated the new phase with the unmanned vehicle. The major problem was how to get the machine off the ground. Since the experiments were using catapult launching, the

11. For details, see Chris Gibson and Tony Buttler, *British Secret Projects: Hypersonics, Ramjets and Missiles* (Midland Publishing Limited, 2007).
12. Warrell, n.4,p. 20.
13. Thomas P. Hughes, *Elmer Sperry* (Baltimore, Md.: John Hopkins, 1971), p. 265.
14. Warrell, n.4, p. 8.
15. Ibid.
16. "Hewitt-Sperry Automatic Airplane", http://en.wikipedia.org/wiki/Hewitt-Sperry_Automatic_Airplane

take-offs upset the azimuth control.[17] Therefore, there was considerable doubt about both the catapult system and the device's flying ability. Also, the manned tests brought to fore the problem of mismatch of the control system and missile. The control system for the N-9 proved to be inadequate for the more responsive flying bomb. To enhance the longitudinal stability, the designers lengthened the fuselage by two feet and made other suitable modifications.[18]

The first successful flight took place on March 6, 1918, when the flying bomb flew 1,000 yards as planned. Beside the catapult launch, Sperry wanted a better launching device. He then tried a test-bed of an auto-missile combination consisting of a Marmon car fitted with an OX-5 aircraft engine and an overhead frame for the "flying bomb".[19] The experiments were tried on a straight section of the Long Island Railroad, but the flanged wheels could not keep the Marmon on the tracks.[20] While the Norden catapult proved satisfactory, the "flying bomb" did not. Successive failures discouraged neither the designers nor the defence establishments owing to the perception that "the device still had a promising future."[21] The first attempted unmanned flying bomb by the US Navy, launched on August 18, 1920, was also a failure. The third flying bomb, launched on April 25, 1921, flew less than two minutes. The missile's lack of progress, coupled with declining funds, led the US Navy to cancel the programme in 1922. Meanwhile, the US Army had developed a somewhat more successful "flying bomb".

Elmer Sperry, though he was unsuccessful before the war, could convince the army subsequently by a flying demonstration in late 1917. Maj Gen George O. Squier, who watched the demonstration, recommended the flying bomb project to the Chairman of the Aircraft Board. A four-member

17. Lee Pearson, "Developing the Flying Bomb," www.history.navy.mil/download/ww1-10.pdf
18. Charles Keller, "The First Guided Missile Program", *Journal of American Aviation Historical Society* Winter 1975, p.271.
19. Warrell, n.4.
20. Keller, n.18, p. 271.
21. Warrell, n.4, p. 12.

board explored the possibility of developing such weapons and only one member, Charles F. Kettering, inventor of the automobile self-starter and later Vice President of General Motors, gave a positive report. Money was sanctioned to develop the device[22] and a team was formed consisting of Kettering's company Dayton Metal Products, Elmer Sperry, S.E. Votey of Aeolian Player Piano, Orville Wright and C.H. Willis. The flying bomb that emerged from this experiment was a biplane smaller than the Navy-Sperry device. Similar to the Sperry flying bomb, an air log impeller actuated a standard National Cash Register counter which "measured" the distance and, after a designated number of turns, cut the ignition and folded the wings. There were no ailerons. Wright suggested a 10 degree positive dihedral for stability, which gave the aircraft its characteristic look. The device came to be called the Kettering "Bug", perhaps due to its appearance, although its official name was the "Liberty Eagle".[23]

However, Kenneth P. Warrell identifies the following lessons learnt from all these initiatives during the pre- and post-World War I:

- Designers experienced difficulties just getting unmanned aircraft into the air. Launch problems caused a number of crashes, complicating the development of the "flying bombs".
- Building a stable aircraft that could fly without pilots was not easy. Limited knowledge on aerodynamics, lack of testing, and haste in building the machines guaranteed problems. Little wonder, the flying bombs had basic aerodynamic faults.
- Many other technical problems hindered the progress, particularly as neither guidance systems nor engines performed as designed.
- Destruction of the flying bombs on most of the tests restricted the programmes. This fragility was due to the fact that these machines were designed to be cheap and fly short one-way missions. The army was unable to recover many for subsequent testing, thereby rapidly exhausting the

22. Guy L. Gearhart, "Resume of Aerial Torpedo Development," April 10, 1926, cited in Warrell, n.4, pp. 13-14.
23. Bryan Dorn, "Cruise Missiles: The 'Poor Man's Air Force", *New Zealand International Review*, vol. 30, 2005.

number of available vehicles. Also the wrecks yielded little positive data on why the crashes occurred.

- Despite all the fanfare, expense and effort, the experimenters achieved minimal success. Only one of the 12 Sperry-Navy tests succeeded. Taken together, there were only 8 successes on 36 attempts. The flying bomb idea could not be realised despite best efforts; the theory remained more advanced than the technology of the day.[24]

Despite these hurdles, US interest in the "flying bomb" continued in the post-War period. The US Army contracted Sperry Gyroscope Company in February 1920 to design and manufacture four gyro units, and then in April 1920 to perfect the automatic control.[25] But subsequent difficulties with the automatic controls encouraged Sperry to use radio-control guidance. Also, the US Navy's interest in radio-controlled vehicles reemerged in the mid-1930s. The US Navy began flight tests in February 1937 and by the end of the year, had achieved good results. It first used the device as a target in exercises with the carrier *Ranger* in August 1938. Lieutenant Commander Delmar Fahrney suggested combat uses for drones (termed "assault drones") as early as August 1936.

Despite all the technical advances, the drone programme advanced relatively slowly. But the attack on Pearl Harbour gave impetus to the programme. In the mid-1930s, interest in Kettering-General Motors A-1 appeared. It was monoplane powered by a 200 hp engine designed to carry a 500-pound bomb load to 400 miles range at 200 mph.[26] But during all its tests up to 1942, directional control did not function properly. In October 1942, the new idea of air launching emerged. The A-1, with air launch technique, coupled with a TV sensor, was expected to become a useful military weapon. In 1943, the US Army tested models of the missile mounted on the bomber in a wind tunnel at Wright Field but the tests failed.[27]

24. Warrell, n.4, pp.16-17.
25. Gearhart, n.22, pp. 1-3.
26. Warrell,n.4, pp.23-25.
27. R.L. Mayrath, Memorandum Report, "Controllable Bomb, Power Driven", November 13, 1942, cited in Warrell, n.4, p. 29.

During the same time, another American guided missile project was initiated, mainly as defence to prevent another Pearl Harbour. It was viewed that the quickest way to get aerial torpedoes into action was to use radio-control target drones. In March 1942, the US Army initiated projects involving two types of aerial torpedoes, one with a 2,000-pound bomb load; the other with a 4,000-pound bomb load. Fleetwings was contracted on July 10, 1942, to build two aircraft of the first type (XBQ-1 and XBQ-2A), whereas Fairchild was contracted on October 1, 1942, to construct two of the larger craft, designated XQB-3.[28] The US Army Air Force (AAF) also requested for US Navy aerial torpedoes for testing – the Interstate TDR-1, TDR-1, XTD2R-1 and XTD3R-1 which the army redesignated respectively, XBQ-4, XBQ-5 and XBQ-6.[29] The entire XBQ series consisted of twin-engine devices that looked like aircraft. During World War II, the only AAF "flying bomb" used in combat had the code-name APHRODITE. Its first mission, on August 4, 1944, failed. One modified B-17 crashed with the pilot aboard. The Germans shot down a second machine, a third overshot its target by 500 feet, and a fourth impacted 1,500 feet short of its target. Two further attempts on August 6 also failed, one missile crashing in England, and the other into the North Sea.[30] Concurrently, the US Navy engaged in a similar project, using B-24s, a different radio-control system, and a television sensor. During the first trial, on August 12, the weapon blew up, killing Navy Lieutenants Wilford J. Willy and Joseph P. Kennedy, Jr. A second attempt that day demolished some German facilities at Heligoland.[31] Subsequently, there were no further naval efforts.

In retrospect, the American "flying bomb" experiments, before and during World War II, were failures. Technical problems proved very complicated and the results presented only marginal improvement over the World War I experiments. Thereafter, American flying bomb development shifted

28. "Summary of Power Driven Weapons Developed by Special Weapons Branch Equipment Laboratory", November 20, 1943, pp. 4-5.
29. Ibid.
30. Paul A. Whelan, "History of the Third Air Division in World War II: 1943-45", Ph.D. dissertation, St. Louis University, 1968, pp. 249-462, cited in Warrell, n.4, p. 32.
31. Third Air Division, "Final APHRODITE Project Report", (AFSHRC-527.431-1), cited in Warrell, n.4, p. 34.

from pre-set guidance to radio-control from an accompanying aircraft. But the Germans came up with a breakthrough to make the flying bomb a marginal, if not truly practical, weapon.[32]

The American "flying bomb" experiments, before and during World War II, were failures. Technical problems proved very complicated and the results presented only marginal improvement over the World War I experiments.

PHASE II: WORLD WAR II AND AFTER

Though the Germans started working on guided missiles in the form of glide-bombs as early as October 1915[33], their first considered "flying bombs" trials were done only in the 1930s. While the two German companies, Askania and Siemens, did some work in the field, an independent inventor, Paul Schmidt, achieved success. He began work in 1928 on a pulsejet. In 1934, along with G. Madelung, Schmidt proposed a flying bomb powered by a pulsejet. While the German Air Force wanted such a device, it abandoned the project because of range, accuracy and cost problems. Nevertheless, the Argus Company began work on the pulsejet in 1938 and in 1940, the Air Ministry brought Schmidt to Argus.[34]

German Efforts: V-1 or the Vengeance Weapon

As the name of the weapon (vengeance) indicates, there were many factors that encouraged the Germans to develop what would become the V-1.[35] They were: [36]

- The bombing of Germany infuriated Hitler; to take revenge, he demanded a terror weapon for retaliation against Britain.
- The capture of France in 1940 reduced the distance to England, thereby

32. Warrell, n.4, p. 35.
33. Michael Armitage, *Unmanned Aircraft* (New Delhi: Brasseys, Ritana Books,1995), p. 1.
34. Basil Collier, *The Battle of the V-Weapons, 1944-45*, (London: Hodder and Stoughton, 1964), p. 18.
35. While most authors assert that "V" stands for *vergeltungswaffe* (vengeance weapon), some claim it initially stood for *versuchmuster* (experimental).
36. Warrell, n.4, pp. 41-42.

One source indicates that they wanted to launch 5,000 V-1s per day against England. According to another figure, the planned rate was 6,000 to 9,000 per month.

ending the need for some form of radio-control which experts thought to be necessary over the much longer distance between Germany and Britain.

- The war depleted and dispersed the Luftwaffe's (German Air Force) ranks by 1942, making the pilotless bombers more attractive.
- Inter-Service rivalry came in – the German Air Force wanted a weapon to match the army's V-2. Therefore, in June 1942, Erhard Milch, GAF production chief, gave the highest priority to a proposal by three German companies to produce a pilotless bomber constructed from cheap materials: Argus the engine, Fiesler the airframe, and Askania the guidance system.

The V-1 was small missile powered by a pulsejet.[37] It flew in December 1942, first in a glide test. The engine operated a Venetian blind-type device which opened to admit air and then closed to fire at 50 cycles per second. This propulsion system gave the V-1 its characteristic buzzing sound, therefore, it was called the "buzz bomb". The weapon's average range was about 150 miles. By this time, the Germans had decided to build both the V-1 and the V-2, but problems associated with mass production were believed to have adversely affected the missile's speed, accuracy, and operational altitude.[38] The Germans used a gyro autopilot, powered by compressed air, to follow a course determined by a magnetic compass and a barometric device to regulate altitude. The downward attitude of the V-1 usually cut the fuel flow to the engine, causing it to stop and explode.[39] The Germans are known to have planned

37. "Rocket and Missile System", *Enclopaedia Britannica*, http://www.britannica.com/EBchecked/topic/1357360/rocket-and-missile-system/57343/The-V-1

38 Warrell, n.4, p. 43.

39. *Air Intelligence Report No. 2258*, cited in Warrel, n.4, p. 43.

for a V-1 production rate of up to 8,000 per month by September 1944, with operations starting from 64 sites on December 15, 1943. One source indicates that they wanted to launch 5,000 V-1s per day against England. According to another figure, the planned rate was 6,000 to 9,000 per month.[40] But numerous technical problems delayed the start of the V-weapon campaign by at least three months.

By June 18, 1944, the Germans had launched their 500th V-1; by June 21, their 1,000th; by June 29, their 2,000th; and by July 22, their 5,000th.

Following the cross-Channel invasion of June 6, 1944, mainly to relieve his troops, Hitler expedited the V-1 campaign. By June 18, 1944, the Germans had launched their 500th V-1; by June 21, their 1,000th by June 29, their 2,000th; and by July 22, their 5,000th.[41] But about 20 percent of the V-1 proved defective, exploding half way, crashing shortly after take-off, or deviating well off course. Out of all the tests between August 18 and November 26, 1944, only 31.4 percent of 258 V-1s impacted within either 30 km of the aiming point at 225 km range or 15 km at 100 km range. The Germans attributed at least 35 percent of the failures to premature crashes.[42]

During the course of the summer campaign, the Germans introduced the new air launch method. The first air launch known to the British occurred on April 6, 1944, at Peenemunde with the first recognisable air launch against England on July 9, 1944.[43] The final act in the V-weapon campaign against Britain came in March 1945 when the Germans introduced a long-range version of the V-1. Fitted with a wooden wing (which weighed 395 pounds compared with 445 to 480 pounds of the metal wing) and a reduced warhead, it could fly 220 miles as compared to the standard range of about 150 to 160

40. United States Strategic Bombing Survey, *V-Weapons (Crossbow) Campaign*, January 1947, p. 214.
41. David Irving, *The Mere's Nest* (London: Kimber, 1964), p. 236.
42. Warrell,n.4, p. 50.
43. Roderic Hill, "Air Operations by Air Defence of Great Britain and Fighter Command in Connection with the German Flying Bomb and Rocket Offensives, 1944-45," *London Gazette*, October 19, 1948, p. 5599, cited in Warrell, n.4, p. 58.

miles.[44] One estimate shows that the Germans built 30,000 V-1s—half the 60,000 planned.[45]

The German V-1 had many *advantages*.[46] First, it was a cheap weapon that did not use critical materials; therefore, the missile was employed in mass. Second, the missile could be launched regardless of weather conditions. Third, because of its relatively high speed and low altitude approach, it was difficult to spot and attack. Fourth, it was durable as a target since it had few vulnerable parts and no aircrew could be killed or injured unlike in the manned bomber. However, the weapon had a number of *limitations*.[47]

- While the remarkable and cheap pulsejet engine did the job, the ground-launched version required a booster and a long ramp which, in turn, meant a fixed and vulnerable launch site.
- The much larger and more complex V-2 had mobility but the smaller and simpler V-1 did not.
- Fixed launch sites, along with fixed targets indicate that the missile's flight path was predictable. This, in turn, meant that defenders could mass their forces in a relatively concentrated and narrow zone.
- As the missile flew a constant course, altitude, and speed, it was easy to engage it once located.
- Its poor accuracy limited it to use against the largest of targets (cities)
- The V-1's small warhead restricted its impact.

Also, owing to the success of the Allied forces' defence against the "flying bomb", many observers as well as the public downgraded the device. But it proved to be a remarkable achievement that was somewhat cost-effective. But, on balance, "at that stage it proved doubtful as weapon of war."[48] Most

44. Air Intelligence Report No. 2321, March 8, 1945, cited in Warrell, n.4, p. 60.
45. USSBS, Aircraft Factory Division Industry Report, 115 (AFSHRC-137. 302-3), cited in Warrell, n.4, p. 61.
46. Warrell, n.4, p. 62.
47. Ibid.
48. Ibid., p. 62.

importantly, German efforts were the primary catalyst in rejuvenating the dormant US missile programme.

The US version of the V-1 differed only slightly from the German version, except in launch and guidance procedures.

American Efforts: JB-2 (the Terror Weapon)

Towards the end of the War, the US recovered 2,500 pounds of V-1 parts from Great Britain. The American Air Force (AAF) was ordered to design 13 copies of the "flying bomb" and within three weeks, the AAF had completed its first JB-2.[49] But there were some inherent drawbacks in the system. Mainly, there were problems with the logistics and with the accuracy of the system. In comparison, the US version of the V-1 differed only slightly from the German version, except in launch and guidance procedures. The JB-2 cost about $8,620 and the weapon required about 1,047 man-hours to produce which was close to the man-hours needed to produce the V-1.[50] The difficulty with the German catapult propellant and production encouraged the US to use something new to get the missile airborne and attain the minimum speed required for pulsejet operation. The AAF considered a number of alternative launch technologies such as flywheel, cart powered by an aircraft engine, and powder. They adopted the ground launch technique, but a shortage of powder led to consideration and testing of an air launch. But the first flight on October12 failed.[51]

As the major concern of the AAF was for accuracy, it strived for an improved guidance system. Tests with the German method of "pre-set controls" achieved results similar to the Germans; the Americans experienced an average error of over eight miles at a range of 127 miles. Therefore, the airmen installed radio-control guidance in the missile.[52] The AAF equipped the JB-2 with a

49. Richard Hallion, "The American Buzz Bombs," *Aeroplane Monthly*, November 1976..
50. Berend D. Bruins, "US Naval Bombardment Missiles, 1940-58", PhD Dissertation, Columbia University, 1981, p. 105..
51. Warrell, n.4, p. 65..
52. David Griggs, "The Role of the Controlled Buzz Bombs in the German War" (AFSHRC-519.311-1), cited in Warrell, n.4, p.65.

radar beacon that assisted tracking by a ground radar unit and remote control equipment. But the tests revealed an average error of about 6 miles on 14 tests and almost twice that at 127 miles on 20 tests.[53]

The US Navy was also involved in such experiments. By April 1945, the navy had named their version of the V-1 "Loon" and extended their study of launch platforms to include landing craft (LSTs), PB4Y-1s and off the beach. The navy launched its first Loon on January 7, 1946. After a number of trials, the navy achieved success but in March 1950, it terminated the Loon programme to make way for the more advanced and promising Regulus.[54]

In the post-War I period, essentially as follow-ons to the German V-1, the US had 19 different guided missile projects, both powered and unpowered, in progress though "of doubtful value."[55] In August 1945, the AAF asked for a 600-mph, 5,000-mile-range missile with a 2,000-pound warhead. Northrop presented a proposal in January 1946 for a subsonic, turbojet-powered, 3,000-mile range missile. Jack Northrop, the company President, nicknamed the former (MX-775A) Snark, and the latter (MX-775B) Boojum, both names from the pages of Lewis Carroll.[56] Snark was larger and heavier than previous "flying bombs" and possessed much greater performance. It flew in a nose-high flying altitude because it lacked a horizontal tail surface as did so many of Northrop's machines. Instead of conventional control surfaces (ailerons, elevation), the Snark used elevons and had a disproportionally small vertical tail. Northrop, therefore, produced a new design – the N-69, which was initially called "Super Snark".[57] The company made some modifications by lengthening the fuselage, sharpening the nose shape, replacing the external scoop with a flush scoop, and increasing the launch weight.[58] It added a larger wing but slightly shortened the wing span. It broadened the wing by extending

53. Summery Handbook (AFSHRC-145.96-195), cited in Warrell, n.4, p. 67.
54. Warrell, n.4, p. 68.
55. Tara Kartha, "The Rationale of Cruise Missiles – I", *Strategic Analysis*, August 1998, p. 805.
56. Max Rosenberg, "The Air Force and the National Guided Missiles Program, 1944-50," June 1964, [AFSHRC-202-46 II], p. 78.
57. "SM-62 Snark (United States), Obsolete Systems - Offensive/Defensive Weapon Systems," http://www.janes.com/articles/Janes-Strategic-Weapon-Systems/SM-62-Snark-United-States.html
58. Warrell, n.4, p. 86.

it further behind, thus, increasing the wing area from 280 to 326 square feet. In addition, because wind tunnel and N-25 tests showed some instability in pitch, Northrop redesigned the wing with a leading edge extension, thereby giving the Snark wing its "saw tooth" shape.[59]

Consequently, numerous problems beset the Northrop missile during testing. The Snark proved unstable in all except the straight and level flights. The programme suffered numerous test failures. By May 1955, wind tunnel and flight tests indicated that Northrop's operational concept, the terminal dive of the missile into the target, would not work because of inadequate elevon control. Five flight tests of the N-69C, a non-recoverable radio-controlled missile with fuselage speed brakes, confirmed these findings. Eventually, the Snark programme did not appreciably improve and the central problems of guidance and reliability remained. In 1961, John F. Kennedy scrapped the project. Generally, the reasons for the demise of the Snark were linked with its air breathing companion, the Navaho.

Concurrent with the Snark was the emergence of the Navaho cruise missile[60]. Compared to the Snark, it was much more ambitious. The Navaho programme called first for the design, construction, and test of a turbojet test vehicle, followed by a 3,600-mile-range interim missile, and culminating in a 5,500-mile-range operational weapon.[61] However, the experiments of the missile faced many problems. Most serious problems, however, centred on the ramjets and auxiliary power unit— the latter did not operate successfully until February 1956.[62] The first XSM-64 launch attempted in November 1956 ended in failure after a mere 26 seconds of flight. With the lack of positive results, cost pressures, schedules slippages, and increasing competition from ballistic missiles, the US Air Force (USAF) cancelled the programme in early July 1957.[63]

59. Ibid.
60. "North American SSM-A-2,4,6/B-64/SM-64 Navaho," Directory of U.S. Military Rockets and Missiles, Andreas Parsch, http://www.designation-systems.net/dusrm/app1/sm-64.html
61. SAC History, July-December 1951, pp.24-26, cited in Warrell, n.4, p.97.
62. Robert L. Perry, "System Development Strategies: A Comparative Study of Doctrine, Technology and Organisation in the USAF Ballistic and Cruise Missile Programs, 1950-1960", Rand RM-4853 PR, 1966, pp. 43-45.
63. James N. Gibson, *The Navaho Missile Project* (Schiffer Publishing Ltd, 1996).

The coincidence in timing of the development of cruise and ballistic missiles and the competition between the two types comprised an important factor in the demise of the Snark and Nevaho.

However, the Navaho project was a leap forward in the state-of-the-art of US missile technology. It showed the path for new technology that ultimately transformed it into a complex missile. For example, aerodynamic heating (300 degree at Mach 2 and 660 degree at Mach 3) required new materials. The USA used titanium alloys as well as precious and rare metals at contact points on much of the electrical gear. Other complicated areas included the canard configuration, ramjets, guidance, and the massive rocket booster.[64] Most importantly, experiments on the Navaho and later on the tactical Matador, led to important technological breakthroughs like the ATRAN (Automatic Terrain Recognition and Navigation), "a forerunner of the TERCOM that was to give the cruise its true "strategic" capability".[65]

But, according to Warrell, the Snark and Navaho, in spite of all adaptations, failed to come up anywhere near the expectations. For Warrell, the important reasons included : (1) the technology of the day could not meet the ambitious requirements of accurately and reliably flying 5,000 miles over many hours without the intervention of a pilot or navigator, therefore, many of the missiles crashed or did not perform satisfactorily; (2) the manufacturers failed to master the situation, and overly optimistic estimates and loose management led to cost overruns and delays; (3) the coincidence in timing of the development of cruise and ballistic missiles and the competition between the two types comprised an important factor in the demise of the Snark and Nevaho.[66]

The Interregnum

In a broader sense, the first generation cruise missiles developed during the first three decades of the 20th century such as the German V-1, employed

64. James F. Scheer, "Project Fantastic", *Skyline*, August 1956, pp. 77-78.
65. Kartha, n.55, p. 805.
66. Warrell, n.4, p. 101.

during World War II, were largely unsuccessful. The second generation cruise missiles like the Snark, Navaho, Matador and Regulus seemed to hold considerable promise as interim weapon systems. But the fact was that, for all these second generation cruise missiles, the operational requirements were beyond the technological capability of that age. This led to very serious programme delays and these weapons, instead of preceding the intercontinental ballistic missiles (ICBMs) into service in the strategic role as intended, became contemporaneous with them. On the other hand, ballistic missiles were proving to be more accurate and more reliable weapons, and, above all, they were impregnable to enemy defences. Nor were the cruise missiles able to compete with the advantages of the manned bomber.

Moreover, there were some critical operational objections. First, bombs and bombers were proven weapons that could hit distant targets with very reasonable accuracy; cruise missiles, on the other hand, were proving to be often wildly inaccurate. It was realised that cruise missiles were more vulnerable than the bomber to enemy defences because they flew a steady and predictable flight path without carrying any defences. Also, cruise missiles lacked the flexibility of the manned bombers. They could not disperse for survival; they could not adopt an ostentatious alert posture in a crisis; they could fly only one, terminal, sortie. It was true that cruise missiles put no crews at risk, and that they were far less costly than bombers, but these advantages were not enough to prevent the demise of the cruise missile in favour of the manned bomber and the ICBM in the late 1950s.

This coincidence of the emergence of ballistic missile development brought home the impression that it could do the same job as the cruise missile in a better way. By October 1953, the US Air Force learned that a megaton-class warhead weighing 1,500 to 3,000 pounds would become available shortly, making the ICBM much more feasible and encouraging its development.The only two advantages that cruise missile seemed to offer were: (a) they appeared to be cheaper; and (b) the crew was not put at risk. But the list of disadvantages overwhelmed these two advantages.[67] Those days, the two systems (cruise

67. Warrell, n.4, p. 103.

and ballistic missiles) appeared to have comparable capabilities, but a closer examination of these weapon systems reveals something else. In the 1950s, the ICBMs had an edge in accuracy due primarily to their much shorter flight time.[68] Second, the Snark and Navaho test record indicates that their reliability was also substantially less than that of the ICBMs. The ICBMs reached the targets much faster than the cruise missiles. Second, once launched, the ICBMs were invulnerable to counter-measures, while the cruise missile could be downed by fighters and increasingly, after 1960, by surface-to-air missiles. A third factor was political-psychological. While the ICBM was a new weapon, the cruise missile physically resembled the bomber. The fact that the Soviets had made so much of the Sputnik and other missiles aired the "missile gap"[69] between the two adversaries. This forced the US to come up with some sort of equally modern and impressive weapon.

PHASE III: THIRD GENERATION CRUISE MISSILES

Return of the Missile Age

For quite some time, ballistic missiles had occupied the attention of nations as comparatively advanced and efficient weapon systems. But, gradually, their relative value waned with the innovations in the nuclear arsenal, especially during the 1950s onwards. Ballistic missiles designed for strategic purposes needed high acceleration at launch. For this, a huge quantity of fuel is required in order to boost them into their required trajectory and to give them the velocity that will carry them over the long ranges. In the case of a single-stage ICBM, this large quantity of fuel can take up as much as 93 percent of the whole system, leaving only 7 percent for the motor, the guidance system and the structure of the missile itself.[70] In the late 1940s and early 1950s, the early crude atomic warheads weighed as much as 5,000 kg. Any intercontinental

68. Armitage, n.33, p. 51.

69. "Missile Gap" refers to the perceived Soviet superiority in ICBMs due to exaggerated estimates by the Gaither Committee in 1957 and USAF in the early 1960's. See "Who Ever Believed in the 'Missile Gap?': John F. Kennedy and the Politics of National Security," *Presidential Studies Quarterly*, December 1, 2003.

70. Armitage, n.33, p. 50.

missile to carry them was bound to be not only an enormous and unwieldy vehicle, but its development, particularly in terms of required accuracy, was beyond the available technology of the time. Hence, the renewed emphasis on cruise missiles and the constant efforts to overcome the most serious drawback in the system – the inaccuracy of delivery – are clearly perceptible.

Perception of relative value of these two weapons systems changed sharply in October 1953 owing to developments in the nuclear arsenal design. By that time, it was believed that smaller and lighter nuclear warheads could be produced.

Even by 1958, inertial guidance systems were still demonstrating errors of .03 degrees per hour, or almost two miles for a cruise missile flying for one hour at 600 knots. Most of the missiles were, of course, required to fly a great deal further than this. Nevertheless, cruise missiles comprised the only practicable alternative to the manned bomber. As a result, ICBMs were accorded a much lower priority than cruise missiles. For example, in the USA, the Atlas ICBM programme attracted only $26.2 million, while the Snark and Navaho claimed a total funding of $450 million of defence finance.[71]

Interestingly, this perception of relative value of these two weapons systems changed sharply in October 1953 owing to developments in the nuclear arsenal design. By that time, it was believed that smaller and lighter nuclear warheads could be produced. This development brought the nuclear tipped ballistic missiles with strategic ranges into the limelight. For example, systems like the Atlas, Thor and Titan were accelerated. In the USA, the Thor was launched in January 1957, the Titan followed in February 1959 and the Atlas went on to reach full operational status in October 1959, five months ahead of the Snark.[72] In this way, ballistic missiles overtook cruise missile, at least in the striking role. Other comparative advantages attached to ballistic missile which indeed widened the gap between the two competing families of systems are:

71. Ibid.
72. Ibid., pp. 50-51.

- An ICBM could reach its target in minutes as compared to the several hours needed by cruise missiles and the shorter flight time contributed to the greater accuracy of the ICBM.
- The steady flight path of all cruise missiles made them highly vulnerable to the adversary's defences, whereas there was no defence at all against ICBMs.
- There may also have been an element of prestige in the equation. The Soviets were developing ballistic missiles, and in October 1957, they had caused profound dismay in the Western world by launching the Sputnik I satellite by these means.

The US decision-makers learned of the energetic Soviet efforts in the ICBM field and, thus, in July 1954, the US Air Force assigned highest priority to ballistic missiles. Due to the launch of the Sputnik in October 1957 and fears of a "missile gap", the American ICBM programme got top level support; as a result, the Americans launched their first medium-range ballistic missile (Thor) in January 1957, the first Atlas in June 1957, and the first Titan in February 1959.[73] Thereby, the dormant ballistic missile development process got some attention.

However, other cruise missile like the Martin Matador, Crossbow, Hound Dog and decoy missiles like the Buck Duck, Bull Goose and Quail were successful to some extent. Owing to financial pressure and technical problems, these programmes were postponed at certain stages. Therefore, America's experience with cruise missiles in the 1950s and 1960s was largely unsuccessful.[74] But nuclear strike was not seen as the only role for cruise missiles.The concern about the growing effectiveness of Soviet air defences that had led to unease about the vulnerability in flight of cruise missiles was also leading to a search for means of improving the survivability of manned bombers. This led to the development of cruise missiles in two other important roles: (1) as decoys; and (2) as airborne stand-off weapons.

73. For details on the US missile programme, see Curtis Peebles, *High Frontier: The US Air Force and the Military Space Program* (Air Force History and Museums Programe 1997).
74. Warrell, n.4, p. 128.

Cruise Missiles as Decoys. To avoid the adversary's defences, employment of decoys became the fashion. Since radar is the principal means by which aircraft are detected, identified, and engaged by opposing defences, it is on the basis of radar characteristics that most of the emphasis is placed in the design of decoy aircraft. During the mid-1950s, the US Air Force developed three systems for this role. The first was the Consolidated-Vultee Buck Duck, which underwent trials during the early months of 1955. A second decoy aircraft was the Bull Goose, a ground-launched device started in 1952, designed to be carried by attacking bombers. But trials showed that the Bull Goose could not convincingly simulate the B-52 on the radar, and in 1957, this project was cancelled.[75] Another successful programme was the Quail decoy developed from an operational requirement of January 1956 for an aircraft to simulate US Air Force bomber aircraft.[76]

Stand-off Cruise Missiles. Stand-off strike was chosen as the other role for unmanned aircraft and two significant developments in this field had taken place in the US Air Force: (1) the GAM-67 Crossbow; and (2) the AGM-28 Hound Dog. The Crossbow was an air-to-ground cruise missile designed to home on to enemy air defence radars. Designed by the Radiophone Company to meet an operational requirement of the early 1950s, the Crossbow was a high-wing twin-fin weapon carrying a 1,000 lb warhead.[77] But subsequent tests found that it had a slower airspeed than required and its range turned out to be less than that of Soviet radars. The Hound Dog was a response to the US Air Force requirement in 1956 for an air-to-surface missile with which to arm the B-52 bomber.[78] This was a "reasonably successful venture." Although its inertial navigation guidance system produced errors of about one mile over the maximum range, this was not critical with the size of the nuclear warhead fitted. But the less satisfactory features were: (1) the general

75. Armitage, n.33, p. 51.
76. "MCDONNELL ADM-20 Quail," National Museum of the US Air Force, http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=384
77. "GAM-67 CROSSBOW", National Museum of the US Air Force, http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=9502
78. "AGM-28 Hound Dog Missile History/Data", *AMMS Alumni*, http://www.ammsalumni.org/html/agm-28_history_data.html

unreliability of the missile; and (2) the undesirable addition to the drag of the parent bomber that the Hound Dog generated, thus, reducing the top speed of the B-52 aircraft. This consideration led to the Hound Dog being phased out in 1976, and it was replaced by the SRAM (Short Range Attack Missile), of which by 1974 over 11,000 were fitted to the fleet of B-52 bombers.[79]

The Cold War competition had its impact on the evolution of cruise missile technology evolution as well. By this time, further concerns about the likely Soviet developments in its air defence had highlighted the compelling need for a Quail replacement. The US Air Force was aware of the Soviet use of the Airborne Warning and Control System (AWACS) and look-down/shoot-down interceptors. Therefore, studies were undertaken to propose the successors to the Quail. The first one was the SCUD (Subsonic Cruise Unarmed Decoy), an advanced decoy cruise missile with a range of 2,000 km and a speed of .85 Mach,[80] and the second system suggested was SCAM (Subsonic Cruise Attack Missile), an armed version of the same vehicle. At the same time, the USAF Air Systems Command put forward a proposal for yet another cruise missile, the SCAD (Subsonic Cruise Armed Decoy) which could equip the B-52 in the decoy role.[81]

The reluctance of the USAF to reconsider the strike cruise missile was revisited when in October 1967, the Soviet SS-N-2 Styx anti-ship cruise missile sank the Israeli destroyer *Eilat*.[82] This incident led to renewed and widespread interest in the cruise missile as a weapon. The American Navy put out a study contract with McDonnell-Douglas to explore the possibility of these missiles for its own purpose. This led to the start of the AGM-84 Harpoon programme which had as its objective an anti-ship sea-skimming missile able to carry a 250 lb conventional warhead over a range of 40 nautical miles.[83] The first long-term importance of the Harpoon was that it eventually led to more advanced weapon systems, particularly in the case of the submarine-launched version of the Harpoon that was added to

79. Armitage, n.33, pp. 53-54.

80. Richard K. Betts, *Cruise Missiles: Technology, Strategy, Politics* (Washington DC: The Brookings Institution 1981).

81. Ibid.

82. "SS-N-2 STYX," http://www.globalsecurity.org/military/world/russia/ss-n-2.htm

83. "AGM-84 Harpoon SLAM (Stand-Off Land Attack Missile)", http://www.fas.org/man/dod-101/sys/smart/agm-84.htm

the programme in 1971. Second, another proposal envisaged a cruise missile system launched from a new class of nuclear powered submarine, known as Submarine Tactical Anti-ship Weapons Systems (STAWS). Third, a proposal was made to fit cruise missiles into ten converted Polaris ICBM submarines.[84]

Because cruise missiles can strike targets at long ranges, it was recognised that they could supplement or replace manned aircraft for many strategic missions.

PHASE – IV: THE WAY FORWARD

Cruise Beyond 1970s

The performance of the cruise missile was of interest to other countries than just the United States. Since the late 1970s, the US cruise missile programme attracted the attention of defence officials around the globe. Because cruise missiles can strike targets at long ranges, it was recognised that they could supplement or replace manned aircraft for many strategic missions. Until the late 1980s, other than the US, much of the technology needed to produce accurate land attack cruise missiles was available only to France and the Soviet Union. The history of French effort is as old as the history of aviation itself. Even before World War I, a French artillery officer, Rene Lorin, had proposed the use of flying bombs to attack distant targets.[85] This aircraft, he suggested, could be stabilised in flight by a combination of gyroscopes and a barometer, guided along track by radio signals from an accompaying piloted aircraft and propelled by a pulsejet or a ramjet engine to hit the target.[86] This seems to have been one of the first attempts to design a weapon along the lines of the V-1; but there were other and similar inventions by Victor De Karavodine and Georges Marconnet of France, although none of these early inspirations actually resulted in an aircraft being produced in that country or anywhere else.[87]

84. Armitage, n.33, p.57.
85. Dennis Larm, "The Unmanned Aerial Vehicle's Identity Crisis," http://www.dtic.mil/cgibin/GetTRDoc? AD=ADA424221&Location=U2&doc=GetTRDoce.pdf, p. 13
86 Armitage, n.33, p.1.
87 Ibid.

The Gulf of Tonkin incident of August 4, 1964,[88] led to the American involvement in Vietnam. The US unit from Davis-Montham was alerted and dispatched to Kadena Air Force Base on Okinawa, from whence it was planned that the Ryan drones would fly surveillance and reconnaissance missions over China and Vietnam. In an attempt to give the missions a 'cover', the Nationalist Chinese logo was painted on the drones before they left Kadena, but concealed by a patch that was removed immediately before take-off.[89] Since several drones were lost over China, the American origin of the aircraft was very clear to the Chinese from the components recovered. This must have guided the Chinese to think about their own programme thereafter.

Yet another nation, Israel, has actively employed unmanned aircraft in war since 1973. Israeli efforts for cruise missiles probably started with three machines: the Tadiran Mastiff, the Israel Aircraft Industries Scout and the Mazlat Pioneer.[90] All three are miniature Remotely Piloted Vehicles (RPVs). Not much is known about the subsequent programme, but Israeli use of unmanned aircraft during the air operations over the Bekaa Valley in 1982[91] is well known. Also, since the 1950s, China is known to have developed and deployed a number of coastal defence, ship-launched, and air-launched anti-ship cruise missiles, based originally on the Soviet P-15 missiles (NATO designation of SS-N-2A Styx).[92]

Period of Revival

The revival of interest in cruise missiles started in the 1970s, and had its root in the "politico-strategic factors" of the age. Firstly, formal discussions had begun between the US and Soviet Union on Strategic Arms Limitations Talks (SALT-1) in November 1969. Secondly, the agreement was reached by

88. Edward J. Marolda and Senior Historian, "Tonkin Gulf Crisis, August 1964," http://www.history.navy.mil/faqs/faq120-1.htm

89. Armitage, n.33, p. 71.

90. See Ralph Sanders, "UAVs, An Israeli Military Innovation", *JFQ* / Winter 2002–03, pp. 114-18, available at: http://www.dtic.mil/doctrine/jel/jfq_pubs/2033.pdf

91. Matthew M. Hurley, "The BEKAA Valley Air Battle, June 1982: Lessons Mislearned?", *Aerospace Power Journal*, Winter 1989, http://www.pakdef.info/forum/showthread.php?t=8588

92. Shirley A. Kan, "China: Ballistic and Cruise Missiles", *CRS Report for Congress*, August 10, 2000, p. 18..

May 1972 on anti-ballistic missile systems. Thirdly, an interim agreement was also reached on strategic offensive weapons. The ceiling that the treaty placed on nuclear weapons meant that as the new American Poseidon-equipped submarines became operational, the older Polaris-armed boats would have to be withdrawn.[93] But the treaty did not mention cruise missiles, and the Soviets were not prepared to negotiate about such systems since they had a monopoly. Fourthly, there was growing evidence in the late 1960s and the early 1970s of a constantly increasing efficiency in Soviet air defences.[94] Owing to this, there was serious concern in the US about the vulnerability of the B-1 bomber aircraft. Fifthly, the cost of the new generation US long-range bomber, the B-1, was itself under heavy criticism. President Carter decided to discontinue the production of the B-1 in June 1977, saying that it was "a very expensive weapon system conceived in the absence of the cruise missile factor."[95] With the cancellation of the B-1, the ALCM's work was accelerated and the US Administration took the decision to deploy about 3,000 of these weapons on the 151 B-52G bomber aircraft.[96] By that time, new technologies were making possible an entirely new concept of air-breathing missiles that could be launched from outside the enemy's air defences to make their way with great accuracy to distant targets.

Innovations in the navigation, guidance and propulsion technology to strengthen the accuracy of the weapons available then had actually strengthened the concept of cruise missile and the determination to march ahead. The most important developments in the field of navigation and guidance were: (1) the Terrain Contour Matching (TERCOM)[97] for strategic

93. Armitage, n.33, p. 72..

94. During the mid-1960s the Soviet air defence system blossomed to approximately 9,000 SAM missiles and 3,500 interceptor aircraft. "History of The B-52 Stratofortress", http://www.geocities.com/goose_topgun2k/b52.html

95. Jeffrey G. Barlow, "Congress and the Manned Penetrating Bomber Debate", *Backgrounder #125*, http://www.heritage.org/research/nationalsecurity/bg125.cfm

96. Ibid.

97. For details, see Mark W. Cannon, Jr, *Terrain Contour Matching (TERCOM): Sensitivity to Heading and Ground-Speed Errors* (Ohio: Aerospace Medical Research Lab Wright-Patterson AFB, May 1978).

New technologies were making possible an entirely new concept of air-breathing missiles that could be launched from outside the enemy's air defences to make their way with great accuracy to distant targets.

systems; and (2) the Digital Scene Matching Area Correlator (DSMAC)[98] for technical employment and for terminal guidance. TERCOM (Terrain Comparison Navigation Technique) uses a form of map in which variations in the height of the terrain to be traversed is converted into a digital presentation across a matrix of cells. For example, in the version produced by E-Systems Company, there is a matrix of 64 cells, each of which covers an area of 400 square feet on the ground. Each square is allotted an average elevation which is stored in the computer memory of the missile. The cruise missile carries a radar-altimeter which compares the reading, taken from the terrain below, with the digital map, by means of the computer and determines what corrections are required, if any, to bring the two to match and, thus, to put the missile back on track.[99] Also, instead of constant readings, the missile can depend on modern inertial platforms and their high quality gyroscopes to carry it with very good accuracy from one distinctive geographical feature to the next. This feature is known as "way-points", at which periodic updating is carried out before the missile sets out on the next stretch of its path.[100]

To supplement the input of TERCOM data, another important targeting technique developed was the Digital Scene Matching Area Correlator (DSMAC). Analogue and digital versions of DSMAC were tested during 1979 in experiments comparing photographs taken in flight by the missile, with photographs of the target stored in an on-board computer. This system is claimed to direct the missile very close to the target, at least within tens of feet. During the same period, the density of computers was greatly increased by the use of solid-state and micro-circuit electronics. In another crucial step, the size of the inertial navigation system was drastically reduced. Such inertial

98. Marshall Brain, "How Cruise Missiles Work", http://www.howstuffworks.com/cruise-missile.htm/printable

99. Armitage, n.33, pp. 88-89.

100. Ibid.

navigation weighed around 300 lb, whereas by 1970, the size and the power needed for such a system had fallen to such an extent that it could weigh as little as 29 lb.[101] The total guidance package consisting of the inertial system, radar altimeter and computer, together weighed only 115 lb, and occupied as little as 1 1/3 cubic feet of storage space.

The other revolutionary technical development during the same period was the improvement in propulsion technology. Very small fuel-efficient jet engines had been developed in the US, and by 1962, the Williams Research Company had produced the WR-2, an engine that delivered 70 lb of thrust which was used to power small target drones such as the US MQM-74. By 1967, the WR-19 engine had demonstrated a thrust of 430 lb for a weight of only 68 lb and a fuel consumption of .7 lb per hr per lb of thrust.[102] Also, further improvements in the same area took place with the use of advanced fuels such as Shelldyne. Though it was much more expensive than the conventional fuel, Shelldyne H has 33 percent more energy per unit volume than JP-4 and could give improvements for the cruise missile in the range of about 10-20 percent.[103] Above all, by this time, nuclear warheads could also be miniaturised. Therefore, very small, highly accurate, reliable and long-range cruise missiles were viewed to be a feasible option for the strike missions. Using these all innovative technologies, the US started examining a variety of proposals for a new cruise missile. By the end of 1972, the choice had narrowed down to a Submarine Launched Cruise Missile (SLCM) called the Tomahawk.[104]

All these advancements in technology that had taken place over the intervening decades, transformed the cruise missile into a most reliable and affordable weapon system to be acquired by many other states in subsequent stages of global politics.

101.Ibid.

102.Ibid.

103.George N. Lewis; Theodore A. Postol, "Long-Range Nuclear Cruise Missiles and Stability", *Science & Global Security: The Technical Basis for Arms Control, Disarmament, and Nonproliferation Initiatives*, 1547-7800, vol 3, issue 1, 1992, pp. 49 – 99

104."BGM-109 Tomahawk", http://www.globalsecurity.org/military/systems/munitions/bgm-109.htm

REVIEW OF THE DEFENCE BUDGET

AMIYA KUMAR GHOSH

Under India's parliamentary system of governance, making of budgets is the exclusive responsibility of the Executive. However, the overall budget is to be approved by the Parliament each year as a Money Bill. The Parliament can approve or reject the budget or any of its demands but cannot modify them. The system, thus, differs significantly from the American one, where Congress has the authority to modify the budget. The parliamentary review of the budget undertaken in India should be seen in this context.

A brief description of the defence budgeting process may be in order.

The defence budgeting process in India starts along with the budgeting process of other Ministries and Departments of the Government of India, on the basis of the Budget Circular issued by the Budget Division of the Ministry of Finance (MoF) in the middle of September each year, containing instructions and guidance for the preparation of the Revised Estimates (RE) of the current year and Budget Estimates (BE) of the next year. The budgets are finalised by the end of December.

The Budget Circular is accompanied by various instructions issued in the past by the Department of Expenditure regarding economy measures, rationalisation of expenditure, and measures for augmentation of revenues,

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for being kept in view while preparing estimates. Particular attention is drawn to the instruction regarding the exchequer control system introduced from April 1, 2006, known as the Modified Cash Management System whose main aim is to obtain greater evenness in budget expenditure and reduce the rush of expenditure in the last quarter of the financial year. Under this, Monthly Expenditure Plans are to be worked out, and in the last quarter, not more than 33 percent of the budgetary provisions can be spent.

On receipt of the Budget Circular, the Budget Division of the Ministry of Defence (Finance), in turn, issues circular to the Service Headquarters (HQ), Defence Research and Development Organisation (DRDO) and Department of Defence Production for their budget projections for the RE for the current year and the BE for the next year, keeping in view various parameters, including trends of expenditure.

The defence budget in India, is mainly composed of the budgets of the three Services, which represent 92 percent of the total budget. Projections are made by the Services on the basis of (i) expenditure pattern of past years and current trend of expenditure; (ii) prevailing inflationary trends; (iii) committed liabilities; (iv) anticipated requirement of stores; (iv) Annual Acquisition Plan; (v) requirements on account of new units/formations/establishments; (vi) Annual Works Programmes, etc. The projections by the Services and Departments are consolidated and estimates are projected to the Ministry of Finance. This is the first stage in budget preparation.

These estimates are discussed in the MoF with the Financial Advisers of Ministries/Departments in October/November. After the pre-budget meetings are over, approved ceilings of expenditure, as finalised in these meetings, are communicated to the Ministries / Departments, on the basis of which Financial Advisers are to prepare the final Budget Estimates.

So, in effect, the budget takes its final shape after the Ministry of Finance imposes its "ceilings" keeping in view competing demands and overall constraint of resources.[1]

1. Report of the Standing Committee on Defence, on the Demands for Grants 2008-09, Lok Sabha Secretariat, Para 2.27, p.13, April 2008.

The ceiling indicated by the MoF is not the overall ceiling on the defence budget but is indicated demand-wise.

The entire defence expenditure is treated as non-Plan expenditure, which gives the Ministry of Defence more autonomy in the preparation of the budget than other Ministries/Departments, whose budgets are divided between Plan and non-Plan segments.

The Standing Committee has no role in the preparation of the budget of the Department concerned. Its role is confined to undertaking a review of the Demands for Grants for the Ministry/Department concerned.

The departmentally related Standing Committee system, was inaugurated by the Vice President and Chairman of the Rajya Sabha (Upper House) on March 31, 1993. The Committees were constituted soon thereafter. It was a historical landmark in the evolution of the Committee system in the Indian Parliament.

Each of the Standing Committees consists of not more than 45 members—30 to be nominated by the Speaker from among the members of the Lok Sabha and 15 to be nominated by the Chairman, Rajya Sabha, from among the members of the Rajya Sabha. The term of the members of these committees is not to exceed one year.

After the general discussion on the budget is over, the Lok Sabha (Lower House) adjourns for a fixed period and the Standing Committee consider the Demands for Grants during the recess. The demands are thereafter considered by the Lok Sabha in the light of the reports of the Committee.

As would be seen, the Standing Committee has no role in the preparation of the budget of the department concerned. Its role is confined to undertaking a review of the Demands for Grants for the Ministry/Department concerned. Its recommendations on the basis of review, if they pertain to certain allocations made are , however, given due weightage in the preparation of the next year's budget.

The budgetary requirements for the defence Services are included in the following six Demands for Grants presented to Parliament:

- Demand No.21, Defence Services – Army
- Demand No.22, Defence Services – Navy
- Demand No.23, Defence Services – Air Force
- Demand No. 24, Defence Services – Defence Ordnance Factories
- Demand No.25, Defence Services – Research and Development Organisation
- Demand No. 26, Capital Outlay on Defence Service

The first five Demands for Grants (Demands 21 to 25) are categorised as Revenue Expenditure of the defence budget. Revenue Expenditure includes expenditure on pay and allowances, transportation, revenue stores like ordnance stores, revenue works, expenditure on petroleum, oil, lubricants (POL), etc.

Requirements for Capital Expenditure are contained in the Capital Outlay (Demand No. 26), which caters to the requirements of capital expenditure of all the Services, ordnance factories, Research and Development (R&D) organisation. It includes expenditure on land, construction works, plants and machinery, equipments, tanks, naval vessels, aircraft and aeroengines, dockyards, etc.

The defence budget is formulated on the basis of the structure mentioned above, making it a totally input oriented budget. Control of expenditure is the main theme of defence budgeting in India, for which an input oriented budget is well suited.

The fundamental rule on which the system of budgetary control may be said to rest is that no item of public expenditure may be incurred, unless provisions exist to meet it in the sanctioned BE of the year concerned. This rule applies to the nature of expenditure as well as the amount.

While analysing various points made by the Standing Committee on Defence while scrutinising defence budgets year after year, it may be worthwhile to look into the perspectives from which the defence budget, as it stands, can be analysed.

The key ingredients of the defence budget can be looked at from the "requirements" as projected by the three Services, going into their reasonableness .

But it can take us only up to a point, for in the final stage of the budgetary process, as per the laid down procedure, there is a "ceiling" which is imposed by the MoF.

Control of expenditure is the main theme of defence budgeting in India, for which an input oriented budget is well suited.

Secondly, the "requirements" are projected by the Services on the basis of their respective Perspective Plans and Annual Plans, which are not open to scrutiny. So, for the reasonableness of the "requirements" which form the basis of their respective budget projections, one has to depend to a large extent on the analyses and judgement of the Services which have their financial planning wing and control mechanism.

There is another approach towards scrutiny of the defence budget from the "cost" angle i.e .by treating it as composed of various *costs* that the defence Services have to incur or the *prices* they have to pay, from their respective budgets, to maintain the forces and supporting staff, to achieve an acceptable level of defence preparedness and build up necessary capability.

The basic ingredients of the defence budget , from this point of view, are the *costs* which are to be incurred to meet the *requirements,* and many requirements cannot be met because the costs of other items exhaust the total budgetary resources made available to a Service. Prioritisation is the only answer, but that keeps many requirements unsatisfied.

Thus, the defence budget of India can be scrutinised from two perspectives: from the perspective of requirements and from the perspective of costs. One could also add another perspective, that is, requirements, keeping in view the costs. That would mean the introduction of the programme concept in defence budgeting which would enable both requirements and costs to be seen in the context of specific programmes. That would mean introducing an output orientation in defence budgeting.

But since our defence budget, as explained above, is an input oriented budget and is not formulated in terms of programmes, it is difficult to analyse the budget as at present, simultaneously from the requirement and cost point

Since our defence budget is an input oriented budget and is not formulated in terms of programmes, it is difficult to analyse the budget as at present, simultaneously from the requirement and cost point of view.

of view, nor is it possible to link the budget to the end objectives of defence spending.

Accepting the present limitation from an analytical point of view of an input oriented budget, the main aim while scrutinising the defence budget from the "cost" point of view is that these costs, which are the ingredients of the defence budget, are not more than what is reasonable and should be reflective of good management practices. Cost consciousness should prevail all along the line so that costs borne by the defence budget in carrying out various defence related activities are not more than what is fair and reasonable.

Some of these costs are controllable and some are not. The manpower costs, infrastructure costs, inventory costs and many other costs are controllable by adopting proper manpower policies and good management practices.

Costs, as reflected in the budget, are to be looked into with a view to economise on them without reducing efficiency, so that public money is not wasted and we get cost-effective defence.

The aim, for example, should be to eliminate inefficiencies in support processes and to ensure that the quality of maintenance does not suffer. Cost effectiveness in support areas also helps in better allocation of resources to maximise military capability available to the front line.

It should be the endeavour of any critical scrutiny of the process of defence budgeting to see whether, among other things, it ensures that the front line receives the logistic support needed within the framework that provides the best balance between operational effectiveness and efficiency. Over-enthusiastic effort to cut down the maintenance expenditure to increase the allocation for capital acquisition should not lead to reduction in operational efficiency and impairing readiness.

In defence budgetary literature in India, most of the costs are often treated as "obligatory," for which it is held that budgetary provisions, in any case,

are to be made. These are treated as policy related costs, determined by the "*strength and composition of Armed Forces maintained for the defence of the country.*"[2]

Defence planning and linking it with budgeting is not a luxury, but a necessity for evolving an affordable and effective defence.

But these costs are also controllable through a periodic review of force structure which should be both strategy driven and resource driven.

Some of the infrastructure costs are controllable in the medium term, by taking effective measures from now on so that future defence budgets are less burdened by these costs. For this, a longer term view regarding cost control is necessary.

This also underlines the need for both medium and long-term planning and linking defence budgeting with it, so that savings can be generated for modernisation efforts. Defence planning and linking it with budgeting is, therefore, not a luxury, but a necessity for evolving an affordable and effective defence. Planning should be regarded as a necessary ingredient of defence, which has often been emphasised by the Standing Committees by expressing their anxiety in timely approval of Defence Plans.

As would be seen from the discussion which follows, of the general approach adopted by India's Parliamentary Committee on Defence (Standing Committee) on the Defence Budget that they have looked into mainly into the cost aspects in the first few years of their scrutiny of the defence budget, as the general environment for public finance was of expenditure control and economy in expenditure. In the subsequent years, however, with easing of financial stringency and higher rate of economic growth, they have looked into the requirements aspects more intensively.

As per the first report on the Demands for Grants 1993-94, the scrutiny of the demands was conducted on the basis of the following information:

- policy/programmes/activities brought out by the Ministry of Defence (MoD) in the Annual Report;

2. Defence Services Estimates, 2008-2009. Procedure followed in regard to budgetary control over defence expenditure, Appendix C, Para 3.

- past commitments carried over in the current year i.e. 1993-94
- anticipated liabilities for the current year; and
- increase over previous year's estimates.

The above documents were consulted by the Committee while scrutinising the demands for grants for subsequent years also. This reflected the concern regarding the "requirement" aspects of the defence budget.

In the first two years of its review of the Demands for Grants for the Ministry of Defence, the Standing Committee, went into the aspect of "reasonableness" of the increase sought in the Revised Estimates of the previous year's budget as also that for the budget of the current year over the Revised Estimates. It went into the reasons for the increases, and found the increases given as reasonable and modest.

The Committee also looked into allocations which had been provided for modernisation schemes in the budget of 1993-94 in both the Capital and Revenue accounts. It was noted that the term "modernisation" was not a classification for budgetary purposes. The Committee were informed that the budgetary constraints had an impact on the modernisation programmes.

The Committee came to the conclusion, keeping in view the overall constraint in resources, that the best way to generate funds for modernisation of the armed forces was through generating internal savings by taking well considered economy measures.

The Committee took particular interest in various measures of economy being undertaken by the Services and the Ministry. It gave special emphasis to these in its reports on the defence budgets of 1993-94 and 1995-96. Apparently, it succeeded in conveying an effective message to the Ministry of Defence and armed forces to manage defence expenditure in a cost-effective way.

The Standing Committee referred to the earlier recommendations of the Committee on Defence Expenditure (CDE) set up in June 1990 regarding achieving economies in specific areas of defence expenditure. In response , the Ministry of Defence explained that action had already been taken to reduce expenditure relating to manpower, petrol, oil, transportation, inventory management, etc. The Standing Committee expressed the hope

that the economies will be suitably reflected in the Demands for Grants of the future years.

The Committee also went into the specific details relating to the economy measures initiated by the Services. In response, the Ministry explained that in the Army, savings were achieved through reduction in the authorisation of equipment, one-time reduction in the inventory in the Army Ordnance Corps, reduction of land norms, introduction of fuel efficient vehicles, introduction of transportation model, etc. These had resulted in a saving of about Rs. 1,000 crore per annum. These savings were envisaged in the budget and had been observed in practice. Similarly, the economy measures initiated by the Navy were likely to result in an annual savings of Rs. 49.93 crore and economy measures initiated by the Indian Air Force (IAF) were to result in a saving of Rs. 67.19 crore. The Committee recommended that the measures regarding conserving of petroleum products should be undertaken by all organisations under the Ministry of Defence, more vigorously.

By emphasising that money saved by a particular Service should be available for modernisation (presumably for the same Service that effected the saving), the Committee was enunciating an important principle.

The Committee made very significant recommendations for achieving economy in the inventory of ordnance stores. Similarly, personnel requirement of the manpower for non-combat duties, the Committee felt, needed constant review for all the Services.

By emphasising that money saved by a particular Service should be available for modernisation (presumably for the same Service that effected the saving), the Committee was enunciating an important principle. It was : economy achieved by these measures by a particular Service which required efforts and sacrifice should not lead to reduction in their overall allocation of the budget, but should be redistributed to increase the allocation, say under the capital head, for expenditure on modernisation. This is an important principle. If this kind of incentive is not provided, the Services may not be enthusiastic in achieving economy in areas where it is possible.

The Standing Committee also reiterated the need for the report of the Committee on Defence Expenditure to be made public as early as possible.

The report pertaining to the Demands for Grants 1994-95 also looked into the economy aspects with a lot of attention. Some of the important steps taken and consequent savings per annum, which the Committee was informed about by the Ministry, were: (i) Rationalisation of the non-combatant manpower in the Army (Rs. 200 crore); (ii) rationalisation of authorisation of tanks per regiment (Rs. 60 crore); (iii) modernisation of inventory management and introduction of the Central Inventory Control Point System (Rs. 100 crore); (iv) off-loading of the requirements hitherto met by EME and other units of the Army to the civil market (Rs. 20 crore); (v) introduction of a new transportation model including decentralisation of the supply system (Rs. 12 crore); (vi) use of simulators for training (Rs. 300 crore); and (vii) the rationalisation of plinth area for residential accommodation for officers and men (Rs. 8 crore).

The Committee observed that measures regarding conservation of petroleum products as recommended by its first report has not led to reduction in allocation under the POL head. It noted that the Budget Estimates under these items for 1993-94 was revised at a higher figure and a still higher amount was planned to be spent in 1994-95. It was explained by the Ministry in its Action Taken Note that the increase was due to increase in the prices of POL, and in actual terms, there was no increase in consumption of POL.

The Standing Committee also reiterated the need for the report of the Committee on Defence Expenditure to be made public as early as possible.

The Committee was of the view "that a little more openness even in the matters relating to the defence will not militate against the national interest. …"[3] This is an important point for a democratic system of government. Reports dealing with the efficacy with which public money is spent and how this could be improved upon should be made public, as also measures taken

3. Report of the Standing Committee on Demands for Grants 1994-95, Para 37 of the report.

by the government to implement the recommendations, as the taxpayers should be satisfied that public money was well spent.

The Committee was concerned at the fact that there had been an increase of 10.87 percent in the Budget Estimates of 1995-96 as compared to that of 1994-95 whereas the rate of inflation during 1994-95 was 11.41 percent, allowing no increase in real terms in the defence budget, 1995-96. The Committee also noted that the Gross Capital Expenditure which was 29.45 percent in 1994-95 (RE) declined in 1995-96 (BE) to 28.84 percent, indicating a deceleration of the modernisation effort.

As per the next report, the increase in the BE for 1996-97 over the previous year's RE worked out to 3.2 percent only as against the existing rate of inflation of about 4.5 percent. In other words, there had been no increase in real terms in the defence budget for 1996-97 at all.

The Committee, in its report for 1996-97, gave a table showing how defence expenditure as a percentage of Central Government Expenditure had fallen from 17.55 percent in 1986-87 to 13.58 percent in 1996-97. It also indicated that defence expenditure as a percentage of Gross Domestic Product (GDP) had fallen from 3.58 percent in 1986-87 to 2.72 percent in 1994-95 .

Referring to the budget provision for 1997-98 which represented 20.75 percent increase over that of the previous year, the Committee observed that if the amount required for implementation of the Fifth Pay Commission was excluded, the actual budgetary hike would only be 8.5 percent over the RE 1996-97 against the existing inflation rate of about 7.8 percent "Thus, in real terms, the hike in the Defence Service estimates for 1997-98 is only notional."[4]

The inadequacy of the increase in the defence budget was again commented upon by the Committee while reviewing the Demands for Grants 1998-99 when it observed that the hike in the defence budget was just about enough to meet the outflow of the Fifth Pay Commission's recommendations and general inflation. The rupee devaluation had further eroded budget capacity. "Thus, in real terms, the provision for items other than salary in the defence

4. Report of the Standing Committee on Demands for Grants 1997-98, Para 23.

Thus, in real terms, the provision for items other than salary in the defence budget remains static, if not reduced. In terms of percentage of GDP also, the defence budget has stagnated at 2.4 percent over the last decade. This low level of funding is totally insufficient to meet crucial requirements, including modernisation of the armed forces.

budget remains static, if not reduced. In terms of percentage of GDP also, the defence budget has stagnated at 2.4 percent over the last decade. This low level of funding is totally insufficient to meet crucial requirements, including modernisation of the Armed Forces," it observed. The Committee emphasised that in the interest of the security of the country, defence spending should be raised at least to the level of 3 percent of the GDP.[5]

The same kind of comments were made while examining the Demands for Grants 1999-2000. In real terms, the hike in defence outlay for the year 1999-2000, appeared to the Committee as "notional."[6]

In a table presented in the report, it was shown that the recommendations made by the MoD for the budget were much lower than the projections made by the Services/Departments and allocations made by the MoF were still less. In effect, the amount allocated by the MoF by imposing a ceiling was about 18 percent less than the amount projected by the Services/Departments.

In scrutinising the Demands for Grants for 2001-02, a similar table was presented, which showed that the amount allocated as per ceiling made by the MoF was about 16 percent less than the amount projected by the Services/Departments.[7]

In the Action Taken Notes, the government, in their replies relating to the Committee's observations on the inadequacy of the increases in the defence budget, have all along stated that the observations had been communicated to the Ministry of Finance for their consideration and necessary action. In one of the replies, the government categorically stated, "As already brought

5. Report of the Standing Committee on Demands for Grants 1998-99, Para 24.
6. Report of the Standing Committee on Demands for Grants 1999-2000, Para 26.
7. Report of the Standing Committee on Demands for Grants 2001-02, Para 23.

to the notice of the Committee, the Ministry of Finance make final allocations for defence taking into consideration all relevant factors."[8]

The recommendations of the Standing Committee of the presentation of the budget do not result in any increase for defence allocations. As per India's system of financial administration and governance, this really should be accepted as a final point. Reiteration of this point leads to needless discussions, points and counterpoints, without any tangible result.

It is felt that discussing the adequacy or otherwise of the overall defence budget after it is finalised, is not a very productive exercise and the Committee should rather look into other aspects which relate to economy and efficiency of defence expenditure.

Therefore, it is felt that discussing the adequacy or otherwise of the overall defence budget after it is finalised, is not a very productive exercise and the Committee should rather look into other aspects which relate to economy and efficiency of defence expenditure. This point was appreciated by the Committee while scrutinising the Demands for Grants 2001-02 when it stated," The Committee is of the view that effective security cannot be had by merely presenting a bigger defence budget. It requires effective defence finance procedures which, in turn, needs an integrated defence planning organisation."[9] The reason for this observation was that an analysis of the figures showed that an amount of Rs. 4,100 crore of the allocated defence budget remained unspent during the year 2000-01. The Committee felt that the tedious and time consuming procedures that had led to delay in defence spending, particularly that relating to procurement. The Committee desired that the procedure should be streamlined. While scrutinising the Demands for Grants 2002-03, the Committee again took note of unspent funds amounting to Rs. 5,000 crore, the major portion of which related to capital expenditure. This story of surrender of funds from the allotted budget, year after year, has been a recurring one.

8. Report of Standing Committee 1998-99, Action taken on recommendations on Demands for Grants, MoD 1997-98, p.7.
9. Report of the Standing Committee on Demands for Grants 2001-02, Para 27.

This story of surrender of funds from the allotted budget, year after year, has been a recurring one.

The Committee in its report on the Demands for Grants 2004-05 noted that the Budget Estimates for the defence Services for the year 2004-05 showed an increase of 17.92 percent over the Budget Estimates of the year 2003-04 and an increase of 27.69 percent over the Revised Estimates for the year 2003-04. The increase was mainly in capital expenditure (Para 30 of the Report on Demands for Grants for 2004-05). Notwithstanding the higher allocation, the Committee noted that the MoD might have to seek additional funds from the MoF because almost the entire amount allocated for capital expenditure would be spent on committed liabilities. The Committee suggested that the MoD might approach the MoF after reassessing the situation.[10]

The Committee also noted that during the previous five years i.e. from 1999-2000 to 2003-04, substantial funds amounting to Rs. 32,740.26 crore for capital expenditure has lapsed due to non-fructification of modernisation schemes. In their earlier reports, they had recommended creation of a Defence Modernisation Fund (DMF). The Committee noted that the MoF had in principle agreed to the creation of the DMF ,which would be available for utilisation during the next three years and that the then Finance Minister, while presenting the Interim Budget, 2004-05, announced the setting up of a non-lapsable Defence Modernisation Fund with a corpus of Rs. 25,000 crore. The Committee was , however, surprised to note that no allocation was made for this fund in the General Budget 2004-05 and was dismayed at the policy reversal.[11]

In the report on the Demands for Grants for 2006-07, a table has been furnished indicating provisions in the Budget Estimates, Revised Estimates, Actuals and Shortfall. The figures shown in the table indicated that there was reduction of allocation from BE to RE and from RE to actual since 2000-01, except in the year 2004-05. These again indicated shortfall/under-utilisation of budgetary allocations. What bothered the Committee was reduction of

10. Report of the Standing Committee on Demands for Grants, 2004-05, Paras 31 and 33.
11. Report of Standing Committee on Demands for Grants, 2004-05, Paras 40 to 43, pp.19-20.

the amounts allocated at the RE stage compared to BE provisions. It was stated by the Ministry of Defence that the Ministry of Finance reduced the amount at the RE stage based on the progress of expenditure and their assessment of requirements of funds during the remaining part of the financial year.

During the course of the mid-year review, it was found that the capital expenditure of the MoD was much below the amount provided in the budget.

The MoF also stated that in all these years, during the course of the mid-year review, it was found that the capital expenditure of the MoD was much below the amount provided in the budget. The Revised Estimate was arrived at keeping the pace of expenditure and absorptive capacity of the MoD in the next two months in view. The MoD indicated that streamlining the acquisition procedures through the procurement manual would help reduce the time between various stages of acquisition proceedings. The Committee was not satisfied with the explanation. To quote, "Expressing strong displeasure, the Committee feel that there is a need for better financial planning and management in the Ministry of Defence."[12]

The Committee, as mentioned above, in its earlier reports had recommended creation of a non-lapsable DMF to ensure timely availability of funds for acquisition of defence equipment.

It was brought out by the MoF, that it would not help matters as parliamentary approval would be required for utilising the money from the fund. But the Standing Committee reiterated its recommendation regarding creation of the DMF for better budgetary management of defence procurement.

But the position taken by the MoF has been that as adequate funds were made available in the beginning of each financial year for meeting the requirements of capital expenditure, there appeared "to be no need for sequestering scarce public resources in a Fund."[13]

12. Report of the Standing Committee on Demands for Grants, 2006-07, Para 1.43.
13. Report of the Standing Committee on Demands for Grants, 2006-07, Para 1.58 and Demands for Grants, 2008-09, Para 2.33, p.16.

The Committee has all along emphasised in its reports the need for achieving self-reliance in defence acquisitions.

The attention of the Committee while examining the Demands for Grants for 2008-09 was focussed on "Curbing of Wasteful Expenditure." The Committee's attention was drawn to various studies that have been undertaken by the Services "in-house" and by the Integrated Defence Staff (IDS) to identify wasteful expenditure. Reference was also made to findings of the IDS that (1) optimisation of defence resources could be achieved, for example, by amalgamation of assets in several areas through promotion of tri-Service institutes; (2) by a pragmatic review of reserve levels which fall in the realm of over-assurance; (3) effective exploitation of the Information Technology (IT) revolution backed up by a sound networking system and in other ways.

The Committee has all along emphasised in its reports the need for achieving self-reliance in defence acquisitions and in this context, recommended a higher percentage of allocation of the budget to defence R&D which was about 4.5 percent of the defence budget in 1994-95, so that R&D programmes are completed on schedule. Its reports also drew attention to the Ten-Year-Self-Reliance Plan to achieve a self-reliance index of 0.7 percent.

Following the Standing Committee's recommendations, the percentage of allocation of defence R&D is now higher at 6 percent of the defence budget.

For better management of the defence budget, the Committee had desired that the 9th Defence Plan for the period 1997-2002 be finalised on time. It also wanted that a firm commitment be made by the government for allocation of resources for five years rather than year to year.

In the Action Taken Note submitted in 1998, the Ministry of Defence had said that the 9th Defence Plan was approved by the Cabinet Committee on Security in December 1997 for which a firm commitment of funds for five years was given.

In fact, this became possible because of the combined efforts made by MoD, Minister of Finance, Service Chiefs, the Cabinet and the then Principal Secretary to the Prime Minister. The yearly budgetary allocations made

from 1997-98 to 2001 to 2002 to defence i.e. in the 9th Plan period and the expenditure made, broadly conformed to the figures originally approved in the beginning of the Plan period.

A well formulated Defence Plan can get approved in time only when concerted efforts are made at the higher level of decision-making in the government.

But this could not be repeated for the 10th Defence Plan (2002-2007), in spite of the concern shown by the Standing Committee in several of its reports. The same problem continues for the 11th Plan. It only shows that a well formulated Defence Plan can get approved in time only when concerted efforts are made at the higher level of decision making in the government, though Standing Committees could help by repeatedly referring to its need, in their reports.

Although legally and technically, the recommendations of the Standing Committees are not binding, the government generally accepts most of them. For example, in its report on the Demands for Grants 2008-09, in the very first chapter, a reference is made to the Action Taken Report on the recommendations relating to the Demands for Grants 2007-08. It contained 76 observations/recommendations of which 57 were accepted. For reasons put forth by the government, in respect of 10 recommendations, the Committee did not wish to pursue Action Taken replies. One of the recommendations referred to allotment of 3 percent of the GDP for the defence budget, another related to a separate Pay Commission for the armed forces. In the case of four recommendations, it did not accept the replies of the government, one of which related to the need for increasing the budgetary allocation to the Navy. In five cases, the replies of the government were awaited.

One should not forget the limits within which the Parliamentary Committees are required to function. They have to function as per the rules of procedures. The Standing Committee can express its views and make recommendations in the form of a report, but it does not fall within its purview to direct any authority or government to do or not to do any particular act or do it in a certain way. Its main function would be to influence the government for taking such action which it considers desirable.

The Standing Committee, through its reports, has succeeded in putting defence budgeting in the proper perspective.

The Standing Committee, through its reports, has succeeded in putting defence budgeting in the proper perspective. Today, through the medium of its published reports, there is a wealth of information in the public domain about defence budgeting process, trends in budgetary allocation and various considerations which go into defence budgeting. By inviting representatives of the Finance Ministry in its deliberations and asking them to put their point of view before the Committee regarding budgetary allocations, alternative points of view and putting them on record, the reports have succeeded in making the analysts, decision-makers and the public aware of various issues that are relevant in defence budget making and managing.

The Standing Committees on Defence have gradually expanded the scope of examination of defence related activities to gain better insight into defence expenditure management. They have furnished reports on Defence Public Sector Undertakings, Defence Research and Development—Major Projects, Welfare of Servicemen and Ex-Servicemen, Upgradation and Modernisation of Naval Fleet, Manpower Planning and Management Policy in Defence.

The report rendered in 2001 pertaining to Manpower Planning is of particular importance as 35 percent of defence expenditure is manpower related. The Committee noted that the Army had formulated a plan for effecting under-posting of 50,000 soldiers over a period of financial years till 31.3.1999, covering all types of units and formations. The basic aim was to cut down on manpower cost so as to release resources for more investment in higher technology weaponry. The Committee wanted it to be done in a time-bound manner. [14]

The Committee also expressed its unhappiness about the deficiencies in the cadre strength of officers in the Army and advised the government for taking necessary steps to fill up the vacancies. The Committee noted that

14. Twelfth Report, Standing Committee on Defence (2001) Manpower Planning and Management Policy in Defence, Para 13.

about 50,000 Service personnel who constitute a rich source of trained and disciplined manpower, retired or were released from active service every year. The Committee recommended that more ex-armed forces personnel should be retrained and absorbed in the paramilitary forces.[15]

In this connection, it supported the recommendation of the Fifth Pay Commission's regarding engagement of one-third of the annual intake into the combat and combat support arms of the Army Personnel Below Officer Rank (PBOR) on a shorter term of seven years, with the provision of their remustering into the other supporting arms and services within the Army. The Committee did not understand the reasons for the government not considering favourably any proposal to reduce the colour service. Reduction in colour service would reduce the pension bill of the Service personnel.[16]

The Committee also stressed the need for improving the "teeth to tail" ratio to reduce manpower cost by economising on support staff in the Army.[17] Eminent experts from outside were also invited to present their point of view in this respect. One expert commented that the manning strength in the IAF in certain activities was more than the standard adopted abroad for similar activities. These affected the teeth to tail ratio in the IAF.[18]

The Committee, in this context, reviewed the functioning of the Standing Establishment Committees of the three Services which are the expert bodies to examine the staffing strength of various units, with a view to optimise the manpower strength. The Committee expressed unhappiness on the functioning of the one of the Standing Establishment Committee.

By giving a very detailed report on manpower planning in defence, the Committee not only provided very useful information relating to manpower in the Army, Navy and Air Force but also put the issues in proper perspective to enable defence analysts and decision-makers to arrive at the correct conclusions.

The reports of the Standing Committee on Defence have been a great help in focussing attention on important aspects of defence budgeting, on the

15. Ibid., Para 40.
16. Ibid., Para 42.
17. Ibid., Para 88 to 90.
18. Ibid., Para 98.

The problem facing defence budgeting from the late Nineties onwards has been, paradoxically, the inability to spend the allotted amounts, particularly under the capital outlay account.

necessity for cost control and curbing of wasteful expenditure, as also the need for early approval of Defence Plans so that money for defence is spent efficiently for achieving the strategic objectives in a cost-effective way.

Control of defence expenditure is, no doubt, a very important aspect of defence budgeting. But the problem facing defence budgeting from the late Nineties onwards has been, paradoxically, the inability to spend the allotted amounts, particularly under the capital outlay account.

In every report of the Standing Committee in recent years , both the unfulfilled requirements for various schemes and projects of the Services and the extent of surrender of budgetary allotments have been brought out. The Finance Ministry has also been frequently criticised for allotting less than the projected amounts in the Plan and for the annual budget, as also for reduction of the budget at the RE stage.

One wonders, however, what the surrenders would have been like from the budgetary provisions, if the projected amounts had been allotted.

The phenomenon of surrendering funds has become more pronounced since 2000-01. Since then, every year, barring 2004-05, substantial funds have been surrendered at the RE stage and at the end of the financial year, in spite of all the efforts made to spend the allotted amounts by frequent monitoring of expenditure. Up to 2008-09, upwards of Rs. 40,000 crore have been surrendered in this way, because of inability to spend the allotted amount.

The Standing Committee in its several reports has criticised this aspect of defence budgeting and attributed it basically to bad financial management and cumbersome procurement procedure.

The Committee's repeated insistence for the creation of the Defence Modernisation Fund (DMF) emanates from this phenomenon of surrender of

funds under the capital head year after year, though there is huge requirement of funds for modernisation.

The MoF has not agreed to the DMF (as per their deposition before the Standing Committee) because, they say :

- funds have never been denied to defence whenever a scheme has matured for implementation and provision for a supplementary budget is always there;
- every year, the Ministry of Defence has surrendered funds at the RE stage, because of inability to spend the allotted amount on the basis of trends of expenditure;
- even if the DMF is created, for drawing money from it , supplementary budgets would have to be prepared as Parliament's approval has to be there; therefore, there is hardly any benefit.

For these reasons, the MoF feels that there is no necessity to keep aside so much funds for future spending in defence, as there are many competing demands for other activities for which funds are required now. In other words, if money cannot be spent, it should be surrendered.

It is not the question only of somehow spending the allotted amounts by any means, but also securing efficiency in spending the amounts. The Standing Committee itself, in its reports, has drawn attention to wastages and the need for economy and efficiency in defence spending so that more money can be spared for modernisation. This kind of economy cannot be brought about by ad hoc measures, as these economies have be enduring ones. So control of expenditure has to be emphasised but the "control" has to be defined in a wider context of achieving planned targets within the resources made available.

Economy in defence expenditure should always be the desired goal of expenditure management. But it cannot be achieved by ad hoc measures.

Effective measures for achieving economy in defence spending have to be properly planned for on the basis of specific studies. It takes time to fructify, as it may involve restructuring of support areas, introducing economical models

Expenditure prioritisation is about choices between alternative policies and the fiscal impact of specific policy choices on future budgets.

of logistic support and even closure of establishments which have lost their utility, and achieving economy in manpower by rationalisation of activities . Achieving this kind of economy requires multi-year focus, with performance measures and clear targets for achieving savings for each year .

Then there is the basic issue of prioritisation of expenditure among competing programmes because of scarcity of resources. We often mention its need without realising that the annual budgetary exercise is hardly conducive to a prioritisation exercise, as it provides for all on-going activities and existing commitments in a routine manner, as the reports of the Standing Committee show.

Expenditure prioritisation is about choices between alternative policies and the fiscal impact of specific policy choices on future budgets.. This cannot be done when attention is confined to one year of the budget, as the fiscal impact of the choice would be in the subsequent budgets. A prioritisation exercise has to be an integral part of the budgetary process.

So, for prioritisation of expenditure decisions, keeping in view the impact of present decisions on future budgets, multi-year budgeting is very essential. As Marc Robinson puts it, international experience proves that for being effective, "*expenditure prioritisation needs to be conducted as a systematic routine integrated with budgetary process"* and that "*expenditure prioritisation tends to work best when the budget is put on a multi-annual basis, either through multi-year allocations or a system of rolling forward expenditure estimates*….fiscal impact of specific policy choices can often not be measured in the prospective budget year. This point has long been recognised by performance budgeting advocates, well before the recent resurgence of interest in medium–term budgeting. The original US program budgeting system (PPBS), for example, aimed to plan expenditure over at least a five-year plan horizon."[19]

19. Marc Robinson, ed. , "Making Performance Budgeting Work," Performance Budgeting, *Linking Funds and Results* (Palgrave Macmillan, IMF, 2007), p.115.

So when we aim to introduce prioritisation in expenditure decisions which is a must in expenditure management in defence, there is an imperative necessity to introduce multi-year budgeting, for optimal allocation of resources.

Allotments of funds for capital expenditure, in both absolute and percentage terms, have gone up significantly in the defence budget in recent years.

The other very important aspect in defence budgeting in India which calls for immediate introduction of multi-year budgeting, is that allotments of funds for capital expenditure, in both absolute and percentage terms, have gone up significantly in the defence budget in recent years. The percentage in recent years has been above 40 percent which is very high by all standards. Only a decade ago, the capital budget used to be 28-29 percent of the defence budget.

Many of the projects/schemes under consideration, are 'big ticket' items where huge expenditure is involved over several years. These are all in the nature of investments for future capability building, where careful analyses of costs/benefits are involved.

These investments should not be made in a hurry, without proper cost-benefit analysis. It may be prudent in some cases to deliberately wait before taking a decision, as various alternatives are required to be assessed and new opportunities continue to arise due to rapid technological changes.

For building of capabilities under the concept of the Revolution in Military Affairs(RMA) which is getting incorporated in the doctrines of the armed forces, investments for items categorised as force-multipliers, have to take place over a period of several years, as considerable R&D activities are involved. Many of these investments are inter-linked.

Planning for such investments also underlines the *need for multi-year budgeting in defence*.

It is also to be remembered that in defence procurement cases, to ensure transparency, fairness, proper evaluation and assessment of all aspects of the proposed investment, the laid down procurement procedure has to be

There are four aspects in the defence budgeting process which need to be attended to.

followed strictly. It cannot be curtailed to fit a given time-frame. Issues arise which have to be sorted out after due deliberation. In urgent cases, a fast track procedure can always be followed but that should be the exception.

So there are four aspects in the defence budgeting process which need to be attended to:

- ensuring economy and efficiency in defence spending in a planned manner;
- prioritisation of expenditure between competing programmes;
- avoiding surrender of funds under the capital account in the defence budget;
- supporting multi-year investment planning and expenditure planning for optimum allocation of resources.

All the four aspects mentioned above lead to only to one conclusion: that is there is an urgent need for budgetary reform in defence, giving particular attention to budgetary process for optimal utilisation of resources. We have to introduce output oriented budgeting. Defence budgeting has till now avoided performance budgeting. Already, outcome budgeting has been introduced in the civil side.

We have to introduce performance budgeting, with the programme concept in defence budgeting. The programme concept is necessary so that one can meaningfully talk of output or objectives and relating output to relevant costs.

This variant of performance budgeting, we may also call *programme budgeting*.

"Programme budgeting is the performance budgeting mechanism which has had the most enduring influence."[20]

Basically, programme budgeting comprises (a) the objective-based ("programme") classification of expenditure; and (b) use of performance

20. Marc Robinson, "Performance Budgeting Models and Mechanism," in Robinson (ed.), Ibid., p.4.

information in a systematic way for taking decisions about budgetary priorities between competing programmes.

For defence, keeping in view the heavy investments in weapons and systems where investments have to be spread over a number of years, performance budgeting has to be more in the nature of Planning-Programming-Budgeting System (PPBS) which is aimed at moving "planning from the periphery to the center of budget operations"[21] rather than its simpler version, where performance budgeting is concerned only with the use *of performance measures* in the budget.

In fact, *"performance information"* that we mentioned above, goes beyond *performance measure* to include performance evaluation and cost/benefit analysis.[22] Using performance information, in this sense, makes performance budgeting indistinguishable from programme budgeting.

Without the abovementioned reforms in budgeting, the review of the defence budget by the Standing Committee is not likely to be effective and the Committee is apparently aware of this.

This point can be illustrated by reference to some of the points which have emerged in the Committee's budget review reports so far.

SHARE BETWEEN REVENUE AND CAPITAL IN DEFENCE BUDGET

While scrutinising the defence budget for 2007-08, the issue of what should be the proper allocation between revenue and capital expenditure in the defence budget, came up for lot of discussion in the deliberations of the Standing Committee.

It was brought out by the representative of the MoD that in the 8th Plan period, overall 70 percent of the budgetary allocation was for revenue spending and 30 percent was for capital expenditure. In the 9th Plan, it was 74 percent for revenue expenditure and 26 percent for capital; while in the 10th Plan period, the percentage of revenue expenditure came down to 64 percent and the percentage for capital expenditure went up to 36 percent. This showed

21. A. Schick, *Budget Innovation in the States* (Brookings Institution, 1971).
22. Robison, n.20.

The revenue spending, which goes into their budget, is very essential for ensuring the readiness level of various weapon platforms that they have.

greater emphasis on modernisation than before. In 2007-08, as per budgetary allocation, 56 percent was for revenue expenditure and 44 percent for capital expenditure.

The Defence Secretary, however, added a word of caution, saying that beyond a certain point, the revenue expenditure cannot be brought down.[23] He also added that keeping in view the inflationary trend, the amounts projected by the Services for revenue expenditure in the 11th Plan period might be inadequate. "The revenue spending, which goes into their budget, is very essential for ensuring the readiness level of various weapon platforms that they have. If they have to maintain70, 80 or 85 percent level of serviceability, all those spares are needed. All the ammunition gets funded through the revenue budget. *So, if we have to have enough ammunition to fire from various types of weapons that we have, revenue spending has to remain at a reasonable level."*[24]

The Committee stated, " During evidence , the representative of the Ministry of Defence also admitted that beyond a point, revenue expenditure cannot be curtailed as that may hamper defence preparedness and the allocation for revenue expenditure for the year 2007-08 is inadequate." The Committee also felt that "due precaution should be taken in the matter so as not to adversely affect the defence preparedness of the country."[25]

These depositions raise several points. What is the "reasonable level" of allocation for revenue expenditure in the defence budget? What is the point below which revenue expenditure cannot be allowed to fall, so that defence preparedness is not affected? As is evident from the deposition of the Defence Secretary before the Committee, he was apprehensive that projections made by the Services for revenue expenditure for the 11th Plan were inadequate, indicating that probably more emphasis was being given on allocation

23. Report of the Standing Committee on Demands for Grants 2007-08 para 2.31.
24. Ibid., Para 2.35.
25. Ibid., Para 2.36.

for the capital budget. The same predilection can be there while projecting requirements for the annual budget. In any case, allocation of 44 percent for the capital budget is unsustainable. It could lead to a situation , as in the past, where weapon systems would be acquired but there may not be enough resources to operationalise or maintain them

Mere division of the defence budget into revenue and capital expenditure may be all right for voting purposes, but hardly adequate for rational allocation of resources in defence.

Secondly, the Committee itself noted that the bulk of the expenditure of the Army was on the revenue account and "*there is a huge gap between the revenue expenditure and capital expenditure of the Army, due to different kind of requirement and work performed by it. The Committee endorse the views of the Ministry of Defence that revenue expenditure cannot be curtailed beyond a certain point and that any reduction in revenue expenditure should not be at the expense of the Army's readiness/preparedness.*"[26]

The Committee also expressed its concern about "the declining trend in the share of the Army in the defence budget, which was 57 percent in the year 2002-03 and has now come down to 47 percent in the current year."[27]

So, what it makes clear is that behind the issue of allotment of the defence budget between the revenue and capital budget, there is a much bigger issue of the respective roles of the three Services and the tasks they have to perform in ensuring the security of the country.

There is now, of course, the concept of jointness and the doctrine is evolving in this direction. This puts emphasis on mission and task orientation in resource allocation decisions, rather than on Service-wise allocation, though that issue cannot be avoided in taking a macro view of the matter on the basis of technological changes and new concepts of warfare.

In fact, mere division of the defence budget into revenue and capital expenditure may be all right for voting purposes, but hardly adequate for

26. Report of the Standing Committee on Demands for Grants, 2007-08, Para 4.10, pp. 40-41.
27. Ibid., Para 4.8.

rational allocation of resources in defence; in fact, it is a means of hiding the real issues.

For rational allocation of resources, we have to introduce programme budgeting, in which all elements of cost would be included in a programme for achieving an approved mission. Whether the allocation for the revenue expenditure is adequate or not has to be ascertained programme by programme and on the basis of its specific requirements. To quote Charles Hitch who was the main architect in introducing programme budgeting in US defence under Robert McNamara, indicating the importance of allocating for operating expenses which is catered for what is categorised as revenue expenditure in our budget, "The operating costs are the annual operating costs required to man, operate, and maintain the capability. Quite often, the cost of operating a system over its expected life is more important than investment costs. For example, it costs as much to operate and maintain an infantry division for one year as it does to equip it in the first place. Thus, operating costs can be crucial to the initial management decision to produce and deploy one weapon system as compared with another."[28]

It is not enough to equate the capital budget with modernisation; we must know what the modernisation is composed of, and how it is helping in building capability for meeting the emerging threats, in other words, what is the output of the defence budget, keeping in view both the revenue and capital expenditure.

Only programme budgeting can help in relating resources "inputs"—manpower, material and installations—together with their costs, to military "outputs"—strategic retaliatory forces, general power forces, airlift capabilities, air defence capabilities, surveillance capabilities, protection of maritime interests, etc—which cannot be done by merely distinguishing between revenue and capital expenditure.

OUTCOME BUDGET: HOW TO MOVE TOWARDS IT

In its report on the Demands for Grants 2008-09, the Committee showed

28. Quoted by William W. Kaufmann in *McNamara Strategy* (Harper and Row, 1964), p.176.

its interest in the formulation of an "Outcome Budget" in defence. In this context, it stated, "The Committee desired from the Ministry of Defence, brief particulars of all major schemes/ projects under implementation and project- wise achievement against the targets (both physical and financial) during last two years in the Ministry of Defence. The Ministry of Defence have not furnished any information thereon." [29]

There is nothing in the nature of the functioning of defence or in the nature of defence expenditure to prevent it from introducing output budgeting which will help in assessing the outcome.

If the aim is to examine the outcome, going through the schemes and projects may not be very illuminating, unless one is able to link them with the budgetary allocations, on the one hand, and the objectives they are supposed to serve, on the other. Outcome can be assessed only in relation to the programme, of which the scheme/project under review, is a part.

Output budgeting is the basic step towards outcome budgeting, for which we require a well-conceived programme structure, keeping end objectives in view as also the decision-making mechanism at the apex level for major resource allocation decisions.

Incidentally, the Ministry of Defence is one of those Departments/Ministries that have been exempted from presentation of an Outcome Budget by the MoF. However, even those that have been exempted, have been requested by the MoF to carry out this exercise for internal use and voluntarily decide to place it in the public domain , fully or partially. The desire of the Committee was indicated in this background.

The Defence Secretary clarified during the evidence that the Ministry was trying to develop an infrastructure for this exercise. He also stated, "In the Ministry of Defence, because of the nature of its functioning and the nature of expenditure, we could not produce the outcome budget. But if you feel it should be submitted, we will try to do it for certain areas."[30]

29. Report of the Standing Committee on Demands for Grants 2008-09, Para 2.40.
30. Ibid., Para 2.43.

There is nothing in the nature of the functioning of defence or in the nature of defence expenditure to prevent it from introducing output budgeting which will help in assessing the outcome. In fact, programme budgeting, which is the other name for output budgeting , was first introduced in the Department of Defence in the USA in 1962 and on its overwhelming success there, it was introduced in the rest of the federal government in 1965 which is referred to as PPB. The basic aim of PPB was to establish a firm linkage between programme planning and budgeting. Without such a linkage, planners can easily lose touch with the constraints imposed by scarce resources, while budgeters can easily be divorced from the contents of plans and programmes.

It was not just as a budgeting technique—it was an aid to higher management decisions. The basic aim was, as McNamara put it, "We must ensure that the Army is balanced to the Air Force, that the Navy is balanced to the requirements of the Army, that the financial budget is balanced to the military force structure required as a foundation for our foreign policy.

"It is this type of decisions that come up to my level, and until we translate this basic policy into a *balanced force structure*, I know of no other way to follow."[31] The method which McNamara adopted in assisting him in making these decisions was the planning-programming-budgeting system.

In this context, it is worth recalling that the Group of Ministers on Security Management in their report in 2001 had recommended that steps to be taken toward programme-based budgeting in defence.

The Task Force on Management of Defence (set up by the Group of Ministers) constituted a Study Group on Budgetary Reform in August 2001 to overcome the deficiencies in the existing input-based budgeting.

Among the terms of reference of the Study Group was expansion of classification of expenditure to promote programme budgeting. The Study Group made recommendations in this regard to enable introduction of programme budgeting .

But programme budgeting involves facets other than detailed classification of expenditure. The basic building block of this system is classification of

31. Quoted by Kaufmann, n.28, p.172.

expenditure into programmes i.e. objective oriented classification so that activities with common objectives are considered together, where the objective of each programme is explicitly defined. Therefore, it requires a well conceived framework of programmes/sub-programmes/activities to facilitate allocation of resources keeping in view the intended output.

With the introduction of programme budgeting, the introduction of multi-year budgeting becomes necessary.

The primary objective of programme budgeting was improved allocative efficiency and better expenditure prioritisation. To achieve this it requires (a) a decision-making structure in the MoD to decide about priorities in the allocation of resources among programmes, as also reallocation on the basis of evaluation of ongoing programmes and strategic considerations ; (b) a longer time-frame for budgeting than what the annual budget provides as costs and benefits are to be considered in a longer time-frame; and (c) introduction of system analysis for evaluation of alternatives before deciding upon a programme from the cost-effectiveness point of view.

All three elements are essential for the introduction of programme budgeting in defence. So mere introduction of more classification heads of expenditure would not do. In any case, the starting point is introduction of an objective oriented programme structure.

Why do we require a longer time-frame for budgeting under this concept? As McNamara, testifying in 1962, explaining the reasons for a longer time horizon stated, "Sound choices of major weapon systems in relation to military tasks and missions have become the key decisions around which much else of the defense program revolves. But the full cost implications of these decisions cannot be ascertained unless both the programs and their cost are projected over a period of years, ideally over the entire life cycle of the weapon system. Since such a long-term projections are very difficult to make with any degree of accuracy, we have fixed on a 5-year period…"[32]

32. Ibid., p.175.

This requirement puts the need for multi-year budgeting in defence in the proper perspective. With the introduction of programme budgeting, the introduction of multi-year budgeting becomes necessary.

The Study Group that set up the Task Force on the Management of Defence did not recommend introduction of multi-year budgeting as it was not in its terms of reference.

It, however, recommended introduction of Vol II of the Defence Services Estimates (DSE) to show where money is allocated, on what it is spent and by whom.

The DSE Vol II was introduced in 2002-03. While it was the right step, it did not show programme/activity-wise allocation; as such, a framework is still to evolve. But the principle that we have to focus on, in activities and outputs in defence, has been accepted by the introduction of DSE Vol II, whatever be its present limitations.

It also resuscitated the concept of Budget Centres, which was introduced in the early Nineties in defence for better management of resources. The concept was supposed to introduce planning, programming, evaluation and accountability in defence expenditure management . This concept is important as it led to substantial delegation of financial powers to Service Headquarters and subordinate formations. In view these earlier initiatives which involved the introduction of Authority and Responsibility Centres, Accountability Centres, Budget Holders and substantial delegation of powers, the basic structure exists to introduce performance budgeting in defence. What is required is introduction of the programme concept for resource allocation decisions, multi-year budgeting and a higher level institutional mechanism for setting objectives and taking resource allocation decisions keeping in view the objectives.

Outputs in government are services, that is, these are service outputs. Service outputs consist of a bundle of activities for which resources are to be allocated. These constituent activities cannot be considered as outputs in their own right because only when they are combined with other activities that an intended outcome can be potentially achieved. This important distinction has to be kept in view.

Introduction of the concept of capability planning enables easier introduction of the concept of outcome budgeting, as is evident from its fairly successful use in Australian defence budgeting.

Introduction of the concept of capability planning enables easier introduction of the concept of outcome budgeting.

Input budgeting has hardly any utility in achieving efficiency and effectiveness in defence expenditure management. It cannot even achieve economy in the real sense of the term, as it is formulated on an incremental basis, without conscious resource allocation decisions.

By properly implementing the Budget Holder and Budget Centre concepts which were introduced in the mid-Nineties in defence for better budgetary management in support of the concept known as the New Management Strategy, it is possible to easily introduce performance orientation in the defence budget.

This is because substantial delegation of powers has been made for implementing the concept of Authority and Responsibility Centres which were introduced as part of the New Management Strategy.

Keeping in view the hierarchical mode of functioning in defence, the concept of Top Level Budget Holder should also be introduced to facilitate introduction of performance budgeting in defence.

The Standing Committee, while reviewing the defence budget, may like to enquire about implementation of the ideas contained in the New Management Strategy or New Financial Strategy as it was called in the Army, and to what extent performance budgeting has been or is being introduced in the context of large delegation of powers for implementing the concepts of authority, responsibility and accountability. It should be remembered that these concepts emanated from Service Headquarters, precisely because they became aware of the limitations of the existing input oriented budgeting and wanted to give defence budget an output orientation by bringing in the concepts of authority and responsibility.

Therefore, with a decade and a half long pioneering background of implementation of these concepts in the defence budget (which were not

The Committee noted that there has been no thorough review of the structural set-up of the armed forces since independence, especially of the Army.

thought of in the civil Ministries/Departments), which have also been formally introduced in Vol II of the DSE, with performance budgeting and outcome budgeting being adopted in the civil Ministries/Departments, there is no reason why performance budgeting should not be introduced in defence without delay.

The review of input-based defence budgets, as at present, cannot reveal much, as it is designed only for control of expenditure. The control aspect has lost much of its relevance with the inability to spend the allotted amounts year after year.

What is worthwhile to concentrate upon is what is the 'output' of this massive expenditure, for which a programme-based budget is essential, both for rational decision-making in resource allocation as also for review of the defence budget by the Standing Committee of the Parliament.

DEFENCE BUDGETING IN A STRATEGIC FRAMEWORK

We have noted above that under the existing budgeting system, much of the allocations in the defence budget are treated as "obligatory" in nature, which is determined by the "strength and composition" of the armed forces. Most of the defence expenditure falls in this category, being policy driven expenditure, for which allocations have to be automatically made in the defence budget every year.

From time to time, however, restructuring of the armed forces may be required for strategic reasons. Being aware of this fact, the Standing Committee made the following observation while scrutinising the Demands for Grants for Defence, 2006-07, "The Committee are aware of the *rapid technological advancements and changes taking place globally in the warfare technology and feel there is an imperative need to constitute a high level empowered Committee* to examine the entire security gamut and suggest *reforms including restructuring*

of the armed forces, as may be necessary to meet any eventuality in future."[33]

Since the 11th Plan is yet to be approved , though three years have passed, it is clear that the LTIPP would again be revised.

The Committee noted that there has been no thorough review of the structural set-up of the armed forces since independence, especially of the Army whose strength constitutes almost 90 percent of our defence forces. "The need of the hour is to optimally use the available limited resources…*The proposed Committee should be given the mandate to suggest suitable manpower restructuring by trimming the force size (teeth to tail ratio) with corresponding increase in the use of advanced and sophisticated technology in our armed forces*; review the authorisation of the peace and war establishments which are existing since the Second World War… *It is high time to effect substantial savings within the available defence budget for restructuring and modernising our forces*" (emphasis mine).[34]

Such a review would have a major impact on the resource allocation decisions and would have helped in developing the right capabilities for future conflicts. In fact, the future conflict scenario has to be clearly visualised in such a review, as force restructuring has to be done on that basis. Another benefit of such a review would have been that it would have to indicate availability of funds on a long-term basis so that capability planning could be done in a meaningful way. Further, if savings are to be generated, it would have to indicate the areas where it was to be done and what should be the extent of savings.

In the next report pertaining to the Demands for Grants 2007-08 , the issue came up in a different way in the context of drawing up the Long-Term Integrated Perspective Plan (LTIPP) 2007- 22. The earlier LTIPP 2002-17 did not get approved as the 10th Plan did not get approved and had to be revised for covering the 11th, 12th and 13th Five-Year Plans. Since the 11th Plan is yet to be approved , though three years have passed, it is clear that the LTIPP would again be revised.

33. Report of the Standing Committee on Demands for Grants 2006-07, Para 1.4, p.2.
34. Ibid.

The Ministry of Defence in a written reply indicated, "The revised LTIPP (2007-22) is being prepared following a deliberate and integrated 'Top Down' approach by articulating National Security Strategy, National Military Strategy, National Military Objectives .. and so on. Such an exercise has been undertaken for the first time and is an extremely involved process with inputs from three Services, MoD, NSA and various other agencies. The document is expected to be ready by Dec. 2009."[35]

On above basis, the Committee noted "that an integrated Perspective Plan covering three Plan periods from 11th to 13th Plan, i.e. from 2007-2022 will be approved by the Defence Acquisition Council by 31st October 2009." It is also added that this long-term plan would be different from earlier plans in that there will be a "shift from *equipment-based* approach to *capacity-based* approach."[36]

There are a few points here which add to the confusion.

The minor one is about the dates. While the document is expected to be ready by December 2009,[37] the Defence Acquisition Council is supposed to approve it by October 31. Secondly, about the sequence of events: since the LTIPP is supposed to be a strategic document following a top-down approach involving a major shift in planning procedure from an equipment-based approach to a capability-based approach, its approval has to precede the preparation of the plans. But the 11th Plan (2007-12) has already been prepared on the usual basis as in the past by taking into account *"committed liabilities, prioritised modernisation schemes, obligatory charges and maintenance requirements of the defence services and departments"*[38] *and projected to the Ministry of Finance in July 2006.*[39]

There was no indication in the deposition before the Committee whether any strategic thought had been given regarding objectives to be attained in the Plan period, the nature of conflicts for which preparation was being made,

35. Report of the Standing Committee on Demands for Grants 2007-08, Para 3.4.
36. Ibid., Para 3.5.
37. Ibid., Para 3.4.
38. Ibid., Para 3.12.
39. Ibid., Para 3.16.

the capabilities that are required to be developed in view likely threats, etc. It apparently is not derived from the LTIPP 2002-17 which was already available, which was supposed to have an articulated a strategy adopting a top-down approach. As is evident, from the way the 11th Plan is stated to be put together, it is not very different from the annual budgetary exercise in which the same inputs are taken into account. In other words, the Five-Year Plan basically boils down to five annual budgets and nothing more than that.

The Five-Year Plan basically boils down to five annual budgets and nothing more than that.

It is no wonder it is treated as such by the MoF as is evident from the following response, as indicated in the report of the Committee.

"The proposals of the Ministry of Defence were examined and the views of the Ministry of Finance were conveyed… indicating therein that it would be realistic to assume year on year increase in defence allocations in the range of 8-10 percent for the purpose of the planning exercise for the 11th Plan as against the annual average growth rate of 12.35 percent per year indicated by the Ministry of Defence." [40]

Interestingly, the reply of the MoF also refers to certain suggestions being made by it on the 11th Plan regarding *"certain operational aspects having substantial financial implications with the request that the Ministry of Defence review the same with the objective of rationalising expenditure while, at the same time, not compromising on modernisation plans."* [41]

In other words, the MoF is no longer prepared to look at the projected Plans only from the financial affordability point of view, and would be going into the operational and strategic aspects of the Plan. This provides a new challenge to the DoD, which has to go into these aspects independently, so that these aspects are gone into from a system analysis point of view, so that the MoF feels assured that all aspects of "rationalising expenditure," including from operational and strategic angles, is gone into in the MoD before finalising the plan.

40. Ibid., Para 3.16, p.35.
41. Ibid., Para 3.16, p.35.

As indicated by the MoF, the 11th Plan should be redrawn, keeping in view financial realities, and the entire effort in preparing the Plan has apparently gone waste.

In any case, as indicated by the MoF, the 11th Plan should be redrawn, keeping in view financial realities, and the entire effort in preparing the Plan has apparently gone waste. The position is not different from other Plan periods. So we are back to square one. And the LTIPP is still to be approved.

The third point is: how is the LTIPP supposed to be articulating the National Security Strategy or even for that matter National Military Strategy? Is it not a matter of political decision-making where National Security Council and Cabinet Committee on Security would deliberate, and the Indian Parliament give its approval? How can the Defence Acquisition Council give approval to such a document without first getting approval for the National Security Strategy?

The Standing Committee did not raise these issues. But what it said is also very relevant. It stated, *"The Committee are of the view in the changing paradigm of the security scenario, threat perception and fast changing scientific and technological field, the long-term plan need a regular and sustained review of its content and thrust. Therefore, the Committee wish to recommend that the long-term plan should be reviewed and updated from time to time well in advance, in order to make it realistic…"* [42]

This recommendation is in keeping with the earlier recommendation made while scrutinising the 2006-07 budget for review of the structure of the armed forces. Since the LTIPP is prepared on the basis of Perspective Plans of the three Services, this kind of proposal of restructuring cannot emanate from the LTIPP. This point will be evident from the following paragraph in the report of the Committee. Referring to the status of the revision of the Perspective Plan, the Ministry indicated, "*The process of revision has already been completed by the Navy in terms of the Maritime Capability Perspective Plan ,which covers the period 2007-22.* The other two Services are in the process of completing this exercise, updating the

42. Ibid., Para 3-7, p.31.

LTIPP from 2002-17 to 2007-22. Once these individual plans are ready, these will be integrated into one Long-Term Perspective Plan and after necessary approvals within the Ministry of Defence, it will be taken up with the Ministry of Finance for approval in principle…"[43] So much for the Top-Down approach in preparation of the LTIPP 2007-22, deriving it from National Military Strategy, etc.

From the deposition before the Committee, it seems the Navy is pushing ahead in implementing its Perspective Plan. There is stated to be a directive by the Defence Acquisition Council that the total number of ships should not fall below 140 . The Committee noted that "in pursuance of this directive, 10-year (upto 2012) ship building plan was envisaged for induction of 83 vessels of various categories…19 ships are presently under construction (excluding *Admiral Gorshkov*) and cases for acquisition of 24 new ships and 6 submarines and 11 aircraft are being processed."[44] The Committee went on to add that it *"earnestly desires that the Ministry should take effective steps in order to strictly adhere to the directives of the Defence Acquisitions Council that the total number of ships does not fall below 140 ."*[45]

The Committee also noted that there have been shortfalls in certain critical areas of the Navy like surveillance , mainly in terms of long range aircraft, and acquisition of submarines, and desired that "immediate steps should be taken to meet the above requirements of the Navy in a time- bound manner." Sufficient funds should be made available for it.[46].

Elsewhere, the Committee takes note of the manpower shortage in the Navy. "The Navy has also highlighted the shortage of manpower in critical areas. This is a matter of crucial importance." The Committee recommended that the Navy should be allowed to make additional recruitment.[47] So the mismatch between capital acquisition and manpower has started in the Navy which will adversely affect its combat capability.

43. Report of the Standing Committee on Demands for Grants, 2007-08, Para 3.2, p.30.
44. Report of the Standing Committee on Demands for Grants 2005-06, Para 4.16 pp. 49-50.
45. Ibid., Para 4.21.
46. Ibid., Para 4.18.
47. Ibid.,Para 4.20.

The Ministry of Finance have already stated that the LTIPP should be drawn up assuming an average budgetary increase between 8-10 percent per annum.

In the above context, the Ministry assured the Committee, "In order to ensure that naval preparedness is not adversely affected, the progress of the Navy's expenditure and status of ongoing/ new schemes would be constantly reviewed during the fiscal year and Plan period. *If need be ,Ministry of Finance would be approached for additional allocation of funds*"[48]

This is the issue. What are the long-term cost implications of the new force structure of the Navy as envisaged in their Perspective Plan? We have to include in it both the acquisition cost and operational cost of the *Admiral Gorshkov* and the other aircraft carrier being built indigenously, not to talk of the third one which is being recommended by the Committee .

What if the Ministry of Finance does not allot additional funds? They have already stated that the LTIPP should be drawn up assuming an average budgetary increase between 8-10 percent per annum.

If the planned naval force structure containing 140 ships with two aircraft carriers is given effect to, and other deficiencies are to be met, can it be contained within 18 percent of the defence budgetary allocation as it is at present? Or would it need to go up to higher percentage of allocation, say 21 to 22 percent of the defence budget? In that case, the percentage of allocation for which Service should go down? The Committee has also expressed its apprehension about the falling percentage share of the Army in the defence budget.

It has also strongly recommended that the government should accord highest priority to "ensure that squadron strength (of the Indian Air Force) at any time should not fall below 39.5 and strive to achieve the ideal requirement of 44 squadrons."[49]

All these requirements, given that unit cost of weapon systems is increasing at a rate approaching 10 percent or so per annum, in other words, a modern

48. Ibid, Para 4.10.
49. Report of the Standinmg Committee on Demands for Grants , 2006-07, Para 5.12, P.63.

weapons system can double in cost every seven years or so, mean a rate of increase no defence budget can be expected to match.[50]. There has, therefore, to be a trade- off, even within a Service in planning for force structure, keeping in view, very limited growth in the budget in real terms, about which the Standing Committee itself has shown concern from time to time.

The Committee has strongly recommended that the government should accord highest priority to "ensure that squadron strength (of the Indian Air Force) at any time should not fall below 39.5, and strive to achieve the ideal requirement of 44 squadrons."

With the fiscal deficit being now much higher than was contemplated in the FRBM Act, and the government's attempt to contain the deficits, the chances of substantial increase in the defence budget in future years are not very bright.

In this background, a piecemeal approach to force planning can only lead to an unbalanced force structure which will mean a less capable military than could be achieved with the resources made available. What is required is a strategic defence review by a high level empowered committee, as recommended by the Committee in its report on the Demands for Grants 2006-07, which will "examine the entire security gamut" and go into the whole issue of "restructuring of the armed forces" within the given budget, and make recommendations "to make substantial savings for restructuring and modernising our forces." [51]

Such a report, containing recommendations regarding the restructuring of forces, capability to be built, readiness and preparedness to be achieved and resources likely to be made available for the next five years, on being accepted by the government, shall become the basis for defence planning and budgeting for the next five years.

Otherwise, we may land up with an unbalanced force structure and/or inadequate balance between defence preparedness and modernisation.

50. David Karpatrick,"Is Defence Inflation Really as High as Claimed ?", *RUSI Defence Systems*, October 2008, pp. 66-71.

51. Report of the Standing Committee on Demands for Grants 2006-07, Para 1.4.

It may be mentioned that the major and medium powers of the world, have all made such strategic reviews during the last decade and half in view of the change in the conflict scenario , rapid advances in technology and the process of innovation brought about by the notion of the RMA.

For example, in the UK, the Strategic Defence Review (SDR) was conducted in 1997-98 and the report came out in July 1998. It was regarded for a long time as a model of defence planning. It aimed at bringing foreign policy and defence policy together in an affordable manner. The major organisational changes as a result of the SDR was the combination of single–Service logistics through the creation of the tri-Service Defence Logistics Organisation (DLO). Since its creation, it has sought to rationalise logistic provisions. This is how a defence review helps in achieving economy and efficiency through organisational changes. Recently, the DLO was combined with the Defence Procurement Agency (DPA) and is now collectively known as Defence Equipment and Support (DE&S), creating the largest Top Level Budget Holder in the Department. Though we have in our budgetary management partially introduced the concept of High Level Budget Holder , we are yet to introduce the concept of Budget Holder, which is essential if we want to introduce performance budgeting in defence where the objectives are set at the very top of the hierarchy and then 'cascaded' down through various levels.

Force structuring issues are addressed though these reviews on the basis of strategic guidance. The experience with these strategic reviews shows that because of limitation of resources, each Service has to accept trade-offs in force structure decisions , otherwise it would lead to an unbalanced force structure. Further, the strategic posture should keep in view the resource position.

For example, the centrepiece in terms of procurement requirements resulting from the SDR was the decision to focus on expeditionary warfare with two large aircraft carriers at the heart of the new capability.

The major casualty in the last decade as per an informed commentator has been the surface fleet of the Royal Navy. It has come down to 26 surface ships and some 16 mine hunters, much below the force level envisaged in the SDR.

This became necessary to protect the funding for the future aircraft carriers.[52] In the view of many experts, the expeditionary strategy adopted by the UK government was never affordable.

It is reported that the British government may be about to move to a system of regular reviews as in the case of the Quadrennial Defence Review (QDR, the first of which was conducted in 1997.[53]

The QDR is mandated by the US Congress. It is performed every four years. The process for the Defence Department's 2010 QDR has already started. It may have major restructuring proposals. The US Defence Secretary in April 2009 announced some major moves affecting the US Air Force in the proposed retirement of 250 tactical aircraft. The move is supposed to allow the air force to instead to buy things like modern ammunition, unmanned aircraft and other surveillance and other reconnaissance enablers. They have also decided to reduce purchase of F-22 stealth fighter to 187 as more were not affordable, and cancel a next generation bomber programme.[54].

The aim, in other words, of such reviews is to increase the combat and operational capabilities to meet the strategic requirements, within the likely available resources. This requires the trade-off between squadron strength and gaining overall combat capability.

In making these reviews, the defence planners today have to keep in view the challenges posed by RMA.

Defence planners of important military powers in Asia have acknowledged the potential of RMA, particularly Information Technology (IT) in adopting a more cost-effective force structure. RMA calls for changes in organisational structure, resource allocation, doctrine and strategy.

For the Chinese political and military leaders, RMA is regarded as the major area of great power competition that will determine China's position in the world in the next 20 years. The Chinese military has accorded IT the highest

52. Dr Jeffrey Bradford, "Contrasting Efforts: the British Strategic Defence Review and the United States Quadrennial Defense Review Processes," *RUSI Defence Systems*, October 2008, p. 83.

53. Andrew Chuter, "U.K. Preps 1st Strategic Review in 11 Years," *Defense News* , June 15, 2009.

54. *Defense Daily*, May 15, 2009, The Daily of Aerospace and Defense USA, report by Marina Malenic.

priority in its modernisation programme. Advocates of RMA in the People's Liberation Army (PLA) feel that superiority in information technology leads to superiority in combat operations. Information technology makes possible small-sized battle formations without compromising strength and outcome, if they are suitably equipped with high- tech weapons.[55] China is stated to be studying "the offensive employment of IW against foreign economic, logistics, and C4I systems…"[56]

Japan has gone in for the IT-RMA with a defensive posture in consonance with its defence policy, "The Japanese Perception of Information Technology-Revolution in Military Affairs"[57]

This bring out the point that RMA concepts would have different applications depending on the defence policy and strategy. It would be different for a country adopting an 'offensive' operation oriented policy from a country adopting RMA for defensive purposes. Countries facing different strategic conditions will choose alternate paths. As Takahashi puts it, "Unless it is strategically relevant, even highly advanced weapon systems will not support national security."[58]

Society is moving from an industrial to an information age . The defence strategists feel that military power would in future flow from information technology and strongly argue for pushing information down to tactical level and for more widely distributed operations. Advances in technology led to the concept of "network-centric warfare". Forces at tactical and operational levels can make use of it and take quick decisions in operational matters. This may call for major restructuring of forces. In the Navy, for example, network-centric operations can allow spreading the capabilities now lodged in big ships among more numerous, faster and stealthier ships.

IT has led to developing a new kind of warfare like cyber warfare. Press reports quote the UK's Security Minister's recent warning on a cyber threat

55. You Ji,"Learning and Catching Up: China's Revolution in Military Affairs,"in Emily O. Goldman and Thomas G. Mahnken, eds., *The Information Revolution in Military Affairs in Asia* (Palgrave 2004)pp.97,103.
56. Thomas G. Mahnken, in concluding article, Ibid., p.216.
57. Sugio Takahashi, in Goldman and Mahnken, eds., Ibid., p.85.
58. Ibid., p. 92.

from Al Qaeda, confirming that the UK has already faced cyber attacks from some foreign countries. The UK government has published its new Cyber Security Strategy to combat these threats.[59] Both China and Pakistan are reported to be bolstering cyber warfare capability at a rapid rate. The Indian Army, as per reports in the Press, has set up some institutions to guard against this kind of warfare.[60] But these steps may not be enough as the threat can be widespread, affecting financial markets, power grids, air traffic control and other facets of public life. Cyber warfare is yet to become an important component of India's security doctrine.

The challenge is that we have to fit in all these programmes when the allocation for the defence budget is only around 2 percent of the GDP.

Then there are space-based programmes.

The point is that, ultimately, the challenge is that we have to fit in all these programmes when the allocation for the defence budget is only around 2 percent of the GDP. The question is: how to evolve a balanced force structure which would be affordable, keeping in view what would be the strategies of adversaries? What would be the use of each of the high cost systems in the strategic environment we are placed in? What would be the defence policy that would guide the acquisitions ?

It is seen from the experience of other countries that any long-term defence capability plan is soon likely to get outdated because of the change in the security environment. The capability priorities are likely to change every few years.

The threats to national security today are emanating from many sources from state and non-state agencies. The character of the national security environment has changed totally with threats emanating from many sources, particularly terrorist threats and other threats to internal security, which are taking larger dimension in terms of national concern, than threats from external aggression. Various agencies would be engaged in the assessment

59. Report in *Business Standard,* July 5, 2009.

60. *The Times of India* News Report on May 2 ,2008.

of threats in their arena of activity, which may vary in approach and quality. What is really required is strategic planning for national security which is inclusive and deliberative in order to come up, among other things, with policy priorities for resource allocation decisions across the agencies to develop different capabilities for meeting the spectrum of threat to national security, in an integrated manner. This calls for capacity for long range planning at the highest level of the government.

For getting a true example of such an inclusive and integrated process of strategic planning, one has to go back to the initiation of "Project Solarium" in the USA under the leadership of President Eisenhower.[61] This kind of inclusive and integrative strategic planning is missing even in the USA today.

What is required today is the conducting of a National Security Review to develop a national security strategy through an inter-agency process, which may be led by the National Security Adviser to the Prime Minister to identify various capabilities required to meet the full spectrum of threats to national security. Such a review should logically precede the Defence Review suggested above.

In the above background, the Standing Committee on Defence can play an important role in influencing the decision-makers in the government through its deliberations and reports:

- in instituting a comprehensive strategic review at the national level to be followed by defence reviews at periodic intervals;
- defence reviews should be the basis of defence plans which in turn should be the basis for defence budgets;
- adopting performance budgeting on the basis of programmes; the programmes to be based on end objectives in view and should be costed on the basis of activities to be performed;
- adopting multi-year budgeting and long-term costing of ongoing programmes to ensure that ongoing programmes are affordable.

61. Michele A. Flournoy and Shawn W. Brimley, "Strategic Planning for National Security, A New Project Solarium," JFQ/ Issue 41, 2nd quarter 2006, pp.80-86.

As explained above, only when the defence budgets become programme based as also performance oriented, would it be possible to review these on the basis of their costs and benefits as also evaluate their progress on the basis of appropriate benchmarks.

Programmes with end objectives in view and criteria of performance, would be the basis for introducing output and outcome budgeting in defence. It cannot simply be done on the basis of input budgeting.

The defence budget should reflect the defence strategy and decisions of higher management regarding force structure and capability. Today's budgeting process is a totally inadequate tool for higher level decision-making for optimal allocation of resources in defence.

Therefore, immediate efforts should be made to introduce programme budgeting in defence on the basis of the framework mentioned above, reactivating the concepts of Budget Centres and Budget Holders who should be provided with indicative budgets for the next few years, with a view to plan their expenditure. The objectives to be achieved and performance parameters, however, should flow from the top, which would make it necessary to introduce the concept of Top Level Budget Holders. This concept has helped in the introduction of cost-effective expenditure management in defence in the UK.

The defence budget should reflect the defence strategy and decisions of higher management regarding force structure and capability. Today's budgeting process which is summation of the budgetary projections of the three Services and two Departments of defence, subject to imposition of a ceiling by the Ministry of Finance, is a totally inadequate tool for higher level decision-making for optimal allocation of resources in defence. The budgetary process in defence has to be streamlined to incorporate the resource allocation decisions emanating from higher management, for which there has to be required institutional support in the Ministry of Defence. As already stated, a comprehensive Defence Review should provide the basis for defence plans and annual defence budgets.

If the defence budget is formulated on the above basis, deriving from a strategic review and showing allocations on programme basis, with performance orientation, it would provide a proper basis for scrutiny by the Standing Committee as to whether it is achieving optimal allocation of resources for effectively meeting the goals and objectives of national security.

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NOTES FOR CONTRIBUTORS

Articles submitted to Air Power Journal should be original contributions and should not be under consideration for any other publication at the same time. If another version of the article is under consideration by another publication, or has been, or will be published elsewhere, authors should clearly indicate this at the time of submission.

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